GLOSSARY OF TERMS, ABREVIATIONS AND ACRONYMS

AECI	- Associated Explosives and Chemicals Industries Limited
AMTS	- Advanced Manufacturing Technology Strategy
API	- Active Pharmaceutical Ingredients
ARC	- Agricultural Research Council
Assaf	- Academy of Science of South Africa
BABS	- Bio prospecting, Access and Benefit Sharing
BEE	- Black Economic Empowerment
BERD	- Business Expenditure on R&D
BMI	- Business Monitor International
BMPs	- Bone Morphogenetic Proteins
BOP	- Balance of Payments
Brics	- Biotechnology Regional Innovation Centres
BRICS	- Group of countries comprising Brazil, Russia, India, China and South Africa
CBD	- Convention on Biological Diversity
CeSTII	- Centre for Science, Technology and Innovation Indicators
CIPC	- Companies and Intellectual Property Commission
CIPRO	- Companies and Intellectual Property Registration Office
CSIR	- Council for Scientific and Industrial Research
CUT	- Central University of Technology
DACST	- Department of Arts, Culture, Science and Technology
DBSA	- Development Bank of Southern Africa
DST	- Department of Science and Technology
EPC	- European Patent Convention
EPO	- European Patent Office
FDI	- Foreign Direct Investment
FTI	- Foundation for Technological Innovation
GAP	- Gauteng Accelerator Programme
GCI	- Global Competitiveness Index

GDP	- Gross Domestic Product
GEI	- Global Entrepreneurship Index
GEM	- Global Entrepreneurship Monitor
GEP	- Gauteng Enterprise Propeller
GERD	- Gross Expenditure on Research and Development
GIPC	- Global Intellectual Property Center
GII	- Global Innovation Index
GIKES	- Gauteng Innovation and Knowledge Economy Strategy
GMP	- Good Manufacturing Practice
GPA	- German Patent Act
GR	- Genetic Resources
HEI	- Higher Education Institution (encompasses universities)
HSRC	- Human Sciences Research Council
HySA	- Hydrogen South Africa
ICT	- Information Communications Technology
IDC	- Industrial Development Cooperation
Institutions	- means publicly financed institutions and includes HEIs and SCs
IP	- Intellectual Property
IPAP	- Industrial Policy Action Plan
IPRs	- Intellectual property rights
IPR-PFRD Act	- Intellectual Property Rights from Publicly Financed Research and Development Act 2008 (Act No. 51 of 2008)
ISA	- International Search Authority
ISR	- International Search Report
LDC	- Least Developed Country
MINTEK	- Council for Mineral Technology
MMV	- Medicines for Malaria Venture
MRC	- South African Medical Research Council
NACI	- National Advisory Council on Innovation
NDP	- South Africa’s National Development Plan, Vision 2030

NECSA	- Nuclear Energy Corporation of South Africa
NEF	- National Empowerment Fund
NHLS	- National Health Laboratories Services
NIPMO	- National Intellectual Property Management Office
NMISA	- National Metrology Institute of South Africa
NMMU	- Nelson Mandela Metropolitan University
NRDS	- South Africa's National Research and Development Strategy (2002)
NRF	- National Research Foundation
NSI	- National System of Innovation
NWU	- NorthWest University
OCIPE	- Office of Companies and Intellectual Property Enforcement
OECD	- Organisation for Economic Co-operation and Development
OTT	- Office of Technology Transfer, also referred to as Technology Transfer Office (TTO)
Patents Act	- South African Patents Act 57 of 1978 as amended
PCT	- Patent Cooperation Treaty
PEB	- Patent Examination Board
PMBR	- Pebble Bed Modular Reactor
PTIP	- Photovoltaic Technology Intellectual Property
QLFS	- Quarterly Labour Force Survey
R&D	- Research and Development
RTA	- Revealed Technology Advantage
SABS	- South African Bureau of Standards
SADC	- Southern African Development Community
SAIIPL	- South African Institute of Intellectual Property Lawyers
SANBI	- South African National Biodiversity Institute
SANSA	- South African National Space Agency
SASTI	- South African Science, Technology and Innovation
SC	- Science Council
SCA	- Supreme Court of Appeal

SEDA	- Small Enterprise Development Agency
SEFA	- Small Enterprise Finance Agency
SETI	- Science Engineering Technology and Innovation
SIC	- Standard Industrial Classification
SiMODISA	- is a collaborative research, stakeholder engagement and policy design effort by key stakeholders from both the public and private sector in South Africa
SKA-SA	- Square Kilometre Array South Africa
SME	- Small Medium Enterprise
SOE	- State Owned Enterprise
SPII	- Support Programme for Industrial Innovation
SSE	- Substantive Search and Examination
SSP	- Start-Up Support Programme
STI	- Science, Technology and Innovation
S&T	- Science and Technology
SUN	- Stellenbosch University
TAC	- Treatment Action Campaign
TBP	- Technology Balance of Payments
TEA	- The Early-Stage Entrepreneurial Activity
the dti	- the Department of Trade and Industry
THRIP	- Technology and Human Resources for Industry Programme
TIA	- Technology Innovation Agency
TIH	- The Innovation Hub Science and Technology Park
TIHMC	- The Innovation Hub Management Company
TK	- Traditional Knowledge
TRIPS	- Trade Related Aspects of Intellectual Property Rights Agreement
TYIP	- Ten-Year Innovation Plan
TUT	- Tshwane University of Technology
TVET	- Technical and Vocational Education and Training College
UCT	- University of Cape Town

UFS	- University of Free State
UJ	- University of Johannesburg
UKZN	- University of KwaZulu-Natal
UNCTAD	- United Nations Conference on Trade and Development
UNISA	- University of South Africa
UOFS	- University of the Free State
UP	- University of Pretoria
USA	- United States of America
USPTO	- United States Patent and Trade Marks Office
UWC	- University of the Western Cape
VC	- Venture Capital
WCT	- World Copyright Treaty
WEF	- World Economic Forum
WIPO	- World Intellectual Property Organisation
WITS	- University of the Witwatersrand, Johannesburg
WPPT	- WIPO Performances and Phonograms Treaty
WPS&T	- White Paper on Science and Technology
WRC	- Water Research Commission
WTO	- World Trade Organisation

LIST OF FIGURES

Figure Description **Page**

Chapter 9

LIST OF TABLES

Table Description **Page**

Chapter 8

Chapter 9

Table of Contents

CHAPTER 1: INTRODUCTION

"South Africa's competitiveness will rely on national systems of innovation, permeating the culture of business and society. Innovation and learning must become part of our culture. This will require interventions from the schooling system, through to shop-floor behaviour to R&D spending and commercialisation." – NDP (2012)

1.1 OVERVIEW

Since the end of the apartheid era in 1994, there have been a number of policy and legislative changes in respect of South Africa's intellectual property (IP) and innovation systems. From the 1996 White Paper on Science and Technology (WPS&T, 1996) to the 10-Year Innovation Plan (TYIP, 2008), the focus has been on establishing a working and dynamic National System of Innovation (NSI). A number of institutional arrangements have followed various policy positions. These have included the following: Firstly, the Biotechnology Regional Innovation Centres (Brics) were established pursuant to the 2001 Biotechnology Strategy (Biotechnology Strategy, 2001). Secondly, the Innovation Fund was set up, following the formation of the National Research Foundation (NRF) in April 1999 as an autonomous statutory body. Thirdly, in 2002, the National Research and Development Strategy (NRDS) was formulated. Fourthly, the Technology Innovation Agency (TIA) was established pursuant to a policy decision to merge several entities in order to address the innovation chasm effectively. Fifthly, the National Intellectual Property Management Office (NIPMO) was established, pursuant to the 2006 National Policy on IP emanating from Publicly Financed Intellectual Property (IP Policy, 2006) and the Intellectual Property Rights from Publicly Financed Research and Development Act 2008 (IPR-PFRD Act). In 2004, South Africa also embarked on a wholesale reorganisation of higher education institutions (HEIs). In the past 20 years, with changes in Government Ministries, certain Science Councils (SCs), such as the Council for Scientific and Industrial Research (CSIR), changed their reporting Ministry from the Department of Trade and Industry (*the dti*) to the Department of Science and Technology (DST), as part of efforts to ensure coherence within the NSI. Suffice to say that the South African NSI has, since the start of democracy in 1994, been driven from a science, technology and innovation (STI) perspective, and hence the DST plays an important role. Notwithstanding the fact that the *dti* is the responsible department in the case of IP matters (legislative, multilateral arrangements, registration and enforcement), most progressive policy initiatives and in particular the importance of IP in the transition to a more knowledge driven economy have been driven by the DST. *The dti* has however continued to play its role in as far as IP registration and enforcement are concerned, as well as in multilateral negotiations and agreements.

In the more recent past, specifically in December 2010, South Africa became a member of the BRICS group of nations (Brazil, Russia, India, China and South Africa). Whereas the South African economy is characterised by a desire to move away from being dependent on resources and commodities towards a more knowledge based and innovation driven economy, the NRDS (2002:90) identified the differences in patent rates between developed and developing countries as being one of the biggest divides. Consequently, it calls for a full appreciation of the value of IP and its commercialisation, and hence innovation. The Organisation for Economic Cooperation and Development (OECD) has in OECD (2007:9) characterised South Africa's economy as:

> *"… now in the midst of two specifically economic transitions: it is responding to globalisation, and it is shifting the structure of its economy away from dependence on primary resources production and associated commodity-based industries."*

In 2012, a Ministerial Review of the Science, Technology and Innovation (STI) landscape in South Africa (Ministerial Review, 2012) made recommendations to strengthen the STI landscape and effectively the NSI. These recommendations are extensively dealt with in **Chapter 6.**

Late in 2013, *the dti*, on behalf of Government, published draft recommendations that would have an impact on the country's IP system. Pursuant to public comments and widespread concerns, a National IP Policy Framework was published in 2016, to provide a more consultative engagement towards South Africa's National IP Policy, to guide, *inter alia*, legislative amendments.

In September 2012, almost 20 years after the end of apartheid, the South African Government published the National Development Plan, Vision 2030 (NDP, 2012), which outlines South Africa's desired developmental goals. The NDP (2012:289) also identifies innovation as being important for South Africa's socio-economic development:

> *"The National System of Innovation needs to function in a coherent and coordinated manner with broad common objectives aligned to national priorities."*

Although South Africa has a functioning IP system, its relevance for South Africa's socio-economic development trajectory is not established, however, and much more needs to be understood about its output over the past two decades. IP by itself is of little value, unless it is commercialised or used in trade, industry and agriculture. Accordingly, the IP system must foster innovation and support the NSI. The Agreement on Trade-Related Aspects of Intellectual Property Rights (the so-called TRIPS Agreement), administered by the World Trade Organisation (WTO), which came into effect on 1 January 1995, provides that IP must contribute to the innovation and transfer of technology and knowledge in a manner that is conducive to social and economic welfare. Certain provisions set out the foundations of an IP system within the context of each member state.

Significant changes have taken place in the global economy in the last two decades. In particular, this period has been characterised by the rise of the BRICS group of countries and the so-called Asian tigers (Singapore, South Korea, Taiwan, and Malaysia). An analysis of the Asian tigers' transition to becoming globally competitive nations with vibrant innovation systems reveals that they took a number of deliberate actions from a policy and legislative point of view. These include significant investment in research and development (R&D), refinement of their IP systems, while taking into account their stage of development, strengthening their innovation eco-systems, and making deliberate choices in terms of industrial policy. The Commission on Intellectual Property Rights (2002:20) notes that:

> *"Countries in East Asia, which used weak forms of IP protection, tailored to their particular circumstances at that stage of their development Throughout the critical phase of rapid growth in Taiwan and Korea between 1960 and*

> *1980, during which their economies were transformed, both countries emphasised the importance of imitation and reverse engineering as an important element in developing their indigenous technological and innovative capacity. In India, the weakening of IP protection in pharmaceuticals in its 1970 Patent Act is widely considered to have been an important factor in the subsequent rapid growth of its pharmaceutical industry."*

It would appear that it is not a strong IP system *per se* that is a pre-requisite for fostering development, but that it is rather a conscious adoption of an appropriate IP system relevant to the level of development of a country that is important. Similarly to Commission on Intellectual Property Rights (2002:20), Straus (2012:263) observes that imitation has been a key part of the journey of some of the more successful countries, in realising better use of the IP system. Over a period of time, these countries have refined and tailored their IP systems to respond to their level of development as well as their needs and priorities. The evidenced relationship between the IP system and development provides a basis for assessing the potential of an IP system to foster development. In the past two decades, changes in the international IP landscape, notably the TRIPS Agreement, have influenced approaches to IP and harmonisation. Article 7 of the TRIPS Agreement specifically identifies the important role of IP protection and enforcement in contributing towards innovation.

An effective IP system that stimulates innovation, also assumes the existence of a certain level of technological capabilities and capacity. Such capabilities must include knowledge and technology generation as well as the ability to absorb or use such knowledge or technology to unlock social and economic benefits for the broader society. Thus, for any economic growth to be sustained and to be inclusive there is a need to grow technology capability across all spheres so as to be able to address tomorrow's challenges, with solutions that do not yet exist. Notwithstanding what appears to be a well-established IP system, Teljeur (2003) and Kaplan (2009) point out that its impact of the South Africa's innovation and economic performance is not well understood. The role of the IP system and the use of the built-in TRIPS flexibilities to ensure that South Africa's position in the global economy is strengthened as well as that the country transitions from an economy based on the production of primary resources and associated commodity-based industries to a viable knowledge-based economy merit further research.

This study reviews South Africa's IP System and NSI over a 20-year period (1996-2015), and seeks to explore the complex, complementary and rather contested relationship between IP and innovation, with particular emphasis on the potential of the IP system to stimulate innovation and foster social and economic development.

1.2 DEFINITION OF CONCEPTS

A number of terms, commonly used in this thesis, have the meanings set out below. Although this study places a significant emphasis on patents, it adopts the definition of IP from the IPR-PFRD Act:

> *"… any creation of the mind that is capable of being protected by law from use by any other person, whether in terms of South African law or foreign intellectual property law, and includes any rights in such creation, but excluded copyrighted works such as a thesis, dissertation, article, handbook or any other publication which, in the ordinary course of business, is associated with conventional academic work."*

The following definition for *innovation* is adopted from NRDS (2002:20):

> *"the introduction into a market (economic or social) of new or improved products and services."*

It is submitted that invention and innovation are two different concepts. In the case of an invention, an investment of resources financial or otherwise is made with the outcome being new knowledge. Innovation on the other hand is the outcome of utilising the new knowledge that is the outcome of the invention process to address a market or societal need and thereby results in value creation, which may be monetary or otherwise. In other words, whereas an invention may be a product or process, it does not necessarily follow that the product or process is used. On the other hand, an innovation requires a market to embrace the knowledge in the form of a product or process offering that is actually used or someone pays for. As articulated in OECD (2010:14) *“innovation is about creating value from knowledge. ... Knowledge is the key input to innovation.”*

With reference to NRDS (2002:20), the NSI is defined as:

> *“a set of functioning institutions, organisations and policies that interact constructively in the pursuit of a common set of social and economic goals and objectives, and that use the introduction of innovations as the key promoter of change.”*

1.3 STATEMENT OF THE PROBLEM

The study reviews South Africa’s IP system and NSI within the context of international IP arrangements; more particularly, it investigates the performance of the IP system and its impact on the NSI in the country. The complex, complementary and rather contested relationship between IP and innovation is explored, with particular emphasis on the potential of South Africa’s IP system to stimulate innovation and foster socio-economic development and competitiveness. Consequently, a systematic analysis of the IP landscape has been undertaken, with particular reference to international arrangements, policies, legislation, adoption, outputs and commercialisation within the context of South Africa’s evolving NSI and the country’s membership of the BRICS group of countries.

The study also makes relevant contributions to the body of knowledge on how South Africa can establish an enabling IP system that is capable of stimulating innovation and fostering socio-economic development in a developing country such as South Africa.

1.4 RESEARCH OBJECTIVES

The study provides a critical review and analysis of the following:

- the South African IP landscape, in particular, the policies, legislation, infrastructure, instruments and practices in respect of protection and management of IP;
- the interconnectivity of IP and also innovation with other international legal instruments, such as the TRIPS Agreement, in view of the fact that South Africa is located within a global context, particularly as a member of the BRICS countries;
- the built-in TRIPS flexibilities and the extent of their incorporation into South African IP legislation and policies;
- the NSI and how the IP system has enabled or hampered innovation in both the public and private sector;
- the character of the NSI in respect of key players and the extent of their contribution in respect of investments in R&D and outputs including patents and publications;
- enablers and constraints with respect to IP and its real impact on innovation; and
- mechanisms and interventions to ensure that the IP system and the NSI are well coordinated and coherent, and thus able to help South Africa to improve its socio-economic development.

The outcome of this study will be to identify critical policy, legislative, institutional and infrastructure reviews and to recommend changes that will ensure coherence between the intellectual property and innovation systems.

1.5 POINTS OF DEPARTURE, ASSUMPTIONS AND HYPOTHESES

In analysing the IP system and the NSI, the following definition of a system advanced by Makgoba (2010:67) in his analysis of the South African System of Innovation is relevant:

> *"A system by simple definition consists of different components and/or elements that function coherently and in a coordinated manner for a common objective or major function."*

There is also a need to provide further clarity on the four key issues advanced by Kaplan (2009:1) in respect of the IP system:

> *"Four issues are of particular relevance here. The first is the broad characterisation of the overall IP regime and its likely impact on innovation and diffusion. The second is South Africa's innovation performance overall and its determinants and constraints. The third is the relationship of South Africa's innovation performance to the prevailing IP regime. The fourth is the policy context – i.e. government's perspective on innovation and the proposed policy changes specifically in regard to intellectual property."*

The study is based on the following hypotheses:

(i) South Africa's IP system is characterised by low use by South African residents, owing to a lack of awareness of its importance and benefits;

(ii) Publicly financed institutions (referred to as 'institutions' below) have become effective in using the IP system, owing to the obligations placed on them by the IPR-PFRD Act;

(iii) The IP system is still not effectively utilised as an essential component of driving innovation in the NSI; and

(iv) There is still incoherence within the NSI that affects the value that can be derived from the IP system.

The relationship between IP and innovation should be assessed on the basis of the extent of endogenous innovations reaching the market as finished products and/or services resulting from IP commercialisation that have real (direct or indirect) socio-economic impact domestically and that translate into innovations for the global markets. A sound understanding of this relationship within the context of actual patent data, as well as a review of the NSI, would be helpful in appreciating the extent to which the South African NSI has been able to be transformed from what the OECD (2007:10) had described as an innovation system in transition that was characterised by:

> *"the reshaping of a relatively strong innovation system serving one set of social, economic and political goals towards another strong system serving a very different set of goals".*

In the characterisation of the structural features of the South African economy by the OECD (2007), it is surprising that the IP system is not dealt with under the necessary framework conditions for innovation, given the importance of IP for innovation and development. Kaplan (2009:13) observes in this regard that:

> *"In contrast with the NRDS, intellectual property is not identified by the OECD as one of the weaknesses in the innovation system. Accordingly, the OECD makes no proposals with respect to it – indeed the report is completely silent on the whole issue. As a consequence, there has never been a discussion or consideration of the economic role of the IP system in toto in South Africa or the objectives sought".*

Could it be that the OECD (2007) was of the view that the IP system was appropriate and did not require any changes to be made to it? Or maybe the terms of reference of the OECD (2007) did not extend to IP. This study advances the view that this was a glaring omission by the OECD (2007) alternatively the definition of the IP system was confined only to protection and enforcement of IP rather than its utilisation, particularly when one considers that Makgoba (2010:71) identifies a disjuncture within the NSI in South Africa as being:

> *"… in the failure to translate ideas, to translate products and intellectual property in the interest and for the benefit of the country and its people …. Most leaders of our system have never developed or patented a product i.e. have never engaged in a process of nurturing an innovative idea from conception to translation and to product development and commercialisation".*

Perhaps what the NSI requires is more emphasis on translation than on generation of new IP. This study further explores this disjuncture, placing particular emphasis on the commercialisation of IP that emanates from publicly financed institutions. Of particular importance is the need for coherency and coordination within the NSI.

1.6 SUMMARY AND STRUCTURE OF THE THESIS

The thesis consists of nine (9) chapters, beginning with this introductory **Chapter 1**, which sets out the scope of the study and discusses some key concepts.

Chapter Two introduces the details of the research design and methodology that this study has followed. In particular, as the study has adopted a mix of both qualitative and quantitative approaches, this chapter also delves into the sources of primary and secondary data used.

Chapter Three analyses South Africa's macro-economic environment as well as socio-economic development objectives and priorities. The chapter also details the relative global positioning of the country, particularly in comparison to the rest of the BRICS countries, and in relation to the development policy objectives, as captured in the National Development Plan (NDP) and in other official documents; it further considers the outlook in context (challenges, opportunities, stated government priorities, economic indicators). The analysis also identifies potential areas of competitiveness, where IP and innovation could have an impact.

Chapter Four contains a critical review of various international IP legal instruments, and in particular those administered by the WTO and the World Intellectual Property Organisation (WIPO). In addition, the concept of flexibilities under the TRIPS Agreement is introduced, with specific reference to their relevance for development and public health.

Chapter Five presents an in-depth review and analysis of South Africa's IP policy and legislative environment in the light of the international arrangements, in particular the flexibilities discussed in the previous chapter. This chapter also details South Africa's approach to IP that emanates from publicly financed R&D.

Chapter Six discusses South Africa's innovation environment, the NSI, with particular reference to the policy and legislative landscape and the NDP.

Chapter Seven analyses the performance of South Africa's IP system, in the light of both domestic and international patent filings. A comparative analysis of the BRICS group of countries is also detailed in respect of both patent outputs as well as top technology sectors for each of the countries. The trends and patterns from patent data are analysed to provide a clear picture of the output of the IP system.

Chapter Eight looks at the performance of the South African NSI. The chapter also analyses the results of a questionnaire sent out by the author to a number of publicly financed institutions.

Chapter Nine presents a critical analysis and consolidation of all the findings with specific recommendations on aligning the IP system and the NSI to foster innovation for inclusive development (social and economic development priorities) for South Africa. South Korea is used as a case study of such consolidation occurring within that particular context, and it identifies strategic shifts that could be adopted by South Africa.

The study provides a rich and new set of patent data from the analytics pertaining to patenting domestically and abroad by South African residents, as well as giving insights into how the NSI can be strengthened to ensure that it is receptive to the outputs of the IP System. Further new insights into the impact of the IPR-PFRD Act on Institutions are also provided.

1.7 CONCLUSIONS

Whereas this chapter has provided the basis for the study and an overview of the various aspects covered in this thesis, the next chapter will deal with the research methodology and the approach taken to carry out the research.

CHAPTER 2: RESEARCH DESIGN AND METHODOLOGY

"The time will come when diligent research over long periods will bring to light things which now lie hidden. A single lifetime, even though entirely devoted to the sky, would not be enough for the investigation of so vast a subject... And so this knowledge will be unfolded only through long successive ages. There will come a time when our descendants will be amazed that we did not know things that are so plain to them.... Many discoveries are reserved for ages still to come, when memory of us will have been effaced." – Seneca, Natural Questions

2.1 INTRODUCTION

This study presents an overview of post-apartheid South Africa's IP system and NSI within the context of South Africa's macroeconomic environment; it further looks at international arrangements under the WTO and WIPO, coupled with perspectives on policy and systemic changes, and considers how these relate to the interconnectivity of IP and innovation. It also takes into account the positioning of South Africa within the globalised economy and in particular as a member of the BRICS group of countries. A critical review is presented of the developments of South Africa's macroeconomic environment, with a view to identifying sectors and areas of current strength and potential competitiveness and then determining South Africa's present IP portfolio in supporting these areas. The macroeconomic environment review is juxtaposed with the ideals set out in the NDP (2012), which is South Africa's development policy, to reduce employment to single digit levels and eliminate poverty and inequality by 2030.

A review of the legal instruments of the WTO and the WIPO and the marriage of convenience that was introduced particularly by the TRIPS Agreement is an important basis for understanding the extent to which South Africa's IP system aligns with these instruments. In addition, the chapter looks at the flexibilities of TRIPS and at the extent to which they have been incorporated into South African laws, and what their potential value to the NSI will be. Developments in both the IP system and the NSI in the post-apartheid South Africa era are then documented, with insights on how these two are linked to each other.

Thereafter, the study introduces new data on the performance of the IP system with reference to patent statistics in relation to South African residents both at home and abroad. In this regard, use has been made of data relating to the filing of patent applications and the granting of patents and trends from the South African Patent Office, falling under the Companies and Intellectual Property Commission (CIPC), the European Patent Office (EPO), the Patent Cooperation Treaty (PCT), and the United Stated Patent and Trademarks Office (USPTO). Detailed analysis is also undertaken of the performance of these institutions in an effort to assess the impact of the IPR-PFRD Act, and the potential contribution to areas of potential competitiveness, as detailed in the macroeconomic environment review that will be presented in **Chapter 3**. Changes in the IP landscape over the 20-year period of this study, divided into two 10-year segments, provide insights and correlations with changes in the macroeconomic environment. South Africa's performance during that period is compared with that of the other BRICS countries.

A review of the NSI and its performance looks at IP commercialisation and the NSI's capacity to transform the South African economy by means of IP and innovation. R&D survey data is used to correlate areas of focus between the public sector and business as far as investments in R&D and IP portfolios are concerned. Bansi (2016:16) highlights the significance of IP commercialisation activities at universities, arguing that they have a direct impact on, *inter alia*, the increased competitiveness and economic growth of the country.

The study has thus conducted a comparative review and critical analysis of the IP system in South Africa and its interface with the NSI. The new insights and data obtained will contribute to critical policy, legislative and institutional reviews and changes towards a dynamic and progressive IP system and NSI. The ensuing coherence and alignment should strengthen South Africa's ability to stimulate innovation and foster inclusive development and competitiveness, which will be relevant for addressing South Africa socio-economic development priorities.

This study moreover contributes to the body of knowledge regarding the commercialisation of IP at institutions, and determines the progress made since the promulgation of the IPR-PFRD Act in 2008. By contrasting the institutions' patent portfolio with South Africa's patent portfolio further new insights are provided, regarding technological areas of focus by the most prolific patenting and publishing institutions, both individually and as a collective. This is also contrasted with the macroeconomic review and prospects for development of new industries, where South Africa has traditionally not had strength or where the country has not been viewed as being globally competitive. It is submitted that a dynamic and progressive IP system is essential for the the NSI to contribute to South Africa's developmental priorities, global competitiveness and prosperity.

2.2 PRIMARY AND SECONDARY DATA

The study utilises both primary and secondary data, which comprises literature reviews, patent searches and analytics, as well as a survey in the form of a questionnaire. This mixed research method facilitates the ease of reconciling the findings and means that we are better able to explain some of the trends, as detailed in Hammond (2005:16).

Primary data for this study was derived mainly from two sources. Firstly, searches and data analytics, primarily using the Thomson Innovation patents and publications databases, are detailed below. Secondly, use was made of responses to a Commercialisation Questionnaire that was sent out to institutions as part of this study; further details of this are given below. During the period 2004-2016, the author has been involved in a number of studies, and in the development of policies and legislative texts relating to IP and innovation. As such, the author has established a good network with people working in the NSI and has thus gained access to various other primary data over this period. Consequently, some aspects of this study release into the public domain, data, insights and discourse that would otherwise have remained unrepresented or out of the public domain.

Secondary data comprised published patent statistics by the CIPC, EPO, PCT and USPTO. In addition, a literature review of various published articles, journal articles, relevant books, published surveys, reports, studies, policy documents and legislative documents and texts, international legal instruments such as the TRIPS Agreement, blogs, as well as other materials as detailed herein, all form part of the secondary data.

2.3 METHODOLOGY

2.3.1 Time Period

This study covers a 20-year period, starting on 1 January 1996 and ending on 31 December 2015 (1996-2015), with the objective of understanding the evolution of South Africa's IP landscape and system, as well as the NSI, and the relationships with South Africa's economy.

2.3.2 Patent Data

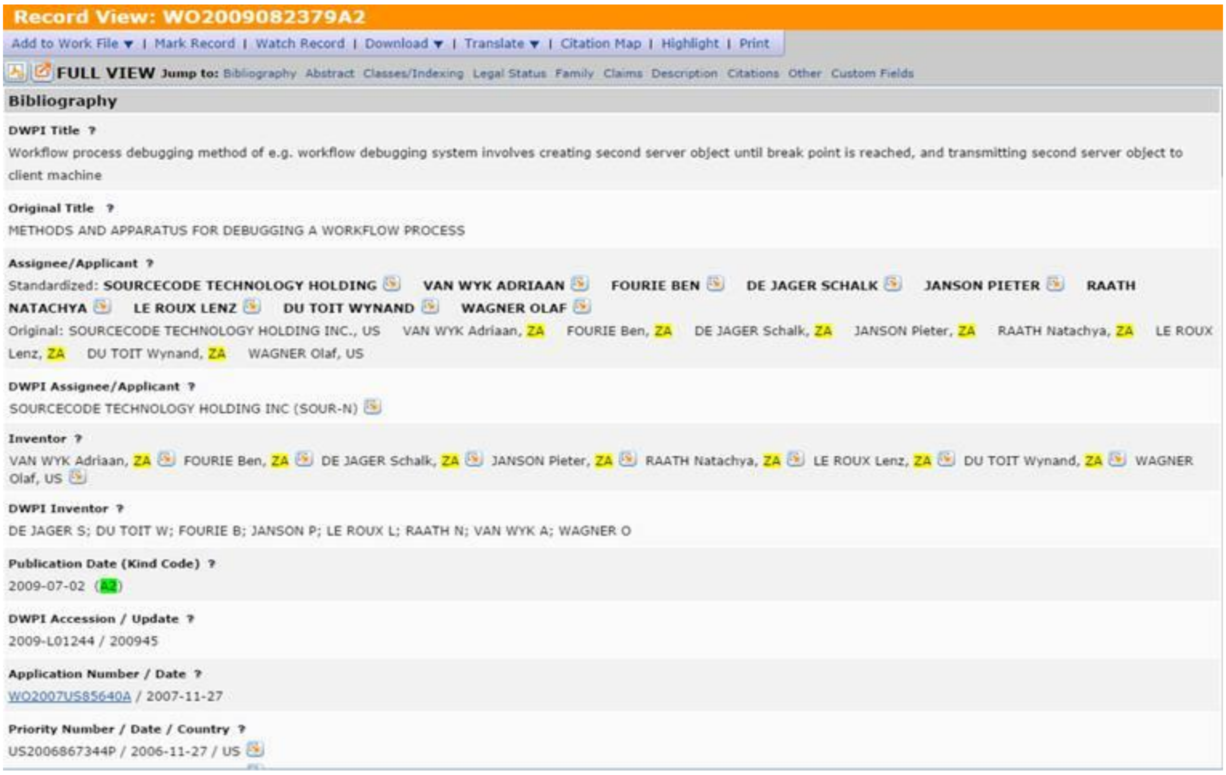
Use was made of international patent data published by the USPTO (www.uspto.gov), the PCT administered by the WIPO (www.wipo.int)[1], and domestic patent data from the CIPC (www.cipc.co.za) for the period of the study. In addition, specific searches and further analysis of the search results were undertaken, using the patent databases from Thomson Innovation,[2] for the same period. The searches focused on patent applications and patents that (i) claimed priority from a South African patent application filed immediately before or within the above period (ZA Priority), and (ii) had one or more of the inventors with a South African address (ZA Inventor Address). Sibanda (2007) utilised ZA Priority data to understand South Africa's patent landscape in the period 1991-2005. The Inventor Address has been used in a number of studies, including Bhattacharya (2004), Kahn (2007) and

1 http://www.wipo.int/ipstats/en/index.html [last accessed on 4 May 2017]

2 http://info.thomsoninnovation.com/en/features/analyze [last accessed on 4 May 2017]

Patra and Muchie (2015). Bhattacharya (2004) for example, has used an Inventor Address approach in a case study that mapped the inventive activity and technological changes of India and China through patent analysis. Searches based on ZA Inventor Addresses would also identify Non-Convention[3] applications, which are patent applications not claiming priority from any prior patent application, but that are filed in the first instance; these are often regarded as exceptions rather than the norm, but are filed anyway for one reason or another. ZA Priority data captures patent applications and patents filed pursuant to the Paris Convention. Consequently, searches using ZA Priority and ZA Inventor Address yield different results, often with the ZA Inventor Address searches yielding higher search results, as they cover patent data for non-South African applicants and assignees with inventors or employees in South Africa, or collaborating with a South African inventor; they also cover Non-Convention patent applications. An example of such a patent document is **WO2009082379A2** (see bibliographical data below), which could only be identified through a ZA Inventor Address. As the inventor was based in South Africa, the R&D leading to the invention covered by the patent document was evidently also done in South Africa, but the company the inventors were working for was domiciled in the USA.

3 Convention Applications are patent applications filed on the basis of the Paris Convention, constituting a patent application within 12 months of a first application in a Paris Convention member state, which provides a priority claim. On the other-hand, Non-Convention applications do not claim priority from any prior patent application and are filed with a complete patent specification without reliance to the rules under the Paris Convention.


Record View: WO2009082379A2

Add to Work File ▾ | Mark Record | Watch Record | Download ▾ | Translate ▾ | Citation Map | Highlight | Print

FULL VIEW Jump to: Bibliography Abstract Classes/Indexing Legal Status Family Claims Description Citations Other Custom Fields

Bibliography

DWPI Title ?
Workflow process debugging method of e.g. workflow debugging system involves creating second server object until break point is reached, and transmitting second server object to client machine

Original Title ?
METHODS AND APPARATUS FOR DEBUGGING A WORKFLOW PROCESS

Assignee/Applicant ?
Standardized: SOURCECODE TECHNOLOGY HOLDING VAN WYK ADRIAAN FOURIE BEN DE JAGER SCHALK JANSON PIETER RAATH NATACHYA LE ROUX LENZ DU TOIT WYNAND WAGNER OLAF
Original: SOURCECODE TECHNOLOGY HOLDING INC., US VAN WYK Adriaan, ZA FOURIE Ben, ZA DE JAGER Schalk, ZA JANSON Pieter, ZA RAATH Natachya, ZA LE ROUX Lenz, ZA DU TOIT Wynand, ZA WAGNER Olaf, US

DWPI Assignee/Applicant ?
SOURCECODE TECHNOLOGY HOLDING INC (SOUR-N)

Inventor ?
VAN WYK Adriaan, ZA FOURIE Ben, ZA DE JAGER Schalk, ZA JANSON Pieter, ZA RAATH Natachya, ZA LE ROUX Lenz, ZA DU TOIT Wynand, ZA WAGNER Olaf, US

DWPI Inventor ?
DE JAGER S; DU TOIT W; FOURIE B; JANSON P; LE ROUX L; RAATH N; VAN WYK A; WAGNER O

Publication Date (Kind Code) ?
2009-07-02 (A2)

DWPI Accession / Update ?
2009-L01244 / 200945

Application Number / Date ?
WO2007US85640A / 2007-11-27

Priority Number / Date / Country ?
US2006867344P / 2006-11-27 / US

Figure 2.1: Screen shot of bibliographic information relating to PCT patent application WO20009082379A2

Within the period covered by the study, two 10-year segments (1996-2005) and (2006-2015) were analysed to determine trends. These time segments represent what the author views as time periods, where there were shifts in South Africa's IP and innovation policy: the period 1996-2005 was regarded as the formative years of the NSI and was characterised by management of IP that emanated from publicly financed research and development (R&D). The later period of 2006-2015 represents the establishment of policies and legislation on IP that emanated from publicly financed R&D, the consolidation of institutional arrangements within the NSI, and shifts in South Africa's macroeconomic environment. As such, patent data from the abovementioned searches were analysed in terms of:

(i) Absolute numbers and pace of filing;

(ii) Publications per year;

(iii) Top assignees;

(iv) Top International Patent Classification (IPCs) Index; and

(v) Technological areas or clusters (as illustrated by means of ThemeScape® maps).

These statistics were used as surrogates or proxies for measuring technological positions and progress. The IPC's hierarchical structure consists of sections, classes, subclasses and groups, based on technical features covered by the patent document. Accordingly, the IPCs have been utilised to gain a better understanding of the technological areas where South African residents file and register most patents, and possible areas of innovative activity. More particularly, the IPCs utilised by the OECD (2008) were adopted in the further analysis of South Africa's patenting activity in the ICT and Biotechnology technology fields. Details of ICT codes for these two technology fields as suggested by the OECD[4] are detailed in **Chapter 7**.

PCT Applications

The following parameters were used for searches of PCT patent applications, based on the date of application:

(i) 1 Jan 1996 to 31st Dec 2015 [20-year period]
   - 1 Jan 1996 to 31st Dec 2005 [10-year period]
   - 1 Jan 2006 to 31st Dec 2015 [10-year period]

(i) For the purposes of the searches, and in order to eliminate duplications, the following Patent Document Codes were used for the search A1 or A2 {KI=((A1) OR (A2))} [A1 is a PCT publication with the International Search Report (ISR); A2 is for publication without the ISR; and A3 is for publication of the subsequent ISR to A2 PCT patent publication]. Since an A3 publication is a publication of a document that would already have been published as A2, A3 documents were excluded from the search.

(ii) Priority Country Code (ZA) and Inventor Address Code (ZA)

Figure 2.2 shows a screen shot of a Thomson Innovation Search Screen for PCT applications for the period 1996-2015.

4 http://www.oecd.org/science/inno/37569377.pdf Last accessed on 15 May 2017]

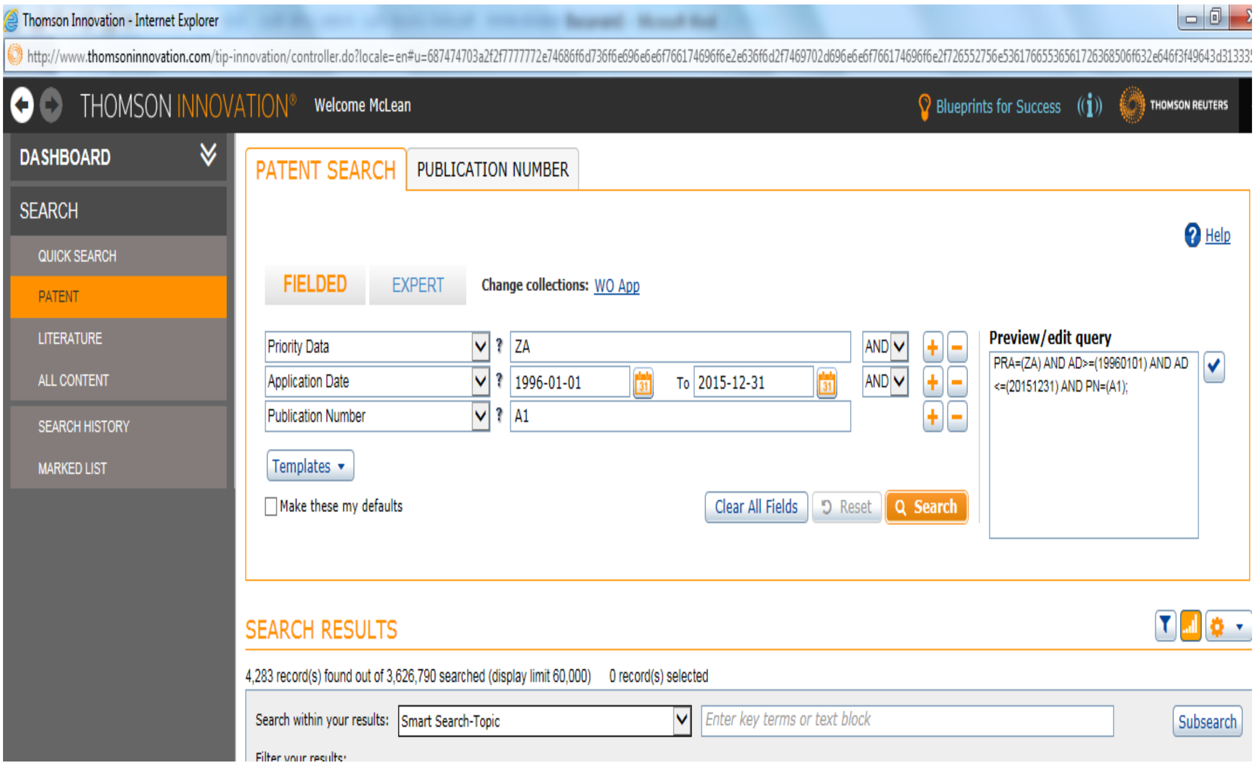


Figure 2.2: Thomson Innovation screen shot of search criteria for ZA Inventor Address PCT patent applications filed by South African residents

<u>EPO Granted patents</u>

The following parameters were used for searches of USPTO patents, based on the date of application:

(i) 1 Jan 1996 to 31 Dec 2015 [20-year period]

- 1 Jan 1996 to 31 Dec 2005 [10-year period]
- 1 Jan 2006 to 31 Dec 2015 [10-year period]

(ii) B1 [Granted patents]

(iii) ZA Priority Country Code and also ZA Inventor Address

Figure 2.3 shows a screen shot of a Thomson Innovation Search Screen for EPO granted patents for the period 1996-2015.

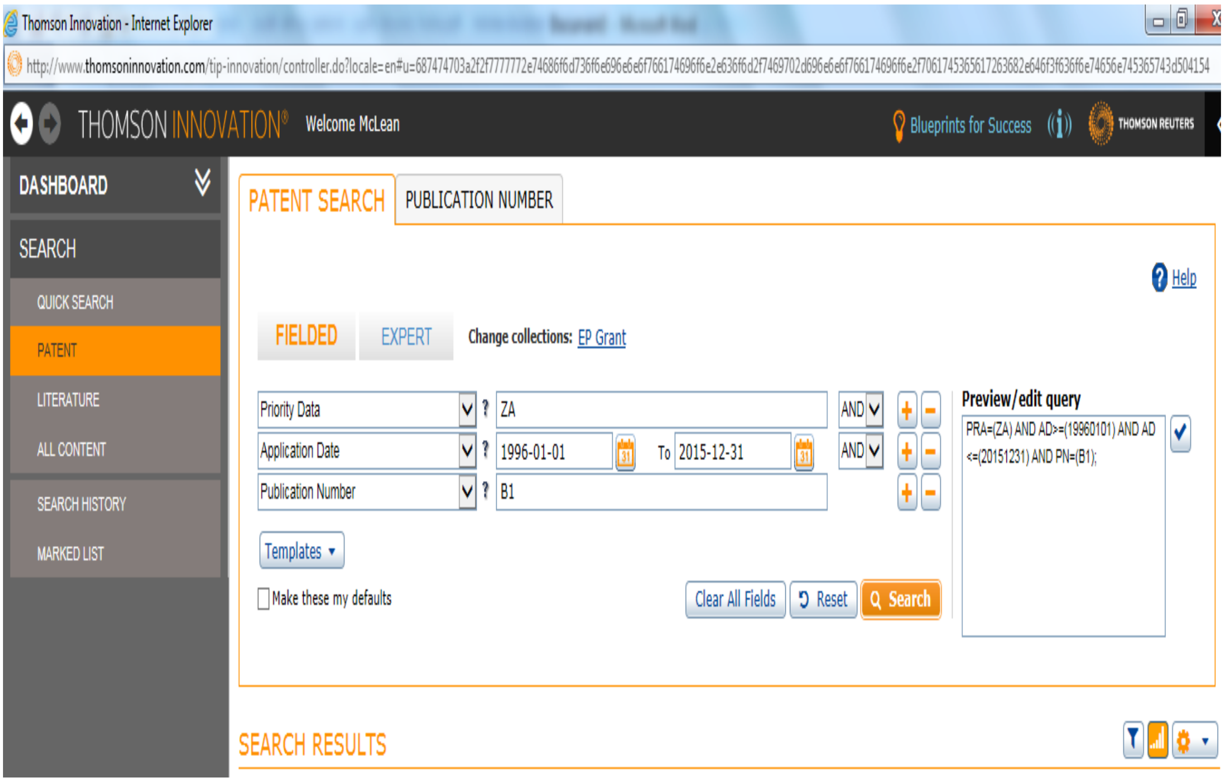


Figure 2.3: Thomson Innovation screen shot of search criteria for ZA Inventor Address patents granted by the EPO to South African residents

<u>US Granted patents</u>

The following parameters were used for searches of USPTO patents, based on the date of application:

(i) 1 Jan 1996 to 31 Dec 2015 [20-year period]

- 1 Jan 1996 to 31 Dec 2005 [10-year period]
- 1 Jan 2006 to 31 Dec 2015 [10-year period]

(ii) Granted patents

(iii) Exclude Design Patents (S1) as these are included in the USPTO patents database

(iv) ZA Priority Country Code and ZA Inventor Address

Figure 2.4 shows a screen shot of a Thomson Innovation[5] Search Screen for EPO granted patents for the period 1996-2015.

5 Note that as of May 23, 2017 Thomson Innovation was renamed Derwent Innovation.

Figure 2.4: Thomson Innovation screen shot of search criteria for ZA Inventor Address patents granted by the USPTO to South African residents, excluding design patents

2.3.3 Commercialisation Questionnaire

As already mentioned, a Commercialisation Questionnaire (see **Annexure A**) was utilised as one of the sources of primary data. The results of this Questionnaire were used to correlate the patent statistics with commercialisation and hence innovation.

Table 2.1: Institutions surveyed during the study

INSTITUTION	RESPONSE
1. Agricultural Research Council (ARC) **	Yes
2. Council for Scientific and Industrial Research (CSIR)**	Yes
3. Medical Research Council **	Yes
4. Council for Mineral Technology (MINTEK) **	Yes
5. Nelson Mandela Metropolitan University	Yes
6. North West University	Yes
7. Nuclear Energy Corporation of SA **	Yes
8. Central University of Technology	Yes
9. Tshwane University of Technology	Yes
10. University of KwaZulu Natal	Yes
11. University of Cape Town	Yes
12. University of Johannesburg	Yes
13. University of South Africa	Yes
14. University of Stellenbosch	Yes
15. University of Pretoria	Yes
16. University of Western Cape	Yes
17. Vaal University of Technology	No
18. WITS University	Yes

The Commercialisation Questionnaire was sent out to all institutions that, over the period 1996-2015, had filed at least one PCT patent application, or that had been granted a patent by the EPO or the USPTO. In total, there were 18 such institutions (**Table 2.1**), comprising five science councils (marked **) and thirteen higher education institutions. The Questionnaire was sent to the Heads of the Technology Transfer Offices (TTOs) at these institutions, followed by telephone calls and interactions with the TTO managers to clarify and confirm information provided. As shown in **Table 2.1**, a total number of 17 completed Questionnaires were received, representing a response rate of 94%.

The Questionnaire was made up of two main sections: a) Biographical, background and qualitative information; and b) Quantitative information comprising twelve questions with regard to commercialisation. Responses to section b) of the Questionnaire were used as the main source of primary data in the study in respect of the commercialisation of IP at institutions and also the impact of the IPR-PFRD Act on the NSI.

2.4 LIMITATIONS OF THE STUDY

The study considers patent data from the EPO, PCT and USPTO based on up-to-date datasets appropriately categorised by Thomson Innovation. The data for South Africa are not appropriately categorised in a similar way as that found on electronic patent databases, as electronic records are a recent development with respect to the patent office under the CIPC. As such, there is no ability to interrogate the data to the same level as in the case of the EPO, PCT and USPTO datasets, save through a laborious manual process, which would not be to the same level of accuracy and consistency as that provided by Thomson Innovation, let alone any other non-proprietary electronic patent databases.

There was no quality assurance in respect of responses to the Questionnaire as far as ensuring that data provided was indeed verifiable. However, given the seniority levels of the personnel who responded on behalf of the institutions and the engagements by the author with these institutions, the responses are regarded as relevant and correct; they provide new datasets and insights into the state of commercialisation at institutions. As can be seen from **Table 1.1**, only one institution did not respond to the Questionnaire. This institution had a low patenting track record and as such the lack of response has a very negligible effect on the findings and conclusions of this study on IP and its commercialisation by institutions.

In the comparative studies with the BRICS group of countries, no domestic patenting data was available for the other countries, except for South Africa, and as such, the author had to rely on reported EPO, PCT and USPTO data in patent statistics reports published by these offices.

2.5 CONCLUSIONS

This chapter has provided a comprehensive overview of the various themes and approaches to the study and, in particular, the research design and methodology adopted, including the various tools employed to obtain the primary data. The next chapter presents a critical review of South Africa's macroeconomic environment, which is essential for any study of IP, as IP is an economic construct. In particular, the Chapter has discussed how patent databases available through the Thomson Innovation search engine will be utilised to gain a better understanding of the South African patent landscape over the period 1996-2015. Searches were conducted using both patent priority data as well as inventor country address, for PCT applications as well as EPO and USPTO patents, over the entire 20-year period as well as two 10-year periods (1996-2005 and 2006-2015). An approach to the comparative studies with the BRICS group of countries' international patent landscape is also discussed.

Furthermore, the preceding sections, also provide details of the 18 institutions that the Commercialisation Questionnaires was sent to, in order to gain a better understanding of the IP and commercialisation practices in publicly financed institutions. A 94% response rate was attained, with only one institution not having responded to the Questionnaire. The author adopts the view that IP and innovation are economic constructs and that they find no other basis for their existence, if they cannot have an impact on the economy. Accordingly, **Chapter 3** will provide a detailed review of the South African macroeconomic environment. Through such an analysis of the macroeconomic environment, an appropriate context is created for the importance of this study on the role of IP system on South Africa's NSI, economy and development.

CHAPTER 3: SOUTH AFRICA'S MACROECONOMIC ENVIRONMENT

"Over the past twenty years, South Africa has become a service-based economy with agriculture, mining and manufacturing representing a much smaller portion of overall economic activity, and finance, shopping, communication and transport outperforming most other sectors. This fundamental shift in the structure of the economy was not intentional, but instead reflects a lack of global competitiveness in manufacturing, combined with the population's demand for increased access to credit, cell phones, transport and branded consumer goods." – Lings (2014)

3.1 INTRODUCTION

The underlying hypothesis of this study is that IP and innovation are economic concepts. As such, when analysing South Africa's IP system and the NSI, it is important to understand the structure of the South African economy, in particular the macroeconomic environment, and thus to have a solid foundation for any recommendations in terms of how IP and innovation could foster growth, inclusiveness and competitiveness, in order to have an impact on the economy. In this regard, the study reviews South Africa's macroeconomic environment in order to identify strengths and opportunities, in particular, with regard to areas in which IP and innovation can have a meaningful impact. The study advances the view that, by analysing how South Africa has fared compared to its peers globally, it is possible that a model could be put forward for inclusive development in which IP and innovation play pivotal roles. Such an approach may not *per se* be original, as there are numerous examples globally that have followed this approach; the most notable of these is South Korea and, in more recent years, countries such as China and Brazil appear to be pursuing similar approaches too.

In 1994, South Africa's post-apartheid government required a new approach to development, as detailed in **Chapter 6**. The post-apartheid democratic government elected to follow what was essentially a mixed economy approach, hedging its bets on science and technology as being the instruments that could be used to drive development. As such, the innovation policy was adopted in 1996 in the form of the White Paper on Science and Technology (WPS&T) (1996). As would become apparent in the review of the NRDS (2002), the implementation of this policy was endangered by, *inter alia*, the lack of a critical pool of both innovation generation and enabling human capital, as well as a lack of appreciation of IP as a tool for wealth creation. Twenty years later, although progress has been made, it is submitted that much has remained the same, as will become apparent in **Chapter 8**.

Commenting on South Africa's journey since 1994, Maharaj (2010:237) submits that:

> *"the new South Africa that emerged after 1994 adopted the National System of Innovation paradigm as its conceptual framework for reform. This was formally endorsed as government policy in 1996 and placed the country as a foremost developing country, emerging market and transitional economy …. South Africa [has since] forged ahead in redressing some of its legacies, generated new and emergent contradictions and also generated interesting indicators of performance.''*

From a macro policy environment point of view, in order to address inherited defects and discrepancies in the economy, South Africa has formulated and implemented a range of policies, strategies, and laws, including but not limited to: the Reconstruction and Development Programme (RSA, 1994), the Growth, Employment and Redistribution Strategy (RSA, 1996), the Employment Equity Act (RSA, 1998), the Broad Based Black Economic Empowerment Act (RSA, 2003), the Technology Innovation Agency Act (RSA, 2008), the Intellectual Property Rights from Publicly Financed Research and Development Act (IPR-PFRD Act), the New Growth Path (RSA, 2010), and the National Development Plan (NDP, 2012). In addition, a variety of institutions have also been established or designated to implement these policies, strategies and laws, with a view to addressing the defects in the economy, most of which find their basis in the apartheid era. Notwithstanding these policy and legislative interventions, the South African economy remains characterised by low growth and high levels of unemployment. Some of the reasons advanced by Lings (2014:19) for the lack of growth, the persistence of high levels of unemployment, and the lack of progress are that these relate to policy ambiguity, and in particular to the following: too frequent switching from one economic policy to another, very broad policy documents lacking sufficient and specific details on implementation, a lack of prioritisation on sequencing frameworks, and a lack of persuasive communication of the various policies. Other possible reasons for the apartheid era discrepancies persisting despite a plethora of policies include poor or ineffective coordination amongst government departments responsible for the various policies, and also low implementation capacity in government given a changing civil service and the fact that the apartheid era government had been concerned largely with the welfare of a small proportion of the population.

It is further submitted that the different interest groups in South Africa, particularly within the ruling party ANC-led Tripartite Alliance have ensured robust debates on an appropriate choice(s) or approaches to the economy, essentially whether it should be capitalist or socialist, given the discrepancies in the structure of the economy amid low growth and persistent high unemployment, particularly amongst the youth. However, whereas significant progress has been made in the past 20 years to address many of the challenges caused by apartheid, the dream of a knowledge driven economy espoused in the NRDS (2002) remains elusive. According to the NRDS (2002:22):

> *"Currently there is less than one researcher for every thousand members of the workforce, as compared to five in Australia and ten in Japan. Given that 'technology walks on two legs', the frozen demographics prevalent in our National System of Innovation represents a critical state of affairs."*

It is thus not surprising that building a knowledge driven economy requires deliberate efforts to grow the number of researchers per million population, who in turn will contribute towards the expansion of the knowledge base to ensure that knowledge is not produced for the sake of knowledge but that it has a specific purpose, viz. to address the challenges faced by the economy. Given that generation of knowledge takes time and requires a critical mass and scale, in particular with regard to the right type of knowledge generating skills, it is important to ensure that strategies and plans in place are directed towards the long term. Translation of such knowledge to influence the economy takes even more time and requires innovation enabling skills, which are essentially different types of skills to those utilised in knowledge generation.

In looking at South Africa's macroeconomic environment, the NDP (2012), which provides a 20-year horizon plan for South Africa's economy, is also considered as being an indication of the economy that South Africa desires to have in 2030. This policy instrument categorically recognises innovation as being of great importance in realising the embodied vision of the NDP (2012:110):

> *"South Africa's competitiveness will rely on national systems of innovation, permeating the culture of business society. Innovation and learning must become part of our culture. This will require intervention from the school system, through to shop-floor behaviour to R&D spending and commercialisation."*

It is therefore important to understand what has happened in the economy over the past 20 years, to analyse the status quo and then to consider how South Africa can achieve her vision for 2030.

3.2 CONTEMPORARY SOUTH AFRICA

In 2013, at the time of writing this thesis, South Africa, a territory spanning approximately 1.2 million km^2 and divided into nine provinces, had a population of 55.6 million, distributed as set out in **Figure 3.1** below.

South Africa is a youthful country, with at least 49.6% of the population being under the age of 25 (**Figure 3.1**). Whereas having such a youthful majority presents immense opportunities in respect of having a productive population, there is also a need to ensure that the economy grows at a sufficient pace to provide employment and economic opportunities for this productive population, in order for them to be gainfully engaged.

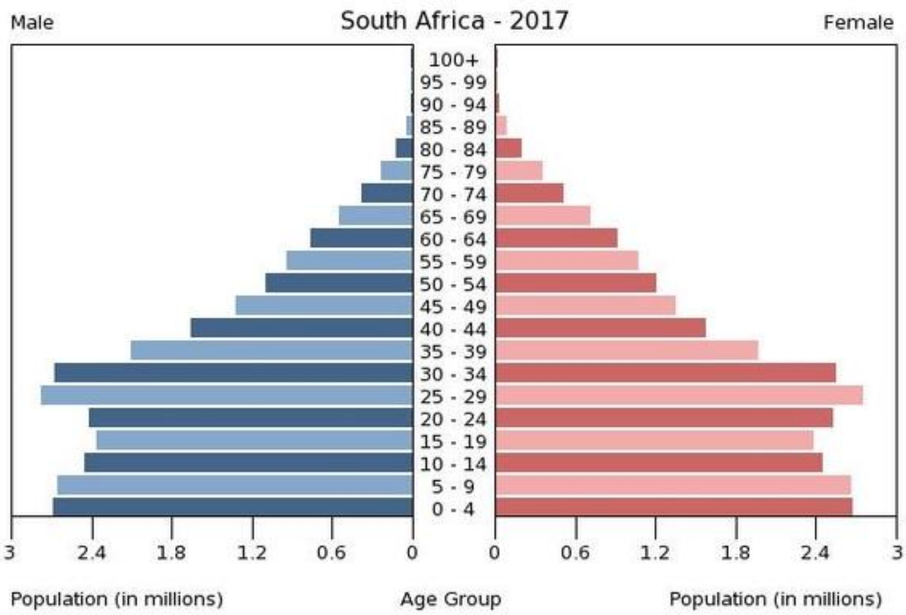


Figure 3.1: South African Population Demographic Composition [Source: US Census Bureau (2013) International Database]

South Africa has experienced significant growth in its urban population, rising from 54% in 1994 to almost 64% in 2013, as illustrated in **Figure 3.2**. There is growing youth population,

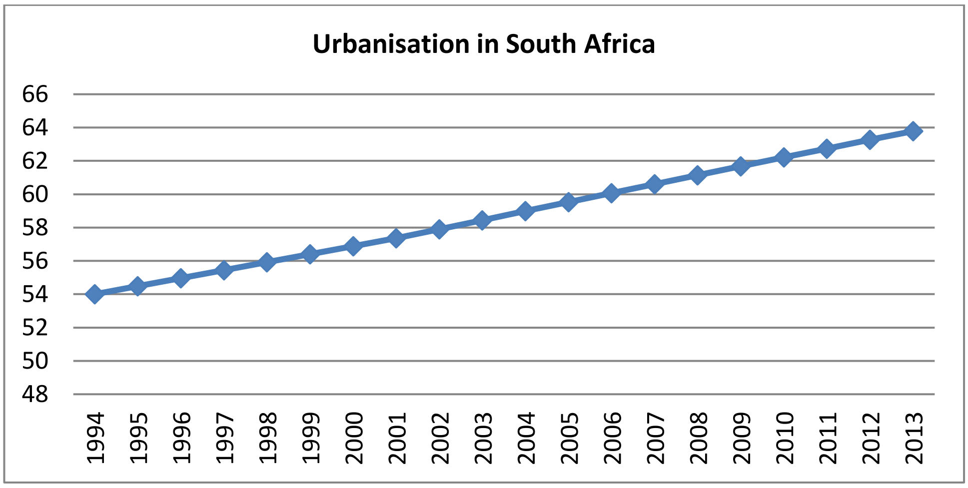


Figure 3.2: Share of South African Urban Population since 1994 [Source: World Bank Data]

The combination of a youthful population as well as a significantly high urban population requires South Africa not only to hasten service delivery improvements but also further to industrialise its economy so as to create economic opportunities for its people, particularly the youth. Emerging from the apartheid era, in which the economy excluded a significant proportion of the population, South Africa has had to strive to build a more inclusive economy in the past 23 years. Albeit adopting an essentially market or capitalist-led approach to the economy, amid high unemployment, poor education, skewed skills availability, and a growing middle class, the NDP (2012) points out that South Africa has battled to develop a more inclusive economy. Unemployment has been a big hurdle, with joblessness reaching *"its highest level since 2008 – 25.5% in the second quarter of 2014,"* according to Statistics SA.[6]

Working on the basis of the gross domestic product (GDP) as a primary economic indicator of the health of a country's economy (representing the total US$ value of all goods and services produced over a specific period), **Figure 3.3**. illustrates that the earlier years of South Africa's emergence from apartheid rule until about 2007, were also its golden years, with fairly high GDP growth rates.

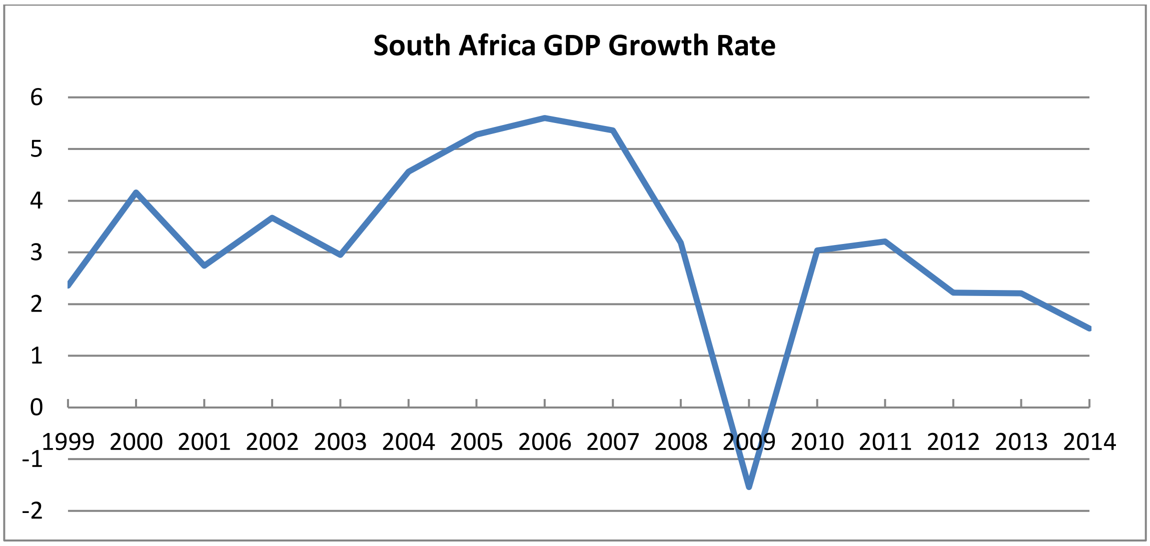


Figure 3.3: South Africa GDP Annual Growth Rate [Source: http://countryeconomy.com/gdp/south-africa]

Maharaj (2011:15) points out that:

> *"GDP per capita grew at an average rate of less than 1% per annum between 1994 and 2003. Between 2003 and 2010, this growth rate has averaged 3.7%".*

6 Statistics South Africa quarterly labour force survey (QLFS), http://www.statssa.gov.za [last accessed on 15 May 2015]

The GDP growth rate was on a decline in the period 2011 to 2014, as illustrated in **Figure 3.3**. The best GDP growth rate that South Africa has ever achieved since 1994 was 5.6% in 2006. In this regard, Lings (2014:16) observes that:

> *"Despite a somewhat disappointing growth rate over the past twenty years, the country has been able to maintain its share of the world GDP …. In 1994 South Africa comprised 0.50% of the world economy, measured in dollars at the prevailing market exchange rate. Twenty years later, South Africa represents 0.47% of the world economy ….*
> *In contrast, China has grown from less than 1.8% in 1990 to over 11% in 2013 ….*
> *In 2013 South Africa was ranked as the 31st largest economy in the world, down slightly from 29th position in 1994."*

With a GDP of US$ 350.63 billion in 2013,[7] arguably South Africa has historically been the most developed country and the largest economy in Africa, ranked as the 31st largest economy in the world in 2013. In particular, South Africa has a well-developed financial system, the largest in Africa, which also attests to its third place ranking out of 148 countries in the 2014 Global Competitiveness Index (GCI), a financial market development component. As of 2013, however, South Africa's contribution to the economy of Sub-Saharan Africa had halved compared to 1994, with the South African economy accounting for only 23% of the sub-Saharan African region's economic output, compared to 50.7% in 1994.[8] This can be attributed to a large extent to other countries in the region, particularly East Africa strengthening their economies and to some extent, to the weakening of the South African economy in some sectors such as manufacturing as will be illustrated later in this chapter.

During the same period, other countries in the region that have experienced GDP growth rates above 6%, such as Nigeria, Angola, Ghana, Tanzania, Kenya and Ethiopia (see **Figure 3.4**), increased their contribution to the region's economic output, which consequently explains the decline of South Africa's share. Given the significant growth rates experienced

7 http://www.tradingeconomics.com/south-africa/gdp [Last accessed 12 February 2017]
8 http://www.economist.com/news/finance-and-economics/21600734-revised-figures-show-nigeria-africas-largest-economy-step-change - the Economist 12th April 2014

by other countries in the region, it does appear though that South Africa's dominance in the region's economy will continue to decline.

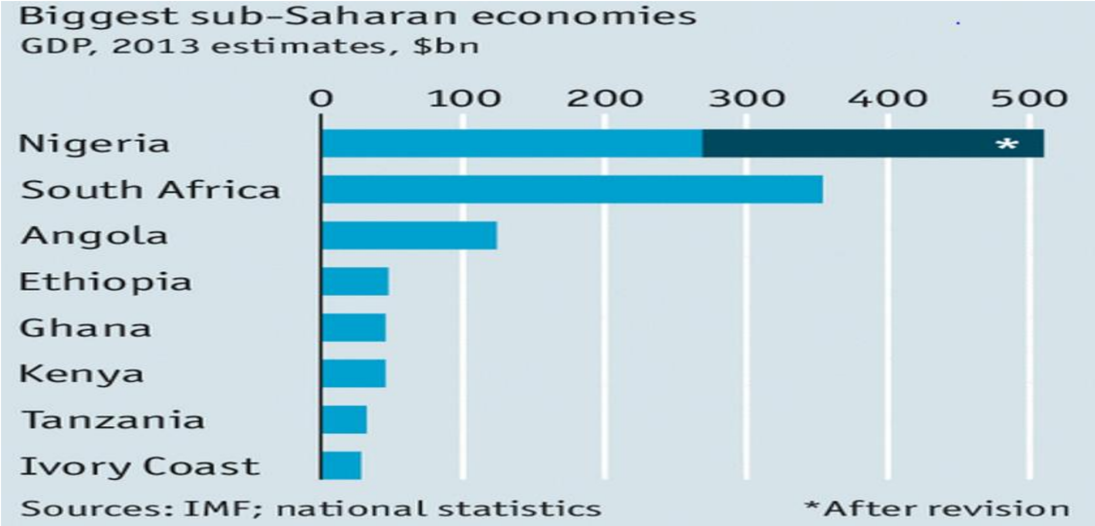


Figure 3.4: South Africa and Nigeria GDP Comparison[9]

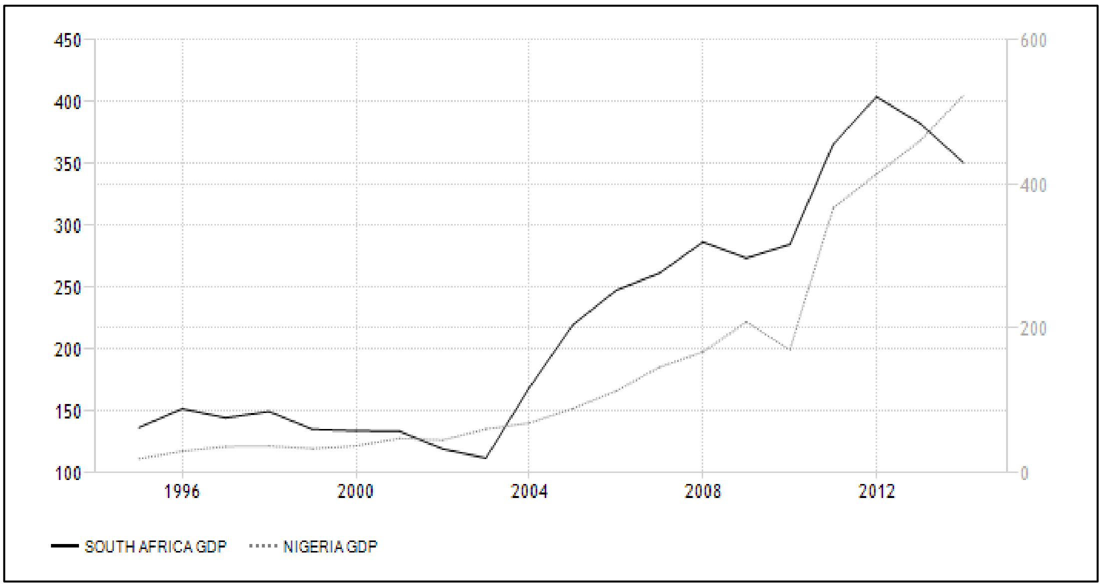


Figure 3.5: South Africa and Nigeria GDP Comparison [Source: http://countryeconomy.com/gdp/south-africa]

In 2013, Nigeria rebased its GDP, and thereafter, leapfrogged South Africa to become Africa's largest economy (see **Figure 3.5**) as well as the 24th in the list of the world's big economies.

9 Ibid.

Despite the size of South Africa's economy, unemployment has been a particularly difficult challenge to address. Unemployment stood at 25% (in 2013), three basis points higher than in 1994, when it was at 22%. Given South Africa's GDP growth hovering around 4%, on average, over the period 1994-2014, in order to address the high rate of unemployment and poverty levels *"a far higher rate of growth is needed, particularly in the private sector,… to support government's long-term development plans".*[10]

The 2015 Budget Review stated that, in 2015, GDP was expected to grow by 2%, improving gradually to 3% by 2017.[11] However, the NDP (2012) was predicated on South Africa's economy growing at a rate of 6% year on year until 2030, a feat that appears to be impossible, given the actual GDP growth rate in the past 20 years.

What further compounds this is the fact that South Africa's economy is now dominated by the services sector, whilst the technology, industrial and productive sectors including manufacturing have been on the decline, presumably on the back of sluggish investment in R&D (**Figure 3.6**)[12], a situation that will be addressed in **Chapters 8** and **9**.

10 National Treasury, 2013 Budget review – available at http://www.treasury.gov.za/documents/national%20budget/2013/review/chapter%202.pdf [last accessed on 4 May 2015]

11 National Treasury, 2015 Budget Review – available at http://www.treasury.gov.za/documents/national%20budget/2015/review/FullReview.pdf [Last accessed on 4 May 2015]

12 National Survey of Research and Experimental Development – Main Analysis Report 2012/13, Department of Science and Technology, March 2015; available at http://www.dst.gov.za/index.php/resource-center/rad-reports/1290-rad-survey-results-2012-2013 [last accessed on 12 July 2015]

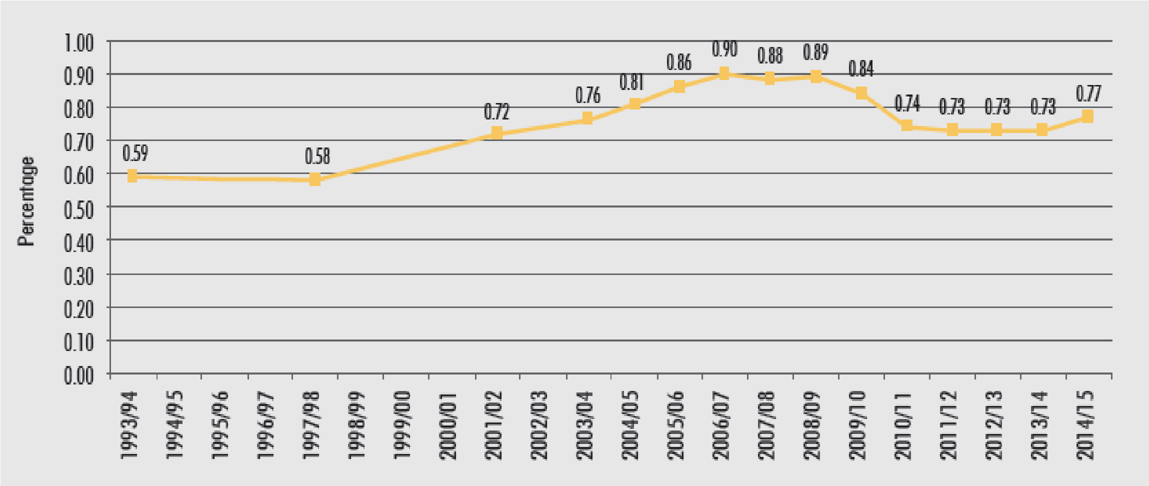


Figure 3.6: GERD as a percentage of GDP, South Africa [Source: CeSTII, 2017][13]

Suffice to say that increased R&D investment would spur innovation, increase efficiencies and productivity in the productive sectors of the economy, and enhance prospects for increased GDP growth, particularly given the experiences of countries such as Korea and China in this regard. Sibisi (2014) aptly summarises this as follows:

> *"In the South African context there are very specific conditions that provide further motivation for an increase in R&D investment, including the clear inability of the existing economic framework to provide the necessary growth, a sustained period of relative underinvestment in R&D, and the limitations of the current models of service delivery."*

3.3 DOMINANT ECONOMIC SECTORS, EXPORTS, IMPORTS AND BALANCE OF PAYMENTS

South Africa is endowed with natural resources, predominantly minerals, which is the reason for the traditional dominance of the mining sector in the South African economy in the past. Whereas historically gold dominated the mining sector, accounting for 49.2% of the sector in 1994, by 2013, however, gold had declined to 15.2% (see **Table 3.1**). The significant decline in the share of gold in the mining sector has been propped up by

13 http://www.dst.gov.za/index.php/resource-center/rad-reports/1290-rad-survey-results-2014-2015 [Last accessed 12 May 2017]

"commodities such as platinum group metals increasing to 18.6% in 2012, coal (25.7%) and iron ore (17.1%)" (IDC, 2013).

Table 3.1: Share of the mining sector according to sales [Source: IDC, 2013]

METAL	1994	2013
Gold	49.2	15.2
PGM	11.4	22.0
Chromite	0.8	3.0
Copper	2.5	1.6
Iron Ore	2.8	16.2
Manganese	1.3	3.7
Coal	20.4	26.1
Other	11.7	12.2

Figure 3.7 illustrates the contribution to the GDP of various economic sectors in 1993 and 2013. Over this period of time, significant changes in contribution of various sectors to GDP were experienced, such that in 2014, manufacturing accounted for 13.9% of GDP, mining and quarrying for around 8.3% and agriculture for 2.6%.

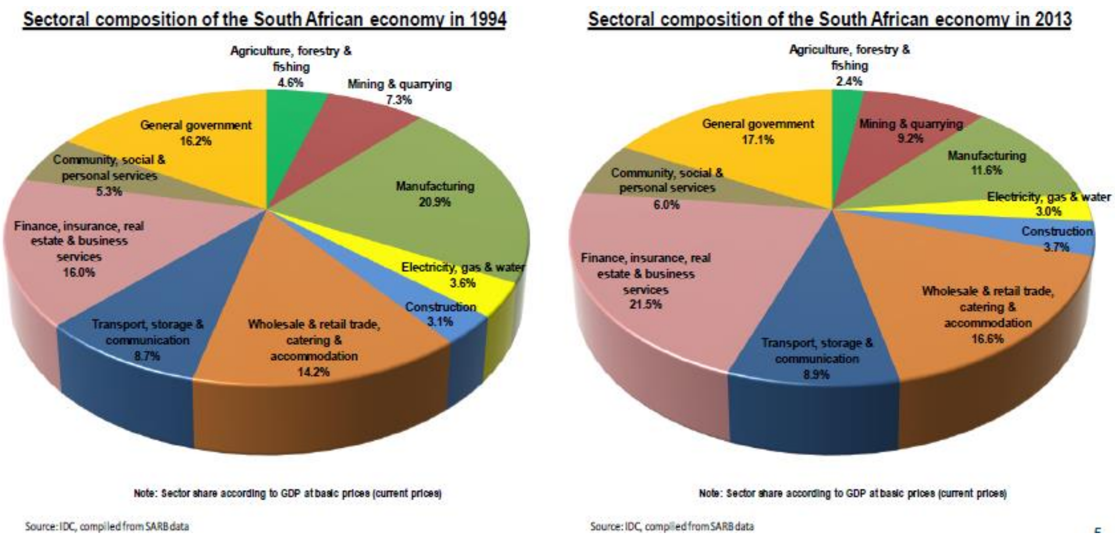


Figure 3.7: Contribution to Gross Value Added, 1993 and 2013 [Source: SARB in Hedley (2015)]

The services sector has grown significantly, since 1993. This growth has been driven largely by consumption and credit, outpacing the more productive sectors of the economy. According to Hedley (2015), as of 2014, the services sector was made up as follows: real estate and business services (21.6%); government services (17%); wholesale, retail and motor trade, catering and accommodation (15%); and transport, storage and communication (9.3%).

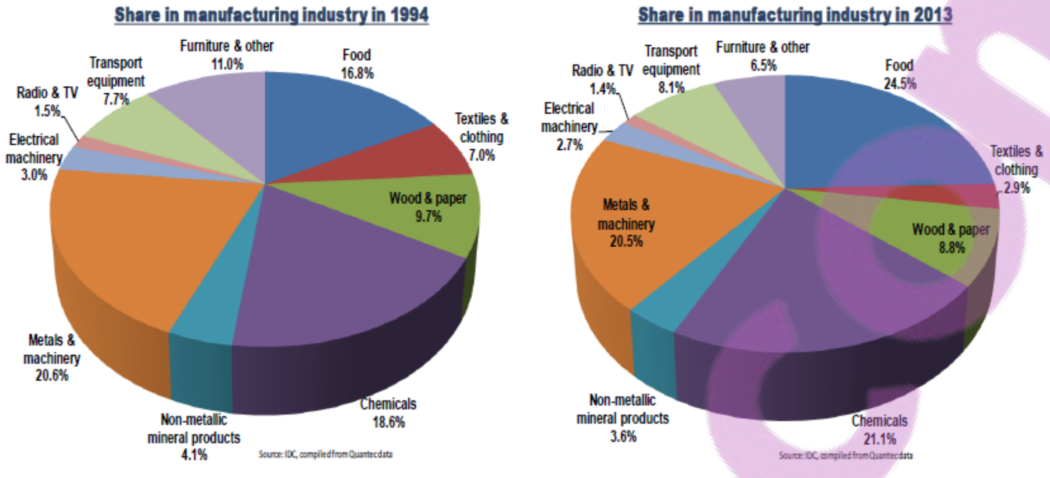


Figure 3.8: Share in the manufacturing industry in South Africa in 1994 and 2013 [Source: IDC (2013)]

A review of the manufacturing sector in 2013 compared to 1994 by the IDC (2013), illustrates the following important trends: growth in chemicals, food, transport equipment; decline in wood & paper, textiles & clothing, electrical machinery, furniture & other; and essentially little to no changes in metals & machinery and radio & TV.

It is the author's submission that if South Africa is to achieve 6% plus GDP growth rates, as set out in the NDP (2012), the South African economy will need to be based on stronger industrial, technology, and manufacturing sectors, which must be driven by the generation of new IP and innovation. However, the NDP indicative scenarios, **Figure 3.9**, postulate a higher growth in employment within the services sectors than in the more productive sectors of manufacturing, agriculture, and mining, presumably on the assumption that these sectors will rely more on mechanisation and technology.

Indicative scenarios - Sector distribution of employment

Sectors	2010	2030		
		Scenario 1 mediocre minerals	Scenario 2 solid minerals	Scenario 3 diversified
Agriculture	4.8%	2.2%	2.6%	3.4%
Mining	2.3%	1.1%	1.6%	1.8%
Manufacturing	11.8%	7.9%	9.1%	9.6%
Leader & high paid services (e.g. finance, transport)	15.4%	12.7%	15.4%	17.6%
Follower services (e.g. retail, personal services)	14.7%	17.6%	20.5%	20.9%
Construction & utilities	6.3%	4.4%	5.4%	5.9%
Informal sector & domestic work; excl EPWP	22.3%	17.2%	19.4%	21.1%
Public sector, private social services & parastatals	19.3%	13.8%	14.8%	17.8%
EPWP	3.2%	23.1%	11.1%	1.8%
Total	100.0%	100.0%	100.0%	100.0%
Manufacturing as a % excluding informal sector & EPWP	15.2%	9.6%	11.3%	12.2%
High-skill services as a % of employment excluding informal sector & EPWP	18.9%	15.3%	19.1%	22.3%

Figure 3.9: Indicative scenarios for sector distribution of employment [Source: NDP (2012)]

Manufacturing has the greatest prospects for job creation. However, there are a number of structural constraints within South Africa's macroeconomic environment that need to be addressed for this sector to be revived. These constraints include: skills deficit, policy uncertainty, labour laws coupled with wage increases that appear to have outpaced inflation and exceeded productivity, rising costs and uncertainty of electricity supply, as well as low technology use as a result of underinvestment in R&D in the past 20 years.[14] Notwithstanding these challenges, the chemicals component of the manufacturing sector, dominated by Sasol's gas to liquid and coal to liquid technologies, has shown great potential amidst the fluctuating oil and gas prices. South Africa's natural resources could be strategically used to spur the mining industry. For example, the potential use of platinum metals in fuel cells, which is supported by the Hydrogen South Africa (HySA) initiatives,[15] could spur a new manufacturing industry. Significant R&D investment to generate IP with commercial merit coupled with investment in the acquisition of appropriate technologies from abroad is required, in the short to medium term.

14 The dti, Industrial Action Policy Plan 2015, pp. 27

15 http://www.hysasystems.com/ [last accessed on 20 June 2015]

South Africa has traditionally had a strong export market as can be seen in **Figure 3.10**. However, this appears to have changed from the middle of 2003, whereafter imports have been exceeding exports. The decline in exports could be driven largely by a declining manufacturing sector coupled with increases in imports of 'computer, electronics and optical', pharmaceutical, and entertainment goods.

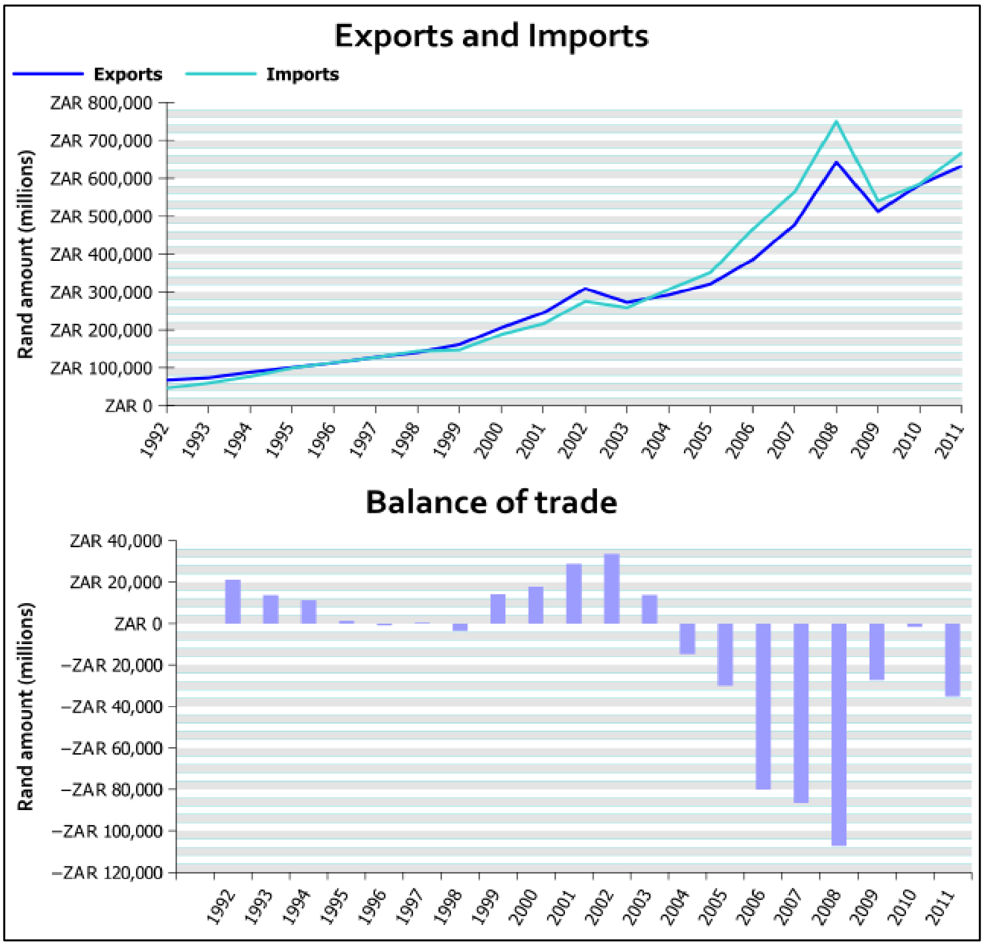


Figure 3.10: South Africa's imports, exports and balance of trade in the period 1992 to 2011 [Source: the dti][16]

This has resulted in a growing negative balance of payments, which cannot be sustainable if South Africa were to achieve its development goals set out in the NDP (2012). The role of IP and innovation in addressing this negative balance of payments form the basis of this study.

16 http://en.wikipedia.org/wiki/Foreign_trade_of_South_Africa#/media/File:South_African_trade_balance_1992-2011.svg [last accessed on 6 May 2015] – source data from http://apps.thedti.gov.za/econdb/raportt/raptottr.html

Significant increases in the trade deficit and balance of trade that have characterised the South African economy in recent years have occurred mainly in the high technology sectors. In particular, the contributions of the various sectors are: electronics sectors 14.5%, pharmaceuticals 12.7%, scientific instruments 11%, office, accounting and computing machinery 10.7% and aerospace 3.5%.[17] The National Advisory Council on Innovation (NACI) (2015:20) points out that the pharmaceuticals and 'computer, electronics and optical' industries had an export market share of 0,05% in 2004, which in 2013 had risen to 0,09% and 0,07%, respectively (**Table 3.2**).

Table 3.2: Export Percentage Market Share for High Technology Manufacturing Industries [Source: NACI (2015)]

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Pharmaceuticals	0,05	0,05	0,04	0,04	0,05	0,04	0,09	0,10	0,04	0,09
Computer, Electronics and Optical	0,05	0,05	0,05	0,06	0,06	0,06	0,07	0,07	0,06	0,07
Aerospace	0,16	0,37	0,27	0,23	0,25	0,10	0,13	0,14	0,11	0,14

Source: OECD "Main Science and Technology Indicators"

The pharmaceutical sector, at US$3.65bn in 2015 according to Business Monitor International (BMI) (2015), is an important sector, as it contributes about 1.6% to the GDP (NACI, 2015). This sector provides direct employment to over 9 600 people and a further 11 100 indirect jobs according to NACI (2014:45). Given South Africa's growing disease burden, as further illustrated by the increase in pharmaceutical imports, **Table 3.3**, this sector is important, especially considering that, according to BMI (2015:44):

> *"South Africa's pharmaceutical market is the single largest on the African continent; its pharmaceutical spending per capita is also the highest on the continent at US$69 in 2014."*

An analysis of the balance of trade for the pharmaceutical sector also suggests that South Africa has the capacity to increase the exports in this sector. By the same token, whereas

17 DG's presentation to TUT, CSIR Board and Parliamentary committee, slide entitled – 'A High-Technology Manufacturing Trade Deficit Trend'

the trade balance has been on the increase in the 'computer, electronics and optical' industries, the exports have been on the increase, thus suggesting some capabilities as well as the capacity to drive exports through innovation.

Table 3.3: Trade Balance for High Technology Manufacturing Industries (million US$) [Source: NACI (2015:46)]

		2005	2006	2007	2008	2009	2010	2011	2012	2013
Pharmaceuticals	Imports	1 218	1 377	1 530	1 640	1 665	2 138	2 257	2 432	2 358
	Exports	706	636	585	688	251	221	459	379	544
	Trade Balance	-1 091	-1 248	-1 375	-1 446	-1 473	-1 972	-2 066	-2 224	-1 903
Computer, Electronics and Opticals	Imports	7 331	8 408	8 263	8 283	6 689	8 850	9 895	9 215	9 967
	Exports	847	1 002	1 162	1 216	1 080	1 063	1 221	1 389	1 629
	Trade Balance	-6 484	-7 406	-7 101	-7 067	-5 609	-7 786	-8 674	-7 826	-8 338
Aerospace	Imports	1 894	1 599	1 807	2 119	1 284	1 311	1 934	1 301	833
	Exports	706	636	585	688	251	221	459	379	544
	Trade Balance	-1 188	-963	-1 221	-1 431	-1 033	-1 090	-1 475	-922	-289

Source: OECD "Main Science and Technology Indicators"

South Africa still has significant exports of manufactured goods into the rest of the African continent, despite a decline in manufacturing sector (**Figure 3.11**).

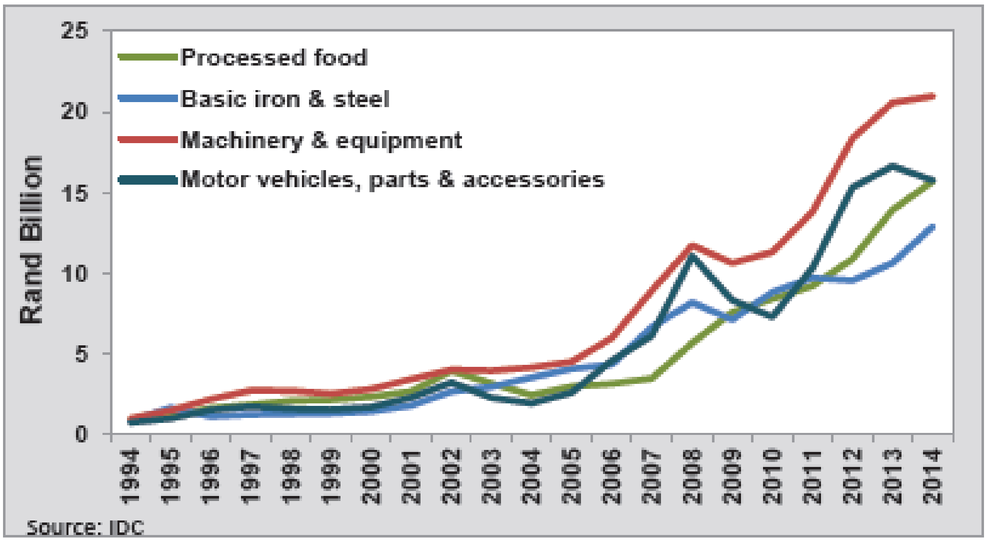


Figure 3.11: South Africa's top manufactured exports to the rest of the African continent [Source: IPAP (2015:23)]

On the basis of the growth in value of South Africa's top manufactured exports, it appears that there is an untapped opportunity to grow South Africa's manufacturing industry in these areas, through appropriate use of IP, technology and innovation.

3.4 SOUTH AFRICA'S RELATIVE GLOBAL POSITIONING

The relative global positioning of South Africa in relation to some of its trading partners, in particular, the BRICS countries, it needs to be understood in order to develop a pragmatic approach to the generation and use of IP and innovation for South Africa's development. Whereas in this chapter the focus is on macroeconomic indicators, the relative comparison in respect of IP and innovation positioning will be dealt with in **Chapters 7-9**.

Perhaps a starting point would be to get a better appreciation of the so-called BRICS grouping of countries, comprising Brazil, Russia, India, China and South Africa. South Africa was only admitted to the BRICS group in 2010. According to Straus (2012:655), as of 2014, the BRICS countries represented more than 3 billion people (approximately 41% of the world's population) and contributed more than 20% to the global economy. The combined GDP of the BRICS countries is about US$16.039 trillion (approximately 20% of the gross world product).[18] According to Singh and Dube (2014), the BRICS countries constitute 25% of the world's GDP and 15% of world trade. In addition, the BRICS countries' share of the world's economically active population is about 45.3%.

3.4.1 GDP Comparisons

Comparative analysis of South Africa's GDP per capita to Kenya and India, which have traditionally lagged behind South Africa, **Figure 3.12** and **3.13**, respectively, shows South Africa levelling off and Kenya and India either equalling or surpassing South Africa in 2014.

18 World Economic Outlook IMF, April 2013

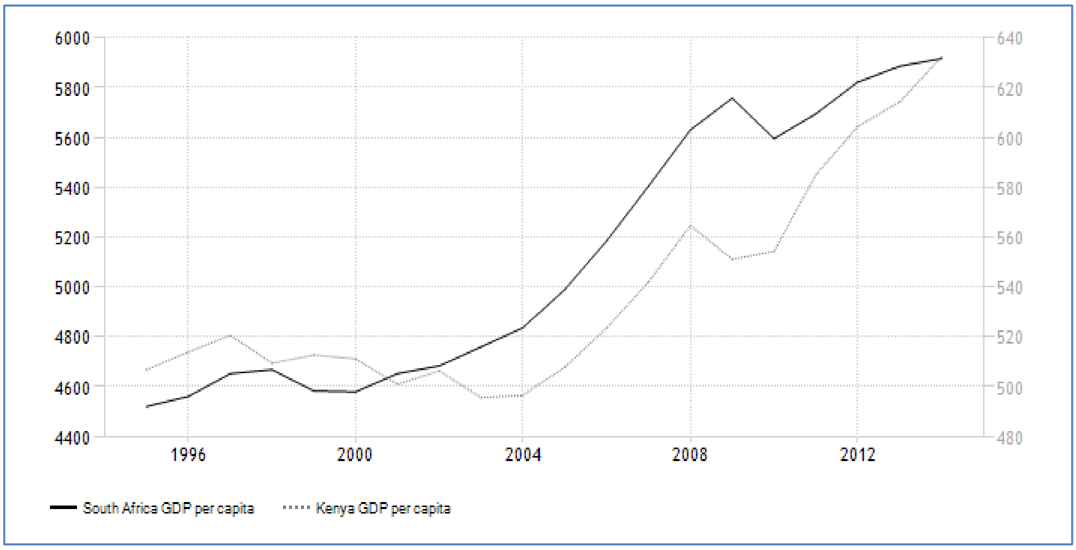


Figure 3.12: GDP per capita for South Africa and Kenya [Source – World Bank Data]

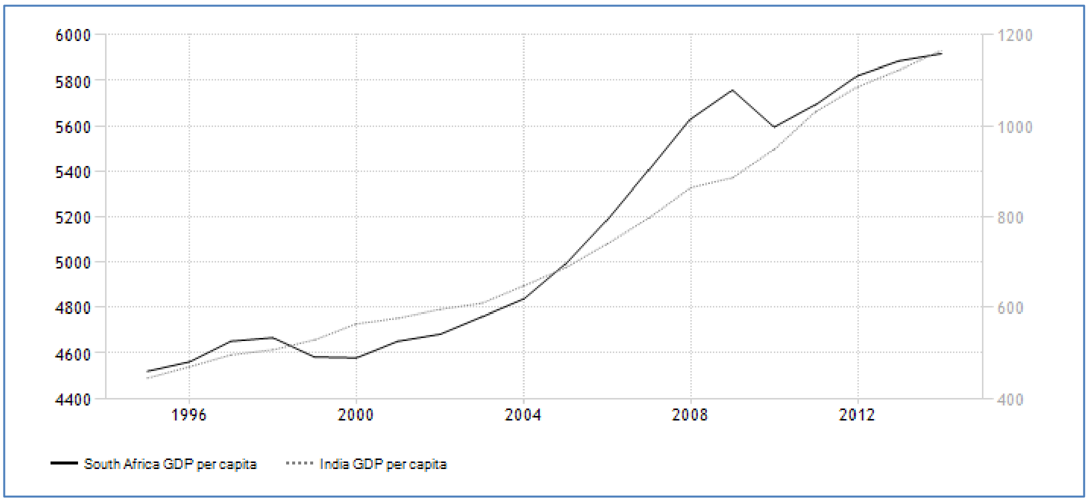
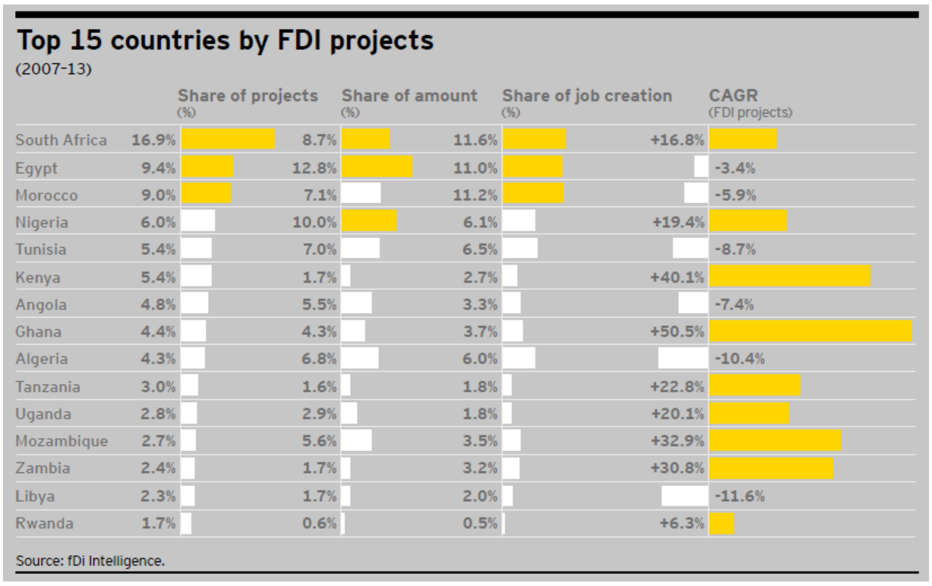


Figure 3.13: GDP per capita for South Africa and India [Source – World Bank Data]

3.4.2 Foreign Direct Investment (FDI)

FDI indicators for the top 15 countries by projects (**Figure 3.14**) show that South Africa has the lion's share of projects and investments in Africa, with concomitant job creation benefits.



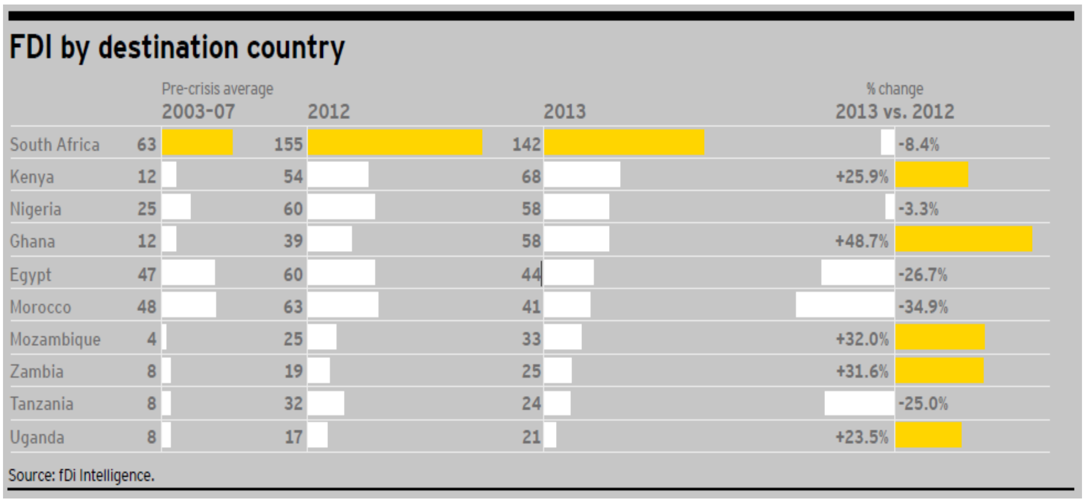
Top 15 countries by FDI projects
(2007-13)

	Share of projects (%)	Share of amount (%)	Share of job creation (%)	CAGR (FDI projects)
South Africa	16.9%	8.7%	11.6%	+16.8%
Egypt	9.4%	12.8%	11.0%	-3.4%
Morocco	9.0%	7.1%	11.2%	-5.9%
Nigeria	6.0%	10.0%	6.1%	+19.4%
Tunisia	5.4%	7.0%	6.5%	-8.7%
Kenya	5.4%	1.7%	2.7%	+40.1%
Angola	4.8%	5.5%	3.3%	-7.4%
Ghana	4.4%	4.3%	3.7%	+50.5%
Algeria	4.3%	6.8%	6.0%	-10.4%
Tanzania	3.0%	1.6%	1.8%	+22.8%
Uganda	2.8%	2.9%	1.8%	+20.1%
Mozambique	2.7%	5.6%	3.5%	+32.9%
Zambia	2.4%	1.7%	3.2%	+30.8%
Libya	2.3%	1.7%	2.0%	-11.6%
Rwanda	1.7%	0.6%	0.5%	+6.3%

Source: fDi Intelligence.

Figure 3.14: Top 15 African countries by FDI projects for the period 2007 – 2013 [Source: EY (2014)]

However, in the period 2012-2013, **Figure 3.15**, other African countries such as Ghana, Kenya, Mozambique, Zambia and Uganda demonstrated greater positive FDI growth of up to 48% in the case of Ghana, compared to South Africa, which had shrunk by 8.4%.



FDI by destination country

	Pre-crisis average 2003-07	2012	2013	% change 2013 vs. 2012
South Africa	63	155	142	-8.4%
Kenya	12	54	68	+25.9%
Nigeria	25	60	58	-3.3%
Ghana	12	39	58	+48.7%
Egypt	47	60	44	-26.7%
Morocco	48	63	41	-34.9%
Mozambique	4	25	33	+32.0%
Zambia	8	19	25	+31.6%
Tanzania	8	32	24	-25.0%
Uganda	8	17	21	+23.5%

Source: fDi Intelligence.

Figure 3.15: FDI in Africa by Destination for the period 2003 – 2013 [Source: EY (2014)]

According to EY (2014:24):

> *"The strength of Southern Africa as an investment destination is derived largely from the power of the South African economy. South Africa has maintained its lead in FDI projects, positioning itself as a launch pad for foreign investment into the fast-growing African markets to its north. While some investors are concerned that the country may lose its 'gateway to Africa'*

> *status, FDI numbers indicate that it remains very attractive. In FDI project numbers, South Africa has widened its lead over other countries since 2008. In fact, in 2012 and 2013, the country received at least double the number of FDI projects of the second-largest recipient."*

Figure 3.15. shows growth in FDI investment for a number of major African countries. South Africa has demonstrated significant growth since 2003-07 pre-crisis period compared to then dominant peers, Egypt and Morocco. In 2012 and 2013, South Africa attracted more than double FDI investment than the next major countries, with Kenya and Nigeria being second and third, respectively. South African has been and continues to be the top FDI investment destination, despite other African countries becoming more attractive as a destination, as illustrated in particular by the significant FDI growth for Ghana, Mozambique, Zambia, Kenya and Uganda, between 2012 and 2013 as illustrated in (**Figure 3.15**). It is thus submitted that South Africa must make an effort to grow its knowledge sector, particularly by increasing its knowledge creation and by enabling human capacity to ensure that it becomes an attractive FDI destination for the technology and productive sectors, to enable it to compete with its African peers. The NDP (2012), however, whilst acknowledging the importance of innovation, seems to underplay South Africa's potential and growth in the knowledge and productive sectors, as illustrated by the indicative scenarios of sector distribution of employment, **Figure 3.9**.

A comparative analysis of South Africa's Balance of Payments (BOP) with the rest of the BRICS countries, is shown in **Figure 3.16**. BoP comprises payments and receipts between residents and non-residents for use of proprietary rights (such as patents, trademarks, copyrights, industrial processes and designs, including trade secrets, and franchises) and for the use, through licensing agreements, of produced originals or prototypes (such as copyrights on books and manuscripts, computer software, cinematographic works, and sound recordings) and related rights (such as for live performances and television, cable, or satellite broadcast). South Africa makes very little use of its own IP as demonstrated by the significantly higher payments for IP use than receipts it receives from third parties and non-residents who utilise its IP.

An analysis of the proportion of high technology exports in respect of manufactured exports shows South Africa to have relatively low proportions than its peers do in the BRICS countries: just above 5.4% in 2013, compared to India at 8.1%, Russia at 8.4%, Brazil at 9.6%, and China at 27%, **Figure 3.17**.

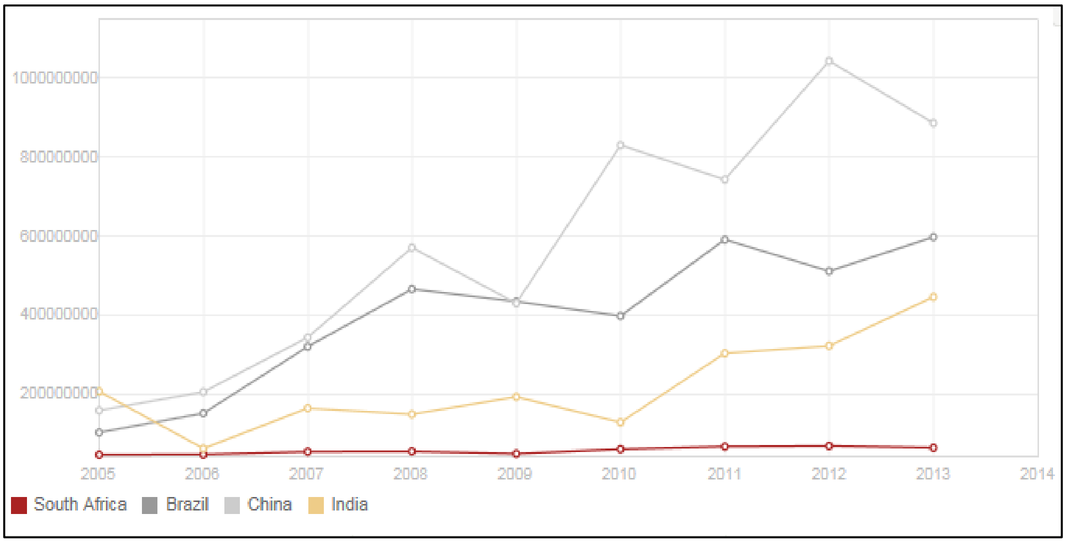


Figure 3.16: Charges for the use of intellectual property, receipts (BoP, current US$) [Source: World Bank][19]

Figure 3.17: High-technology exports as a percentage of manufactured exports amongst the BRICS Countries [Source: World Bank Data]

19 http://data.worldbank.org/indicator/BX.GSR.ROYL.CD/countries/ZA-BR-CN-IN?display=graph [last accessed on 6 May 2015]

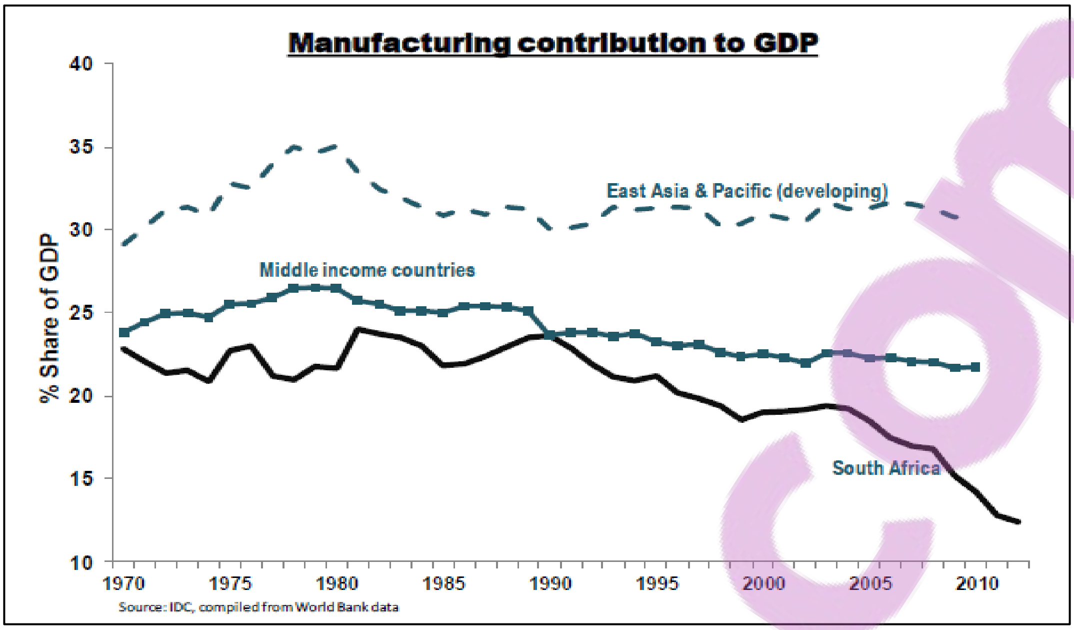


Figure 3.18: Manufacturing share of GDP - South Africa and other world regions[20]

Figures 3.18 and **3.19** illustrate the share of the GDP of the manufacturing sector and the services sector, respectively, for the period 1970 to 2010, of South Africa and other world regions.

As already illustrated earlier, whereas the manufacturing sector has been steadily on the decline, the services sector for South Africa has grown substantially over the same period. Of particular interest is the comparison of both sectors with the rest of the world. In particular, whereas there has been a general decline in the manufacturing sector, the decline in South Africa has been much more marked than in other middle-income countries, which in 1994 had an almost similar contribution to GDP at about 24%. This declined over the period to about 22% for the middle-income countries, compared to South Africa's decline to about 13% of GDP.

Ideally, South Africa needs to increase its manufacturing contribution to levels above 25% for economic growth to have meaningful outcomes. One suggestion for growing the

20 http://c.ymcdn.com/sites/www.bmfonline.co.za/resource/resmgr/docs/south_african_economy_-_over.pdf [last accessed on 4 June 2015]

manufacturing sector, as made by Hedley (2015:20), presumably on the basis of South Africa's growing inter-trade with the other African countries, is for South Africa to *"export its technology and intellectual property to regional African markets and in that way stimulate our manufacturing industry for the African continent."*

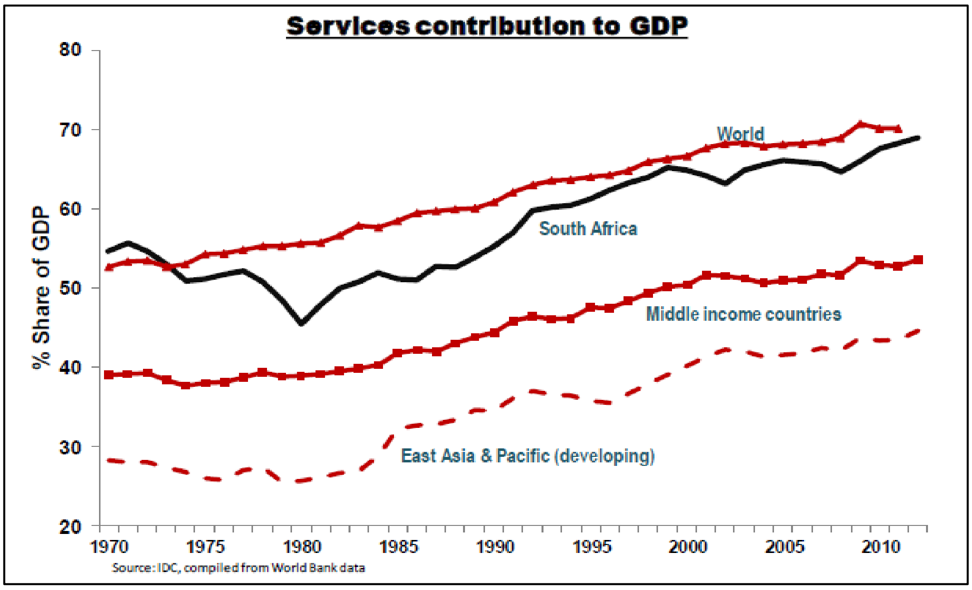


Figure 3.19: Services share of GDP - South Africa and other world regions[21]

As illustrated in **Figure 3.19**, the services sector's contribution to the South African GDP has historically been higher than in other middle-income countries as well as in the Asian and Pacific developing economies. However, the increase in the contribution of the services sector to GDP has become much more significant in the case of South Africa, with the net contribution at approximately 70% of GDP for South Africa in 2010 compared to 54% for middle-income countries and 45% for East Asian and Pacific economies. It can be argued that the extent to which the services sector has outpaced the manufacturing sector in the case of South Africa, compared to other middle-income countries or the Asian and Pacific developing countries, is one of the underlying reasons for the sluggish growth of the South African economy.

21 http://c.ymcdn.com/sites/www.bmfonline.co.za/resource/resmgr/docs/south_african_economy_-_over.pdf [last accessed on 4 June 2015]

3.4.3 Global Competitiveness and Innovation Rankings

South Africa's Global Competitiveness Index (GCI) ranking of 56 out of 144 countries in 2014/15, places it ahead of both Brazil (57) and India (71). This is poorer ranking than that of 50 out of 142 countries in 2011/12, **Table 3.4**.

Table 3.4: Global Competitiveness Index Ranking - BRICS Comparison (2011-2015)

YEAR	NO OF COUNTRIES	SOUTH AFRICA	BRAZIL	RUSSIA	INDIA	CHINA
2010/11	142	54	58	63	51	27
2011/12	142	50	53	66	56	26
2012/13	144	52	48	67	59	29
2013/14	148	53	56	64	60	29
2014/15	144	56	57	53	71	28

With South Africa placed third amongst the BRICS in terms of the GCI, World Economic Forum (WEF) (2014:39) states that:

> *"South Africa does well on measures of the quality of its institutions (36th), including intellectual property protection (22nd), property rights (20th), the efficiency of its legal framework in challenging and settling disputes (9th and 15th, respectively), and its top-notch accountability of private institutions (2nd). Furthermore, South Africa's financial market development remains impressive at 7th place, although our data point to more difficulties in all channels of obtaining finance this year. The country also has an efficient market for goods and services (32nd), and it does reasonably well in more complex areas such as business sophistication (31st) and innovation (43rd), benefitting from good scientific research institutions (34th) and strong collaboration between universities and the business sector in innovation (31st)."*

In respect of the 20 largest emerging economies, **Table 3.5** shows South Africa's ranking to have declined 16 places since 2010 in the labour market efficiency component of the GCI, at a ranking of 113 out of 144 in 2014/15.

Table 3.5: Ranking of some of the 20 largest emerging economies on selected components of the GCI [Source: WEF (2014:34)]

		Public institutions		Market competition		Labor market efficiency	
GCI 2014–2015 rank	Country	2014–2015 rank	Since 2010*	2014–2015 rank	Since 2010*	2014–2015 rank	Since 2010*
20	Malaysia	23	+21	9	+20	19	+16
24	Saudi Arabia	26	–5	33	–24	64	+2
28	China	43	+3	86	–22	37	+1
32	Thailand	93	–23	47	+6	66	–42
34	Indonesia	53	+4	57	+3	110	–26
43	Poland	56	–2	46	+3	79	–26
45	Turkey	67	+23	44	+18	131	–4
52	Philippines	75	+49	109	+12	91	+20
53	Russian Federation	102	+16	119	+10	45	+12
56	South Africa	45	+8	35	+8	113	–16
57	Brazil	104	–8	135	–3	109	–13

South Africa's ranking in the Global Innovation Index (GII) improved from 58 in 2013 to 53 in 2014, ahead of India and Brazil, which were placed 76 and 61, respectively in 2014 (see **Table 3.6**).

Table 3.6: Global Innovation Index BRICS Comparison (2011-2014)

YEAR	NO OF COUNTRIES	SOUTH AFRICA		BRAZIL		RUSSIA		INDIA		CHINA	
		Rank	Index	Rank	Index	Rank	Index	Rank	Index	Rank	Index
2011	125	59	35.22	47	37.75	56	35.85	62	34.52	29	46.43
2012	141	54	37.4	58	36.6	51	37.9	64	35.7	34	45.4
2013	142	58	37.6	64	36.33	62	37.2	66	36.17	35	44.66
2014	143	53	38.2	61	36.3	49	39.1	76	33.7	29	46.6
Source: Global Innovation Index various editions											

Amongst the BRICS countries, Cornell *et al*. (2014:12) find that:

> *"All of them, with the exception of South Africa, qualify as 'efficient innovators' this year, meaning that they have innovation efficiency scores (calculated as total innovation outputs over total innovation inputs) greater than or equal to the average (0.74)."*

It is evident from an analysis of selected components of the GII 2014, **Figure 3.20**, that South Africa scored the lowest amongst the BRICS in three components: Human capital and research, Infrastructure, and Business Sophistication. In the Knowledge and technology outputs component, South Africa is marginally better than Brazil but worse than China and Russia.

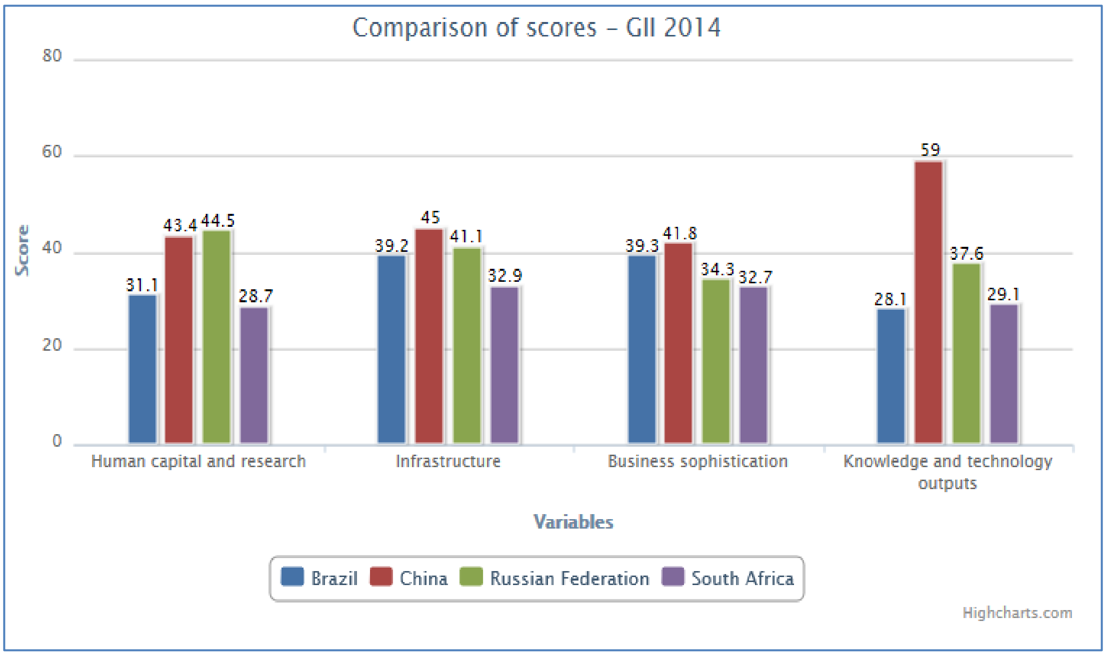


Figure 3.20: BRICS countries' comparative analysis of selected components of the Global Innovation Index 2014 scores [Source: https://www.globalinnovationindex.org]

3.5 SOUTH AFRICAN DEVELOPMENT POLICY ENVIRONMENT AND FUTURE OUTLOOK

The NDP (2012), also known as Vision 2030, given its focus on developing South Africa's economy for 2030, is the main economic vision policy statement. The NDP (2012) adopts a multidimensional framework, supported by other policy instruments, such as the Industrial Policy Action Plan (IPAP), which is driven largely by *the dti*. This section is not intended to reproduce the contents of either the NDP or the IPAP. However, a high-level summary of South Africa's economy in 2030 is provided, as are the underlying assumptions, together with inputs from the IPAP.

The NDP, in recognising South Africa as one of the most unequal societies in the world, sets out six interlinked priorities, namely:

(i) Uniting all South Africans around a common programme to achieve prosperity and equity;

(ii) Promoting active citizenry to strengthen development, democracy and accountability;

(iii) Bringing about faster economic growth, higher investment and greater labour absorption;

(iv) Focusing on key capabilities of people and the state;

(v) Building a capable and developmental state;

(vi) Encouraging strong leadership throughout society to work together to solve problems.

Through successful implementation of the NDP, it is hoped that, by 2030, South Africa will have addressed some of disparities in its economy and society to achieve the following milestones:

(a) reduction of unemployment from above 25% down to below 6%, through the creation of an additional 11 million jobs, whilst preserving existing ones;

(b) tripling the size of the economy to about ZAR 5.27 trillion by growing the economy year-on-year at rates above 5%;

(c) raising the per capita income from ZAR50,000 in 2010 to R120,000 by 2030;

(d) eradicating poverty, which presently stands at 39%;

(e) increasing access to electricity from 85% to 100%; and

(f) making high-speed broadband internet universally available at competitive prices.

The NDP (2012) essentially has three phases, as set out in **Figure 3.21**.

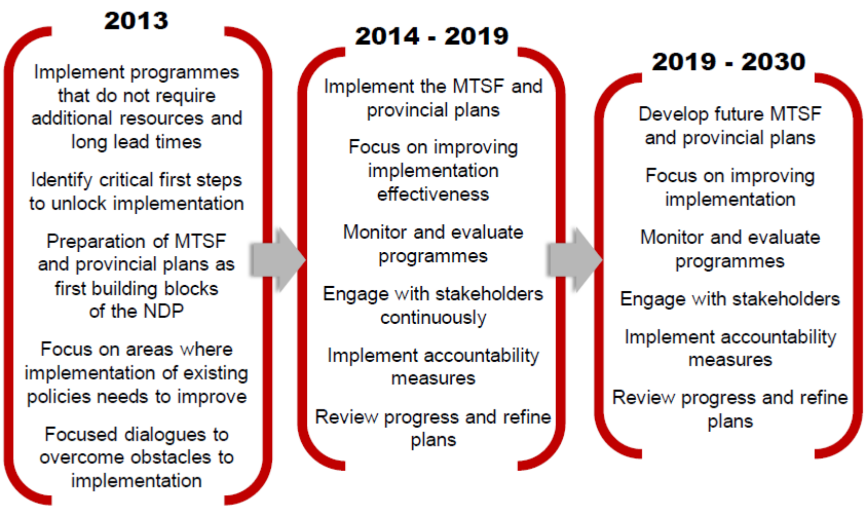


Figure 3.21: Implementation Phases of the National Development Plan [Source: NDP (2012)]

In respect of innovation, the NDP (2012) identifies innovation as being critical in the creation of the 11 million jobs; it spells out the following objectives and actions, in addition to expanding science, technology and innovation outputs through increased R&D investment. In particular, the NDP (2012:28) states that the country must focus on:

> *"Raising competitiveness and export earnings through better infrastructure and public services, lowering the costs of doing business, improving skills and innovation, and targeting state support to specific sectors."*

In addition, the NDP (2012:30) states the aspiration of an ideal NSI that would have an impact on the economy to be:

> *"a larger, more effective innovation system, closely aligned with firms that operate in sectors consistent with the growth strategy."*

Subsequent to the NDP (2012), the McKinsey Global Institute released a report, *South Africa's big five: Bold priorities for inclusive growth* (McKinsey, 2015). This identifies five opportunities to stimulate economic growth in South Africa: *"advanced manufacturing, infrastructure, natural gas, service exports, and the agricultural value chain."* Manufacturing in general has declined between 1994 and 2013 as illustrated in Figure 3.7. Unless South Africa puts in place radical measures to spur manufacturing in general, and also makes effective use of technology and IP, it is the author's view that the identified opportunities in advanced manufacturing may not be realised. McKinsey (2015) advances the view that prioritisation of these five areas by both government and businesses could *"increase GDP growth by a total of 1.1 percentage points per year, adding 1 trillion rand ($87 billion) to annual GDP and creating 3.4 million new jobs"* by 2030. As we have seen in the preceding sections in this chapter, South Africa does indeed have nascent strengths in a number of these areas, and it therefore makes sense to accelerate their development. What is perhaps missing from McKinsey (2015) is the role of IP in ensuring that South Africa is globally competitive in these areas. This study will thus seek to demonstrate the importance of South Africa's growing IP portfolio in financial services (wholesale and retail banking and insurance).

3.6 CONCLUSIONS

This chapter has highlighted South Africa's adoption of the NSI paradigm as a framework for the role of innovation in economic reform. The WPS&T (1996) and NRDS (2002) make specific pronouncements that have since been followed up, by a range of policies, strategies, and legislative developments. More recently, the NDP (2012) sets out a bold developmental vision for South Africa in terms of which it is hoped that unemployment will be reduced to below 5% as a result of higher levels of economic growth (above 6%). This is particularly important given South Africa's youthful population and high levels of unemployment as highlighted in this chapter.

Although South Africa's GDP has been growing since 1996, there have been shifts in the economy, characterised by a continued decline in the manufacturing sector since 1996 to below 13% of GDP in recent times, and an increase in the services sector, which now accounts for almost 70% of the GDP. The levels of both the manufacturing and the services sectors are below and above, respectively, of East Asian and Pacific economies as well as other middle-income countries.

This study advances the view that IP is important for the development of technological capabilities and competitiveness, and that South Africa needs to upgrade its technological capabilities in order to grow its manufacturing sector. With regard to manufactured exports, South Africa performs below its peers in the BRICS countries in terms of high technology exports, which is not surprising, given the high balance of payments for IP, owing to increasing imports of high value products. South Africa has demonstrated resilience and technological capability, and it could reverse the current trend through increased technological capabilities, improved IP systems and a more coordinated NSI. Improvements in its rankings in the GCI, ahead of India and Brazil (amongst the BRICS countries), as shown in this chapter, attest to this possibility.

Although the NDP (2012) indeed identifies innovation as being important to South Africa's future development, there is no clear understanding of the current IP and innovation systems, and to what extent they could be utilised to support the envisaged growth. The next chapter will thus look at the various international legal instruments that are important for the IP system, with particular emphasis on the new world order brought about by the establishment of the WTO and the TRIPS Agreement. South Africa's IP system must be relevant to the country's development and yet align with these instruments, given South Africa's membership of the WTO.

CHAPTER 4: INTERNATIONAL LEGAL INSTRUMENTS RELATING TO INTELLECTUAL PROPERTY

"A successful Intellectual Property structure presupposes independent and exclusive rights holders operate in a functioning market." – Joseph Straus (2012)

4.1 INTRODUCTION

An analysis of various international legal instruments relating to IP, including those administered by the WTO and the WIPO, is essential as a basis for understanding South Africa's IP and innovation systems. These legal instruments include the International Convention for the Protection of Industrial Property (the "Paris Convention"), the TRIPS Agreement and the PCT, which have all had a significant impact on global economies; they will be explored with particular emphasis on their relevance for IP, innovation and development.

The TRIPS Agreement is administered by the WTO. On the other hand, the PCT and the Paris Convention are administered by the WIPO. The TRIPS Agreement needs to be understood from a broader perspective than just intellectual property. In essence, the TRIPS Agreement deals with issues of IP as essential components in trade and developmental priorities. In this regard, the TRIPS Agreement needs to be viewed in relation to its application, and specifically with regard to how IP can be used to support a country's industrial policy and developmental objectives, based on its status of development. Straus (2012) asserts that *"functioning market economies require a complex socio-economic structure supported by the country's legal and social environment."*

The various international legal instruments forming the subject of this chapter have had a significant impact on countries' legal and social environments, and if South Africa is to achieve the developmental objectives set out in the NDP (2012), it is important to understand these instruments. It is also important to understand the role of IP in the development of economies of countries such as Brazil, India, Japan, and South Korea, which, according to Straus (2012:639), *"grew remarkably through imitation and eventual competition with established technological nations."*

Whereas the Paris Convention laid down only minimum standards for IP protection, Straus (2012:643) points out that the TRIPS Agreement provides mandatory protection standards of IP rights: these specifically include duration of protection, subject matter eligibility, effects of granted rights, and burden of proof in infringement proceedings. All of these have had a significant impact on international patent protection regimes. Straus (2012:644) further points out, that the mandatory nature of the TRIPS Agreement and, in particular, Article 27 (1), which stipulates that members are to grant patents for both process and product inventions in all fields of technology, as long as they meet the mandatory criteria, has had a *"substantial economic impact on pharmaceutical inventions,"* where there has been great uncertainty as to what is patentable given access to health concerns.

4.2 PARIS CONVENTION

The International Convention for the Protection of Industrial Property (the so-called Paris Convention), concluded in Paris in 1883, introduced the concept of national treatment,[22] in terms of which member states are required to extend the same treatment in respect of industrial property protection to nationals of other members of the Paris Convention as it does to its own nationals. According to Taubman *et al*. (2012:10), this concept *"forbids discrimination between a Member's own nationals and the nationals of other Members."*

The second concept introduced by the Paris Convention, which is important for design registrations and patents, in particular, is that of priority rights. As disclosed in Burrel (1999:9), this facilitates obtaining patent protection in multiple foreign countries, which are Paris Convention Members, within a priority period of six or twelve months, respectively, from a first application, as long as there has been compliance with requisite formalities. Once, for example, an inventor has filed a design registration or patent application in his own country, the date of filing is deemed as the priority date. This first

22 Article 2(1) of the Paris Convention for the Protection of Industrial Property, March 20, 1883 21 U.S.T 1583, 828 U.N T.S 305, last revised at Stockholm, July 14, 1967

application may serve as prior art or novelty destroying disclosure to invalidate the novelty of any invention covered by a design registration or patent application (as the case may be) with a later filing date in any of the Paris Convention Members. Reiss (2008) teaches that, prior to the Paris Convention, applicants needed to file simultaneous patent applications in all the countries in which they were interested. At the same time, they had to file the application in their home country, or risk loss of novelty through any publication of exhibition or market testing of the invention that might happen before any patent application could be filed in a foreign country. Now all an inventor has to do is to file a Convention patent application, accompanied by a complete patent specification in any Convention Member State, within the priority period, claiming the date of filing of the first application in the applicant's country, as the priority date.

The priority period of twelve months has been seen as too short for proper market testing and deciding in which Convention countries eventually to obtain final patent protection. The PCT system addressed in **Section 4.3** below, addresses some of these concerns, particularly given the significant costs associated with filing individual Convention patent applications.

The Paris Convention also took into account the concept of Utility Models, as a species of industrial property. With less stringent protection criteria than a patent, this form of IPR has found use for incremental innovations in over 40 countries around the world.

4.3 PATENT COOPERATION TREATY (PCT)

The PCT is an international treaty with more than 152 Contracting States, which facilitates obtaining patent protection for an invention simultaneously in multiple countries by filing a single "international" patent application instead of filing several separate national or regional patent applications, or Convention patent applications under the Paris Convention. Whereas the PCT enables a single international patent application to be filed in lieu of individual Convention patent applications, as required by the Paris Convention, it does not provide the grant of a patent, **Figure 4.1**. In essence, the decision to obtain final patent protection is now put in abeyance by an additional 18 months from the date on which it would need to have been made under the Paris Convention.

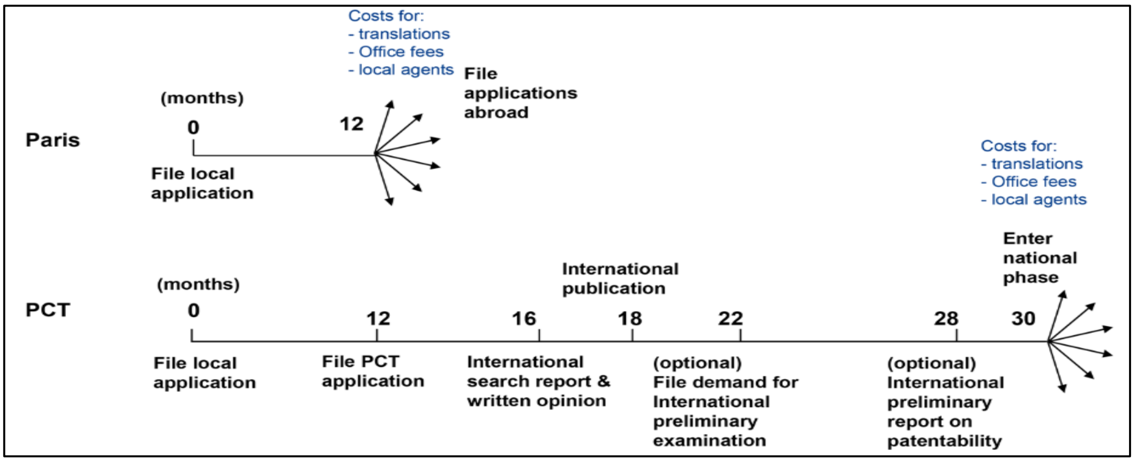


Figure 4.1: Comparison of the Paris Convention and PCT System procedures [Source: WIPO]

As stated by Ranjan (2003:51), the PCT also provides for rationalisation and cooperation with regard to filing, searching and examination of patent applications and dissemination of technical information. Consequently, patents can only be granted from separate patent applications filed at the end of the PCT process at the desired national patent offices, pursuant to examination and grant procedures at such national offices, as disclosed in Sibanda (2003:3):

> *"By filing one international patent application under the PCT, applicants can simultaneously seek protection for an invention in [more than 150] countries [member states of the PCT] throughout the world."*

Accordingly, the PCT is a facilitating treaty, enabling an applicant for a patent to utilise a single patent filing and prosecution system to make informed decisions regarding countries where final patent protection is to be sought. Utilising the Paris Convention as the priority basis, an applicant has up to 30 or 31 months from the earliest priority date to make patent applications in the countries of interest, provided the applicant has filed a PCT application within twelve months from the earliest priority date and has followed the prescribed processes under the PCT. In the case, where patent protection is desirable in more than one country, Ranjan (2003:50) argues that the PCT system provides a cost effective and more economical means of applying for patent protection, particularly in several countries, as the decision to enter national phase is delayed. Moreover, the search and examination under the PCT enable a more informed decision. The PCT system essentially comprises the following steps,[23] which are illustrated in **Figure 4.2.**

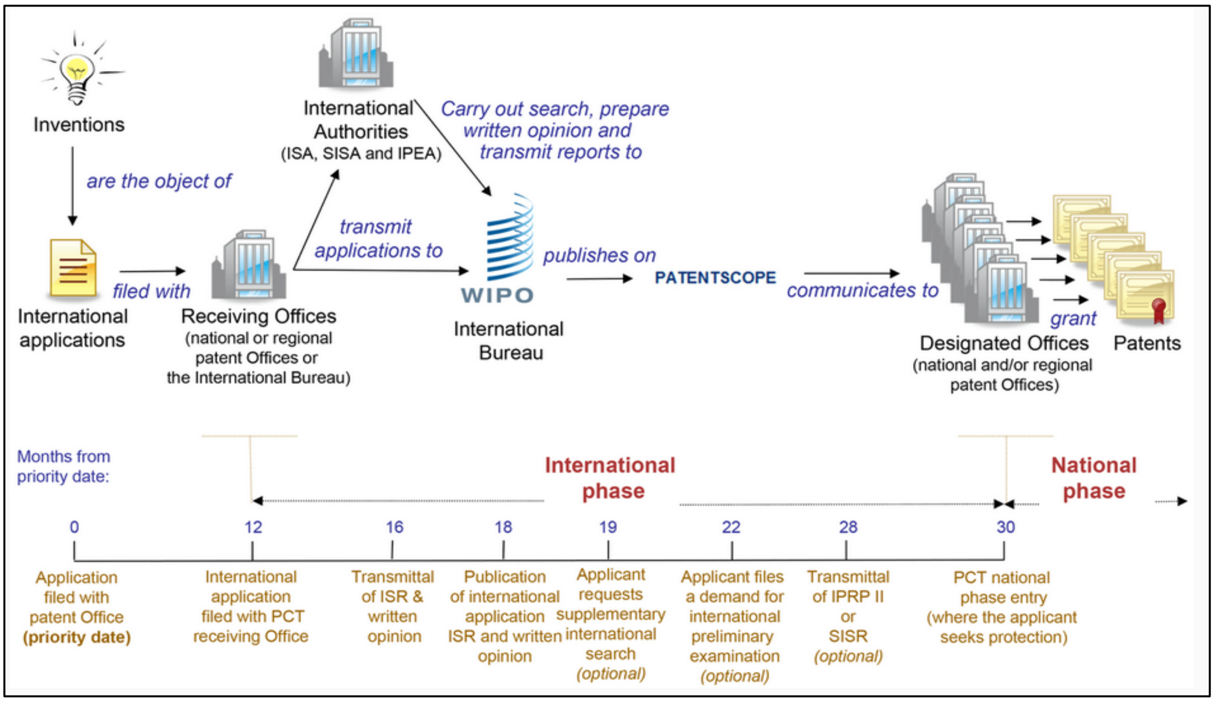


Figure 4.2: Illustration of the PCT System procedures [Source: WIPO]

(a) **Filing**: where a single international application is filed with a national or regional patent office or WIPO, complying with the PCT formality requirements, in one language, with the applicant paying one set of fees;

(b) **International Search:** where a designated "International Search Authority" (ISA) (one of the world's major patent offices), selected by the applicant, identifies relevant prior art that may influence the patentability of the invention, and the ISA provides a written opinion on the invention's potential patentability;

(c) **International Publication**: the contents of the international application are published and become open to the public, as soon as possible after the expiration of 18 months from the earliest filing date (priority date); an optional supplementary International Search Report (ISR) may be requested by the applicant and may then be published;

23 http://www.wipo.int/pct/en/faqs/faqs.html [Last accessed on 5 January 2015]

(d) **An optional International Preliminary Examination:** where additional patentability analysis, usually on an amended version of the application, is carried out by the ISA upon request from the applicant; and

(e) **National Phase:** where, after the end of the PCT procedure, usually at 30 or 31 months from the earliest priority date, the applicant must lodge applications for the grant of patent(s) with one or more national offices of the countries of interest, where final patent protection is desirable. Consequently, the applicant loses their right to obtain a patent in the desired countries should he fail to lodge a patent application at the national offices within the prescribed period of no later than 30 or 31 months from the earliest priority date.

Other than the extension of time for finalising foreign patent applications, the real benefits of the PCT system are the search and preliminary examination reports, which inform the decision whether or not to proceed with the process to obtain a patent in identified countries, it provides an indication of the extent of objections by the patent offices of countries where final patent protection is desirable. It can be argued that these PCT reports would be invaluable to many countries, such as South Africa, which wish to move to a substantive examination patent system. Over the years, the WIPO has signed new agreements with more ISAs; more than 20 ISAs are currently contracted to the PCT.[24] This offers more choices to the inventors, based, *inter alia*, on costs, turnaround times, quality of search results, bias in terms of language and access to full transcripts of the original cited prior art documents, potential countries of final patent protection, etc.

4.4 AGREEMENT ON TRADE-RELATED ASPECTS OF INTELLECTUAL PROPERTY RIGHTS ("TRIPS Agreement")

4.4.1 Overview

The TRIPS Agreement, a multilateral agreement of the WTO came into effect on 1 January 1995; as discussed by De Carvalho (2010:28), this followed the Uruguay Round of Multilateral Trade Negotiations that had started as far back as 1986.

24 http://www.wipo.int/pct/en/access/isa_ipea_agreements.html [Last accessed on 9 October 2016]

Two key principles emerge from the TRIPS Agreement: (i) the national treatment principle – obliging all member states to accord foreign nationals of other WTO Members the same treatment as nationals; and (ii) the most favoured nation treatment – in terms of which all foreigners are to be afforded same treatment regardless of country of origin. As already mentioned, the TRIPS Agreement provides mandatory standards for protection of IP rights.

The TRIPS Agreement is focused on international trade and in particular on how to ensure the reduction of distortions and impediments to international trade as a result of IP.[25] De Carvalho (2010:29) notes that the focus on trade provides the basis for detailed provisions on enforcement of IP in the TRIPS Agreement. Another feature of the TRIPS Agreement that is apparent from its Preamble is the recognition of IP rights as being private rights. The implications of this recognition, as argued by De Carvalho (2010:38), are that these rights cannot be alienated, and that reasonable compensation is to be paid in the case of compulsory licences as well as government use. The concept of private rights is also important in terms of the role of patents in economic development. De Carvalho (2010:53) argues that, in centrally planned economies, where there is substantive government intervention in the economy, patents have very little effect in promoting inventiveness and driving sustainable economic development, as decisions are driven through public spending imperatives.

The TRIPS Agreement sought to achieve a balance or *"a marriage of convenience"*, according to Straus (2012). In order to achieve this balance, it contains recognition of the special status of developing and least developed countries and provides for flexibilities and other measures that must be consistent with the provisions of the TRIPS Agreement. Accordingly, the various flexibilities and exceptions from the main provisions of the TRIPS Agreement, arising from Article 30, provide member states with tools to shape the broad scope of the exclusive rights granted by a patent, to meet the socio-economic development and other objectives of the member states, whilst still recognising the private nature of IP

25 Preamble to the TRIPS Agreement

rights. More will be said on this later on in Section 5.4 below, when we deal with flexibilities and exceptions.

Although the TRIPS Agreement became applicable from the beginning of 1996, certain transitional arrangements and periods existed in respect of least developing and developing countries. For example, developing countries, such as South Africa, were given until 2000, with least-developed countries (LDCs) up to 2006, to reform their IP systems to be in line with the TRIPS standards. In 2005, these were extended to 2013 for LDCs (or the date on which a country ceased to be classified as an LDC, if this was earlier). The transitional period for pharmaceutical patents was also extended to 2016. Whereas the LDCs have a general transition period[26] until July 2021 to implement the overall TRIPS Agreement, according to Taubman *et al.* (2012:22), the transitional period for the protection of pharmaceutical patents and clinical trial data[27] has been extended to 2033. Thus, LDCs are not obliged to amend their laws to make provision for the protection of pharmaceutical patents and clinical trial data until 2033.

Although significant aspects of the transitional periods apply to LDCs, others are relevant for developing countries such as South Africa. As such, countries such as India and Brazil have had to make changes to their patents laws, following the expiry of some of the transition periods relevant to developing countries. Straus (2012:644) notes the significant impact of the TRIPS Agreement on the pharmaceutical industry, as the TRIPS Agreement mandated all member states to grant patent protection for both product and process inventions, as long as they met the patentability requirements of novelty, inventiveness and utility. A particular case in point is India, where the patent law was amended to allow for pharmaceutical product patents, as a consequence of the TRIPS Agreement. Nair (2008:440) documents that, since then, pharmaceutical product patents, which were

26 http://www.ictsd.org/bridges-news/bridges/news/least-developed-countries-table-wto-proposal-to-extend-pharma-patents [Last accessed on 18 March 2017]

27 https://www.wto.org/english/news_e/news15_e/trip_06nov15_e.htm [Last accessed on 18 March 2017]

previously not allowed, have given rise to new export business opportunities and fostered the growth of the Indian pharmaceutical industry.

It is clear from Part I of the TRIPS Agreement that protection of IP is not an end itself but a means of fostering innovation and transfer of technology for social and economic good. Erstling (2010:475) points out that, in the case of the Republic of Korea, its IP system, which was aligned to the TRIPS Agreement, facilitated the transfer of technology by means, such as foreign direct investment (FDI) and licensing, and its *"creative use of the patent system to promote technological capacity has arguably been a significant factor in the country's economic growth."*

The dissemination of technology is based on the *quid pro quo* principle underlying the patent system, requiring a full disclosure of the invention in a patent specification in return for a limited monopoly being granted by the governments to the inventor. This allows improvements to be made thereto, and it ensures that the invention can also be used by others upon expiry of the patent. Straus (2012:639) aptly notes that, owing to globalisation of the IP market and the rapid advanced in information and communication technologies, *"countries like Brazil, India, and Korea grew remarkably through imitation and eventual competition with established technological nations."*

The TRIPS Agreement is therefore a means for member states wanting to attain higher order socio-economic developmental goals, to do so, by incorporating its provisions into their domestic patent legislation; this also ensures a balance between the rights and obligations of the producers and the users of IP. This balance is not unique to the TRIPS Agreement but goes back to the origins of the patent system, having been enunciated in the 1600s by the British Court of the King's Bench, when the rationale behind patents was stated as follows:

> *"But if a man hath brought in a new invention and a new trade within the Kingdom, in peril of his life, and consumption of his estate or stock ... or if a man hath made a new discovery of anything, in such cases the King ... in recompense of his costs and travail, may grant by charter unto him, that he only shall use such a trade or trafique for a certain time, because at first the*

people of the Kingdom are ignorant, and have not the knowledge or skill to use."[28]

Another pronouncement of this balancing of rights is found in the 1598 *"Case of Monopolies"*, involving Edward Darcy's playing card patent, dated Aug. 11, 1598, which was an extension for twenty-one years of an earlier grant made to Ralph Bowes in 1588, for the sole making, importation, and selling of playing cards. This case made a common-law distinction between a patent for an invention and a monopoly in restraint of trade. In this case, the British Court stated that:

> *"Where any man by his own charge and industry or by his own wit or invention doth bring any new trade into the realm, or any engine tending to the furtherance of a trade that never was used before and that for the good of the realm, that in such case the king may grant to him a monopoly patent for some reasonable time, until the subjects may learn the same, in consideration of the good that he doth bring by his invention to the commonwealth, otherwise not."*[29]

An analysis of the principles from the Case of Monopolies shows an alignment with Article 7 of the TRIPS Agreement in respect of IP and public interest (*conducive to social and economic welfare*) as well as the balancing of rights and obligations:

> *"The protection and enforcement of intellectual property rights should contribute to the promotion of technological innovation and to the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare, and to a balance of rights and obligations".*[30]

The TRIPS Agreement comprises four sections, namely:

---

28 78Eng. Rep. 148 (Clothworkers of Ipswich,King'sBench,1615); also found at http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-901-inventions-and-patents-fall-2005/readings/chapter1.pdf [Last accessed on 16 June 2014]

29 Calendar of Patent Records, Nature 124**,** 250-250 (10 August 1929) | doi:10.1038/124250b0 [also available on http://www.nature.com/nature/journal/v124/n3119/abs/124250b0.html - Last accessed on 16 June 2014]

30 Article 7 of the TRIPS Agreement

(a) general provisions and basic principles – dealing with principles, national treatment and most-favoured nation treatment and exhaustion of rights;

(b) standards concerning availability, scope and use of IPRs – in this regard, TRIPS deals with the subject matter eligible for protection, scope of rights, exceptions to those rights and minimum periods of protection, subject to existing obligations that member states have to each other in terms of other treaties, such as the WIPO, the Paris Convention and the Berne Convention;

(c) enforcement, specifically setting out domestic procedures and remedies for enforcement of IPRs; and

(d) other matters, including acquisition and maintenance of IPRs, dispute prevention and settlement mechanisms, institutional arrangements, transition periods, transfer of technology and technical cooperation.

The next sections will go into more detail into each of these four sections so as to provide sufficient basis to be able to assess how South Africa's IP system has, to date, responded to the TRIPS Agreement and to identify the extent of possible alignment still to be done.

4.4.2 General Provisions and Basic Principles

From the Preamble to the TRIPS Agreement, we can see that, whereas there was a need to promote effective and adequate protection of IPRs, there was also a need to ensure that enforcement measures and procedures did not become barriers to legitimate trade. There is also recognition of the need to create a sound and viable technological base by providing maximum flexibility in the implementation of the TRIPS in domestic legislation for least developed countries (LDCs).

The objectives of TRIPS are contained in Article 7, which articulates the protection and enforcement of IPRs as being in pursuit of the promotion of technological innovation, transfer and dissemination of technology. Thus, in implementing the provisions of the TRIPS Agreement, member states should seek to strike a delicate and appropriate balance between the rights and obligations of producers and users of technological knowledge (i.e. incentives to innovate and the need for adequate diffusion of technical knowledge into their economies) to ensure mutual advantage for the socio-economic benefit or welfare of a country's citizens.

Article 8 sets out important principles regarding the formulation of domestic laws and regulations by member states; it urges members in formulating or amending their laws and regulations to:

> *"… adopt measures necessary to protect public health and nutrition, and to promote the public interest in sectors of vital importance to their socio-economic and technological development, provided that such measures are consistent with the provisions of this Agreement."*[31]

In this regard, Article 8 goes further to state that such measures may include those necessary to curb abuse of IPRs by holders,[32] thereby providing the basis for compulsory licence provisions in many domestic legislations.

4.4.3 Minimum Standards, Scope and Use of IPRs

Each member state is required to provide minimum standards of IPR protection, with higher standards (consistent with TRIPS provisions) being at the members' discretion, though not obligatory.

With regard to the standards for protection, Article 27 states that patents shall be granted for any inventions (products or processes) in all fields of technology provided they are new, involve an inventive step and are capable of industrial application. Of particular interest, as articulated by De Carvalho (2010:64 and 171), is the fact that the TRIPS Agreement does not define what an invention is nor does it provide conditions for the patentability requirements of novelty, inventiveness, or utility, other than stating what subject matter is deemed not an invention. It would appear that the definition of invention, novelty, inventiveness and capability of industrial application is left to the member states to determine in terms of their national law. This is a view also supported by De Carvalho

31 Article 8(1)
32 Article 8(2)

(2010:171). Naturally, such discretion will have to be implemented within the context of the TRIPS Agreement's two key principles of Most-Favoured Nation Treatment and National Treatment.

In respect of industrial design, new or original designs may be protected.[33] The scope of protection is against third parties making, selling or importing articles embodying the design, without the owner's consent for a period of no less than 10 years.[34]

Patents are dealt with in Articles 27 to 34. Article 27(1) has had far-reaching implications on a number of industries, in particular pharmaceuticals. The following inventions, though not peremptory, may be excluded by member states from patentability:

(i) inventions necessary to protect public order or morality, human, animal or plant life or health, avoid serious prejudice to environment (Article 27(2);
(ii) diagnostic, therapeutic and surgical methods for the treatment of humans or animals (Article 27(3)(a)); and
(iii) plants and animals other than micro-organisms, and essentially biological processes for the production of plants or animals other than non-biological and microbiological processes (Article 27(3)(b).

In the same vein, member states are obliged to ensure protection of plant varieties, whether by patents or by an effective *sui generis* system or combinations thereof. There is also provision for review of Article 27(3)(b), initially four years after TRIPS has come into force.

The TRIPS Agreement does not make provision for patent protection of computer programs per se, but copyright protection rather, as literary works under the Berne Convention. The OECD (2004) discloses that there has been an increase in the demand for patent protection for software, computer programmes and business methods in various countries. What is interesting is an argument advanced by De Carvalho (2010:171) that:

33 Article 25
34 Articles 26

> *"software is no different from a set of instructions for the operation of a machine. In this sense, software is not very different from a set of instructions for the operation of a high-furnace. The only major difference is that the latter is to be read and applied by a human being, while computer software is to be read and applied directly by a machine."*

De Carvalho (2010:186) further argues that this is not sufficient basis for excluding software from patentability. In particular, he proposes "a *sui generis* system of software protection, combining features of the patent and copyright regimes." To date this has not materialised, largely thanks to resistance from, *inter alia*, the USA, despite attempts by WIPO. De Carvalho further points to the conundrum posed by Articles 9.2 and 10.1 when read together. On the one hand, Article 9.2 points out that copyright extends to expressions and not ideas, but on the other hand, Article 10.1 specifically states that computer programs (source or object code), are to be protected as literary works under the Berne Convention.[35]

The same argument would appear to extend to business methods, which the United States Court of Appeals for the Federal Circuit held, in *State Street Bank & Trust Co. v Signature Financial Group Inc.*, to comprise processes that lead to the production of goods or services. As such, business method claims are to be evaluated in a similar fashion as process inventions, as stated by De Carvalho (2010:187). However, it would appear that, where the business method does not operate as a process and is a mere documentation of how to do business, this would not comprise patentable subject matter.

What is perhaps instructive from the TRIPS Agreement is that it does not confer any obligations on member states to provide protection for subject matter that they do not consider to be of a technical nature, and thus as business methods. This is notwithstanding the fact that the TRIPS Agreement itself does not oblige member states to limit patent protection to so-called technical inventions. The approach followed in *State Street Bank* was abandoned in the 2014 seminal case of the US Supreme Court, *Alice Corp. v. CLS Bank*

35 Berne Convention for the Protection of Literary and Artistic Works (as amended on September 28, 1979)

International, 573 U.S. __, 134 S. Ct. 2347 (2014), which articulated a two-step procedure in determining the patentability of software implemented inventions and business method inventions. The case involved an electronic escrow service where financial transactions were computer-implemented. In the first step, there must be a determination as to whether the claims are indicative of a non-patentable abstract idea, and if so, whether the claims transform the abstract idea into an inventive concept or something that itself meets the subject matter threshold of patent eligibility. The second step then involves an analysis, whether there is an element or combination of elements that is *"sufficient to ensure that the patent and practice amounts to significantly more than a patent upon the ineligible concept itself."* This approach has been followed in subsequent US Federal Courts decisions in *DDR holdings v. Hotels, 773 F.3d 1245 (2014)* and in *Enfish v. Microsoft, 1244 (2015)*.

The other issue worth touching on briefly is the so called 'second uses'; these are typical of the pharmaceutical industry. The question is whether such second uses are patentable subject matter within the context of Article 27.1 of the TRIPS Agreement. De Carvalho (2010:190) points out that it would appear that the TRIPS Agreement does not *per se* oblige member states to grant protection for second uses, although in principle, it could be argued that, for as long as they meet the patentability criteria, such second uses should be patentable. In some jurisdictions, including the European Patent Convention (EPC) the substance or the composition, as opposed to the second use, is recognised as patentable subject matter, on the basis that the second use is more of a result or an advantage, as detailed in De Carvalho (2010:190). EPC 54(4) does not exclude the patentability of a use of substance or composition, in a method for treatment of the human or animal body by surgery or therapy and diagnostic method practised on the human or animal body, provided such use does not form part of the state of the art. Accordingly, the second use of a substance or a composition already used in a method of treatment is patentable, provided such second use does not comprise the state of the art. It is also important to note that patents granted for such second use will generally be dependent patents, in respect of patents for the first use of the substance or composition for a method of treatment.

4.4.4 Patentability Disclosure, Scope and Duration of Protection

The scope of protection of patents is against a third party making, using, offering for sale, selling, or importing the subject matter of a patent without the owner's consent (Article 28), for the 20-year protection term (Article 33). Applicants for a patent are required in terms of Article 29 to:

> *"disclose the invention in a manner sufficiently clear and complete for the invention to be carried out by a person skilled in the art."*

Optionally, member states may require applicants to disclose:

(i) the best mode for carrying out the invention known to the applicant at the date of filing of the application (Article 29(1));

(ii) information concerning applicant's corresponding foreign applications or patents (Article 29(2)).

Suffice it to note that the 'best mode' disclosure is optional and not mandatory under the TRIPS Agreement, and that it is in essence one of the flexibilities that member states may exercise under Article 30.

The TRIPS Agreement does not *per se* prescribe procedures for acquisition and maintenance of IPRs except that such procedures must not be unnecessary, costly and difficult (Article 62). In addition, it states that in the case where such procedures involve opposition, revocation and cancellation, they must be fair and equitable. However, there is a requirement for a judicial review of the final administrative decisions in any of the procedures (Article 62(5)). Immediately, we can thus see that TRIPS does not *per se* prescribe substantive examination of patents, although it does refer to substantive and formal procedures, and it obliges member states to grant the registration of rights within a reasonable period, following compliance with any substantive conditions for acquisition of such rights (Article 62(2)). Nonetheless, Article 27.1 does not oblige member states to undertake substantive examination of patent applications. De Carvalho (2010:193) observes that member states are not obliged:

> *"to assign the examination of patent applications to their patent offices … the only task that is formally assigned to the industrial property offices, under Article 12 of the Paris Convention, is the publication of patents granted …."*

On this basis, he argues that the examination of patent applications in specific fields, for example health, could be assigned to a relevant body with the requisite capacity to do so, such as the Ministry of Health (as in the case of Brazil).

It would appear that, for a country to extract maximum benefit from the TRIPS Agreement, it should implement it in support of its own innovation strategy, national priorities and technology development policies. The TRIPS Agreement could also promote dynamic competition, whilst allowing for appropriate legal incentives for information diffusion and local innovation. A possible approach in this regard cited in UNCTAD (1996:1) would comprise:

> *"a) establishing IPRs laws consistent with TRIPS Agreement but [that] do not significantly disadvantage follow-on inventors and creators; b) instituting incentive structures that will help stimulate innovation at the local level; c) taking greater advantage of access to scientific and technical information that resides within the global information infrastructure; d) applying coherent competition policies to curb the adverse effects of the abusive use of IPRs; and e) improving the innovation system through broader programmes of intellectual skill acquisition and improvement of capacities to absorb new technical information."*

4.4.5 TRIPS Agreement Flexibilities

Article 30 provides the framework for flexibilities and exceptions to rights conferred by a patent that countries can implement in their national laws:

> *"Members may provide limited exceptions to the exclusive rights conferred by a patent, provided that such exceptions do not unreasonably conflict with a normal exploitation of the patent and do not unreasonably prejudice the legitimate interests of the patent owner, taking account of the legitimate interests of third parties."*

The flexibilities of the TRIPS Agreement can be classified in terms of their applicability, i.e. before the grant of a patent (pre-grant) or after the grant of a patent (post-grant). The pre-grant flexibilities can be regarded as proactive steps to address the scope of rights granted by a patent, while the post-grant flexibilities would appear to be designed to limit the scope of granted rights and in essence to address potential abuse of the granted monopoly. UNCTAD (2011:109) details the patent flexibilities under TRIPS, see **Table 4.1**.

Table 4.1: Summary of various patent flexibilities

Pre-Grant Flexibilities	Post-Grant Flexibilities
• Transition periods	• Research exemption
• Patentability criteria	• Regulatory review exception
• Disclosure Related	• Exhaustion of rights
• Patentability of Substances Existing in Nature	• Ex-officio IP Office control of contractual anti-competitive clauses
• Aspects relating to substantive examination of patent applications	• Compulsory licences and Government use
• Utility Models	

The post-grant flexibilities can be viewed as part of the Article 30 mechanism of limiting the negative rights conferred on a patentee in terms of the patent system, in line with Article 28 of TRIPS, to exclude others from exploiting the patent and gaining full advantage and profit therefrom. According to Article 30, WTO member states may provide limited exceptions to the exclusive rights conferred by a patent in terms of Article 28.

For any flexibility to comply with TRIPS Article 30, it must pass the *"cumulative 3-part test"* developed in the case of *Canada-Patent Protection for Pharmaceutical Products*.[36] Accordingly, the flexibility must meet three cumulative conditions, namely:

(i) a limited exception;

(ii) not unreasonably conflict with normal exploitation; and

(iii) not unreasonably prejudice the legitimate interests of the patent owner.

The fact that the conditions are cumulative is important, as an exception that does not meet any one of these conditions would be deemed not to meet the requirements of Article 30. In the review of the *Canada-Patent Protection for Pharmaceutical Products* case, a WTO Panel[37] attached the following meanings to each of the steps as documented in Garrison (2006:23):

36 WT/DS114/R, 17 March 2000

37 *Ibid*.

> *"The word 'exception' by itself connotes a limited derogation, one that does not undercut the body of rules from which it is made. When a treaty uses the term 'limited exception', the word 'limited' must be given a meaning separate from the limitation implicit in the word 'exception' itself. The term 'limited exception' must therefore be read to connote a narrow exception – one which makes only a small diminution of the rights in question (para. 7.30)."*

It is submitted that the exception must make *"only a small diminution of the rights in question,"* as also pointed out by De Carvalho (2010:306). In this regard, De Carvalho (2010:306) goes on to note the Panel's observation that stockpiling in the *Canada-Patent Protection for Pharmaceutical Products* case constituted a substantial impact on the exclusionary rights granted to the patentee and as such did not constitute a limited exception.

According to the WTO Panel, "normal exploitation" has the following meaning:

> *"The normal practice of exploitation by patent owners, as with owners of any other intellectual property right, is to exclude all forms of competition that could detract significantly from the economic returns anticipated from a patent's grant of market exclusivity. The specific forms of patent exploitation are not static, of course, for to be effective exploitation must adapt to changing forms of competition due to technological development and the evolution of marketing practices. Protection of all normal exploitation practices is a key element of the policy reflected in all patent laws" (para. 7.55).*

It would thus appear that the impact on the normal rights conferred to the patentee to make, use, exercise, import and dispose of the patented invention must be reasonable when considering the reasons for the limitation.

In considering the *"legitimate interests"*, the WTO Panel concluded that this must be *"construed as a concept broader than legal interests"* (para 7.71), but it did not address what *"unreasonably"* means. However, the WTO Panel's analysis in the case before it found that there must not be a *"conflict"* with the normal exploitation of a patent. In this regard, it is submitted that the exception must be in line with public policy considerations underlying patents, and that they may include the patent owner's right not have competitors use his invention for commercial purposes or for gain.

A detailed overview of each of these flexibilities and the extent to which South Africa has incorporated any of these into its patent laws will be given in **Chapter 5**.

4.4.6 Enforcement and Other Measures

The TRIPS Agreement requires enforcement mechanisms in domestic intellectual property laws to be fair and equitable (Articles 41(2) and 42), and to include peremptory provisions for injunctions (Article 44), damages (Article 45) and other remedies, including seizure or confiscation and destruction of infringing goods (Articles 46 and 59). Bishnoi and Goyal (2011) point out that there is no additional resourcing required of member states for enforcement of IPRs, other than for law enforcement in general. As will become apparent later, South Africa has in essence implemented these provisions in its patent law.

4.4.7 Obligations of Developed Country Member States

Two specific provisions in the TRIPS Agreement place certain obligations on developed country members in respect of the improvement of the economies of developing and in particular Least Developed Countries (LDCs) to ensure that they benefit from the IP system in as far as their level of development and economies are concerned. The first of these, which is not relevant for South Africa, is Article 66(2), which requires developed member states to put in place incentives for its enterprises to transfer technology to LDCs to enable the latter to enhance their technological base:

> *"Developed country Members shall provide incentives to enterprises and institutions in their territories for the purpose of promoting and encouraging technology transfer to least-developed country Members in order to enable them to create a sound and viable technological base."*

Article 66(2) has not really been used much by LDCs, nor has it benefitted them, largely because there is no monitoring and accountability mechanism for its implementation.

Since South Africa is not an LDC, no detailed analysis of this provision will be undertaken here either; suffice it to say that (i) its intentions are aligned to the objects of the TRIPS Agreement, (ii) its implementation is not necessarily by the developed country member states but by its enterprises, and (iii) the developed country member states must put in place the relevant incentives for the enterprises to do the transfer. De Carvalho (2010:436) observes that Article 66(2) only obliges[38] developed country member states in as far as incentives are concerned and that:

> *"The governments of those countries may not and should not be expected to intervene directly in the transfer of technology because technology in developed countries is mostly controlled by the private sector."*

The second of these provisions is Article 67:

> *"In order to facilitate the implementation of this Agreement, developed country Members shall provide, on request and on mutually agreed terms and conditions, technical and financial cooperation in favour of developing and least-developed country Members. Such cooperation shall include assistance in the preparation of laws and regulations on the protection and enforcement of intellectual property rights as well as on the prevention of their abuse, and shall include support regarding the establishment or reinforcement of domestic offices and agencies relevant to these matters, including the training of personnel."*

It would appear that Article 67 (in Part VI – Transitional Arrangements), aptly entitled *"Technical Cooperation"*, was a compromise between developed and developing countries during the negotiation of the TRIPS Agreement. An immediate observation regarding Article 67 is that it requires a request by the developing countries and LDCs as well as *"mutually agreed terms and conditions"*; thus, in the absence of an oversight structure, it is likely to be faced with great difficulties in its implementation. Correa (2001:28) notes that Article 67 does not provide any specific obligations or operative mechanisms.

38 See also Paragraph 11.2 of the Doha Ministerial Decision of 14 November 2001 on implementation related issues and concerns in respect of Article 66(2)

4.4.8 TRIPS and Development

An effective interpretation and application of the principles set out in TRIPS Agreement Article 8, read together with Article 30 (flexibilities), can provide context based appropriate IP systems that support a country's development policies and strategies, with the levels of protection being tailored to the country's level of development, while prioritising 'sectors of vital importance' to a country.

Ncube (2013), citing Gibbons (2011), illustrates this further when pointing out that:

> *"developed countries began with minimal IP protection to encourage innovation and economic growth …. These systems were incrementally strengthened in tandem with economic growth."*

Ncube (2013:372) states further that this approach has been adopted by the fastest growing economies today, and in particular, Brazil, Russia, India and China, whose IP systems, she argues, *"are not as strong as those of developed nations."* This argument appears to find partial support in Straus (2012:63) who advances the view that *"countries like Brazil, India and Korea grew remarkably through imitation and eventual competition with established technological nations."* Straus (2012:677) further goes on to state that:

> *"Global economic development since the WTO's establishment shows the 'marriage of convenience' has primarily benefitted globally acting industries, emerging economies, and many developing countries".*[39]

According to Pouris and Pouris (2011:9):

> *"… strong IPR may be a constraint for development. A strong argument advanced by the authors is that European countries, the USA and, more recently, Asian countries have based their development on 'infringing' foreign technologies".*

It is submitted that this observation may perhaps be looking at the IPR system in isolation of other factors in a country's economy. In particular, it would appear that there is an assumption that countries with no IPR system might attempt to strengthen their IPR

39 Straus (2012), pp. 677

system overnight, without developing capabilities to increase their absorptive capacity for new innovations developed elsewhere while also encouraging local innovations.

It would thus appear from the foregoing and also as articulated by Straus (2012:678), that a progressive strengthening of an IP system from a weaker to a stronger IP legal framework, during the imitation phase and in the latter phase of competition, respectively, is aligned to the objectives of TRIPS Agreement. This approach is also supported by the use of flexibilities (whether incorporated into legislation or through the WTO dispute resolution mechanisms) to support a country's developmental objectives.

From a developed country perspective, there are also strong arguments made by Braga and Fink (1997:163) for a strong IP system to be a prerequisite for technology driven FDI:

> *"… although the channels through which IPRs influence FDI decisions are many and quite complex – given the interaction between trade, FDI and technology-transfer decisions – the basic presumption is that countries with stronger IPR regimes will be in a better position to attract knowledge-related FDI flows."*

Although such arguments are premised on the need to protect the investment being made by the developed countries through their globally acting enterprises, a balanced approach is perhaps required, taking into account the level of development of each country. Accordingly, as argued by UNCTAD (1996:19), it is important that strengthening a country's IP system to attract FDI must be done within the context of a coherent framework of broader policies, including size of the market, productive infrastructure and degree of stability of the macroeconomic environment, and educational policies. Studies of FDI in emerging markets such as Brazil and India, including those of Anya and Neil (2012:36), suggest that a strong IP system is not necessarily a prerequisite or a necessary condition for firms to invest in a particular country, although it could be persuasive. Instead, it is more important that a strong IP system facilitates location of R&D facilities in such countries; as such facilities require protection of the innovations they develop.

In light of the differential economic environment between developed and developing countries, and in particular, the LDCs, in pursuit of the objectives of TRIPS (Article 7), it is important to consider a developmental path for developing countries and LDCs in the advent of TRIPS. There are lessons to be learnt from Asian countries, such as South Korea, which progressively went through a process of strengthening their IPR systems in the wake of the TRIPS Agreement. Kim (1980) attributes South Korea's economic transformation to a simplified three-stage developmental path comprising:

i) The implementation stage, involving the assembly of foreign components and parts;

ii) The stage of assimilation of foreign technology, through a process of diffusion and capacity improvement; and

iii) The stage of improvement with a specific focus on increased local capability (technology and skills).

Kim (1992:1) provides an excellent synopsis of the Republic of Korea's development based on imported technology, in the era leading up to the TRIPS Agreement, and provides a convincing argument of the importance of the patent system in both identifying relevant technologies to be imported and assimilated as well as the protection of adaptations:

> *"Industrialisation with imported technology corresponds with the Korean experience in which the imported technology has resulted in structural change, cost reduction, and indigenous innovation in industrial production.... Technology is imported through foreign direct investments; foreign licensings and foreign consultant[s] … imported capital goods, studies abroad and subcontracting."*

The role of the IP and innovation systems to South Africa's socio-economic development will be explored in **Chapter 9**, with reference to lessons from other developing countries, such as the Republic of Korea.

4.4.9 TRIPS and Public Health

One of the areas in which the balancing of interests in the implementation of the TRIPS Agreement has been of great interest and importance has been in public health, particularly given the burden of disease in developing countries and LDCs. In order to ensure that there are more innovative medicines entering the market, Maskus (2003) highlights the need to balance the interests in providing incentives for R&D into new drugs and cures, with the interests of access to public health through the wide-scale provision of the drugs, on affordable terms. The TRIPS Agreement specifically refers to the issues of public health in Article 8, which states that:

> *"Members may, in formulating or amending their laws and regulations, adopt measures necessary to protect public health and nutrition…."*

The TRIPS flexibilities, in particular, compulsory licensing, regulatory review or Bolar provisions, and research exceptions are therefore important in ensuring that a country's IP system incorporates those measures necessary to protect public interest whilst at the same time providing adequate incentives to inventors and ensuring a balance. More particularly, the WTO's Fourth Ministerial Conference in Doha, Qatar in November 2001 recognised the relationship between the IP system and affordable access to patented medicine, in adopting a Declaration on the TRIPS Agreement and Public Health.[40] Whilst recognising the importance of IP protection for the development of new medicines, and noting affordability concerns as a result of IP protection, Taubman *et al.* (2012:181) state that the Declaration unequivocally calls for:

> *"the TRIPS Agreement to be interpreted and implemented in a manner supportive of Members' right to protect public health and in particular, to promote access to medicines for all …. [members] will not seek to prevent other Members from using TRIPS Flexibilities."*

The Declaration, in particular, recognises the Member's (i) right to grant and as well as determine the conditions for granting compulsory licenses, which need not be a form of an emergency; and (ii) determine its own regime for the exhaustion of IPRs, subject to the principle of non-discrimination, and thereby enabling parallel importation. In the case where a Member elects the national exhaustion regime to apply, a rights holder may prevent importation of patented products from other countries where they were sold with

40 Declaration on the TRIPS Agreement and Public Health, adopted on 14 November 2001 by the Fourth WTO Ministerial Conference, Doha, Qatar; available at http://www.wto.org/english/thewto_e/minist_e/min01_e/mindecl_trips_e.htm [Last accessed on 15 October 2016]

the right owner's permission. In the case of international exhaustion, a rights owner is not able to do so, as he would be considered to have exhausted their rights through the first sale or making available to the public the patented product.

The Declaration also recognises the importance of TRIPS Article 66.2 (already dealt with in this chapter), which encourages the transfer of technology to LDCs; but it also recognised the limited, or often lack of, manufacturing capacity in the effective utilisation of compulsory licence provisions, and as such paved the way for the so-called Paragraph 6 System.[41] Whereas importation of medicines is permissible under the TRIPS Agreement, the main issue was the export of generic medicines by countries with manufacturing capacity to countries lacking such manufacturing capacity, where these medicines were patent protected, considering that the compulsory licensing is intended to serve predominantly the domestic market.

The Paragraph 6 system essentially provides for easing of the scope and coverage of various aspects of Article 31 in as far as any pharmaceutical patented products are concerned, or ensuing from a patented process or involving diagnostics kits, as detailed in Taubman *et al*. (2012:184) as follows:

a) Obligation of exporting member under Article 31(f) to issue a compulsory licence predominantly for domestic market does not apply to the extent necessary to enable a member to authorise production and export of the needed medicines under a compulsory licence to those countries with insufficient manufacturing capacity;
b) As both exporting and importing countries must issue a compulsory licence, adequate remuneration in terms of Article 31(h) is only paid in the exporting country; and
c) A member may export products manufactured or imported under a compulsory licence more easily amongst members of a regional trade agreement at least half the membership of which consists of LDCs.

41 Decision of the General Council, Implementation of Paragraph 6 of the Doha Declaration on the TRIPS Agreement and Public Health, WT/L/540 (Aug. 30, 2003) [hereinafter Decision of 30 Aug. 2003].

One of the specific requirements of the Decision of 30 August 2003 is a once-off notification of the TRIPS council if a member (other than LDCs, which are automatically eligible), wishes to be an importer; such members are required to take precautions against re-exportation.

4.5 CONCLUSIONS

Various international legal instruments relating to IP, in particular, the Paris Convention, the TRIPS Agreement and the PCT, have had a significant impact on innovation and trade globally.

It has been highlighted that whereas the PCT is more of an enabling and international patent application instrument, the Paris Convention and the TRIPS Agreement have in contrast laid down some global principles. As is evident from Article 7, the TRIPS Agreement has elevated IP issues to being relevant not only for trade but also for ensuring that IP contributes to:

> *"the promotion of technological innovation and to the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare, and to a balance of rights and obligations."*

Article 8 better articulates the purpose of the flexibilities provided by the TRIPS Agreement for countries to incorporate into their domestic laws as being:

> *"to protect public health and nutrition, and to promote the public interest in sectors of vital importance to their socio-economic and technological development, provided that such measures are consistent with the provisions of this Agreement."*

These flexibilities need to be applied in a balanced manner without unreasonably conflicting with the normal exploitation rights of the IP owners, and without unreasonably prejudicing their legitimate interests, as provided in Article 30.

The various flexibilities of the TRIPS Agreement can still be incorporated into South Africa's patent laws within the limits of Article 30, to achieve much broader developmental objectives, given the mandatory nature of the TRIPS Agreement of ensuring that member states grant patents for both process and product inventions in all fields of technology, as long as they meet the mandatory criteria. Perhaps the challenges in respect of the TRIPS Agreement are primarily the so-called TRIPS-plus provisions, which Correa (2005) notes are likely to propagate the controversies around IP and public health. These are more restrictive provisions that go beyond the minimum standards under the TRIPS Agreement and, in some cases, negate the TRIPS Agreement transitional provisions, essentially inhibiting use of the flexibilities.

As detailed in Chang (2006), the case of South Korea, a country that was poorer than Ghana and Mozambique in the early 1960s, is a classic example of how a country can creatively and effectively use its IP and in particular the patent system to drive its economic development. It would appear from the case of South Korea that putting in place laws is but the first step in the right direction and that effective institutions must also be put in place to encourage the creation of new technologies. Erstling (2010), who has studied the impact of Korea's patent policy on its economic development, concludes that:

> *"Korea's creative use of the patent system to promote technological capacity has arguably been a significant factor in the country's economic growth. Emerging nations may do well to study the Korean system, especially Korea's patent information, assistance, and education initiatives and the institutions Korea has established to administer them. Just as Korea has benefited from putting in place a comprehensive, ambitious system directed toward the development of national industry, so may other countries benefit as well."*

There are indeed opportunities available for South Africa to follow the examples of South Korea and other emerging economies that have fully embraced the TRIPS Agreement principles in accordance with the level of development of their economies, to move them to a higher trajectory of economic growth. In order for South Africa to realise the developmental objectives of the NDP (2012), a programmatic approach to developing enabling IP and innovation systems, that effectively takes advantage of the provisions of the TRIPS Agreement, in particular, is required.

In the next chapter, this study will explore in more detail, the South African IP policy and legislative environment and the extent to which these have been influenced by the international legal instruments discussed in this **Chapter 4**.

CHAPTER 5: SOUTH AFRICAN INTELLECTUAL PROPERTY POLICY AND LEGISLATIVE ENVIRONMENT

"Today, in many developing and former communist nations, property law is no longer relevant to how the majority of people live and work. How can a legal system aspire to legitimacy if it cuts out 80% of its people? The challenge is to correct this legal failure." – Hernando de Soto (2000)

5.1 INTRODUCTION

South Africa became a member of the WTO on 1 January 1995, and has acceded to the TRIPS Agreement.[42] In addition, South Africa is a member of most international treaties on IP law, including the Paris Convention, the PCT, the Budapest Treaty on the International Recognition of the Deposit of Microorganisms for the Purposes of Patent Procedure, the Berne Convention for the Protection of Literary and Artistic Works, the WIPO Copyright Treaty (WCT) and the WIPO Performances and Phonograms Treaty (WPPT), to name but a few.

As detailed in Kaplan (2009:1), South African IP law finds its origins in the Patents, Designs, Trade Marks and Copyright Act No 9 of 1916. Over the years, South African IP law has been amended, developed and adapted in line with South Africa's accession to various international treaties. It now comprises the following: the Patents Act 1978 (Act No. 57 of 1978) as amended up to the Patents Amendment Act 2002)[43], the Trade Marks Act 1993 (Act No. 194 of 1993),[44] as amended, the Designs Act 1993 (Act No. 195 of 1993, as

42 http://www.wipo.int/wipolex/en/other_treaties/details.jsp?group_id=22&treaty_id=231 [Last accessed on 14 May 2015]
43 RSA (2002) Patents Amendment Act (2002), Republic of South Africa, Government Printer, Pretoria – also available at http://www.wipo.int/wipolex/en/details.jsp?id=6256 (Last accessed on 14 May 2015)
44 RSA (1993) Trade Marks Act (1993), Republic of South Africa, Government Printer, Pretoria – also available at http://www.wipo.int/wipolex/en/details.jsp?id=4074 (Last accessed on 14 May 2015)

amended by the Intellectual Property Laws Amendment Act 1997),[45] and the Copyright Act 1978 (Act No. 98 of 1978, as amended up to the Copyright Amendment Act 2002).[46]

Other legislation (as amended) relevant for inventions include: the Intellectual Property Rights from Publicly Financed Research and Development Act 2008 (Act No. 51 of 2008) (the IPR-PFRD Act); the Medicines and Related Substances Act 1965 (Act 101 of 1965),[47] the Competition Act 1998 (Act 89 of 1998),[48] and the Armaments Development and Production Act 1968 (Act No. 57 of 1968). A detailed discussion of the nuances in respect of these legislations will be provided below.

The extent to which the South African patent system has incorporated the TRIPS flexibilities (discussed in **Chapter 4** *supra* and in **Section 5.4** *infra*) into the Patents Act will also be discussed, bearing in mind South Africa's accession to the TRIPS Agreement.

Until 2013, South Africa had not made public any attempts or drafts of an overarching national intellectual property policy. On 4 September 2013, the first draft National Intellectual Property Policy, the Draft IP Policy (2013) was published by the Minister of Trade and Industry *(the dti*) for public comment. Subsequently, almost three years after this first draft, on 6 July 2016, the Cabinet approved the Intellectual Property Consultative Framework, the IP Policy Framework (2016), which, according to *the dti*, *"aims to facilitate what will be continuous engagement with governmental partners and society at large towards the formulation of South Africa's IP policy."*[49] Both the Draft IP Policy (2013) and the IP Policy Framework (2016) will be discussed in **Section 5.5** below.

---

45 RSA (1993). Designs Act (1993), Republic of South Africa, Government Printer, Pretoria; also available at http://www.wipo.int/wipolex/en/details.jsp?id=13086 [Last accessed on 2 August 2015]
46 RSA (1997). Copyright Act (1997), Republic of South Africa, Government Printer, Pretoria; also available at http://www.wipo.int/wipolex/en/details.jsp?id=4067 [Last accessed on 2 August 2015]
47 Government Gazette No. 1171, Notice No. 1002, 7 July 1965, as amended by Act 90 of 1997: Medicines and Related Substances Control Amendment Act, 1997 (Government Gazette Notice No. 18505, 12 December 1997)
48 Government Gazette 19412, Notice No. 1392 of 1998, 30 October 1998
49 http://www.thedti.gov.za/ [Last accessed on 14 August 2016]

Policy statements in respect of a national policy governing intellectual property emanating from publicly financed R&D go back as far as 2002, despite the absence of an official National IP Policy to date. In this regard, the NRDS (2002:67), developed by the then Department of Arts, Science and Technology (now the DST), stated that:

> *"At present, South Africa has no formal policy framework for intellectual property protection of publicly financed research. One of the consequences of this is considerable uncertainty (among institutions and individuals) about intellectual property rights and their management, particularly when the research is publicly financed".*

The NRDS (2002:68) advocated an approach whereby *"institutions to protect intellectual property developed from publicly financed research should be established."*

Following extensive public consultations, a policy framework, the IP Policy Framework (2006), governing intellectual property emanating from publicly financed R&D, was approved by the South African government in June 2006. This policy framework gave rise to the development and promulgation of the legislation proposed in the NRDS (2002), the IPR-PFRD Act. Although promulgated in 2008, the IPR-PFRD Act only came into effect in August 2010, following finalisation of its implementation regulations.

5.2 INSTITUTIONAL ARRANGEMENTS AND INFRASTRUCTURE

5.2.1 Companies and Intellectual Property Commission (CIPC)

In May 2011, the CIPC was established under the Companies Act 2008 as an independent juristic person reporting to the Minister responsible for *the dti.* The CIPC incorporated two pre-existing institutions, the Companies and Intellectual Property Registration Office (CIPRO) and the Office of Companies and Intellectual Property Enforcement (OCIPE).[50] Kaplan (2009:2) discloses that the CIPRO had been established in 2002 following a merger of two former directorates of *the dti*, as the registrar of patents, designs and trademarks

50 Companies and Intellectual Property Commission, Annual Performance Plan 2013/14 – 2015/16; available at www.cipc.co.za [Last accessed on 2 August 2015]

and custodian of the registers of associated rights. The CIPC is the custodian of intellectual property registration and is headed by a Commissioner. According to the CIPC Annual Performance Plan, CIPC (2013:4), it has an important element to its mandate, namely:

> *"It administers, regulates and protects South Africa's Intellectual Property assets in accordance with the provisions of a range of legislation enacted over a number of decades."*

Accordingly, the CIPC is responsible for registration of patents in South Africa and its responsibilities include:

(i) Registration of Companies, Co-operatives and Intellectual Property Rights (trademarks, patents, designs and copyright) and maintenance thereof;

(ii) Disclosure of information on its business registers;

(iii) Promotion of education and awareness of Company and Intellectual Property Law;

(iv) Promotion of compliance with relevant legislation;

(v) Efficient and effective enforcement of relevant legislation;

(vi) Licensing of business rescue practitioners; and

(vii) Reporting, researching and advising the Minister on matters of national policy relating to Company and Intellectual Property Law.[51]

It is thus evident that the CIPC has a broad mandate. In relation to intellectual property matters, the CIPC houses or acts as the patents office referred to in the Patents Act.[52] The Commissioner also acts as the Registrar of Patents.[53] However, t*he dti* still has the primary responsibility for policy matters relating to intellectual property, and it provides the framework for registration and granting of rights, as per Kameri-Mbote (2005).

5.2.2 National Intellectual Property Management Office (NIPMO)

NIPMO, as stated by Ncube *et al* (2014:292), oversees the implementation of the IPR-PFRD Act; this office was established in 2010 in terms of Section 8 of the IPR-PFRD Act with the

51 http://www.cipc.co.za/index.php/about/our-functions/ [Last accessed on 22 December 2014]

52 S5 of the Patents Act

53 S7 of the Patents Act

responsibility of promoting the objects of the IPR-PFRD Act. In particular, as highlighted by Chetty (2009), in alignment with Section 9 of the IPR-PFRD Act, NIPMO is responsible for ensuring the identification, protection and commercialisation of intellectual property emanating from publicly financed R&D.[54] Other authors, such as Kraemer-Mbula *et al.* (2011:37) articulate NIPMO's role as being:

> *"to put in place mechanisms to encourage, monitor and quantify intellectual property resulting from publicly financed R&D; and directly support the development of TTOs at public HEIs [Higher Education Institutions] and public research institutions to identify, protect and, where applicable, commercialise their intellectual property."*

NIPMO reports to the DST, which is responsible for issues relating to innovation and, in particular, for funding and promoting research, science and innovation. Accordingly, the fact that it does not report to *the dti*, the ministry responsible for IP matters in South Africa, is an IP policy conundrum. That being said, as articulated by Teljeur (2003:50), legislation affecting intellectual property rights can originate in or involve the participation of a number of government departments. Some of these include the Department of Agriculture, which is responsible for Plant Breeders' Rights; the Department of Environmental Affairs, which is responsible for administering South Africa's obligations in terms of the Convention for Biodiversity and bio-prospecting regulations;[55] the Department of Health, in respect of the Medicines and Related Substances Control Act, 1965, which allows for parallel importation of medicines.[56] As per Gregory (2008:7), the fact that there are ministries or government departments other than *the dti* involved with

54 S9(1) IPR-PFRD Act

55 https://www.environment.gov.za/sites/default/files/docs/biprospecting_background_factsheet.pdf and https://www.environment.gov.za/sites/default/files/legislations/bioprospecting_regulatory_framework_guideline.pdf [Last accessed on 22 December 2014]

56 S15C of the Medicines and Related Substances Control Act

intellectual property policy and legislation is not surprising, given the cross-cutting nature of IP.[57] That being said, the lack of coordination poses a real policy conundrum.

An analysis of Section 9 of the IPR-PFRD Act suggests that NIPMO's role is both an enabling one, in terms of establishing capacity at publicly financed institutions and enabling commercialisation of IP, as well as a compliance one, in respect of the reporting of IP that falls under the IPR-PFRD Act.[58] In terms of the former role, NIPMO has the primary responsibility of providing incentives for IP creators;[59] assisting with the establishment of Offices of Technology Transfer (OTTs) at publicly financed institutions;[60] assisting the institutions with intellectual property transactions and commercialisation; and providing guidelines on management and commercialisation of intellectual property.[61] In addition, NIPMO is mandated to establish and manage an IP Fund[62] to provide financial assistance to institutions for IP protection. In terms of its compliance role, this comprises monitoring, evaluating and reviewing of recipients' IP management; protection, reporting and commercialisation obligations;[63] intellectual property transactions;[64] acquiring IP on behalf of the State[65], owing to a recipient's failure to disclose or commercialise IP; as well as regulating the calculation of full cost funding of R&D to give effect to the provisions of s15(4) of the IPR-PFRD Act. In an analysis of the effects of the IPR-PFRD Act on value generation at HEIs, Ncube *et al*. (2014:299) argue that NIPMO compliance requirements are far too onerous. However, they also point out that this could be mitigated by improved administrative practices at the OTTs, as already seen by the use of databases by the

57 S Gregory, Intellectual Property Rights and South Africa's Innovation Future, Trade Policy Report 23, 2008, pp. 7
58 S9 IPR-PFRD Act
59 S9(4)(b) IPR-PFRD Act
60 S9(4)(c) IPR-PFRD Act
61 S9(4)(d)-(e) IPR-PFRD Act
62 S13 IPR-PFRD Act
63 S9(4)(a) and S9(4)(f) IPR-PFRD Act
64 S11(1)(h) and s12 IPR-PFRD Act
65 S14(5) IPR-PFRD Act

University of Cape Town. In addition, NIPMO's financial assistance in capacity enhancement is also seen as a mitigating factor to the onerous reporting burden.

5.2.3 Offices of Technology Transfer (OTTs)

Offices of Technology Transfer (OTTs) have been established in a number of institutions in South Africa to give effect to Sections 6 and 7 of the IPR-PFRD Act, essentially to manage IP at the institutions, as stated in Kraemer-Mbula *et al*. (2011:37). At the time of writing this thesis, South Africa had 23 HEIs and 10 statutory institutions including research institutes listed in Schedule I of the IPR-PFRD Act.[66] In general, OTTs are relatively new structures at both HEIs and research institutes, as detailed in Sibanda (2009:130). Wolson (2009) notes that the OTTs at the CSIR, MRC, University of Cape Town, Stellenbosch and Pretoria have been functioning for much longer, prior to the promulgation of the IPR-PFRD Act.

According to the NIPMO, of the 23 HEIs and the 10 Schedule 1 institutions, NIPMO had, by the end of 2014, approved all the HEIs' IP Policies (except at the University of Venda), as well as seven of the Schedule 1 institutions' IP Policies (except for the NRF, HSRC and WRC).[67] As detailed in Chetty (2009:81), most of these institutions have, with the support of NIPMO, established OTTs to manage intellectual property in accordance with the IPR-PFRD Act. Three new HEIs are currently being established and it is too early to expect them to have any IP Policies at this stage, as they still have to admit students. In a recent position paper, SiMODISA (2014:49) points out that the IPR-PFRD Act:

> *"enhances the 'triple helix' by introducing formal structures at research institutions, such as technology transfer offices (TTOs). These structures act to ensure technology transfers and knowledge flows between research*

66 Human Resources Research Council (HSRC), Water Research Commission (WRC), Council for Scientific and Industrial Research (CSIR), Council for Mineral Technology (Mintek), Agricultural Research Council (ARC), South African Medical Research Council (MRC), South African Bureau of Standards (SABS), Council for Geosciences, National Research Foundation (NRF), and South African Nuclear Energy Corporation of South Africa (NECSA)

67 NIPMO Internal communication, Dec 2014

> *institutions and industry so that technology is further developed and commercialised."*

Other than the IPR-PFRD Act scheduled institutions, other public entities that had consulted NIPMO on development of their IP Policies, included Eskom, the South African National Biodiversity Institutions (SANBI), the National Health Laboratories Services (NHLS), the South African Weather Services, the South African National Space Agency (SANSA), the Square Kilometre Array South Africa (SKA-SA), the Development Bank of Southern Africa (Green Fund), the Iziko Museums of South Africa, and Transnet (NIPMO, 2014).. Wilson (2005) advances the view that OTTs are an important component of effectively commercialising IP at publicly financed institutions. This view has been investigated further as part of this study and the findings are presented in **Chapters 8** and **9**.

5.2.4 Intellectual Property Education

IP is offered at undergraduate level as an elective rather than as a compulsory course in undergraduate law degree studies at South African HEIs. Over the past few years, a number of chairs in IP have been established at the Universities of Cape Town, South Africa, Stellenbosch and Pretoria. The establishment of these chairs has been driven by the recognition of the growing importance of IP, not only for lawyers, but also for innovation; consequently, the need to develop course material for non-legal students has been recognised. Accordingly, there has been an increase in post-graduate certificate, diploma and degree courses in IP, offered by, *inter alia*, the University of Stellenbosch, the University of Cape Town, the University of South Africa, the University of the Witwatersrand, the University of Pretoria and the University of the Western Cape.

The South African Institute of Intellectual Property Law (SAIIPL)[68], which is a member-based organisation, offers the IP industry courses for prospective IP practitioners and for patent attorneys in collaboration with the statutory Patent Examination Board (PEB)[69], which is administered by *the dti*. The Patents Act provides that any person entitled to practice as an attorney in South Africa may, on passing the examinations set by the PEB, be registered to practice as a patent attorney.[70]

Notwithstanding the above, there is still a need for IP to be taught to scientific and engineering students, in an integrated manner, perhaps through a prescribed course that covers essential topics, such as copyright, trademarks, patents and industrial designs. The principles need to be incorporated into student course work and projects as part of science and engineering undergraduate degrees. Given the growing importance of IP in society, introducing these principles at much earlier stages, say at high school, for instance, may also assist in developing an IP and innovation culture.

5.3 LEGISLATIVE AND POLICY FRAMEWORK

5.3.1 Patents Act of 1978

The Patents Act regulates the protection of inventions in South Africa. A critical review of this legislation and the criteria that an invention must comply with for a valid patent to be granted is detailed in Burrel (1999:10). In this regard, s25(1) states that a patent may be granted for:

> *"any new invention which involves an inventive step and which is capable of being used or applied in trade or industry or agriculture."*

In terms of this definition, three requirements must be met for an invention to be deemed patentable: it must be novel, involve an inventive step and have industrial applicability. In respect of novelty, as disclosed in Pechacek (2012:203), the invention must not form part

68 http://www.saiipl.org.za/ [Last accessed on 21 December 2014]

69 S21 patents Act 1978

70 S20(3) Patents Act 1978

of the state of the art immediately before the priority date of the first filing of a patent application covering the invention. The test, as detailed in WIPO (2011:59) and Burrel (1999:151), is one of absolute novelty, except where the disclosure has been made fraudulently without the patentee's consent. As stated in the Study on Patents and the Public Domain in WIPO (2011:109), *"prior [public] knowledge and use by a single [person] is sufficient"* ground for any prior knowledge that was not protected at the time to comprise the public domain and hence destroy the novelty of the invention.[71] Given that s25(8) of the Patents Act regards secret use …. and on a commercial scale of an invention as part of the state of the art, it would appear that an invention that is used *"secretly and not on a commercial scale"* would not comprise the state of the art, as in the AECI Explosives case.[72] In the case of inventive step, s25(10) of the Patents Act requires that the invention not be obvious to a person skilled in the art, having regard to any matter forming the state of the art immediately before the priority date.[73]

S25(2) then provides a list of what are deemed not to be inventions, thereby providing limitations. In particular, the following are deemed not to be inventions and therefore not patentable in terms of South African law:

"(a) a discovery;
(b) a scientific theory;
(c) a mathematical method;
(d) a literary, dramatic, musical or artistic work or any other aesthetic creation;
(e) a scheme, rule or method for performing a mental act, playing a game or doing business;
(f) a program for a computer; or
(g) the presentation of information."

71 see also WA ScholtensChemischeFabrieken NV v Hoechst SA (Pty) Ltd and Another 1966 BP 371 (CP)
72 see also AECI Explosives Ltd v Ensign-Bickford (South Africa) and Others 1994 BP 42 (60A)
73 Genturico AG v Firestone SA (Pty) Ltd 1971 BP 58 (A) at 155G-156A; also see Ensign_Bickford (South Africa) (Pty) Ltd and Others v AECI Explosives and Chemicals Ltd 1998 BIP 271 (SCA) 281 C-D

In essence, the above subject matter fails the test for invention in most cases for a number of reasons, including the extent of determining novelty (e.g. in the case of a discovery, as in essence, a discovery is something that has existed but that has not yet been located), and not involving technical character (e.g. presentation of information and the creation of a program for a computer, both of which are protected by copyright), as per Klopper *et al.* (2010:273).

S25(3) of the Patents Act goes on to provide an explanatory qualifier in respect of the subject matter of s25(2) and states that it *"relates to that thing as such."*[74] Until 2013, South African courts had not considered the case of patentability of any of the subject matter falling within the scope of s25(2). In particular, an interpretation of *"that thing as such"* qualifier, which is a vague phrase had not been before any of the South African courts for consideration. In 2013, the Supreme Court of Appeal was presented with an opportunity to pronounce on the meaning of *"as such"* when considering the patentability of a computer program in the *Standard Bank of SA v 3MFuture Africa* case,[75] but it failed to do so. The case involved 3MFuture's patent for a '*Transaction Authorisation System*' designed to solve the problem of bank card fraud in transactions, particularly but not necessarily where the card holder and the supplier are in different locations. In the trial court, Standard Bank and MTN had alleged that the patent was invalid. The trial court found three of the claims to be valid and the others invalid; consequently, gave 3MFuture an opportunity to amend the claims. Standard Bank and MTN further challenged the validity of the patent. In determining the matter, the court took the view of only addressing the claims found to be valid and deciding instead to deal with the issue of novelty, without going further to pronounce on the meaning of *"as such"* in the Patents Act.

> *"I assume for present purposes that the method is indeed an invention, and need only deal with the objection against novelty, because I consider it to be decisive of the appeal, which means lack of inventiveness does not arise."*

Accordingly, to date, there has not been any litigation or South African case law in terms of the meaning of *"that thing as such."*

74 S25(3) of the Patents Act

75 Standard Bank of SA v 3MFuture Africa (47/2013) [2013] ZASCA 157 (22 November 2013)

It would thus appear, from Freeman (2011:59) and particularly from interpretations of similar legislative text in Europe,[76] that what is required is a technical effect to occur as a result of the implementation of the computer program for it to be patentable.

The Patents Act has other exclusionary provisions in respect of patentability of certain inventions. In particular, s25(4), bars the patentability of specific inventions on moral and humanitarian grounds:

> *"(a) for an invention the publication or exploitation of which would be generally expected to encourage offensive or immoral behaviour; or*
> *(b) for any variety of animal or plant or any essentially biological process for the production of animals or plants, not being a micro-biological process or the product of such a process."*

A further limitation is found in s25(11), which provides that*:*

> *"An invention of a method of treatment of the human or animal body by surgery or therapy or of diagnosis practised on the human or animal body shall be deemed not to be capable of being used or applied in trade or industry or agriculture."*

South African patent law allows for the patentability of a second medical use of known substances. According to s25(9) of the Patents Act:

> *"In the case of an invention consisting of a substance or composition for use in a method of treatment of the human or animal body by surgery or therapy or of diagnosis practised on the human or animal body, the fact that the substance or composition forms part of the state of the art immediately before the priority date of the invention shall not prevent a patent being granted for the invention if the use of the substance or composition in any such method does not form part of the state of the art at that date."*

76 Article 52(2) and (3) of the European Patent Convention - available at https://www.epo.org/law-practice/legal-texts/html/epc/2016/e/ar52.html [Last accessed on 14 August 2016]

The extent to which a second use provision limits access to health and, in particular, access to generic medicines, while also promoting so-called "ever-greening, has been raised as a concern by policy makers.[77] Ever-greening is regarded as a practice where an owner of a Patent A files patents applications for incremental improvements on the invention covered by Patent A, with the aim of extending the rights of an original, where in essence the inventiveness of the incremental improvement is too low to warrant a patent, but a subsequent patent is granted on the basis of arguments advanced before the patent examiners.

Patenting Procedure – Provisional and Complete Patent Specification

With regard to the patenting procedure, the Patents Act provides that an application for a patent may be accompanied either by a provisional patent specification or by a complete patent application.[78] More particularly, either application may be the basis for claiming priority.[79] However, an application accompanied by a complete specification need not claim priority from an earlier patent application. Nonetheless, it is also clear that only an application accompanied by a complete specification may result in a patent being granted. The basis for this is that, whereas a provisional specification needs only to describe the invention fairly,[80] a complete specification must contain claims defining the invention.[81]

> *"The function of a provisional specification therefore is to establish for protection of the invention, claimed in a complete specification lodged in support of a later application … had been made on the date of the filing of the provisional specification."*[82]

The date of filing therefore establishes the priority date as detailed in Burrel (1999:66). However, it is important to point out some of the pitfalls of the provisional patent system. In particular, as the disclosure in the provisional specification provides the basis for the

77 Comments on the South African Draft National Policy on Intellectual Property - http://www.dmkisch.com/node/502 [Last accessed on 30 September 2014]
78 S30(1)
79 S31(1)(a) and (b)
80 S32(2)
81 S32(3)(d)
82 Burrel, pp 66 at 2.18

claims in the complete patent specification, a provisional specification that too narrowly describes an invention would form a poor basis on which to claim priority, as the claims in the complete patent specification cannot be broader than the disclosure in the provisional patent specification. So, whereas there are indeed merits to the provisional patent system, there are also potential pitfalls. As stated by Burrel (1999:67), a provisional specification must provide a fair basis for the claims of a later complete specification.

The priority date thus relates to the earliest date on which the subject matter described in a patent specification has been disclosed in a patent application; in essence, this lays the basis for international protection, in case the same subject matter is described by an unrelated party in a separate patent application. Accordingly, as detailed in Burrel (1999:9), in terms of the Paris Convention that South Africa adopted, it is required that, once an application laying the basis for a priority date has been filed, a subsequent application for a patent must be filed in convention countries within 12 months of the priority date for the applicant to claim the priority date. That being said, in alignment with Paris Convention Article 4F, which deals with multiple priorities, an application for a patent may have one or more priority dates,[83] each being less than 12 months earlier, if the invention claimed in the application and/or the claims is fairly based on the specifications providing the earlier priority dates.[84]

The right to claim priority in terms of the Paris Convention lapses if a convention or PCT application accompanied by a complete specification is not filed within 12 months of the priority date;[85] any application filed in any convention country after the 12 months of the priority date, would effectively take the date of application as the priority date.

83 S33(3) of the Patents Act
84 Farbenfabriken Bayer AG (Zirngibl and Others) Application 1973 RPC 698 704 "The real point which has to be decided is whether or not the inventions in the complete and provisional specifications are in essence the same or not. If they are, the claims of the complete are entitled to the priority date of the provisional, and, if they are not, then the claims are only entitled to the date of the filing of the complete specification."
85 Article 4C(1) of the Paris Convention

Domestically, as can be seen in Pechacek (2012:202), an extension of three months is provided for the filing of a complete patent application claiming priority from an earlier filed application, meaning that a total of 15 months from filing of a provisional patent application is provided to file a complete patent application.[86]

A provisional patent system has a number of important aspects. In the first instance, an application accompanied by a provisional specification is relatively inexpensive and can be filed directly by the applicant, whereas an application for a grant of a patent must be accompanied by a complete specification and can only be filed by a patent attorney.[87] This, it can be argued, in essence makes the patent system accessible, owing to the inexpensive nature of the provisional patent application. Secondly, as the legal requirement is that a provisional specification should fairly describe the invention and not necessarily contain claims, it makes it an effective way of obtaining a priority date for claiming priority, particularly where there could be an urgent or some other reason to disclose, but not enough time to prepare a complete patent specification. This is quite attractive for academics and students where there are often pressures to publish or disclose in a poster presentation or a conference; it is also attractive for entrepreneurs who may want to obtain priority rights while they explore market interest or undertake further development of the invention before making a decision on final patent protection.[88] Thirdly, a patent granted from a combination of a provisional applications, followed by a complete patent application, has the effect of providing a slightly longer patent protection period in some cases than in the case where a complete patent application has been filed in the first instance. Naturally, the caveats in respect of the provisional specification must be taken into account.

86 see also s31(1)(c)(i) of Patents Act

87 Regulations 26 and 27 of the Patent Regulations, 1978 – only a patent attorney may sign a complete patent specification, whereas an applicant may sign a provisional specification.

88 Lloyd-Jacob J in Glaxo Group Ltd's Application 1968 RPC 473 at 480 – see Burrel, pp 66 *"The interval of time between the filing of the two specifications [i.e. between the provisional and latter complete specification] is intended to provide an opportunity for the development and precise expression of the invention foreshadowed in the provisional."*

Patenting Procedure – Examination System

Patents are granted following some internal procedures by a patent office. Typically, this involves a formal examination, prior art search, substantive examination, or combinations thereof. The formal examination procedure, used on its own, is also often referred to as a deposit system, as the patent office merely checks conformity of the application with formal requirements. However, in the case of search and substantive examination systems, formal examination of patent applications forms part of the preliminary procedures, which are then followed by, *inter alia*, a prior art search to determine the novelty of the invention, an examination of the invention for inventiveness and utility, in light of the prior art, and in some cases, opposition procedures. In the middle are hybrids, such as what is essentially a deposit system, with a prior art search being followed by opposition procedures. In the case of a formal examination, the validity of a patent may be challenged by potential infringers and its validity would then need to be determined by litigation through the courts. However, Kaplan (2009:3) argues that a substantive search and examination (SSE) patent system provides more legal certainty in respect of the validity of the patent, as the grant follows a prior art search as well as an examination of compliance with patentability requirements.

Both systems have their merits, depending on the size of the country's economy, technological sector, and intellectual property output. The deposit system requires very little capacity from the patent office and could be argued to be relatively inexpensive, at least when seeking to obtain a patent; it hence facilitates ease of access to the patent system. As part of advocating for a SSE patent system based on its benefits, Kaplan (2009:3) further argues that such a deposit system, as in the present case in South Africa, is expensive owing to the litigation that often follows where a patent from such a system is infringed.

Conversely, a substantive examination system requires capacity to undertake prior art searches, as well as an examination of the patent application, prior to a patent being granted. Kaplan (2009:5) argues that, whereas for an invention to be patentable, it must be novel, inventive and capable of use in trade, industry or agriculture, under the deposit system that forms part of the South Africa IP law, there is no system at the CIPC of ensuring that the invention covered by a patent application does indeed comply with these requirements. However, s36(1) of the Patents Act does compel the registrar to examine patent applications beyond just the mere formalities.[89] There is no evidence, however, to confirm the extent to which this 'technical' examination of the patent applications is being performed by the CIPC or whether it was in fact undertaken by its predecessors.

Pechacek (2012) recognises the growing number of policy discussions and public discourse on the value of a South Africa patent, given the absence of a substantive examination system. The discourse seems pertinent for a few reasons. Firstly, a patent is *prima facie* valid and the onus is placed on anyone refuting its validity to prove their case on a balance of probabilities.[90] Given this onus, Kaplan (2009) argues that smaller and less capitalised firms as well as individual inventors do not have the resources to initiate revocation proceedings on the basis of invalidity of a patent in terms of s61(1). Consequently, many patents on the register would not have been granted if South Africa had a substantive examination system, thus highlighting the concern raised in *Kimberly-Clark Corporation of SA (Pty) Ltd v Procter & Gamble SA (Pty) Ltd*[91] that:

> *"A further essential feature of the theory [quid pro quo] is that the patent register should not be cluttered with patents which are not valid."*

Secondly, there is a public interest concern, which is summarised in *Miller v Boxes and Shooks (Pty) Ltd*[92]:

89 Section 36(1) - If in the case of any application it appears to the registrar ----(a) that the application is frivolous on the ground that it claims as an invention anything obviously contrary to well established natural laws; or (b) that the use of the invention to which the application relates would be generally expected to encourage offensive or immoral behaviour, he shall refuse the application.

90 Gentiruco AG v Firestone South Africa (Pty) Ltd 1971 BP 58 (A) at 108B and Rotaque (Pty) Ltd v General Mining and Finance Corp and Another 1986 BP 534 (A)

91 1998 BIP 228 (SCA) 241C-D

92 1945 AD 561 at 580

> *"it is not in the public interest that patents should be granted indiscriminately for so-called inventions where, taking everything into consideration, there exists a sufficiently strong probability that they are not really inventions at all; these should not be allowed, even temporarily, to hamper the trade and industry of the country."*[93]

Thirdly, the lack of substantive examination provides uncertainties in the case of investment decisions and in particular whether indeed the patent provides the desired monopoly and competitive advantage to secure an investor's interest.

Although s34 of the Patents Act requires examination of patent specification, such examination is based on formalities set out in the regulations, and not on the basis or merits of the patentability criteria set out in s25 of the Patents Act. Accordingly, patents in South Africa are granted based merely on formalities, as per Pechacek (2012:202). To date, there has been significant reliance on the Court of the Commissioner of Patents and the appeal courts for confirmation of the validity of patents in the case of invalidity or infringement proceedings. In this regard, the Supreme Court of Appeal in South Africa has developed and followed precedents[94,95] over the years in interpretation of legislative novelty and inventiveness requirements. The novelty requirement has largely not presented problems, as it is an objective criterion, based on an absolute novelty enquiry. In this regard, the invention must not have been disclosed in any manner or form prior to the date of filing of an application for a patent for an invention. In the *Ensign Bickford* case, the Supreme Court of Appeal noted the following in respect of s25:

> *"These provisions constitute a statutory code. In effect all available knowledge is the starting point and lack of inventiveness only arises as an issue if the invention has, as it were, survived the attack on novelty".*

---

93 Also in Burrel, pp 2, see 1.2

94 Ensign Bickford (South Africa) (Pty) Ltd. and Others v AECI Explosives and Chemicals Ltd. (4/95) [1998] ZASCA 73; 1999 (1) SA 70 (SCA); [1998] 4 All SA 453 (A)

95 Gentiruco AG v Firestone SA (Pty) Ltd 1972 (1) SA 589 (A)

Kaplan (2009:3) argues that, whereas the deposit system provides easy access to local patent registration, some drawbacks include the lack of certainty in terms of the granted rights.

In August 2012, the CIPC held a roundtable discussion on Substantive Search and Examination with a view to soliciting views on a possible move towards a substantive patent examination system. Straus (2012b) points out that, whereas there are countries in Europe, such as Belgium, France, Italy and Switzerland, which do not have a substantive patent examination system, these countries are parties to the European Patent Convention, and hence rely on the patent examination undertaken by the European Patent Office (EPO). In supporting a move towards the creation of a substantive patent examination system, Straus (2012b) recognises the need to increase the number of skilled human resources that would be needed to undertake search and examination procedures, particularly given the low supply of such resources in South Africa. Some proposed interim measures towards the creation of a full examination system include: (i) implementing a filter in terms of specific types of applications to be examined, within the context of TRIPS Agreement, and in particular, possible recognition agreements with foreign patent offices in terms of which patents they grant would be recognised in South Africa without it being necessary to subject these patents for additional examination; and (ii) establishing a patent opposition board made up of both retired and serving judges, CIPC officers and members of the bar, to hear patent validity cases. In a follow-up roundtable discussion held on 9 February 2015, according to Du Plessis (2015), the following five possible scenarios for SSE patents models were proposed:

i. full examination in all cases
ii. a partial validation or re-registration system
iii. the outsourcing or sub-contracting of the SSE function
iv. partial recognition of work done by other agencies
v. a mixed or hybrid system (i.e. full SSE only for certain sectors, a deposit system for others).

Du Plessis (2015) further comments that a so called 'composite model' was proposed at the 2015 roundtable by the CIPC comprising the following elements:

i. a hybrid system will be used, namely a full SSE process in respect of domestic applications, and a partial recognition of the results of an examination conducted by another authority in respect of foreign applications; and
ii. the SSE system will not be generally applied to all applications but will be implemented only in respect of certain selected technology sectors, where the selection of technology sectors is to be made on the basis of the South African economic priorities.

In the final analysis, the move towards a substantive search and examination (SSE) system needs to balance, on the one hand, the interests of providing certainty in terms of granted patents and thus ensuring that the patent register is not cluttered with essentially invalid patents, and on the other hand, the interests of domestic investors who must be given access to the patent system. Any costs associated with a move towards a SSE must not be a barrier to such access.

Patenting Procedure – Indigenous Biological and Genetic Resources

Amechi (2015) teaches that the amendment to the Patents Act by the Patents Amendment Act 2005 (Act No. 20 of 2005) introduced the disclosure and prior informed consent requirements of the 1992 Convention on Biological Diversity (CBD) of which South Africa is a signatory, and which was ratified on 31 January 1996.[96] Accordingly, in terms of s30(3A) of the Patents Act as amended, an applicant for a patent is required to disclose whether or not the invention is derived from any indigenous biological or genetic resource:

> *"Every applicant who lodges an application for a patent accompanied by a complete specification shall, before acceptance of the application, lodge with the registrar a statement in the prescribed manner stating whether or not the invention for which protection is claimed is based on or derived from an indigenous biological resource, genetic resource, or traditional knowledge or use."*

96 https://www.cbd.int/countries/?country=za [Last accessed on 10 August 2015]

Therefore in terms of the amendments made to the Patents Act, any patent applicant in South Africa must disclose any traditional knowledge actually used in the course of developing the invention, and the actual source or origin. In this regard, Amechi (2015:13) states that the applicant must provide an undertaking or evidence of prior informed consent and/or of equitable benefit-sharing with the traditional knowledge holders.

5.3.2 Designs Act, No. 195 of 1993

The Designs Act grants protection for industrial designs; such protection is limited to the appearance or aesthetic features of an article of manufacture, embodying the design. Two types of design registrations are possible in terms of the South African law, namely aesthetic and functional design:[97]

Aesthetic design is defined as:

> *"any design applied to any article, whether for the pattern or the shape or the configuration or the ornamentation thereof, or for any two or more of those purposes, and by whatever means it is applied, having features which appeal to and are judged solely by the eye, irrespective of the aesthetic quality thereof;"*

Functional design is defined as:

> *"any design applied to any article, whether for the pattern or the shape or the configuration thereof, or for any two or more of those purposes, and by whatever means it is applied, having features which are necessitated by the function which the article to which the design is applied, is to perform, and includes an integrated circuit topography, a mask work and a series of mask works."*

97 s1 Design Act

Whereas the design registration system generally protects aesthetic features, the functional design would appear to protect the aesthetic features of the functional parts of an article of manufacture. In the English case of *Amp Incorporated v Utilux (Pty) Ltd*[98], the British court held that the features must appeal to or be judged solely by the eye, and therefore, as articulated by Burrel (1999:458), must have *"some individual characteristic. It must be calculated to attract the attention of the beholder."*

In both cases, the design must be capable of reproduction by an industrial process.[99] The period of protection is 10 and 15 years for functional and aesthetic design registration, respectively.[100] Owing to the uncertainty of distinguishing between a functional and an aesthetic design, most design registrations, particularly those with some functional aspect, are typically filed in both parts of the register as aesthetic and functional designs.

5.3.3 Armaments Development and Production Act, No. 57 of 1968

The Armaments Act, as amended, regulates inventions relating to any armaments, and provides for assignment of such inventions and patents to the Minister of Defence on behalf of the State.[101] An invention assigned in terms of this Act is not open to public inspection.[102]

5.3.4 Competition Act, No. 89 of 1998

The Competition Act, as amended[103], is important in respect of intellectual property, as IP rights are by their very nature exclusive and limiting competition. Of importance is Section 10(4) of the Competition Act, which provides that the:

98 1973 RPC 103
99 S14(4) Designs Act
100 S22(1) Designs Act
101 S79 of the Patents Act
102 S79(4) of the Patents Act
103 Government Gazette 19412, 30 October 1998

> *"Commission may exempt an agreement, or practice, or category of either agreements, or practices, that relates to the exercise of a right acquired or protected in terms of the Performers' Protection Act, 1967 (Act No. 11 of 1967), the Plant Breeder's Rights Act 1976 (Act No. 15 of 1976), the Patents Act, 1978 (Act No. 57 of 1978), the Copyright Act 1978 (Act No. 98 of 1978), the Trade Marks Act 1993 (Act No, 194 of 1993) and the Designs Act, 1993 (Act No. 195 of 1993)".*

5.3.5 Medicines and Related Substances Control Act 101 of 1965 as amended

In 1997, the Medicines and Related Substances Control Amendment Act introduced s15C into the Medicines and Related Substances Control Act 1965 to make provision for easier access to more affordable medicines, and in particular, to combat South Africa's growing AIDS epidemic (Kameri-Mbote, 2005:8). More specifically, s15C provides for conditions, which the Minister of Health may prescribe for parallel importation of more affordable medicines:

> *"in certain circumstances so as to protect the health of the public, and in particular may - (a) notwithstanding anything to the contrary contained in the Patents Act 1978 (Act No. 57 of 1978), determine that the rights with regard to any medicine under a patent granted in the Republic shall not extend to acts in respect of such medicine which has been put onto the market by the owner of the medicine, or with his or her consent."*

Pursuant to the government having published the intention to promulgate s15C, the Pharmaceutical Manufacturers Association instituted legal proceedings against the government,[104] citing that the proposed s15C contravened the TRIPS Agreement, when in effect it was based on one of the TRIPS flexibilities. Reviewing the Patents Act, we are of the view that the government could have achieved the same outcomes intended by s15C amendment by invoking the provisions of s4, s56 (compulsory licensing) and s78

104 Pharmaceutical Manufacturers' Association of South Africa v President of the Republic of South Africa. Case No 4183/98, filed Feb 18, 1998

(acquisition of an invention by the State) of the Patents Act, which allows a Minister of State to use an invention for public purpose.[105] However, the provisions of the Patents Act do require agreement on the conditions of use, and in the absence of such, for these to be determined by the Commissioner after hearing the patentee. Section 15C, in contrast, gives the Minister the right to determine the conditions, without consulting the patentee.

5.3.6 Intellectual Property Rights from Publicly Financed Research and Development Act No. 51 of 2008 (IPR-PFRD Act)

The IPR-PFRD Act provides a legislative regime to govern intellectual property generated in the course of R&D supported with public funds. The scope of this legislation is much broader than what was proposed in the policy framework that gave rise to its development, which considered patenting whilst negating other forms of IP; it was also limited to publicly financed institutions as opposed to anyone generating IP with public funds. Accordingly, the IPR-PFRD Act considers IP in its broadest form, as opposed to specifically advocating patenting, recognising that IP is an asset and can manifest in either patentable or non-patentable forms or both. Furthermore, owing to increased public investment in innovation since the NRDS in 2002, this legislation is not only confined to publicly financed institutions but affects anyone who generates IP with public funds received for purposes relating to research and development. In this regard, the stated objective of the IPR-PFRD Act is to ensure that IP emanating from publicly financed R&D is:

> *"identified, protected, utilised and commercialised for the benefit of the people of the Republic, whether it be for a social, economic, military or any other benefit."*[106]

105 S4 of the Patents Act
106 s2(1) of IPR-PFRD Act

Whereas the IPR-PFRD Act gives a recipient ownership of IP created with public funding, it also imposes a number of obligations aimed at ensuring that its objective is met; in particular, it requires a recipient to, *inter alia*:

- Put in place mechanisms for the identification, protection, development, management of intellectual property, intellectual property transactions;[107]
- Ensure that research personnel disclose to their institutions, through the OTTs, possible IP before it is made public or prior to publication;[108]
- Ensure benefit sharing of revenues received from IP commercialisation amongst the IP creators;[109]
- Report to NIPMO, a government agency established to ensure implementation of the IPR-PFRD Act, on all matters pertaining to IP falling under this legislation.[110]

The IPR-PFRD Act was promulgated against the backdrop of a weak intellectual property awareness culture, evidenced by low patenting rates by publicly financed institutions. According to Sibanda (2007:29), in the period 1981-2004, the 23 South African higher education institutions had a filing rate combined of 23 applications per year, meaning one per institution. In essence, a review of the objects of the IPR-PFRD Act would appear to be aligned with the recommendations made in Sibanda (2007:29) that what is required for South Africa is the creation of:

> *"a culture of intellectual property awareness, protection and management, aligned with government's national priorities, which will result in patenting on the basis of commercial merit and for strategic reasons."*

The rate of patenting by both HEIs and research councils in South Africa as far back as 2007, appears to have been on the increase, when considering the rate of filing of provisional patent applications. The implementation of the IPR-PFRD Act has the ultimate objective of creating an appropriate enabling environment for research outcomes to be protected and commercialised. Such an environment is essential for strengthening the IP and innovation

107 s5(1)(a) of IPR-PFRD Act
108 s5(1)(c) of IPR-PFRD Act
109 s5(1)(f) of IPR-PFRD Act
110 s5(1)(h) to (j) of IPR-PFRD Act

systems in as far as it applies to publicly financed institutions. This supports the findings by Sibanda (2009:132) that there is a correlation between patenting activity and institutional IP policies and structures for managing and commercialising IP.

Notwithstanding the fact that the IPR-PFRD Act has been operating since 2010, there remains scepticism in respect of its objectives, particularly amongst academics, much of which, the evidence also suggests, is based on a lack of understanding of its objectives. According to Bansi and Reddy (2015:185-196), a majority of academics did not understand the IP ownership provisions in the IPR-PFRD Act. In addition, some did not support the ownership of the IP by the institutions but would have preferred rather to have ownership vesting with the inventors, notwithstanding the fact that a lack of financing for patenting had been identified as a constraint to IP registration. Bansi and Reddy (2015:194) conclude that IP registration and commercialisation continue to be "viewed not as a primary goal of research", which is consistent with the findings of Sibanda (2009). Although the authors conclude that the researchers are of the view that the IPR-PFRD Act would result in lower IP registrations, they failed to provide a basis in terms of registration figures prior to the promulgation of the IPR-PFRD Act, to be able to substantiate their conclusion or findings.

5.4 TRIPS FLEXIBILITIES AND APPLICATION IN SOUTH AFRICAN PATENT LAW

The TRIPS Agreement sets out the minimum standards for the protection of intellectual property (see discussion in **Chapter 4** *supra*). In addition, TRIPS provides a number of flexibilities that member states can incorporate into their domestic legislation to ensure that the IP system meets the socio-economic development and other objectives of the relevant country. It will be recalled that, in terms of TRIPS Article 7, the IP system should contribute to the promotion of technological innovation and to the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare, and to a balance of rights and obligations. This view is also emphasised in CDIP (2000).

The flexibilities must be aligned with TRIPS Article 30, which provides that:

> *"Members may provide limited exceptions to the exclusive rights conferred by a patent, provided that such exceptions do not unreasonably conflict with a normal exploitation of the patent and do not unreasonably prejudice the legitimate interests of the patent owner, taking account of the legitimate interests of third parties."*

As discussed earlier, and also detailed in UNCTAD (2011:109), the flexibilities are classified in terms of their applicability, i.e. before the grant of a patent (namely pre-grant flexibilities) or after a patent has been granted following compliance with all formal and informal requirements (post-grant flexibilities). They are summarised in **Chapter 4** (see **Table 4.1**).

Tomlinson and Rutter (2014) note that, although South Africa, as a developing country, was only required to amend its laws to comply with TRIPS Agreement by 2000, South Africa did so in 1997. Some of the TRIPS flexibilities were thus incorporated into South African patent law through the amendment. In the sections that follow, we analyse these flexibilities within the context of South African patent law.

5.4.1 Disclosure Related Flexibilities

TRIPS Article 29 sets out certain requirements in terms of information that an applicant for a patent must provide to a patent office, as detailed in Thorpe (2002:23) and Henninger (2009:11). The requirements pertain to the information that an applicant should disclose in a patent specification and in the application itself. This may include, for example, though this is not peremptory, the best mode for carrying out the invention, the prosecution history, and the search and examination reports of equivalent foreign applications filed by the applicant, which must comprise disclosure related flexibilities.

There are also different schools of thought as to whether the disclosure of information relating to genetic resources (GR) and traditional knowledge (TK) falls within the scope of TRIPS flexibilities. Thorpe (2002) and Henninger (2009) argue, correctly so, that disclosure of information relating to GR and TK falls outside the scope of Article 29. Accordingly, legal frameworks that now include this requirement, including that of South Africa, have introduced what is perhaps a substantive requirement to patentability that is additional to that required by TRIPS and that could be considered to fall foul of Article 27.1, which requires that no discrimination be made based on field of technologies. The requirement of disclosure of TK and GR is a result of the Convention for Biological Diversity (CBD)[111] and could be dealt with through a *sui generis* law or be incorporated into existing laws.

Straus (2008:229-295) deals extensively with the issues pertaining to the CBD objectives of access to genetic resources, equitable sharing of benefits arising from the use of traditional knowledge and genetic resources as well as from erroneously granted patents. Two systems of dealing with the CBD Objectives are elaborated on: on the one hand, the contract-based systems approach proposed largely by the USA and in part by Japan; and on the other hand, the opposing view of incorporating disclosure of geographical origin or source of genetic resources in patent law through an amendment of the TRIPS Agreement. The following proposed TRIPS Article 29bis, directed at disclosure of origin of biological resources and/or associated TK:, is of interest

> *"Article 29bis: Disclosure of Origin of Biological Resources and/or Associated Traditional Knowledge*
>
> *1. For the purposes of establishing a mutually supportive relationship between this Agreement and the Convention on Biological Diversity, in implementing their obligations, Members shall have regard to the objectives and principles of this Agreement and to the objectives of the Convention on Biological Diversity.*
>
> *2. Where the subject matter of a patent application concerns, is derived from or developed with biological resources and/or associated traditional knowledge, Members shall require applicants to disclose the country providing the resources and/or associated traditional knowledge, from whom in the providing country they were obtained, and, as known after reasonable inquiry, the country of origin. Members shall also require that applicants provide information including evidence of compliance with the applicable legal requirements in the providing country for prior informed consent for*

111 5 June 1992, 30 I.L.M. 818. Available at https://www.cbd.int/doc/legal/cbd-en.pdf [Last accessed on 17 September 2015]

> *access and fair equitable benefit sharing arising from the commercial or other utilization of such resources and/or associated traditional knowledge.*
>
> *3. Members shall require applicants or patentees to supplement and to correct the information including evidence provided under Paragraph 2 of this Article in light of new information of which they become aware.*
>
> *4. Members shall publish the information disclosed in accordance with Paragraphs 2 and 3 of this Article jointly with the application or grant, which is made first. Where an applicant or patentee provides further information required under Paragraph 3 after publication, the additional information shall also be published without undue delay.*
>
> *5. Members shall put in place effective enforcement procedures so as to ensure compliance with the obligations set out in Paragraphs 2 and 3 of this Article. In particular, Members shall ensure that administrative and/or judicial authorities have the authority to prevent the further processing of an application or the grant of a patent and to revoke, subject to the provisions of Article 32 of this Agreement, or render unenforceable a patent when the applicant has, knowingly or with reasonable grounds to know, failed to comply with the obligations in Paragraph 2 and 3 of this Article or provided false or fraudulent information."*[112]

In the case of South Africa, although issues relating to TK and GR are effectively dealt with in terms of Chapter 6 of the Biodiversity Act[113], which regulates access to such resources for bio prospecting purposes, as well as the 2008 Regulations on Bio Prospecting, Access and Benefit-Sharing (BABS),[114] these issues have also found their way into the Patents Act. It is on this basis, therefore, that for the sake of completeness, we have included the GR and TK disclosure requirement in **Table 5.1**. This summarises the applicability of disclosure requirements in terms of South African patent law. The issue of TK and its interface with patent law is comprehensively dealt with by Emechi (2015). It is patently clear even from Emechi (2015) that TK and GR disclosure in the Patent Act is not as a result of TRIPS flexibilities but rather because South Africa implemented its obligations in terms of the Convention for Biological Diversity, as further detailed in the BABS Regulations.

112 WTO DOC WT/GC/W/564/Rev. 2 (TN/C/W/41 Rev. 2, IP/C/W/474) of 5 July 2006

113 National Environmental Management: Biodiversity Act 10 of 2004, (Biodiversity Act)

114 National Environmental Management: Biodiversity Act, 2004: Regulations on Bio-Prospecting, Access and Benefit Sharing, No. R. 138, 8 February 2008, (BABS Regulations)

Table 5.1: Summary of disclosure related patent flexibilities in Patents Act

DISCLOSURE	LEGISLATIVE PROVISIONS Patents Act
Disclosure requirements in specification and enforcement	
- Within prosecution - (enabling disclosure)	s32(3)(b)
- After Patent Grant	s61(1)
Deposit of micro-organism considered as complement /equivalent to disclosure	s32(6); s61(1)(i)
Provision of information concerning applicant's equivalent foreign applications	N/A
Indication of the source/origin of genetic resources (** Not a TRIPS requirement)	s30(3A) and 3(B)

Table 5.2 provides extracts of legislative texts of disclosures in terms of South African patent law.

Table 5.2: Summary of South African legislative text in respect to disclosure in patent specification, examination and provision of information

EXTRACT OF STATUTORY PROVISION FROM PATENTS ACT
S61(1)e
"complete specification … sufficiently describe, ascertain and, where necessary, illustrate or exemplify the invention and the manner in which it is to be performed in order to enable the invention to be carried out by a person skilled in the art of such invention."
S30(3A) and 30(3B)
"(3A) Every applicant who lodges an application for a patent accompanied by a complete specification shall, before acceptance of the application, lodge with the registrar a statement in the prescribed manner stating whether or not the invention for which protection is claimed is based on or derived from an indigenous biological resource, genetic resource, or traditional knowledge or use. (3B) The registrar shall call upon the applicant to furnish proof in the prescribed manner as to his or her title or authority to make use of the indigenous biological resource, genetic resource, or of the traditional knowledge or use if an applicant lodges a statement that acknowledges that the invention for which protection is claimed is based on or derived from an indigenous biological resource, genetic resource, or traditional knowledge or use.

Prior to the amendment of the Patents Act in 2002, the South African patent law used to have a best disclosure provision, which required that the complete specification must:

> *"disclose in the specification as accepted, the best method of performing the invention known to the applicant for the patent at the time when the specification was lodged at the patent office".*

In 2002, the "best mode" disclosure requirement was struck off the law by RSA (2002), and the disclosure requirement was amended to merely require that the:

> *"complete specification … sufficiently describe, ascertain and, where necessary, illustrate or exemplify the invention and the manner in which it is to be performed in order to enable the invention to be carried out by a person skilled in the art of such invention."*[115]

The determination of the best mode disclosure in patent specifications comprises a subjective element, i.e. determining whether the inventor had a best mode of carrying out the invention at the time of filing the application. Nonetheless, such a disclosure is much more enabling and would be useful for effective technology transfer. There would also appear to be a requirement of "good faith on the part of the patentee", as per the dictum below in a South African case, *Natalite Motor Spirit Company and Another v Davis* cited by Burrell (1999:202-203):

> *"if the person claiming the patent knows that certain proportions of the combinations are the most efficient for working he should state them. It is not to be left to the public to make costly experiments…. in order to become aware that certain proportions are most efficient than others. The patentee should also describe his invention that when the patent expires the public will be in as good a position as he is to exercise the invention. But if he knows that certain proportions are more efficient than others, knowledge which the public cannot obtain from reading the description but only by various experiments, then it is obvious that the patentee on such expiry will be in a more favourable position than the public. In such a case it cannot be said that the specification does in terms of the Act sufficiently disclose or explain the invention. If, therefore, it was clear from the evidence that Mr Adams knew which proportion was most efficient for working, then I think it would have been a sound objection to the specification that he has not stated therein what the proportion is. But … there is no other evidence to show that Mr*

115 s61(1)e of the Patents Act

Adams knew what the best proportion was. If he did not, the specification is not bad on the ground that no such proportion is stated".

A decided South African High Court case *Enka BV v EI du Pont de Nemours & Co 1987* BP *13 (T)* dealt with the requirement of proving this subjecting element. In this case, according to Burrell (1999:203), the Transvaal Division of the High Court found that what was required was to prove that:

"(a) the method ……… is a method of "performing the invention";
(b) the method is in fact a better method of performing the invention than the method disclosed in the specification;
(c) the method was known to the patentee at the time when the application for the patent was lodged at the Patent Office;
(d) the method is not disclosed in the specification ……..as accepted [by the patent office – our emphasis]; and
(e) the patentee knew that the undisclosed method was better than the method(s) disclosed in the specification".

It is thus immediately evident that a heavy burden is placed upon proving (c), (d) and (e), as one must assume the position of the patentee. The case also illustrates two interesting scenarios about this form of disclosure, the first being that disclosure could occur at the time of lodging the specification and the second being that disclosure could occur at the time of acceptance of the specification. The latter scenario would appear to be a more objective one than the first; in essence, it places an obligation on the patentee between the time of lodging and the time of acceptance, to ensure that a best mode disclosure is incorporated in the specification. What was also interesting about this case was that it represented a shift in terms of the South Africa patent law from an emphasis on disclosure at lodgement to disclosure at acceptance.

It would thus appear that the best mode disclosure relies significantly on subjective matters, unlike the sufficiency of disclosure, which has a direct relationship between the disclosure and the undertaking of the invention. Since 2002, the best mode disclosure is no longer a requirement and an applicant is required to provide only an enabling disclosure, sufficient for a person skilled in the art to be able to perform the invention as detailed in the specification. Accordingly, S61(1)(e)(i) on the Patents Act requires:

> *"that the complete specification …. fully describe and ascertain the invention and, where necessary, illustrate or exemplify the invention and the manner in which it is to be performed".*

In *Letraset Ltd v Helios Ltd 1972 BP 243 (A) at 246A-248G*, the South African Supreme Court of Appeal clarified the legal principles pertaining to the sufficiency of disclosure requirements as follows, as per Burrell (1999:188):

> "the degree of sufficiency and clarity of *definition* of the subject matter for which protection is claimed is 'reasonable certainty', and that in interpreting a claim or any other part of a patent specification, the court should bear in mind the fact that it is addressed to persons skilled in the relevant art, who are expected to bring reasonable intelligence to bear upon its language, and who while not required to struggle unduly with it, are to make the best of it, and not to adopt an attitude of 'studied obtuseness'".

The above view was also confirmed in *Unilever Ltd v Colgate-Palmolive Co 1977 BP 200 (CP)* in which the judge concluded that*:*

> "… a specification should not be held to be insufficient if the person to whom it is addressed would be able to produce the article or carry out the process claimed, without difficulty and with the aid of simple or routine experiments not requiring any prolonged research or inquiry …."

A flexibility that perhaps should be considered is that of disclosure of prosecution history pertaining to equivalent foreign patent applications, particularly given the growing debate regarding the quality of granted patents and the need to reduce frivolous patenting. South Africa neither requires disclosure of information pertaining to equivalent foreign patents nor does it undertake substantive patent examination. The following extract from the Draft IP Policy (2013), however, suggests intent to move towards an examination system:

> *"South Africa should adopt a multifaceted approach in as far as registration of patents is concerned; that is, use depository (registration), substantive search and examination and the utility patent systems."*

5.4.2 Research Exemption

By its very nature, rights granted by a patent are exclusionary and are reserved for the patentee, who may in turn grant others access to the patented invention. A big question also posed by Thorpe (2002:22) is to what extent a patent could be utilised for private and non-commercial uses, research and experimental purposes relating to the subject matter, without infringing on the patentee's rights. The WTO Dispute Settlement Panel in the Canada-Patent Protection of Pharmaceutical Product case,[116] which dealt with protection of patented pharmaceutical inventions, defines the research exception as:

> "the exception under which use of the *patented* product for scientific experimentation, during the term of the patent and without consent, is not an infringement".

Although Eisenberg (1989:1017) observes that, at first sight, it would appear that the patent system's *quid pro quo* essentially allows third parties to work with the invention and experiment on ways to improve on it, and thus promote further innovation; however, it does not necessarily follow that this would happen. In support of this, the WTO Panel explained the rationale behind this exception as follows:

> *"… this exception is based on the notion that a key public policy purpose underlying patent laws is to facilitate the dissemination and advancement of technical knowledge and that allowing the patent owner to prevent experimental use during the term of the patent would frustrate part of the purpose of the requirement that the nature of the invention be disclosed to the public. To the contrary, the argument concludes, under the policy of the patent laws, both society and the scientist have a 'legitimate interest' in using the patent disclosure to support the advance of science and technology."*

Of the BRICS countries, both Russia and South Africa do not have a research exception in their patent laws. Countries that do have this flexibility tend to use different wording which also gives rise, often to different interpretations.

116 http://www.wto.org/english/tratop_e/dispu_e/cases_e/ds114_e.htm [Last accessed on 16 September 2015]

Table 5.3 presents extracts of legislative texts of various selected countries from Correa (2004) and Sibanda (2014). Although, in essence, this exception excludes commercial research, what one finds in terms of the texts are different narratives for the research covered by the exception. They include "acts for the purposes of *experimental use*", "acts done for *experimental purposes* relating to the subject matter of the invention", "acts carried out for *scientific research purposes*" (e.g. Kenya, Egypt, United Republic of Tanzania, Mozambique), *"the use of an invention for scientific research only"*, "technological" or "technical" activities [Bangui Agreement], and acts "*solely for academic, scientific research, educational or teaching purposes" (e.g. Botswana).* In view of this, it is perhaps more useful to look at legislative text that is aligned with public policy considerations.

Article 10(6) of Egypt's Law on the Protection of Intellectual Property Rights, Law No. 82, 2002, provides for an additional exclusionary ground that is not contained in the other texts:

> "Any other acts by third parties, provided that they *shall* not unreasonably hamper the normal exploitation of the patent and shall not be unreasonably prejudicial to the legitimate interests of the patent owner, taking into consideration the legitimate interests of others".

Table 5.3: Extracts of research exception provisions from legislative texts of selected countries

COUNTRY	EXTRACT OF LEGISLATIVE PROVISION / COMMENTS
Botswana	Section 25(1)(c) - Botswana Industrial Property Act 2010
	The rights conferred by a patent shall not extend to — (c) acts done solely for academic, scientific research, educational or teaching purposes
Egypt	*Article 10 - Law on the Protection of Intellectual Property Rights, Law No. 82, 2002*
	The following shall not be considered as infringements of that right when carried out by third parties: (1) Activities carried out for scientific research purposes …. (6) Any other acts by third parties, provided that they shall not unreasonably hamper the normal exploitation of the patent, and shall not be unreasonably prejudicial to the legitimate interests of the patent owner, taking into consideration the legitimate interests of others.
Kenya	Article 58 - Industrial Property Act, 2001
	(1) The rights under the patent shall extend only to acts done for industrial or commercial purposes and in particular not to acts done for scientific research.

Mozambique	Article 68 (a): Law No 17 – 97 on Protection of Industrial Property	
	The following shall not be within the scope of the patent: a) Acts related to a patented invention for the purposes of scientific research;	
United Republic of Tanzania	Section 38 Chapter 217 The Patents (Registration) Act 1995	
	(1) The rights under the patent shall extend only to acts done for industrial or commercial purposes and in particular not to acts done for scientific research.	
Australia	Section 119C Australia Patent Act 1990 as amended	
	(1) A person may, without infringing a patent for an invention, do an act that would infringe the patent apart from this subsection, if the act is done for experimental purposes relating to the subject matter of the invention. (2) For the purposes of this section, experimental purposes relating to the subject matter of the invention include, but are not limited to, the following: (a) determining the properties of the invention; (b) determining the scope of a claim relating to the invention; (c) improving or modifying the invention; (d) determining the validity of the patent or of a claim relating to the invention; (e) determining whether the patent for the invention would be, or has been, infringed by the doing of an act.	
Brazil	Article 43: Law No. 9.279, May 1996 (as amended)	
	The provisions of the previous Article do not apply: (II) to acts carried out by unauthorized third parties for experimental purposes, in connection with scientific or technological studies or researches; (VII) to acts performed by non-authorized third parties, regarding patented inventions, which aim exclusively the production of information, data and test results directed to procure commerce registration, in Brazil or any other country, to allow the exploitation and commercialisation of the patented product, after the termination of the terms provided in article 10."	
China	Article 63. Patent Law,1984 (as amended)	
	None of the following shall be deemed an infringement of the patent right: (4) Where any person uses the patent concerned solely for the purposes of scientific research and experimentation.	
Germany	Section 11 of the Patents Act, 1968 (as amended)	
	The Effects of the Patent should not extend to: … 2. Acts for experimental purposes relating to the subject matter of the patented invention 2a. The use of biological material for the purpose of breeding, discovery and development of new varieties of plants 2b. Studies and trials… necessary for obtaining pharmaceutical marketing authorization…	
Japan	Section 69(1) of the Japanese Patent Law (as amended)	
	The effects of the patent right shall not extend to the working of the patent right for the purposes of experiment or research	
USA	Section 271 (e)(1) of Patent Act 35 USC (Hatch-Waxman Act) (as amended)	
	[i]t shall not be an act of infringement to make, use, offer to sell, or sell within the United States or import into the United States a patented invention . . . solely for uses reasonably related to the development and submission of information under a Federal law which regulates the manufacture, use, or sale of drugs **....**	

South Africa's status as a middle-income country, coupled with the advanced nature of its research infrastructure, presents real opportunities for beneficial use of the research flexibility. This view is further supported by the recognition of the importance of innovation for its development as demonstrated by the various policy interventions put in place, including the NDP. It is thus the author's submission that South Africa should consider incorporating this flexibility into its patent law. In **Table 5.3** *supra*, some examples of legislative provisions relating to this flexibility from Australia, Germany, Japan, and the USA are included for the sake of comparison, with the Japanese legislative provisions being the broadest. The Ministerial Review (2012) details South Africa's approach to investment in R&D as:

> *"Government's intention] is] to promote the increase in the R&D intensity (GERD) of the country to the ambitious target of 1.5% of GDP within a few years (specifically 2014)".*

South Africa's R&D expenditure in 2014/15 stood at R29-billion of 2014/2015, about 0.77% of GDP and is projected to grow to about R60-billion a year by 2020 (Campbell, 2017). The significant investments that South Africa has made to date in developing its R&D and innovation infrastructure and its stated intention to develop a Bioeconomy as detailed in RSA (2013) suggest that the absence of a general statutory research exemption is not in line with these objectives. Interestingly, the Draft IP Policy (2013), published for public comment, is also silent on the issue of the research exception. This flexibility facilitates scientific and technological R&D and ensures that it is supported by patent information, without infringement concerns.

With the growing health and food security concerns in South Africa and the potential impact of biotechnology research to addressing these concerns, use of patent information without it being seen as a patent infringement would provide a more enabling R&D and innovation environment. Particularly in the implementation of the Bioeconomy Strategy, this flexibility would be important.

The other important principles in respect of the research exemption can be seen from USA case law in terms of research tools, which find their origin and usefulness in biotechnology, and which are increasingly important in the development of diagnostics and treatments, as exemplified by the Myriad Genetics USA Supreme Court case.[117] The once patented Myriad Genetics *BRCA 1 test* used in the study of genetics of breast cancer is typical of such tools; its use in research facilitated the development of more efficient screening tests for cancer, as detailed in Dreyfuss (2004:457).

The US case law in terms of the research exemption has generally tended to be very restrictive, as illustrated by the following USA Federal Circuit case (Kevin, 2005):

> *"In Embrex Inc. v. Service Engineering Corp., 216 F.3d 1343 (Fed. Cir. 2000), where the defendant used the patented invention in the course of its experiments to design around the plaintiff's patent. The Court held that the defendant's use of the invention did not fall within the experimental use exception. In particular, the court held that as the experiments were being performed expressly for commercial purposes they constituted infringement."*

Another illustration of the USA case law restrictive application of the research flexibility is found in *Madey v. Duke University 266 F.2d 420* (M.D.N.C. 2001): the court had to rule on Duke University's continued use of various research equipment owned and patented by the plaintiff, after termination of the plaintiff's employment with Duke University. The University had argued that its use of the patented inventions constituted non-commercial academic research and was therefore exempted from infringement liability by the experimental use exemption. In holding that the exemption was not applicable to the facts, the USA District Court for the Middle District of North Carolina argued that:[118]

> *"Although the scope of the experimental use defense has recently been the issue of much debate, to date, the experimental use defense remains viable and may be asserted in those cases in which the allegedly infringing use of the patent is made for experimental, non-profit purposes only. Given this standard, for a plaintiff to overcome his burden of establishing actionable infringement, the plaintiff must establish that the defendant has not used the equipment at issue*

117 Association for Molecular Pathology v. Myriad Genetics, Inc, 569 U. S. ____ (2013); also available at http://www.supremecourt.gov/opinions/12pdf/12-398_1b7d.pdf [Last accessed on 21 September 2015]
118 Madey v. Duke Univ., 2002 U.S. Dist. LEXIS 19500 (M.D.N.C., Apr. 29, 2002, available at http://cyber.law.harvard.edu/cyberlaw2005/sites/cyberlaw2005/images/Madey_v._Duke_%28trial%29.pdf [Last accessed on 18 September 2015]

> *solely for an experimental or other non-profit purpose. More specifically, the plaintiff must sufficiently establish that the defendant's use of the patent had definite, cognizable, and not insubstantial commercial purposes."*

In its decision, the Federal Circuit Court in the Madey case also pointed out that even academic research can also be viewed as motivated by monetary incentives.

The US Supreme Court of Appeal in *Merck KGaA v Integra LifeSciences Ltd*[119] eased the Federal Circuit's improper and restrictive interpretation of Section 271(e)(1) to exclude research that is not submitted to the FDA and found it to be inconsistent with the statute's safe harbour language. Thus, this decision clarified that the research flexibility extends beyond merely the R&D and experimentation for generic drug development and that the exemption includes what would have otherwise been regarded as experimental research that would otherwise have been deemed to constitute infringement by the Federal Circuit.

In Europe, Article 31(b) of the Community Patent Convention (CPC) 1975, which never entered into force but which has been followed by national legislators,[120] states that "acts done for experimental purposes relating to the subject-matter of the patented invention" do not constitute infringement,[121] as argued by Waldeck und Pyrmont (2008). Similar language is found in the German legislation,[122] as set out in **Table 5.3**. Waldeck und Pyrmont (2008) argue that reference to 'relating to the subject matter' restrictively narrows the exception.

In a German Federal Supreme Court decisions,[123] the court held that:

---

119 Merck KGaA v. Integra Lifesciences I, Ltd., 545 U.S. ___ (2005); 125 S. Ct. 2372 (2005)

120 Convention for the European Patent for the common market signed at Luxembourg on December 15, 1975, commonly referred to as the Community Patent Convention (CPC 1975)

121 A more extended version of this imitation of the patent right is now to be found in Article 27 of the Agreement on a Unified Patent Court of 19 February 2013, signed by 25 EU Member States (Official Journal of the European Union No. C 175/1 of 20.6.2013)

122 Patentgesetz [PatG] [German Patent Act], Dec. 16, 1980, section 11(2)

123 German Federal Supreme Court [1998] R.P.C. 423 (435) – Confirmed by the German Federal Constitutional Court in 2000

> *"The ground for granting a patent to the inventor is ultimately the public interest in scientific and technological progress. Therefore the unlimited protection of the patent is not justified in a case where the further development of technology is hindered. The patent right – in the national sector as well as in principle in foreign law is aimed at promoting technological progress and stimulating the spirit of invention in the industry in a profitable manner."*

In its first Clinical Trials decision, the German Federal Court of Justice held that Section 11 (2) of the German Patents Act (GPA) *"in principle exempts all experimental acts as long as they serve to gain information and thus to carry out scientific research into the subject-matter of the invention, including its use."*[124] Reference to its use also suggests that the tests may serve future commercial interests. This was indeed the case, as Waldeck und Pyrmont (2008:396) illustrate in the following extract:

> *"Additionally, the court clarified that ultimate commercial purpose is irrelevant, when it stated: "[I]t cannot matter whether the experiments are used only to check the statements made in the patent or else to obtain further research results and whether they are employed for wider purposes, such as commercial interests."*

Notwithstanding the above, it appears that this freedom is not unfettered, as the Dutch Court of Appeals has since held that the experimentation may not include field trials intended to induce customers.[125] In addition, it is also evident from the first Clinical Trials case that uses where the invention is the means for experimentation, essentially research tools, are not exempt or covered by Section 11(2) of the GPA.

Some other arguments advanced in respect of this flexibility include a distinction between experiments *"on the subject matter"* versus experiments "with the subject matter", with the latter bordering on commercial use. These arguments appear to be consistent with the decision in the Bolar Case,[126] in which the Federal Circuit Court in the USA found that Bolar's acts, *which were with the patented subject matter*, of carrying out equivalency tests

124 Bundesgerichtshof [BGH] [Federal Court of Justice], July 11, 1995—Clinical Trials I, 28 IIC 838 (1997); [1997] R.P.C. 623, 640 (F.R.G.) [hereinafter Clinical Trials I], at pp. 639

125 Applied Research Sys. Holding N.V. v. Organon *et al*., Gerechtshof [Hof] [Court of Appeals], 3 Feb. 1994, NJ 463 (Neth.), 28 IIC558 (1997)

126 Roche Products v Bolar Pharmaceuticals, 733 F.2d. 858 (Fed. Cir. 1984)

for the regulatory approval of generic medicines before the expiration of the relevant patent owned by Roche, did not fall under the research exemption, but rather could be considered as part of the regulatory review exemption. Waldeck und Pyrmont (2008:282) point out the following resolution of the International Association for the Protection of Intellectual Property, in AIPPI (1992:282-283):

> *"Experimental use includes any use of the patented invention to an extent appropriate to experimentation (as opposed to commercial use) which is for the purpose of improving the invention or making an advance over the invention or finding an alternative to the invention, but not the commercial exploitation of the subject of any improvement or advance."*

In keeping with the objectives of the patent system being an incentive, one would argue for a balance between the need to ensure sufficient incentive to inventors in a future South African statutory research exemption provision, on the one hand, and, on the other hand, a broader and more enabling statutory research exemption provision for South Africa, rather than leaving it to the South African courts to develop jurisprudence that unnecessarily limits and narrows the scope of the research exemption. In fact, Waldeck und Pyrmont (2008:416) argue that public policy militates against too broad an exemption that encompasses research tools.

The various scenarios anticipated for operation of the research exception in the Australian Patent Act 1990 (as amended)[127] are instructive in terms of an approach for South Africa. These scenarios include, but are not limited to, determining the properties and scope of claims of the invention, improving or modifying the invention, determining the validity of any of the patent claims, whether the experiments are undertaken with or on the patented subject matter, commercial interests, and investigating whether carrying out any particular acts would amount to infringement of the patent.

In conclusion, a research exception provision in South African patent law must in accordance with Article 30 of TRIPS be *"limited"* and not unreasonably conflict with a

127 Section 119C Australia Patent Act 1990 as amended

normal exploitation of the patent; it also may not unreasonably prejudice the legitimate interests of the patent owner, taking into account the legitimate interests of third parties.

5.4.3 Regulatory Review Exemption

The Regulatory Review Exception, also often referred to as the *"Bolar provision or exception"*, following the *Roche Products Inc. v Bolar Pharmaceutical Co* decision ("the Bolar Case"),[128] is one of the patent exceptions available under the TRIPS Agreement. In terms of this exemption, a third party is allowed to undertake certain acts for the purposes of obtaining regulatory approval, which ordinarily would be seen as infringement of a valid and in-force patent, prior to the expiry of the patent. This flexibility is largely available in the life sciences sector (health and agriculture), where products require regulatory approval for their commercialisation. Owing to delays in marketing or regulatory authorisation of these products, the patentee does not enjoy the full benefit of the patent life for the product in question, given that the term for patent protection starts from patent application as opposed to from date of marketing or regulatory approval. At the same time, there is public policy interest in ensuring that generic products of these patented products are able to enter the market as soon as possible following expiry of patent protection, and that they are not delayed by the need for regulatory approval. The exception is thus intended to facilitate the authorisation of new products or drugs equivalent with patented products or drugs that have prior approval, particularly when the patented product or drug is about to come off patent.

Section 69A(1) of the Patents Act provides for regulatory review exceptions where the use of the patented invention is on a *"non-commercial scale and solely for the purposes reasonably related to the … information required under any law that regulates the manufacture, production, distribution, use or sale of any product"* (see **Table 5.4** below).

Table 5.4: Extracts of Regulatory Review Exception legislative texts of selected countries

COUNTRY	EXTRACT OF LEGISLATIVE PROVISION / COMMENTS

128 Roche Products v Bolar Pharmaceuticals, 733 F.2d. 858 (Fed. Cir. 1984)

South Africa	Section 69A of the Patents Act
	(1) It shall not be an act of infringement of a patent to make, use, exercise, offer to dispose of, dispose of or import the patented invention on a non-commercial scale and solely for the purposes reasonably related to the obtaining, development and submission of information required under any law that regulates the manufacture, production, distribution, use or sale of any product. (2) It shall not be permitted to possess the patented invention made, used, imported or acquired in terms of subsection (1) for any purpose other than for the obtaining, development or submission of information as contemplated in that subsection. [S. 69A inserted by s. 16 of Act No. 58 of 2002.]
Botswana	S25 of Industrial Property Act 8 of 2010
	(f) an act done in respect of the patented invention for purposes of compliance with regulatory marketing approval procedures for pharmaceutical, veterinary, agrochemical or other products subjected to such procedures;
Egypt	Article 10 - Law on the Protection of Intellectual Property Rights, Law No. 82, 2002
	(1) Activities carried out for scientific research purposes. (5) Where a third party proceeds, during the protection period of a product, with its manufacturing, assembly, use or sale, with a view to obtain a marketing license, provided that the marketing starts after the expiry of such a protection period. (6) Any other acts by third parties, provided that they shall not unreasonably hamper the normal exploitation of the patent, and shall not be unreasonably prejudicial to the legitimate interests of the patent owner, taking into consideration the legitimate interests of others.
Zimbabwe	s24B of Patents Act 27 of 1971 as amended
	24B Test batches of patented products (1) Test batches of a patented product may be produced without the consent of the patentee six months before the expiry of the patent: Provided that the test batches shall not be put on the market before the expiry date of the patent. (2) Where test batches of a patented product have been produced in terms of subsection (1), the term of the patent of the original product shall not be extended.
Canada	Canada Patents Act, Article 55.2(2)
	It is not an infringement of a patent for any person who makes, constructs, uses or sells a patented invention in accordance with subsection (1) to make, construct or use the invention, during the applicable period provided for by the regulations, for the manufacture and storage of articles intended for sale after the date on which the term of the patent expires.
Brazil	Article 43: Law No. 9.279, May 1996 (as amended)
	The provisions of the previous Article do not apply: VII. to acts performed by non-authorized third parties, regarding patented inventions, which aim exclusively the production of information, data and test results directed to procure commerce registration, in Brazil or any other country, to allow the exploitation and commercialization of the patented product, after the termination of the terms provided in article 10.

China	Article 69 of Patent Law of the People's Republic of China (promulgated Dec 27, 2008, effective Oct 1, 2009), PRC President Order No.8 of 11th NPC	
	[t]he following shall not be deemed to be patent right infringement: . . . (4) [a]ny person uses the relevant patent specially for the purpose of scientific research and experimentation; and (5) [a]ny person produces, uses, or imports patented drugs or patented medical apparatus and instruments, for the purpose of providing information required for administrative examination and approval, or any other person produces or imports patented drugs or patented medical apparatus and instruments especially for that person	
USA	United States 35 USC 271(e)(1)	
	It shall not be an act of infringement to make, use, offer to sell, or sell within the United States or import into the United States a patented invention . . . solely for uses reasonably related to the development and submission of information under a Federal law which regulates the manufacture, use, or sale of drugs or veterinary biological products.	

The regulatory review provisions in South Africa appear to be consistent with those in Canada and USA, respectively:

"It is not an infringement of a patent for any person who makes, constructs, uses or sells a patented invention in accordance with subsection (1) to make, construct or use the invention, during the applicable period provided for by the regulations, for the manufacture and storage of articles intended for sale after the date on which the term of the patent expires."[129]

"It shall not be an act of infringement to make, use, offer to sell, or sell within the United States or import into the United States a patented invention . . . solely for uses reasonably related to the development and submission of information under a Federal law which regulates the manufacture, use, or sale of drugs or veterinary biological products."[130]

Ferance (2003:2) notes that the wording of Section 69A(1) is similar to that of the Bolar provision in Section 55.2(1) of the Canadian Patent Act, which provides that:

"It is not an infringement of a patent for any person to make, construct, use or sell the patented invention solely for uses reasonably related to the development and submission of information required under any law of Canada,

129 Canada Patents Act, Article 55.2(2)

130 United States 35 USC 271(e)(1)

a province or a country other than Canada that regulates the manufacture, construction, use or sale of any product".

The effective use of this flexibility requires the existence of research and manufacturing capacity pertaining to the regulated products. In the case of South Africa, as illustrated in **Chapter 3** above, not only does South Africa have a large life sciences sector, but it also has a well-developed infrastructure and capacity to take advantage of this flexibility.

The application of the regulatory review exception to all uses of patented invention that are reasonably related to obtaining regulatory approval, including but not limited to preclinical data for submission to the FDA, tests that are not necessarily compliant with FDA regulations, and studies that perform a risk-benefit analysis of a proposed clinical trial, safety-related studies to generate pharmacological, toxicological, pharmacokinetic and biological qualities of the drug in animals, was confirmed by the US Supreme Court in the *Merck v Integra case.*[131] As expertly dealt with by Waldeck und Pyrmont (2008:404):

"Integra owned several U.S. patents on pharmaceutically useful peptides containing a short tri-peptide segment of fibronectin (the RGDPeptide) that promotes cell adhesion by interacting with αvβ3 receptors on the cell surface proteins (integrins). … Merck hired Dr. Cheresh and Scripps to identify potential drug candidates which may inhibit angiogenesis. After Dr. Cheresh identified the cyclic peptide EMD 66203, Merck entered into a research agreement with Scripps and funded the experiments necessary to satisfy the regulatory requirements for the implementation of clinical trials with the identified peptide or a derivative thereof. Scripps identified two additional derivative peptides and conducted several in vitro and in vivo experiments on the three peptides to determine their specificity, efficacy, and toxicity with respect to various diseases, as well as the best method for therapeutically administering the peptides. Eventually, in 1997, the derivative peptide EMD 121974 was chosen for clinical development. Scripps also performed basic research on organic mimetics designed to block αvβ3 receptors in similar manner and used the RGD-peptides as 'positive controls' for efficacy testing. When Integra learned of the research agreement between Merck and Scripps, it offered a license to its RGD patents and sued Merck when their lengthy licensing negotiations failed. Merck

131 Merck KGaA v Integra Lifesciences I, Ltd.,125 S. Ct. 2372, No. 03-1237 (2005)

contended that the patents were invalid and that their research fell into the safe harbor of section 271(e)(1).”

Straus (2014:895) analyses the coverage of the “Bolar” rule within the context of the European Union, and in particular as it relates to the rights of third parties who supply active patented ingredients (APIs) to generic drug manufacturers for regulatory authorisation. In this article, Straus considers the interpretation of Article 10(6) of Directive 2004/27 amending Directive 2001/83 on the Community code relating to medicinal products for human use, and the judgements of the Supreme Court of Poland and the Higher Regional Court (Oberlandesgericht) of Dusseldorf. Straus (2014:896) correctly criticises the decision of the Supreme Court of Poland (SCP)[132] that *“the Bolar exemption applies only to the testing entity but not to third-party manufacture and sale of the APIs to a manufacturer testing generic drug and seeking regulatory marketing drug authorisation.”* He further argues that the SCP misunderstood the Bolar rule and applied it contrary to its genuine role. In particular, the SCP ignored the importance of the API in enabling generic manufacturers to be able to undertake the tests and obtain market authorisation. Instead, Straus (2014:907) correctly argues that the decision of the German Higher Regional Court (Oberlandesgericht) of Dusseldorf, that Article 10(6) of the Directive or the so-called Bolar provision covers *“manufacturing, offering for sale and selling, for example, of APIs by third parties to generic companies for their use in studies and trials prerequisite to a marketing authorisation”* is consistent with the WTO DSB Panel Report in Canada — Patent Protection of Pharmaceutical Products.[133] In addition, Straus (2014) finds that the Regional Court’s requirement that the third party supplying the API must be seen as a co-organiser of the studies and trials, is not necessary for compliance with the TRIPS Agreement with regard to the regulatory exemption, and that it is an additional requirement that negates the genuine interests intended to be protected by the Bolar provisions, i.e. to facilitate access to health through improved generics competition and reduced health care costs through lower prices of generic drugs.

132 Astellas Pharma Inc v Polpharma SA, Supreme Court of Poland, Docket No IV CSK 92/13, 23 October 2013

133 WT/DS114/R (17 March 2000)

This flexibility has been argued to serve public health objectives. Given the growing burden of disease, particularly in the developing world, and the need to facilitate early entry of cheaper generic versions of patented drugs, s69A of the Patents Act is an important provision aligned to the TRIPS Agreement flexibilities. Notwithstanding the above, in the absence of research and manufacturing capacity pertaining to the regulated products, whether they are pharmaceutical or agricultural products, within a country, the regulatory review exception may be a toothless instrument in terms of access to medicine. In such cases, the compulsory licence provisions may better serve that purpose, as will be illustrated in the following section.

Berger *et al*. (2010) (see **Figure 5.1)** illustrate the priorities in respect of pharmaceuticals and access to medicines, ranging from the very basic need of access through manufacturing to R&D or contributors to global knowledge and innovation. Given that most African countries are still at the very basic level of access with few having developed a manufacturing capability, it is not surprising that the regulatory review exception is not included in the legislative texts of most African countries; even those that do have a research exemption (see **Table 5.3**). Accordingly, regulatory review exceptions would not be of much use to the countries that are still at the stage of access. However, it is important that the patent legislation be amended to include the 'Bolar' type provisions, in anticipation of them moving up the level of complexity.

Innovation milestone: 7 critical complexity levels	
Research and Development	Novel vaccine innovation
	Novel drug innovation
	Early pharmaceutical innovation (fixed dose combinations, diagnostics, reformulations)
Manufacturing	Manufacturing vaccines
	Manufacturing drugs, including manufacturing APIs
	Formulating and packaging imported API (active pharmaceutical ingredients)
Access	**Minimum baseline:** Access to affortable, qulity imported medicines

Figure 5.1: Level of complexity and countries' priorities in respect of pharmaceutical innovation [Source: Berger *et al.* (2010)]

The South African courts have not had the opportunity to make any rulings on the interpretation or application of s69A(1) of the Patents Act. However, based on the similarities between the legislative provisions of the USA and South Africa, the regulatory review exception applies to all uses of patented inventions that are reasonably related to the development and submission of any information under the regulatory authorities. Moreover, it is to be distinguished from the research exemption that South Africa does not have in its law, but that the USA does have in its law. Whereas the research exemption is directed towards allowable instances of research that would otherwise be deemed to infringe on a patent owner's rights, the regulatory review exception is directed to such acts as performing clinical trials with a patented drug, necessary to achieve marketing authorisation that would be seen as infringing a patent owner's right to dispose of products covered by the patent. In addition, the following conclusions by Straus (2014:908) provide useful insights on possible interpretations and applications of s69A(1) in respect of third parties that may be involved in the production of patented APIs:

> *"The privileged status of the third party should merely depend on whether, at the time of the act of delivery of the API, the third party can rightly assume that, judging all the circumstances (ie profile of the supplied company, small amount of the provided active substance, imminent expiration of the patent protection of the relevant active substance, experience gained concerning the customer's reliability), the supplied manufacturer of generics will use the provided active substance only in privileged trials and studies in the context of a marketing approval. A written commitment attached to the order should suffice: it would be signed by the generic manufacturer that the supplied API will be used exclusively for the purposes of conducting the studies and trials required for obtaining a marketing authorization."*

5.4.4 Compulsory Licences

The rights granted to a patentee are intended to exclude others from using a patented invention for the duration of the period of protection. However, the patentee can licence these rights to a third party, in the form of a voluntary licence, or may be compelled on certain grounds to do so, in the case of a compulsory licence. In essence, a voluntary licence is a mechanism to avoid having to grant a compulsory licence. Compulsory licenses have become an important instrument in intellectual property law, to provide access to patents covering essential medicines. In a South African case before the Competition Commission[134], the threat of having to grant compulsory licences has served as a way of encouraging the granting of voluntary licences on reasonable terms, in which case the licences are between two parties without interference from government.

It is interesting that there have been a number of instances in South Africa, where there have been threats in respect of the granting of compulsory licences, but no such licences have been granted. In all cases, such threats have led to the issuance of voluntary licences. Proponents of the Draft IP Policy (2013), such as Baker (2014), argue that the compulsory licence provisions in the Patents Act are too cumbersome, which may explain why no compulsory licence has ever been granted. **Table 5.5** summarises the provisions of Sections 55 and 56 of the Patents Act that deal with compulsory licensing.

134 Hazel Tau & others v. GlaxoSmithKline & Boehringer Ingelheim ("Hazel Tau Case") – Competition Commission South Africa (2003)

Table 5.5: Summary of legislative text in the Patents Act regarding compulsory licences and/or government use

CATEGORIES PROVIDED AND EXTRACTS OF TEXTS: ***Sections 55 and 56***
• Dependent patent • Abuse of rights - patented invention is not being worked in the Republic on a commercial scale or to an adequate extent, after the expiry of a period of four years subsequent to the date of the application for the patent or three years subsequent to the date on which that patent was sealed, whichever period last expires, without satisfactory reason for such non-working • Demand for the patented article in the Republic is not being met to an adequate extent and on reasonable terms • Trade or industry or agriculture of the Republic or the trade of any person or class of persons trading in the Republic, or the establishment of any new trade or industry in the Republic, is being prejudiced, and it is in the public interest that a licence or licences should be granted • Demand in the Republic for the patented article is being met by importation and the price charged by the patentee, his licensee or agent for the patented article is excessive in relation to the price charged therefor in countries where the patented article is manufactured by or under licence from the patentee or his predecessor or successor in title

The following two cases illustrate various situations where compulsory licences were considered, based on giving access to cheaper medicine.

a) ***CIPLA Case:*** On 7 March 2001, Indian pharmaceutical manufacturer CIPLA formally requested the South African Department of Trade and Industry to issue compulsory licenses to patents on the following HIV drugs: nevirapine, lamivudine, zidovudine, stavudine, didanosine, efavirenz, indinavir and abacavir.[135] The request was made in terms of Article 56(c) of the South Africa Patents Act, which relates to compulsory licenses owing to abuse of rights on basis that the demand in South Africa for the *alleged* patented drugs was not being met adequately and on reasonable terms. In its demand, CIPLA noted that *"there are from 4 to 5 million HIV infected persons in South Africa, and less than 2 percent are receiving antiretroviral treatment."* An interesting point to note with respect to CIPLA's letter to *the dti* is that it did not identify patent numbers for any of the drugs indicated in the letter but merely stated that these drugs were subjects of

135 http://www.cptech.org/ip/health/cipla/ [Last accessed on 23 September 2016]

patents. We are of the view that such a request was deficient and hence our emphasis on *"alleged patented drugs."* It is not clear what the status of the patents was. It is not improbable that some of these drugs might have been either off patent (owing to non-payment of renewal fees) or not patented at all.

b) **Treatment Action Campaign (TAC) vs GlaxoSmithKline (GSK) and Boehringer Ingelheim (GI):** On September 19, 2002, Hazel Tau, working with the Treatment Action Campaign (TAC), filed a complaint with South Africa's Competition Commission against GlaxoSmithKline (GSK) and Boehringer Ingelheim (GI). Twelve parties would join the complaint, which charged GSK and BI with excessive pricing in respect of ritonavir, lamivudine, ritonavir+lamivudine and nevirapine. On October 16, 2003, after an extended investigation, the South Africa Competition Commission issued a statement, saying: pharmaceutical firms GlaxoSmithKline South Africa (Pty) Ltd (GSK) and Boehringer Ingelheim (BI) have contravened the Competition Act of 1998. The firms were found to have abused their dominant positions in their respective anti-retroviral (ARV) markets.

In particular, the Commission found the firms had engaged in restrictive practices and specifically: (i) denied a competitor access to an essential facility, (ii) excessive pricing, and (iii) generally engaged in an exclusionary act.

According to the Commissioner, the Commission concluded that:

> *"We will request the [Competition] Tribunal to make an order authorizing any person to exploit the patents to market generic versions of the respondents' patented medicines or fixed dose combinations that require these patents, in return for the payment of a reasonable royalty. In addition, we will recommend a penalty of 10% of the annual turnover of the respondents' ARVs in South Africa for each year that they are found to have violated the Act."*[136]

Subsequently, on 10 December 2003, the Competition Commission announced it had reached a settlement with GSK. The settlement required GSK to:

---

136 Press statement of 16 October 2003, available at http://www.cptech.org/ip/health/sa/cc10162003.html [Last accessed on 28 June 2013]

- extend a voluntary licence granted to Aspen Pharmacare in October 2001 in respect of the public sector to include the private sector;
- grant up to three more voluntary licences on terms no less favourable than those granted to Aspen Pharmacare;
- permit the licensees to export the ARVs to sub-Saharan African countries;
- permit the importation of the drugs for distribution in South Africa if the licensee does not have manufacturing capability in South Africa;
- permit licensees to combine the relevant ARV with other antiretroviral medicines; and
- charge royalties of no more than 5% of the net sales of the relevant ARVs.

Shortly thereafter, a similar settlement was reached with BI.[137]

In essence, this matter did not go to the Tribunal and, because the settlement was reached, compulsory licences did not need to be issued. Instead, voluntary licenses were issued by GSK and BI, based on a settlement reached with the Competition Commission. It is quite interesting to note that this particular case was not based on the Patents Act or Article 31 of TRIPS *per se*, as this of necessity links the claim to abuse in terms of the Patents Act. Notwithstanding the matter being dealt with in terms of the Competition Act, the complainants did establish a nexus between the cited drugs and the patent numbers of the patents covering such drugs, unlike in the CIPLA case. In addition, the finding that GSK and BI had engaged in excessive pricing would fall within the ambit of abuse of patent rights in terms of Section 56 of the Patents Act, although this provision was correctly not raised, as this was the wrong forum to raise a case in terms of Section 56. This case nonetheless did pave the way for voluntary licensing in the area of pharmaceuticals and the reduction of prices for ARVs.

An important observation is that although the South African Patent Act has legislative provisions (such as sections 55 and 56) for compulsory licensing in the case of abuse, on non-use of a patent, to meet demand on reasonable terms and for national security, there

137 *Knowledge Ecology International (KEI) Statement on Thailand Compulsory licenses,* http://www.cptech.org/ip/health/c/thailand/kei-thaicl-statement.html [Last accessed on 23 June 2014]

are no provisions for exporting drugs to other countries that lack or have insufficient manufacturing capacity. It has been argued by Munyuki and Machemedze (2010:18) that, given South Africa's advanced domestic pharmaceutical manufacturing capacity, such provisions should be considered to ensure access to medicine for the rest of the continent.

5.5 NATIONAL INTELLECTUAL PROPERTY POLICY

5.5.1 Overview

It would appear that, amongst the BRICS group of countries, South Africa's policy landscape in respect of IP and innovation most resembles that of China, the leader within the group, according to Straus (2012:671). The real challenge for South Africa is how to ensure that its IP and innovation policies unlock similar benefits to those that have been seen in some of the fastest growing countries, particularly in the East, for example. Under pressure from a high disease burden and a need for increased access to health, coupled with what appears to be an enabling environment for generic medicines in Brazil and India, South African policy makers appear to be considering policy and legislative changes.

In addition, it has been argued by Ncube (2013) that South Africa's peers in the BRICS have weaker IP systems than South Africa,[138] but have nonetheless received substantially higher FDI inflows than South Africa.[139] In this regard, the Draft IP Policy (2013) strongly advocates that South Africa should adopt a minimalistic approach to intellectual property, with significant focus on ensuring that the system first serves South Africa's socio-economic goals. In principle, such an approach may appear to make sense, given the argument by Ncube (2013:372) that most developed countries initially had weak IP systems, which were strengthened incrementally in line with stage of economic development. However, it is submitted that such an approach should guard against a cavalier attitude towards intellectual property, particularly considering South Africa's accession to the TRIPS

138 Based on 2011 IPRI rankings out of 129 countries, South Africa is placed 21, Brazil and India at 51, China at 59 and Russia 67

139 From UNCTAD 2011 (www.unctad.org) - FDIs were as follows: South Africa ($1.3b), Brazil ($30.2b, China ($101.1b exclusive of the financial sector), India ($23.7b) and Russia ($39.7b)

Agreement in the 1990s. Perhaps it is also necessary to understand what other parameters were responsible for the other BRICS countries attracting higher FDIs than South Africa, particularly in the light of observations by Kaplan (2009:4) that:

> *"While stronger IPRs are likely to have a positive impact on foreign investment, it is evident that they are not the sole or possibly even a major determinant of FDI. Certainly, South Africa has attracted far less FDI than other countries whose IPR system appears to offer potential foreign investors weaker protection."*

The above background is therefore useful in the review of the Draft IP Policy (2013), which has, *inter alia*, the following objectives:

> *"a) To create an environment conducive to economic opportunities aimed at empowering South African citizens.*
>
> *b) To develop an IP Policy that interfaces with other new emerging issues in the area of IP.*
>
> *c) To promote research, development and innovation throughout the South African economy by private and research institutions and individual members of society.*
>
> *d) To improve national compliance with international treaties of which South Africa is a member.*
>
> *e) To promote research, development and innovation in all sectors of the South African economy.*
>
> *f) National IP laws must be appropriate to the level of development and innovation of the country."*

The Draft IP Policy (2013:8) states that:

> *"A well-moulded IP system must suit the economic, social and technological environments of developing countries … [and] can contribute to the eradication of poverty, the enhancement of technology development and transfer, the promotion of access to medicines, and education and learning materials."*

There is explicit recognition in the Draft IP Policy (2013:9) of the cross-cutting nature of IP, and as such:

> *"There is a need for a one-policy approach at national and international level from Government. Government's approach should balance the interests of producers, consumers and users of IP for the benefit of all stakeholders (TRIPS Agreement), primarily for the benefit of the country and its citizens."*

The more substantive recommendations in the Draft IP Policy (2013:11-44), include:

> *"i) … establishment of a substantive Search and Examination of Patents to have strong technologies; and Search and Examination System to co-exist with the current registration of patent system;*
>
> *ii) Human-resources capacity relating to the handling of technology, including technology transfer should be developed;*
>
> *iii) South Africa must change the Patents Act to incorporate patent flexibilities as contained in the TRIPS Agreement after the Doha Decisions; and the Patents Act should be amended to be amenable to issues related to access to public health;*
>
> *iv) The Patents Act should be amended to have both pre- and post-grant opposition to effectively foster the spirit of granting stronger patents;*
>
> *v) South Africa should amend its legislation to address issues of parallel importation and compulsory licensing in line with the Doha Decision of the WTO on IP and public health; and … Develop incentive schemes in the area of IP in general to achieve its developmental goals, particularly poverty alleviation and health;*
>
> *vi) Generic companies should optimally use the Bolar provision without resorting to stockpiling and competing with the owner of the patent before expiry;*
>
> *vii) South Africa should develop awareness campaigns on the use of designs to promote their products …;*
>
> *viii) Patents Act and Plant Varieties Act should not be averse to 'access to technology' for technological advancement and climate change;*
>
> *ix) Protection of 'confidential information' from clinical trials on indigenous medicines should be protected through the law of data protection in terms of Article 39.3 of the TRIPS Agreement; entry of generic medicines in the South African market should not be frustrated per se due to the law of Data protection;*
>
> *x) South African legislation should allow strict rules to apply to patenting as competition principles may be undermined. This should exclude diagnostic, therapeutic and surgical methods from patentability, including new uses of known products, as is the case under the TRIPS Agreement;*
>
> *xi) South Africa must put systems in place that encourage foreign companies to transfer technology to domestic companies. Incentives / tax breaks may be devised to achieve this; and*

> *xii) outreach programmes need to be intensified for small businesses on the use of IP."*

As indicated earlier, the IP Framework (2016) was released by *the dti* for public comment on 6 July 2016. It states that its purpose is to serve as a tool in pursuing public engagement, considering government's internal capacity on IP matters and the pivotal role of government co-ordination in national IP policy formulation and reform (Deere, 2009:113). As of date of submission of this study, the IP Policy Framework (2016) still had to be adopted by Cabinet, according to Daniels (2017). The national IP policy is envisaged to provide:

> *"a coordinated and balanced approach to IP that provides effective protection of IP rights (IPRs) and responds to South Africa's unique innovation and development dynamics … and be aligned to the country's objectives of promoting local manufacturing, competitiveness and transformation of industry in South Africa*." IP Policy Framework (2016:2)

5.5.2 Discussion

The goals of the Draft IP Policy (2013) are laudable, as they position intellectual property as a tool for development and competitiveness. However, it would appear that, though well intentioned, the Draft IP Policy (2013) fails to better articulate some important developments in respect of the current South African IP environment. For example, as of June 2017, the Patents Act:

a) contains most of the TRIPS flexibilities, barring those flexibilities relating to patent examination information disclosures, opposition, research exemption and data protection;[140]

140 South Africa Patents Act, 1978 - s25(11), s32(3), s32(6)

b) provides the State with certain rights in respect of certain inventions and in particular military related and other inventions that the State may wish to remain secret;[141]

c) has specific patent flexibilities relating to compulsory licensing[142] and government use[143], 'Bolar provisions'[144] as well as disclosure of declaration of traditional knowledge.[145]

In addition, although the Medicines and Related Substance Act makes provision for the Minister of Health to prescribe conditions to ensure the supply of more affordable medicines for access to health reasons,[146] the Draft IP Policy (2013) fails to detail its implementation and alignment with the Patents Act and TRIPS flexibilities. Conversely, the IP Policy Framework (2016:8) advocates *"explicitly incorporating total international exhaustion into the Patents Act"* as a possible response to a lack of utilisation of Section 15C of the Medicines Act.

As already discussed in the earlier parts of this chapter and as detailed in the Draft IP Policy (2013), South Africa does not have a SSE patent system. Instead, it relies on a registration or deposit system, in terms of which a patent is granted, following compliance with certain formalities. Only trademarks undergo substantive examination. Whereas this study advances the view that the lack of substantive examination for patents means that the system is fairly inexpensive and accessible, the Draft IP Policy (2013) makes considerable criticism regarding the quality of granted patents. Kaplan (2009:3) argues that, other than the granting of patents with a very broad scope, the lack of a substantive patent examination system results in the patent system being expensive, as infringement and validity issues are determined through the High Court. In the author's opinion there is

141 s79 and s80 of Patents Act
142 s55 and 56 of Patents Act
143 s4 Patents Act
144 s69A of Patents Act
145 Patents Amendments Act of 2005, which amended the Patents Act 57 of 1978 so as to require an applicant for a patent to furnish information relating to the use of indigenous biological resources or traditional knowledge in an invention
146 s15C of Medicines and Related Substances Act, 1965 (as amended)

nothing untoward in having the courts determine infringement and validity issues. In fact, litigation may be considered as one of the means of determining patent value and can potentially be a positive step in asserting one's patent. The major constraint in using litigation to determine the value of a patent is cost, as there is a presumption of validity of a patent, with the party alleging otherwise bearing the onus to prove so. At present, all patent litigation, in terms of s8 of the Patents Act, can only be heard by the Court of the Commissioner of Patents, as a court of first instance. The Court of the Commissioner of Patents effectively comprises judges appointed by the Judge President of the Northern Gauteng High Court. Costs are significant owing to the use of High Court procedures and the tendency to have specialist advocates appear in this Court.

A major challenge in terms of South Africa instituting a SSE patent system would appear to be a lack of skills and limited government resources, as well as the associated increase in the costs of patenting. Whereas any person can file a provisional patent application, only South African registered patent attorneys can file complete patent applications at the CIPC. A SSE patent system is mooted in the Draft IP Policy (2013) as well as the IP Policy Framework (2016). However, the motivation and basis for introducing such a system is not well articulated. It is argued, for example, that introducing a substantive examination would result in a shift from a system predominantly used by large corporates and foreign applicants, as detailed in Sibanda (2007), to one that starts to support endogenous inventions and innovations as well as publicly financed R&D resultant intellectual property. Kaplan (2009) argues that, in principle, a substantive examination system would strengthen the commercialisation prospects abroad by South African innovators. It is difficult to reconcile the argument of how a substantive patent examination system would support local innovations, particularly considering the costs associated with such a system. In fact, the IP Policy Framework (2016:7) does not even make reference to local innovations but rather points to the *"major drawbacks for both the producers and users of IP resulting from the depository system that renders it crucial to work towards the adoption of SSE."* A view amongst patent attorneys stated in the Ministerial Review (2012:129) is that *"South Africa's non-examining patent regime is advantageous in speeding up IP protection."* This can largely be attributed to the predictability of the system, assuming that there has been compliance with all formalities.

In addition, given the acknowledged capacity issues to implement such a system effectively, the Draft IP Policy (2013) fails to advance mechanisms to address these issues and the introduction of TRIPS flexibilities relating to disclosure of foreign patent application and grant information.[147] The one thing that is clear, however, is the co-existence of the current registration system with a substantive examination system, with details missing on how this would, in practice function. The IP Policy Framework (2016:7) alludes to:

> *"…several models including search and substantive examination that combines partial recognition of searches and examination reports conducted in foreign offices, with full substantive examination in certain fields pursuant to the country's development and public interest considerations."*

The Draft IP Policy (2013) has numerous and in some cases misleading definitions of various aspects relating to intellectual property.

Given the significant focus on public health, and the types of flexibilities referred to in both the Draft IP Policy (2013) as well as the IP Policy Framework (2016), it would appear that the *"certain fields"* would certainly include pharmaceuticals. The following TRIPS flexibilities exist in both the 2013 and 2016 documents: parallel importation, disclosure requirements, patentability criteria, Bolar exception, compulsory licences, and government use. The IP Policy Framework (2016) seems to limit the use of the research exemption to address public health needs, which is short-sighted, given that South Africa's investments in R&D extend beyond just life sciences. An enabling IP environment should consider using this flexibility in its full extent, to support South Africa's growing investment in R&D.

The IP Policy Framework (2016:3) advances the view that *"a balanced approach will be taken in the development of the IP policy in line with the [South African] Constitution."*

147 TRIPS Article 29

However, this study argues that this could inadvertently result in an imbalance, as the IP Policy Framework (2016) would place too much emphasis on public health, particularly pharmaceuticals, with proposed policy shifts based on full implementation of TRIPS flexibilities. Whereas access to affordable medicines is but one aspect of the TRIPS Agreement, it is important that South Africa not be too fixated on this aspect to the detriment of others.

Whereas the incorporation of flexibilities and making the Patents Act amenable to issues of access to public health are both advocated, it is unfortunate that the Draft IP Policy (2013) does not provide specific details on which TRIPS flexibilities have or have not already been incorporated into South Africa's Patents Act. It is submitted, for example, as has been seen in the foregoing, that South Africa already has Bolar provisions as well as compulsory licensing provisions in its Patents Act. More particularly, s56 of the Patents Act provides for compulsory licences, for specific cases to address the access to health priorities, *inter alia*, where:

> *"a) the demand for the patented article in the Republic is not being met to an adequate extent and on reasonable terms;*[148] *and*
> *b) the demand in the Republic for the patented article is being met by importation and the price charged by the patentee, his licensee or agent for the patented article is excessive in relation to the price charged therefor in countries where the patented article is manufactured by or under licence from the patentee or his predecessor or successor in title."*[149]

As we have seen in the discussion with regard to TRIPS flexibilities above, given that none of the compulsory licence provisions have been utilised, it is not clear what new approach is proposed to ensure that these provisions are in fact utilised. The IP Policy Framework (2016:10), whilst noting the compulsory licence provisions in the Patents Act, argues for *"a more streamlined and accessible administrative process"* instead of the judicial process before the Commissioner of Patents in terms of Section 56 of the Patents Act. This process is suggested to be expensive; moreover, *"access [is] further delayed in the event that the*

148 s56(2)(c) Patents Act
149 s56(2)(e) Patents Act

decision of the Commissioner to grant a licence is appealed." Although there is an argument to be made that a judicial process is required in terms of TRIPS, the concern regarding the appeal and the suggestion that an administrative process would not be subject to an appeal would appear to be against the spirit of the limitations in terms of Article 30 of the TRIPS Agreement. Whilst advocating a balanced approach to policy making, it is also important to ensure that policy and legislative amendments are not made only for exceptional circumstances. Considering a paucity of evidence regarding the concerns raised in the IP Policy Framework (2016:10-11), such as *"access further delayed"* in the case of compulsory licences, or *"unwarranted delays"* in respect of government use, it would be prudent to ensure that the final National IP Policy, when it is eventually developed and adopted, does not propose legislative amendments that cater for exceptional circumstances with minimum resultant benefits to South Africa as a whole. The aim advocated in the IP Policy Framework (2016:6) of ensuring that *"South Africa protects IPRs and at the same time achieves its objectives of promoting national development imperatives which include among others boosting local manufacturing, innovation and ensuring equitable access to medicines,"* will not be achieved by such a limited approach to developing an appropriate IP environment for local innovations to thrive.

Regarding the parallel importation provision, this would be welcome, as the Patents Act does not adequately make provision for this. Notwithstanding, s15(c) of the Medicines and Related Substances Act, discussed above, was promulgated specifically to address this issue of parallel importation. Again, it has never been utilised, to date. Perhaps, then, South Africa does not require more legislation but rather guidance on how best to utilise the IP system that is already in place.

Pre-grant and post-grant opposition are also recommended, without clear contrast or comparison with the existing post-grant revocation proceedings already forming part of the South African Patents Act.[150] Pre-grant opposition supplement the SSE system, whereas the post-grant opposition are pre-litigation proceedings.

150 s61 of the Patents Act of 1978

Data protection aligned to TRIPS Article 39(3) is suggested in the Draft IP Policy (2013:13) without specific reference to how this would be implemented; nor does it give any details in respect of possible legislative provisions. At the same time, there appear to be conflicting messages in advocating for specific data protection legislation in compliance with Article 39(3), while at the same time arguing that entry of generic medicines should not be frustrated by the data protection legislation. The coexistence of these two principles requires fine policy choices and balancing.

The recommendations to exclude diagnostics, therapeutics, surgical methods and new uses of known products from patentability appear to ignore the current TRIPS compliant provisions in the Patents Act. At present, only methods of diagnosis and therapy practiced on the human body are excluded, in line with the morality principles, whereas second use provisions exist.

The need to elevate the importance of design registration is welcome; indeed, properly utilised, design registration could be a useful tool in broadening participation in the intellectual property system.

5.6 CONCLUSIONS

South Africa has well established institutional capacity for the protection and management of intellectual property. However, there is room for increased cooperation amongst the various institutions, such as CIPC, NIPMO, OTTs, etc., to develop a working IP system.

Although IP education is taught as an elective in most undergraduate law courses, South Africa needs to expand its IP education to ensure that IP is taught to scientific and engineering students, in an integrated manner, ensuring that principles taught are incorporated by students into their projects. Given the shift towards a knowledge-based economy, efforts must be made to introduce IP education at school level. Such efforts will assist in building an IP system that supports innovation.

South Africa has a plethora of IP legislations and provisions incorporated into other legislations, all dealing with IP. Notwithstanding its membership of the WTO, and its accession to the TRIPS Agreement, there remains an opportunity for incorporation of certain TRIPS flexibilities into the IP legislation to create an enabling environment to stimulate local innovations and achieve the objectives of the NDP.

Notwithstanding the fact that South Africa's Patents Act is TRIPS compliant, there are opportunities to use TRIPS flexibilities to enhance use of the patent system to foster socio-economic development, enhance South Africa's R&D and manufacturing capacity, as well as ensure increased access by locals to technologies and innovations covered by patents.

Of particular interest is the incorporation of the research exemption into the Patents Act and the possible enhancement of the disclosure requirements. Although the regulatory review exception or Bolar provisions are already incorporated into the current Patents Act, its interpretation to include third parties critical in the production of the products essential for obtaining regulatory and marketing approval, such as API manufacturers is important. The effective implementation of this exception does require local capacity in respect of pharmaceutical manufacturing or generic drug manufacturing.

There are opportunities for migration to a SSE patent system. However, there are also hard questions to be dealt with regarding the extent of such migration in respect of incentivising local innovations and stimulating local industries, particularly given that a majority of the patent applications filed in South Africa originate from foreign applicants. Some approaches have been discussed in respect of achieving the same objectives of a SSE system, whilst ensuring that the IP system remains accessible to local innovators. A particular approach would be a hybrid of the following: search and examination, reliance on examination reports of corresponding foreign applications, opposition proceedings, and use of foreign IP offices for SSE.

Given South Africa's ambitious aspirations to be a contributor to global knowledge pool, introduction of the research exemption coupled with increased support for the implementation of the IPR-PFRD Act offers real prospects for achieving these aspirations. The OTTs have the potential to support local innovation systems as opposed to merely being focussed on the institutions that have established them.

A National IP Policy has the potential to foster an enabling IP environment in which local innovations could strive to achieve the ideals of the various government priorities, in particular poverty eradication, inequality eradication and reduction of unemployment. However, development of such a policy must not be narrowly focussed in terms of approach, sectors or interest, but must, as detailed in the IP Policy Framework (2016:2), provide:

> *"a coordinated and balanced approach to IP that provides effective protection of IP rights (IPRs) and responds to South Africa's unique innovation and development dynamics … engender the ethos of the Constitution and complement the country's industrial policy and broader socio-economic development objectives … and be aligned to the country's objectives of promoting local manufacturing, competitiveness and transformation of industry in South Africa."*

Although the proposed IP National Policy suggests that a more administrative mechanism for the granting of compulsory licences would result in increased use and also enable access to medicines and serve public health objectives, emphasis should rather be placed on developing a more enabling IP system that recognises the importance of compulsory licences as a means of addressing real abuse of the patent system. To date, there is not sufficient documented abuse of the system to justify such administrative measures. Nonetheless, should such an administrative mechanism be incorporated into the legislation, it is important that it is aligned with TRIPS Article 30 limitations and indeed that it balances the rights of patent holders and the public interest. An expedited judicial appeal or review process will assist in this regard.

Whereas this **Chapter 5** has built on the preceding **Chapter 4**, which focussed on international IP instruments, in the next chapter, the study reviews the South African

National System of Innovation (NSI) with special attention to its interface with the IP system.

CHAPTER 6: SOUTH AFRICAN NATIONAL SYSTEM OF INNOVATION

"We shall accumulate machinery and establish steel works, iron foundries and factories; we shall link the various states of our continent with communications; we shall astound the world with our hydroelectric power; we shall drain marshes and swamps, clear infested areas, feed the undernourished, and rid our people of parasites and disease. It is within the possibility of science and technology to make even the Sahara bloom into a vast field with verdant vegetation for agricultural and industrial developments". – President Kwame Nkrumah[151]

6.1 INTRODUCTION

South Africa's post-apartheid science and innovation policy dates back to September 1996, when the then new democratic government, just two years after the end of apartheid, published the WPS&T (1996), aptly subtitled *"Preparing for the 21st Century."* Maharajh (2011:9) notes the challenges inherited by the democratic government and the need for reform after 1996 as:

> *"… the transition of South Africa from a fragmented, segmented, and stratified racial capitalism towards its contemporary characterisation as a constitutionally defined unitary state with a mixed economy, which is regarded variously as an emergent market; a society in transition; and a developing country."*

Since then, various developments and key milestones have influenced South Africa's innovation landscape, as will be illustrated later in **Section 6.3** of this chapter. Later sections of this chapter detail key aspects of these developments and assess the performance of the NSI. The DST has, to date, championed most of the developments. In recent years, owing to the growing recognition of the importance of innovation, and its

151 First speech at the foundation summit of the Organization of African Unity, Addis Ababa, 24 May 1963, African Union Science Technology and Innovation Strategy for Africa 2024 - On the Wings of Innovation – STISA-2024

cross-cutting nature, just like IP, more national government departments, such as in particular, *the dti*, the Department of Economic Development, the Department of Health, the Department of Small Businesses, the Department of Public Service and Administration and others, have become involved in innovation related discourse.

The detailed discussion of South Africa's science and innovation environment will be undertaken in three phases, namely 1994 to 2003 [Initiation Phase], 2004 to 2013 [Consolidation Phase], and 2014 and beyond [Growth Phase].

6.2 NATIONAL SYSTEM OF INNOVATION

In looking at the Innovation Policy in South Africa, it is also important to unpack the concept of the NSI. This term first appeared in the WPS&T (1996), with its purpose stated as:

> *"… the NSI is to enhance the rate and quality of technology transfer and diffusion from the science, engineering and technology (SET) sector by the provision of quality human resources, effective hard technology transfer mechanisms and the creation of more effective and efficient users of technology in the business and governmental sectors."*

Whereas the WPS&T does not *per se* define the NSI, other than referring to its components, in stating its prime objective, the NRDS (2002:19) defines the NSI as follows:

> *"The NSI itself can be thought of as a set of functioning institutions, organisations and policies that interact constructively in the pursuit of a common set of social and economic goals and objectives, and that use the introduction of innovations as the key promoter of change."*

Manzini (2012) cites Wangwe (2003) who unpacks the concept of the NSI by stating that it is:

> *"A set of interrelated institutions, the core being those which generate, diffuse and adapt new technological knowledge. These institutions may be forms, R&D institutions, universities or government agencies. Institutions mark boundaries, which have an influence on uncertainty (sic)."*

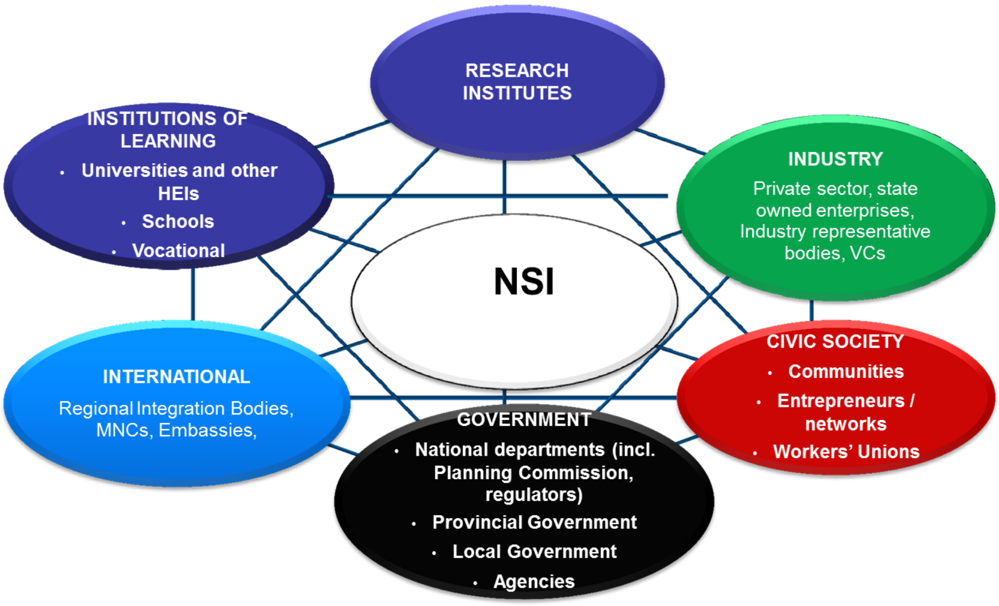


Figure 6.1: High-level illustration of the NSI

Figure 6.1 provides a high-level illustration of the NSI within the context of the WPS&T (1996) and NRDS (2002), with the various institutions in the NSI and their positioning along the innovation value chain being detailed below. This study concurs with the findings of the Ministerial Review (2012) that effective coordination of the activities of the various stakeholders is essential for a functional and effective NSI. The Ministerial Review (2012:117) takes this further and advocates for greater coherence and coordination in the form of a high-level expert body to guide the NSI as a whole as follows:

> *"the clear and inspirational White Paper conception of the NSI be publicly re-endorsed by government as a potentially decisive driver of national economic and social development, indicating clearly that the NSI must be pervasive and truly systemic in its design and functioning, and that its functionality is core to any systematic national approach to creating jobs, addressing poverty and providing fulfilling life opportunities to all South Africa's people and communities."*

The relationship between IP and innovation policies is critical for those institutions that generate, diffuse and adapt new technological knowledge, in ensuring a functional and effective NSI. Accordingly, the Ministerial Review (2012:128) notes that the IP regulatory framework is important for creating an enabling environment for innovation to thrive. Accordingly, the IP regulatory framework as dealt with in **Chapter 5** needs to be attuned to the development of a robust, coherent and well-coordinated NSI. In particular, there is a need for stronger cooperation between the various stakeholders in the NSI, in particular the various government departments and agencies charged with looking after IP issues, in order to address what the Ministerial Review (2012:129) termed *“a systemic disconnect, with deep roots and many drivers.”* While recognising the role of the private sector as being vital for economic growth and value addition in terms of innovation, the Ministerial Review (2012) notes that there has been little growth of the private sector in South Africa in contrast to its leading companies such as Sasol expanding abroad. In addition, the Ministerial Review (2012:185) noted that there *“was the high propensity to innovate alongside the low propensity to patent, despite a long tradition of patent activity, albeit at modest levels.”*

6.3 INSTITUTIONAL ARRANGEMENTS AND INFRASTRUCTURE

The DST (and its predecessor, the then DACST, prior to 2004) has provided leadership in respect of innovation matters in South Africa., notwithstanding the cross-cutting nature of innovation and hence other areas that fall within the responsibility of other government departments In recent years, other government departments have become intimately involved with innovation.

The institutional arrangements that have been established over the years have comprised R&D undertaking and/or innovation creation and/or innovation enabling institutions. The R&D institutions include higher education and training institutions (HEIs) comprising R&D intensive academic institutions, so-called comprehensive universities, universities of technology and Technology and Vocational Education and Training Colleges (TVET). In addition, within this cluster of R&D undertaking and/or innovation creation institutions, there are a number of research institutes, also often referred to as science councils, established during apartheid era, which include the Council for Scientific and Industrial Research (CSIR), Mintek, Medical Research Council (MRC), the Council for Geoscience, the National Metrology Institute of South Africa (NMISA) and the Agricultural Research Council (ARC). More recently established institutions include the South African Space Agency

(SANSA) and the Nuclear Energy Corporation of South Africa (NECSA) (which replaced the apartheid era Atomic Energy Corporation).

Nyatlo (2015:187) documents the history of the offices of technology transfer (OTTs) at institutions and highlights their establishment in a number of the R&D undertaking and/or innovation creation institutions to assist these institutions with commercialisation by *"acting as a bridge between industry and academia."*

Conversely, the innovation enabling institutions comprise:

(i) a number of funding entities and/or instruments, such as the Technology Innovation Agency[152] (TIA), the Small Enterprise Finance Agency (SEFA), the Gauteng Enterprise Propeller[153] (GEP), the Industrial Development Corporation (IDC),[154] the National Empowerment Fund[155] (NEF), the Support Programme for Innovation (SPII), the Technology and Human Resources for Innovation Programme (THRIP),[156] and the National Research Foundation (NRF);

(ii) Essentially enabling organisations, such as the National Intellectual Property and Management Office (NIPMO)[157] and the Small Enterprise Development Agency (SEDA).[158] NIPMO, for example, provides IP management support to institutions and to any company that has received public funds for R&D and whose IP falls within the ambit of the IPR-PFRD Act. SEDA, in contrast, is responsible for the establishment of a range of incubators throughout the country. Other more

152 www.tia.org.za [Last accessed on 5 June 2017]
153 www.gep.co.za [Last accessed on 5 June 2017]
154 www.idc.co.za [Last accessed on 5 June 2017]
155 www.nef.co.za [Last accessed on 5 June 2017]
156 Although SPII and THRIP have for most of their existence been managed by the IDC and NRF, respectively, a decision was made in 2015 that saw their operational management being moved from these entities back to *the dti*.
157 www.nipmo.org.za [Last accessed on 5 June 2017]
158 www.seda.org.za [Last accessed on 5 June 2017]

recently established organisations include SiMODISA[159], which is a privately run non-governmental organisation with the aim of strengthening the entrepreneurship innovation ecosystem.

(iii) Regional innovation agencies, science and technology parks as well as public and private incubators, of which the most notable ones are the innovation of the Gauteng Province - The Innovation Hub[160] , the East London Industrial Development Zone Science Park, and the Vaal University of Technology Science and Technology Park. These agencies also run a range of incubators. For example, The Innovation Hub has specialised incubators in each of its priority sectors, i.e. BioPark@Gauteng (Bioeconomy), Maxum and mLab incubators (Smart Industries), Climate Innovation centre (Green Economy) and eKasiLabs (township incubation).

(iv) Other eco-system enablers include advisory bodies, such as the statutory National Advisory Council on Innovation (NACI), the Academy of Science for South Africa (Assaf), etc.

There has been varied levels of effectiveness in terms of enabling innovation by the above-mentioned institutions. In later sections of this study, reference is made to the work being undertaken by NIPMO and its role in the implementation of the IPR-PFRD Act and establishment of IP management and commercialisation capacity. In addition, there is a review of the work done by The Innovation Hub particularly in the biotechnology sector, whereas the other science parks and incubators have not had as much impact on the innovation system. This Chapter will also look at the challenges that TIA has faced in effectively integrating various agencies that were brought together to establish it, and the impact that has had on the innovation system. An analysis of the effectiveness of the NSI necessitates a closer look at the outputs of the NSI with specific reference to the role played by these organisations. Over the years, a variety of funding instruments have been established to provide funding across the value chain, and some of these are illustrated in **Figure 6.2**. Although most of the early stage funding has been from funding instruments

159 www.simodisa.org [Last accessed on 5 June 2017]

160 www.theinnovationhub.com [Last accessed on 5 June 2017]

falling under the DST, in recent years, funding has become more diversified, with increased funding from other government departments such as *the dti* (e.g. NEF, THRIP, and SPII), the Ministry of Small Business (e.g. SEFA), and Department of Economic Development (e.g. IDC). The Innovation Hub has also established a *"step-up"* funding mechanism (its Start-up Support Programme) to assist innovative entrepreneurs with small amounts of funding to complete minimum viable products to enable them to access larger amounts of funding offered by the funding organisations. This model has been adopted by TIA, who have since set up a Seed Fund[161] in partnership with the universities and a number of regional agencies such as The Innovation Hub.

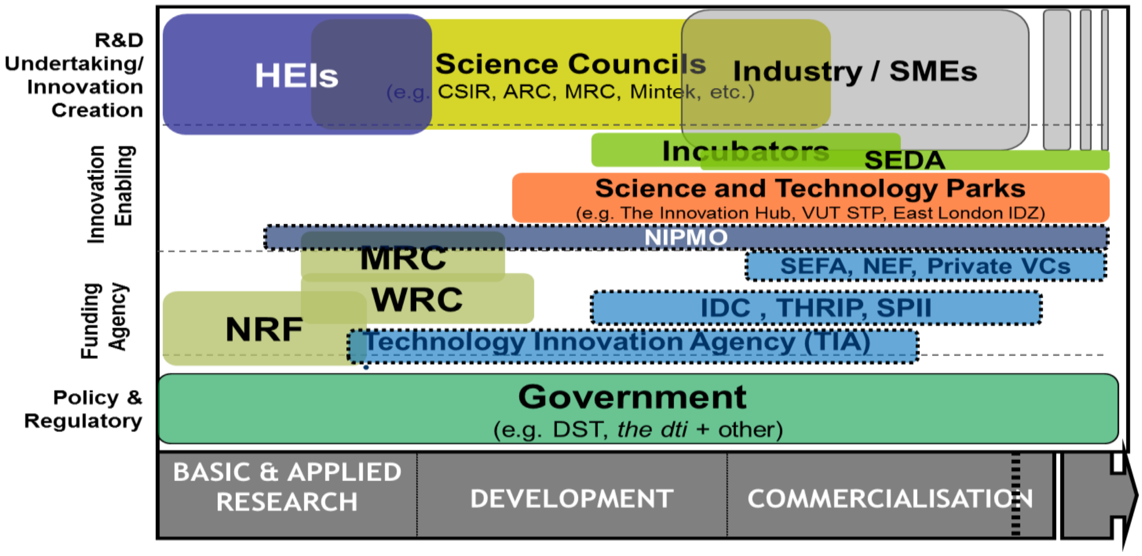


Figure 6.2: Illustration of R&D Undertaking / Innovation Creation and Innovation Enabling institutions in the South Africa NSI [author generated]

161 Since inception in 2013, in the first two rounds of the higher education institution seed fund, 215 projects received funding of R73m, through 21 tertiary institutions. The regional seed fund also disbursed a further R37.5m to 82 projects through seven organisations (Cape Craft Design Institute, The Innovation Hub, Smart Exchange, Invotech, the Free State Development Corporation, Eastern Cape Development Corporation and Limpopo Economic Development Agency). A total of almost R32m was contributed to the Seed Fund in nonfinancial support such as incubation services. [Source: http://www.gapfunding.org/african-technology-innovation-agency-tia-seed-funds-inspirational/- Last accessed on 5 June 2017]

TIA is the main agency responsible for innovation in South Africa; it was established in 2010 by the amalgamation of a number of disparate instruments that included (i) the Innovation Fund, (ii) the Biotechnology Regional Innovation Centres (established as trusts with independently appointed management but fully funded by the DST pursuant to the 2001 Biotechnology Strategy, to foster the commercialisation of biotechnology related innovations, which comprised CapeBio, East Coast Biotechnology Regional Trust (LIFELab), PlantBIO, and BioPAD), (iii) the Tshumisano Trust ,and (iv) the Advanced Manufacturing Technology Strategy (AMTS). The establishment of TIA was to address the *"innovation chasm*."[162] Another motivation for its establishment was to address systemic institutional fragmentation identified by the OECD (2007) that had also compounded into concerns by National Treasury about the proliferation of agencies. Since the formation of these TIA founding organisations, there had been a convergence of mandates; as a result, they were losing differentiation with increased double-dipping by applicants, in addition to increasing confusion as to their unique offering. Accordingly, these instruments' entire portfolio, which for example in the case of the Innovation Fund stood at almost ZAR 1 billion worth of investments, was transferred to TIA, which as stated in the OECD (2011b:24) was established to:

> *"provide and mobilise financial and non-financial support across broad technology areas in various sectors of the economy through the following:*
>
> *(i) Appropriately structured financial and non-financial interventions for the commercialisation of research and development (R&D) results;*
> *(ii) The development and maintenance of advanced human capacity for innovation as opposed to just R&D human capital;*
> *(iii) Building a culture of innovation in the South African economy; and*
> *(iv) Leveraging local and international partnerships in order to facilitate in-bound technology transfer, build local technological competencies, and encourage foreign direct investment for the commercialisation of technologies in South Africa."*

One also notes that the amalgamation of these instruments to establish TIA has not been without its own challenges as detailed in the Ministerial Report (2012: 129), which found that:

162 The Innovation Chasm is often referred to as the gap between research and industry or the market

> *"The Technology Innovation Agency has taken too long to become operationalized and has thus introduced further delays and uncertainties for beneficiaries."*

The TIA Review (2013), commissioned subsequently, has made some fundamental but hopefully effective changes to the operations of TIA.[163] Notwithstanding the establishment of TIA to bridge the innovation chasm, systemic institutional fragmentation still remains, owing to a lack of coherence and coordination across government departments and institutions. Whereas one would assume that the increased involvement of other government departments and their agencies in innovation, besides the DST and its agencies, would be beneficial to innovation in general, the Ministerial Review (2012:113) found that *"the concept of the national system of innovation has failed to gain adherents beyond the Department of Science and Technology",* due to poor coordination across government departments and agencies. The cross-cutting nature of innovation coupled with the fact that no single government department can handle all aspects of innovation necessitates a more structured coordination mechanism, even at the level of the highest office as in countries such as Singapore. This could improve the coordination across government departments and indeed ensure wider acceptability to the concept of the NSI.

Also, it is important, in adopting the concept of the NSI and ensuring its holistic implementation, that the issues of innovation be devolved down to provincial and local governments. The Gauteng Province[164] is a case in point, where the importance of innovation for competitiveness and addressing service delivery has been recognised through the Gauteng Innovation and Knowledge Economy Strategy (GIKES 2012).[165] GIKES

---

163 Technology Innovation Agency Institutional Report: briefing by Department of Science and Technology, September 2013 available at https://pmg.org.za/committee-meeting/16400/ [Last accessed on 13 November 2016]

164 The Gauteng Province as of February 2017, accounted for over 36% of South Africa's GDP and also approximately 48% of total R&D spend in South Africa (see http://www.ekurhuleni.gov.za/files/STATE_OF_THE_PROVINCE_ADDRESS_SPEECH_2.pdf [Last accessed on 5 June 2017]

165 Gauteng Innovation and Knowledge Economy Strategy, Gauteng Provincial Government, April 2012, available at http://www.foresightfordevelopment.org/library/55/1371-gauteng-innovation-and-knowledge-economy-strategy [Last accessed on 8 October 2016]

(2012) has played an important role in the repositioning of The Innovation Hub, which had been set up as a science and technology park in the early 2000s and has since assumed an innovation agency role.

6.4 LEGISLATIVE AND POLICY FRAMEWORK

5.6.1 Overview

South Africa's innovation landscape, associated milestones and developments over the past two decades are illustrated in **Figure 6.3**.

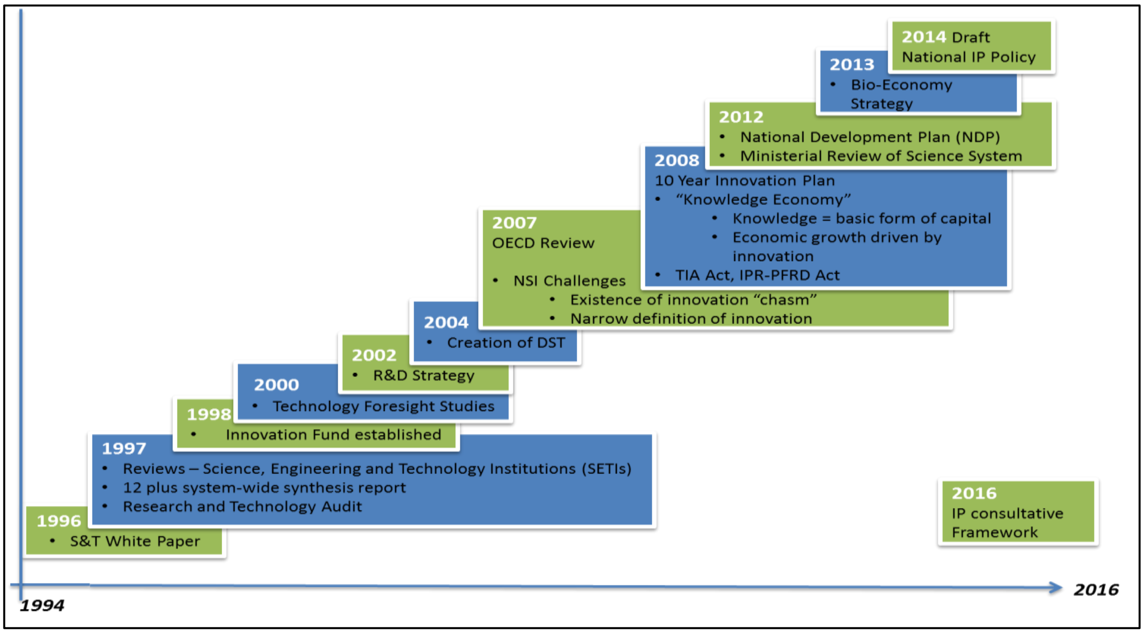


Figure 6.3: Evolution of the South African Innovation Landscape with Key Milestones [author generated]

Only key milestones and institutional establishments are highlighted in **Figure 6.3.** The major science and innovation policy shifts in the period 1994 – 2016, include:

(i) [1996] The WPS&T (1996) identifies the need for a more inclusive science, technology and innovation system, followed by the establishment of the NRF and the Innovation Fund;

(ii) [2001] The Biotechnology Strategy (2001) and the resultant establishment of the Biotechnology Regional Innovation Centres (Brics) provide funding and supporting instruments;

(iii) [2002] The NRDS (2002) is approved by Cabinet, paving the way for many policy and strategic initiatives, including the promulgation of IPR-PFRD Act (in 2008) and the establishment of NIPMO (in 2010) as well as the Technology Innovation Agency (TIA) (in 2010) to fulfil the functions of what had been referred to in the NRDS as the Foundation for Technological Innovation (FTI);

(iv) [2004] A dedicated Ministry and Department of Science and Technology (DST) is established;

(v) [2006] The National IP Policy Framework for Publicly Financed R&D (IP Policy (2006)) is approved by Cabinet, which also recommends public consultation on an enabling legislation to govern IP emanating from publicly financed R&D;

(vi) [2008] Cabinet approves the 10 Year Plan[166], which sets out five grand challenges for the NSI; the Technology Innovation Agency Act, 2008 to establish the TIA is promulgated, as is the IPR-PFRD Act, which establishes NIPMO;

(vii) [2010] The regulations in terms of the IPR-PFRD Act are gazetted, bringing into effect the IPR-PFRD Act with associated establishment of NIPMO. TIA is formally established in terms of the TIA Act, 2008, through the merger of Tshumisano Trust, the Innovation Fund, the Biotechnology Regional Innovation Centres (Cape Biotech, LIFElab, PlantBio, BioPAD), Advanced Manufacturing Strategy (AMTS) and Tshumisano Trust;[167]

166 http://www.esastap.org.za/download/sa_ten_year_innovation_plan.pdf [Last accessed on 26 December 2014]

167 The Innovation Fund, which was hosted by the National Research Foundation (NRF); Tshumisano Trust, managed the technology stations at universities of technology and was hosted by the Council for Scientific and Industrial Research (CSIR); the implementation unit of the Advanced Manufacturing Technology Strategy (AMTS) was hosted by the CSIR; and the four BRICs, i.e. BioPAD (Pretoria), LIFElab (Durban), Cape Biotech (Cape Town) and PlantBio (Pietermaritzburg), each was managed by a trust constituted by the DST and governed by its own trust deed and board of trustees, which reported directly to the DST – see TIA Review Report (2013) available at http://www.pmg.org.za/report/20130918-technology-innovation-agency-institutional-report-briefing-department-science-and-technology-shortlisting [Last accessed on 26 December 2014]

(viii) [2012] A Ministerial Review is conducted of the Science, Technology and Innovation Landscape in South Africa;[168]

(ix) [2012] NDP (2012), the National Development Plan (Vision 2030)[169], is published, with clear support for innovation as being important for a middle-income country such as South Africa to develop;

(x) [2013] RSA (2013), the Bioeconomy Strategy (2013) is approved by Cabinet as a follow up to the Biotechnology Strategy (2001);

(xi) [2014] The Draft IP Policy (2013) is published for public comment;

(xii) [2016] The IP Policy Framework (2016) is published.

5.6.2 The Initiation Phase

As already indicated, the WPS&T (1996) was the start of the development of South Africa's NSI in the post-apartheid era. In 1994, the ANC led government inherited an innovation system that had been designed to cater for a South Africa that was faced with sanctions, and was thus a country that not only needed to provide for its own military needs, but also to ensure self-sufficiency owing to sanctions by the international community. As aptly captured by Maharaj (2011:153), the innovation system essentially only catered for a minority of its people and there was an urgent need for it *"to incorporate nearly 80% of the country's historically excluded citizens."* The innovation system was also premised on the participation of a few in the education system and on the productive industries. Whereas under apartheid the innovation system appears to have effectively served the interests of the dominant but minority group, it was also evident that such a system would need to be adapted to cater for a broader and more inclusive group. What was needed was a more inclusive NSI that would cater for all South Africans. In this regard, the OECD (2007:85) notes:

> *" … a successful defence industry had enabled the country to become self-sufficient in armaments and to capture a substantial export market;*

168 Available at http://www.gov.za/documents/ministerial-review-committee-science-technology-and-innovation-landscape-south-africa [Last accessed on 26 December 2014]

169 Available at http://www.gov.za/issues/national-development-plan-2030 [Last accessed on 26 December 2014]

technological developments and applications had enabled large-scale agriculture, owned by the white population, to ensure self-sufficiency in food supplies (for those able to purchase them); an internationally competitive mining industry was based on leading technologies that had been adapted for the peculiarities of mining in South Africa; the country was the leader in commercial-scale technology for deriving liquid fuels from coal; and high quality medical research supported international standards of health care for the advantaged white community. However, it was doubtful that the system that had delivered those achievements could be transformed into an innovation system, which could help to achieve objectives such as a broad base of internationally competitive economic activity that would generate rising levels of per capita income for the population as a whole."

It is against this background that the WPS&T (1996) was published to prepare South Africa for the 21st century. Accordingly, the WPS&T (1996) was premised on the following goals relevant for innovation:

"The establishment of an efficient, well-coordinated and integrated system of technological and social innovation within which stakeholders can forge collaborative partnerships and interact creatively in order to benefit themselves and the nation at large …;

The development of a culture within which the advancement of knowledge is valued as an important component of national development;

Improved support for all kinds of innovation which is fundamental to sustainable economic growth, employment creation, equity through redress and social development."

The WPS&T (1996) vision of the NSI is one that *"seeks to harness the diverse aspects of S&T through the various institutions where they are developed, practised or utilised"*. Accordingly, a healthy NSI is envisaged as one in which:

"... the knowledge, technologies, products and processes produced by the national system of science, engineering and technology have been converted into increased wealth, by industry and business, and into an improved quality of life for all members of society".

In order for IP rights to support innovation, the WPS&T (1996) advocates for aligning IP regulations to international norms. Such an alignment would need to consider the outcomes of the findings in the OECD (2007) in terms of broadening participation in the NSI, and therefore ensure an IP system that supports such participation. In this regard, recognition is made in the WPS&T (1996) of a system that supports endogenous innovations:

> *"The value to the inventor of the patenting system. Adequate protection fosters investment and stimulates innovation. The rights of South African inventors need to be rigorously protected;"*

Accordingly, the WPS&T (1996: Chapter6) refers to a revision of *"South African patenting regulations … to best promote innovation."*

The symbiotic relationship between IP and innovation is explicitly recognised in the WPS&T (1996):

> *"One of the issues brought to the fore by treating innovation as a national priority is that of intellectual property rights;*
>
> *Whatever regulatory system South Africa adopts for awarding, recording and protecting intellectual property … search and retrieval capabilities should utilise modern information technology to reduce management costs and to promote compliance with international standards; and*
>
> *The issue of not being a patent examining country … can be addressed by doing the examining in South Africa, which is costly. A much less costly alternative is to permit provisional registration of patents pending confirmation by the patenting system of a country, which does examine patents. This approach has been adopted by Saudi Arabia."*

The debate on whether or not South Africa should adopt a SSE patent examining system, goes as far back as 1996. In **Chapter 5** above, it has been demonstrated that little progress has been made in the 20 years covered by this study, to advance this debate, other than more recently in the various pronouncements in the Draft IP Policy (2013) and CIPC (2014:25):

> *"In ensuring that the CIPC is ready to implement the amended Act, the office is interacting with other Intellectual Property Offices to learn best practices on examiners' appointment and training programmes. A proposed model for the substantive examination of patents in South Africa and estimated budget has been prepared in consultation with the dti. As CIPC awaits the legislative changes to provide for this new approach to add value to the patent system, the organisation will start building the necessary competencies and skills."*[170]

Subsequently, in 2016, the CIPC recruited the first batch of about 20 candidates that have been undergoing training to become patent examiners in anticipation of legislative amendments. It would thus appear that it is imminent that South Africa will migrate to a search and substantive examination system for patents. Cochrane (2014) observes that, with about 7 000 patent applications filed annually that need to be examined, the system will require in the region of 80 to100 patent examiners; which would require about four years to establish such capacity. The period of time for establishment of this capacity could be owing to low availability of professionals already or moderately acquainted with patent search and examination procedures. Given that the bulk of the patents are likely to be pharmaceutical patents, it is clear that significant resources would be required for such a system to be effective. Indeed, South Africa does need to migrate towards a substantive patent examination system for it to be competitive with its trading partners. However, such a transition will require careful planning and transition steps. These may include post-grant review proceedings, contracting out examination to other international patent examining offices, enhancing the disclosure provisions to compel applicants to provide CIPC with search and examination reports from foreign jurisdictions, whilst developing appropriate infrastructure, including human capital to implement a substantive examination system effectively in the country.

A critical innovation instrument founded by the WPS&T (1996) was the Innovation Fund, the predecessor to TIA, established in 1999 from top-slicing of budgets of science councils, to provide for pre-competitive large-scale projects funding, and in particular

170 CIPC Annual Report 2014/15, pp. 25, available at http://pmg-assets.s3-website-eu-west-1.amazonaws.com/151014CIPC_AR.pdf [Last accessed on 17 April 2017]

"reprioritisation of the science allocations across government." The NRDS (2002) advocated for:

> *"measures to give effect to the concept of innovation, as opposed to S&T or R&D and wherever it may be taking place. This is especially true of the proposed Innovation Fund, which will offer a new lead in encouraging and enabling longer-term, large innovation projects in the higher education sector (HES), government, SETIs, civil society or the private sector."*

Accordingly, the Innovation Fund was established, *inter alia,* to promote increased networking and cross-sectorial collaboration within South Africa's NSI through competitive funding campaigns and programmes.

In the NRDS (2002) emphasis was placed on effective capitalisation of the Innovation Fund, recognising that *"it had not had the rate of growth intended in the original policy development".* Furthermore, NRDS (2002:59) highlighted the need for increased emphasis to expanding the role of the Innovation Fund to include *"secure IP from appropriate publicly financed research that meets certain criteria".* The NRDS (2002:46) further notes that:

> *"In many areas where South Africa is currently competitive, we do not have a capacity for local innovation and are dependent on imported know-how … countries that make strategic innovation investments (develop missions) will inevitably attract new foreign direct investment and will eventually secure or supplant our current productive capacity."*

From the NRDS (2002:22) we establish that South Africa needed to both increase its investment in R&D from 0.7% of GDP[171] as well as provide appropriate funding for the NSI. It had limited capacity in the areas of ICT and biotechnology, in particular. Its science and technology human resources were not being adequately renewed in the face of an aging and shrinking scientific population. A significant decline in R&D in the private sector threatened achievement of above-average growth rates (see NRDS, 2002:23). The country needed to develop approaches to deal with IP arising from publicly financed research as

171 GDP in 2002 was US$111billion according to http://data.worldbank.org [Last accessed on 12 April 2016]

well as new technologies such as biotechnology (see NRDS, 2002:23). Moreover, at institutional level, there was a lack of integrated capacity to address innovation systematically, i.e. to address innovation missions and provide innovation support so as to stimulate new industries and strengthen existing industries (see NRDS, 2002:24). As disclosed in the NRDS (2002:49), the need for such support advocated for the creation of the FTI, *inter alia*, to:

> *"Establish capacity to identify, coordinate and finance the new technology and innovation missions in South Africa; draw together and integrate the management of separate innovation, incubation and diffusion initiatives; create and synergise innovation activities linked to universities and research organisations; develop the national capacity to manage intellectual property (especially intellectual property derived from publicly financed research); strengthen initiatives for the commercialisation of intellectual property; and establish programmes for small and BEE businesses to source technology internationally when not available locally."*

In the consolidation phase, it became apparent that, in the place of the FTI, the TIA was instead established to assume the FTI's envisaged roles, in addition to a range of interventions to boost South Africa's limited biotechnology capacity, with the Bioeconomy Strategy (RSA, 2013) being the most recent of these.

In this period, in 2002, the Gauteng Province, the economic heartbeat of the South African economy, accounting for at least a third of South Africa's GDP,[172] established The Innovation Hub,[173] the first Science and Technology Park in Sub-Saharan Africa, with a specific focus on ICT and smart industries, as a deliberate strategy to position itself as a smart province. Since about 2014, as already alluded to, The Innovation Hub has assumed the role of an innovation agency of the Gauteng Province. Other science and technology parks, including one in Gauteng (Vaal University of Technology Science and Technology Park) and in the Eastern Cape (East London IDZ Science and Technology Park) have since

172 http://www.statssa.gov.za/ [Last accessed on 28 September 2016]

173 http://www.engineeringnews.co.za/print-version/the-innovation-hub-2002-12-06 [Last accessed on 28 September 2016]

been established with assistance of the DST. Other provinces were in the process of doing so, as of date of finalisation of this study.

The NRDS (2002) would appear to have made an effective case for expansion of the Science and Technology system and indeed the NSI. Kaplan (2004), on reviewing the NRDS (2002), cites the need for enhanced capacities and resources for the DST to manage the NSI effectively.

5.6.3 The Consolidation Phase (2004-2013)

This phase of the NSI has been characterised by implementation of a number of initiatives mooted in both the WPS&T (1996) and the NRDS (2002). Furthermore, a number of key policies and strategies illustrated in **Figure 6.3** were also put in place to support many of these initiatives. What is perhaps important about the Consolidation Phase was that it was marked by the establishment of a dedicated Ministry and the DST, in 2004, as the custodian of the NSI. According to Maharajh (2011:197), the primary imperative of the DST was specified as:

> *"To develop, manage and coordinate the National System of Innovation in order to maximise human capital development, sustainable economic growth and improved quality of life for all as mandated by the White Paper on Science and Technology of 1996."*

The DST continued with the establishment and recapitalisation of a number of strategic interventions, in particular those detailed in the NRDS (2002), for example, in the fields of Biotechnology and Advanced Manufacturing. Additional funding and support was provided to the Innovation Fund as detailed in the NRDS (2002); the Tshumisano Trust was established (to fund technology stations programmes based on the German model); the Advanced Manufacturing Strategy Programme was housed at the CSIR; and the Biotech Regional Innovation Centres (Brics) were created as funding instruments to fund biotechnology initiatives under the Biotechnology Strategy (2001).

As a result of the NRDS (2002:76) the Innovation Fund was provided with additional support during this period, establishing critical IP financing and support instruments from about 2006 onwards, as the Ministerial Review (2012:180) notes:

> *"The operation of the Innovation Fund has been accompanied by its own innovations, such as institutional development involving staff capacity in intellectual property management, which laid the basis for the establishment of what is now the National Intellectual Property Management Office (NIPMO) as well as the IPR capacity of the new TIA. Other innovations were the Commercialisation Manager Development Programme and the National Innovation Competition."*

According to the NRDS (2002), *"there is little appreciation for the value of intellectual property as an instrument of wealth creation in South Africa."* As such, the NRDS (2002:91) advocates for the *"creation of a proper framework and enabling legislation for the management of intellectual property arising from publicly financed research".*

The NRDS (2002:47) also advocated for both the creation and the recapitalisation of various instruments. Amongst some of the initiatives were the strengthening of the Innovation Fund as a financing instrument for innovation, the establishment of an IP fund to be managed by the Innovation Fund, an increased focus on technology diffusion and on the development of appropriate human capital and skills for innovation, and the creation of the Foundation for Technological Innovation as a core agency function to support government in stimulating and intensifying technological innovation. The functions of the FTI were to include, *inter alia*: integration and management of disparate innovation, incubation and diffusion activities in South Africa; coordination of innovation activities linked to universities and research organisations; development of national capacity to manage IP (especially IP derived from publicly financed research); strengthening commercialisation of IP; and sourcing of technology internationally when not available locally (see NRDS (2002:49)).

Innovation generally thrives in economies where production is knowledge intensive, coupled with high levels of entrepreneurship. Although the NRDS (2002) identifies *enhanced innovation* as one of its core objectives, it fails to address the innovation enabling and entrepreneurial skills required to take knowledge to the market. The OECD (2011:71) points to low levels of entrepreneurship in South Africa when compared to both advanced and developing countries, thus implying low levels of innovation or conversion of knowledge produced by the science system. Whereas this could be symptomatic of a developing NSI, unabated, it could stifle growth of the NSI. The OECD (2011:62), referring to the NRDS (2002), identifies the key weaknesses in the NSI in 2002 as being:

> *"(i) the need to maintain a super-critical R&D community, in support of strategic needs and to generate national absorptive capacity;*
>
> *(ii) a failure to renew human resources for science and technology, as the predominantly white male research community is ageing and not being replaced in sufficient numbers; and*
>
> *(iii) declining investments in formal R&D by South African companies."*

Early in 2008, Cabinet approved the DST led Ten-Year Innovation Plan, which, according to the TYIP (2008:iv), had the objective to:

> *"… help drive South Africa's transformation towards a knowledge-based economy, in which the production and dissemination of knowledge leads to economic benefits and enriches all fields of human endeavour."*

Aptly entitled *"Innovation Towards a Knowledge Based Economy"*, the TYIP (2008) emphasises innovation – not for innovation's sake but based on the recognition that South Africa's competitiveness and economic growth are dependent on the commercialisation of science and technology R&D outcomes. The Ministerial Review (2012:108) notes that the TYIP (2008), though initiated during the course of finalisation of the OECD (2007), partially responds to some of the issues raised in the OECD (2007).

Recognising that transformation of the economy towards a knowledge-based economy, would result in an increased proportion of national income being derived from knowledge-based industries, a higher percentage of the workforce being employed in knowledge-based jobs and a greater ratio of firms using technology to innovate, the TYIP (2008) identifies the following four elements to drive this transition:

> *"i) Human capital development*
>
> *ii) Knowledge generation and exploitation (R&D)*

iii) Knowledge infrastructure

iv) Enablers to address the 'innovation chasm' between research results and socioeconomic outcomes."

The TYIP (2008:1)'s five grand challenges in science and technology are *"designed to stimulate multidisciplinary thinking and to challenge our country's researchers to answer existing questions, create new disciplines and develop new technologies"* so as to position South Africa as a globally competitive force by 2018. They are the following:

"a) The "Farmer to Pharma" value chain to strengthen the bio-economy – over the next decade South Africa must become a world leader in biotechnology and the pharmaceuticals, based on the nation's indigenous resources and expanding knowledge base.

b) Space science and technology – South Africa should become a key contributor to global space science and technology, with a National Space Agency, a growing satellite industry, and a range of innovations in space sciences, earth observation, communications, navigation and engineering.

c) Energy security – the race is on for safe, clean, affordable and reliable energy supply, and South Africa must meet its medium-term energy supply requirements while innovating for the long term in clean coal technologies, nuclear energy, renewable energy and the promise of the "hydrogen economy".

d) Global climate change science with a focus on climate change – South Africa's geographic position enables us to play a leading role in climate change science.

e) Human and social dynamics – as a leading voice among developing countries, South Africa should contribute to a greater global understanding of shifting social dynamics, and the role of science in stimulating growth and development.

In pursuit of these five Grand Challenges, the DST has also established a number of enabling interventions, illustrated in **Table 6.1**.

Table 6.1: Summary of the 10 Year Plan Grand Challenges and Enabling Interventions

GRAND CHALLENGE	ENABLING INTERVENTIONS
The "Farmer to Pharma" value chain to strengthen the bio-economy	National Bioeconomy Strategy approved by Cabinet in 2013
Space Science and Technology	Establishment of South African National Space Agency (SANSA)
Energy Security	Establishment of Hydrogen South Africa (HySA) Programme and Centres of Competence (CoCs)
Global climate change science with a focus on climate change	
Human and social dynamics	South African Research Chairs Initiative (SARChI) research chairs programmes

In 2008, the DST also championed the Technology Innovation Act, 2008, paving the way for the establishment of the TIA to assume the national innovation agency role envisaged in the NRDS (2002), with the object, as seen from RSA (2008), being to:

> *"support the State in stimulating and intensifying technological innovation in order to improve economic growth and the quality of life of all South Africans by developing and exploiting technological innovations".*

One of TIA's goals arising from the NRDS (2002) is:

> *"to use South Africa's science and technology base to develop new industries, create sustainable jobs and help diversify the economy away from commodity exports towards knowledge-based industries equipped to address modern global challenges".*[174]

In pursuit of this goal, it was envisaged that the TIA would provide both financial and non-financial support. In the same year that the TIA Act was passed, the IPR-PFRD Act championed by the DST was promulgated, but it did not come into effect, until the enabling

174 Summary Report on the Review of the Technology Innovation Agency, prepared for Minister of Science and Technology, 2013 – available at http://www.pmg.org.za/report/20130918-technology-innovation-agency-institutional-report-briefing-department-science-and-technology-shortlisting [Last accessed on 27 December 2014]

regulations had been gazetted by the Minister of Science and Technology in 2010. In 2010, the DST established the NIPMO interim office, to implement the IPR-PFRD Act.

During the consolidation phase, two independent reviews were undertaken. The first of these was the OECD Review (2007) that has already been mentioned, which was followed by the Ministerial Review (2012).[175] Both of these reviews are detailed assessments of the performance review and recommendations of the NSI at the time. In the meantime, the OECD (2007:9-10) found that the transformation of South Africa's NSI *"has been furthered by revolutionary changes in the political and social context and that it remains constrained by the legacy of the past"*, and that South Africa's most striking achievement had simply been to surmount the difficulties created by the extremely poor framework conditions of the early 1990s, as they concerned the innovation system.

Some of the key recommendations from the OECD (2007) included the following: the need for a broad approach to innovation; re-examination of the major national innovation priorities and missions and their alignment to the NRDS (2002) priorities; improvement of the governance structure of the NSI; strengthening of the human resource base for STI; improvement of R&D funding; and differentiation in public R&D and innovation support organisation to correct the weakness of South Africa's innovation system with respect to SMEs. More particularly, Gaut and Zhang (2010) capture an important recommendation about the NSI, to shift the focus to ensuring that:

> *"Innovation is about creating value from knowledge…. Knowledge is the key input to innovation. It can come from a formal process, such as research and development (R&D), it can be indigenous knowledge developed over centuries of learning from the environment, or it can be local knowledge of what works*

175 Department of Science and Technology: Ministerial Review of the Science, Technology and Innovation Landscape in South Africa, published March 2012; Government Gazette No.35392, Notice 425 of 2012, 31 March 2012, available at http://thornton.co.za/resources/35392_gen425.pdf [Last accessed on 4 June 2016]

and what does not work. Innovation is driven by entrepreneurs who take risks and change things."

5.6.4 The Growth Phase (2014 and Beyond)

It is submitted that two critical developments have marked the start of the Growth Phase. The first of these was the public announcement of the Bio-Economy Strategy (2014)[176] that had been approved by Cabinet late in 2013, heralding a new era of consolidation of investments already made by government in biotechnology in order to start to realise tangible benefits. The second was the beginning of the fifth (5th) administration of the post-apartheid Government following the national elections in May 2014, with a focus on radical economic transformation. This phase has also seen an emphasis on implementation of a number of the recommendations of the Ministerial Review (2012) as well as the TIA Review (2014).[177]

Key weaknesses in the NSI identified in the WPS&T (1996) as well as NRDS (2002) persist, 23 years on, in the post-apartheid South Africa. In order to address these effectively and to build an effective NSI that also capitalises on the IP system that South Africa has been building, South Africa's innovation capabilities must demonstrate both depth and diversity, in the private sector (to enhance competitiveness), in the public sector (to improve efficiencies, service delivery, and modernise the public service), and in society at large (to enhance the quality of life). Accordingly, the IP system must develop and evolve to be able to support this depth and diversity of the growing innovation capabilities. Such an evolution of the IP system requires development of an enabling IP regulatory environment together with a critical mass of human resource capabilities in R&D to generate new knowledge as well as in the commercialisation thereof. There is, of course, recognition that an IP system is but one of a number of components of a functioning enabling policy environment for innovation and for the transformation of ideas into useful solutions that

176 http://mg.co.za/article/2014-01-14-science-department-launches-sas-bio-economy-strategy [Last accessed on 5 June 2017]
177 Technology Innovation Agency Institutional Report, September 2013; available at https://pmg.org.za/committee-meeting/16400/ [Last accessed on 2 October 2016]

can ultimately be deployed for utilisation and benefit of society. In this regard, the NSI should comprise complementary policies essential for generating absorptive capacity for innovations generated elsewhere and their integration with endogenous innovations, whilst at the same time pushing the technological frontier forward and creating new markets for new and often disruptive innovations. It is therefore submitted that, for South Africa to be able to improve the wealth and quality of life of its entire people whilst competing globally, the IP and innovation systems must be developed to foster the introduction of new products and services, into both local and international markets. Such systems must support the establishment of, and increase in the survival rate of small businesses, particularly given the observation by the OECD (2011:71) that:

> *"the highly concentrated market structure dominated by established businesses tends to be associated with lower output and employment and higher prices in the affected sectors."*

In reflecting on the character of the NSI, it is important to understand that South Africa's developmental objectives, as captured in the NDP (2012), require that the NSI should address not only industry and economic needs but societal ills too. Sparks (2014) particularly stresses that the NSI should also address the needs of society and contribute to arresting the increasingly high levels of inequality in South African society, whilst ensuring that South African products and services enter and remain competitive in the global markets.

6.5 CONCLUSIONS

It is evident from the foregoing that South Africa's innovation landscape has evolved significantly in the post-apartheid era, with the WPS&T (1996) having provided a broad foundation for much of the policy environment. The concept of the NSI has played a critical role in the development of the innovation policy landscape, with a focus on plugging the gaps preventing an effective functioning of the NSI. Whereas not many institutions have been established since 1994, a number of key policy and legislative development have resulted in the reorganisation of various institutions and in the establishment of a number of critical institutions for a robust NSI.

From an economic development policy perspective, the NDP (2012) recognises the importance of innovation for the development of a middle-income country such as South Africa. The multifaceted nature of innovation and its dependence on other inputs is also recognised, one of which is the IP policy environment, as it affects the generation, diffusion, use and adoption of innovation within the NSI.

It is argued that the South African NSI has benefitted from a number of both local and international reviews that have also contributed to the development of innovation policy and refinement of institutional frameworks. Suffice to say that South Africa is not short of policies. Nonetheless, at the time of finalising this study, the DST was leading a process to replace the 10 Year Plan, which had a duration until 2018, with a new White Paper on Science and Technology and Innovation, which is a welcome development that could benefit from the findings of this study. The effectiveness of this policy environment is dealt with in the next chapters, which look at the performance of the South African NSI.

The next chapter presents an in-depth study and review of the performance of the IP system in the country. This is followed by a review of the NSI in **Chapter 8** on the basis of this **Chapter 6** and the results of **Chapter 7**.

CHAPTER 7: PERFORMANCE OF THE SOUTH AFRICAN INTELLECTUAL PROPERTY SYSTEM

"It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of Light, it was the season of Darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us, we were all going direct to heaven, we were all going direct the other way – in short, the period was so far like the present period, that some of its noisiest authorities insisted on its being received, for good or for evil, in the superlative degree of comparison only. ….." – Charles Dickens[178]

7.1 INTRODUCTION

The performance of South Africa's IP system over a 20-year period, 1996 to 2015, has been reviewed with respect to a number of parameters, which include patent statistics, and use of the patent system by publicly funded institutions, as demonstrated by the patent statistics in relation to R&D spending. A particular area of interest, as far as institutional arrangements are concerned, has been the significant focus of South Africa on intellectual property emanating from publicly financed R&D and its commercialisation. The commercialisation of such IP is dealt with in **Chapter 8**, when we analyse the performance of the innovation system and also review the progress in the implementation of the IPR-PFRD Act since its promulgation in 2008.

Given South Africa's membership of the BRICS group of countries, which accounts for over a third of global GDP, South Africa's performance will, in **Section 7.4** be contrasted with that of the rest of the BRICS countries.

Some authors have argued that there is anecdotal evidence of a link between R&D spending and GDP growth, whereas others have also argued that there is a relationship between R&D spending and patent statistics. Yet others such, as such as Zhang and Park

178 Charles Dickens *A Tale of Two Cities* English novelist (1812 - 1870)

(2015) and Sinha (2008), have argued that there is a dependence of GDP growth on the extent of technological innovation, as illustrated by patent filings. Straus (2016:451) notes that, despite the debate amongst economists on the impact of patents *"on technological, economic and social development, but also on the performance of companies"*, there is acceptance of their role in *"preventing monopolistic development of entire sectors of the industry."* It would appear that it is not just R&D spending that is important for change but, more importantly, R&D that results in new goods, new processes and new knowledge that could form the basis of patents and competitiveness. It is also common cause, as detailed in Guellec and Van Pottelsberghe de la Potterie (2001:104) that R&D is not the only source of new technology but that other activities that include learning by doing and design, as well as reverse engineering, are vital sources of new technologies too.

Wang (2013:2) argues that:

> *"R&D spending only measures innovation activity input towards new products and processes rather than successful outputs. The innovator usually faces high uncertainty of innovation outcomes, which means that only a random proportion of R&D expenditure will eventually be transformed into innovations. … Whereas R&D measures innovation input, IPR statistics provide innovation output measures."*

Without becoming caught up in a debate on the conflicting evidence with regard to IPR statistics being a measure of innovation output, suffice to say that IPR statistics at best measure R&D output with varying anecdotal evidence, suggesting that they could be indicative of innovativeness and competitiveness. This chapter therefore takes the view that, notwithstanding the complex and non-linear relationship between R&D and innovations produced, the association of the most technological innovations with patents enables us to work on the basis that patents are a good proxy for innovation, particularly technological innovation.

As patents are territorial, the major international jurisdictions must be considered when seeking to understand South Africa's performance. The analysis thus includes the PCT international patent applications based on both a South African priority as well as on a

South African Inventor Address. In addition, the analysis of patents granted to South Africans has been extended to two specific jurisdictions, namely, Europe (through the European Patent Office (EPO)) and the United States of America (through the United States Patent and Trade Mark Office (USPTO)). These two jurisdictions comprise major markets for South Africa and, in addition to Japan, have traditionally been considered the three most important patenting territories.

7.2 DOMESTIC PATENTING IN SOUTH AFRICA

As already indicated in **Chapter 4**, the South African patent system is a deposit system, in terms of which a patent is granted after a patent application has been subjected to certain formalities, as opposed to merely a search and substantive examination.

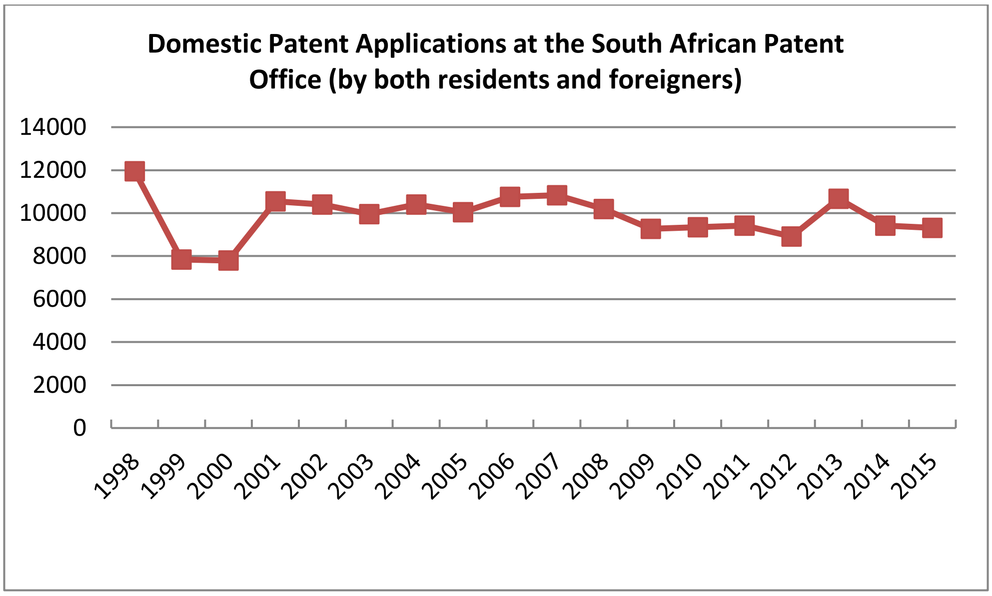


Figure 7.1: South African patent applications in the period 1998 - 2015 [Source: Sibanda (2007:26), CIPC (2014) and CIPC (2015)]

Thus, a patent application accompanied by a complete patent specification would typically proceed to the granting of a patent, subject to payment of grant fees. **Figure 7.1** illustrates the patent applications filed at the South African patent office in the period (1998-2015) and (2006-2015), respectively. As can be seen from **Figure 7.1**, filing rates in South Africa have remained fairly stagnant if not on a decline since 1998, with the filings declining below 10 000 since 2009, other than an odd, unexplainable spike in 2013 (10 676). The patent filing data includes both provisional and complete patent applications, and it was not possible to segregate the provisional from the complete patent applications, from the data provided by the CIPC. Sibanda (2007:26) explains that the decline from 1998 can be attributed to South Africa becoming a member of the PCT and that:

> *"prior to March 1999, foreign applicants who wanted to obtain final patent protection for their inventions in South African had to file a patent application directly [in South Africa] at the end of the 12-month convention period."*

Delays in lodging the patent applications in South African by foreign companies could be some of the reasons for this. Although this explanation may appear plausible, it is also very doubtful that it can completely account for this decline, as one would expect those applications to be filed at least 18 months later, during the national phase and one should see a sharp increase attributable to these delayed filings. Notwithstanding the increase in the patent filings in 2001 (10 553), after the drop in both 1999 (7 838) and 2000 (7 793), the increase falls short of the deficit that could be attributed to the delay. There could be other reasons for this, including some of the South African companies going global and/or foreign applicants not seeing South Africa as an attractive enough market.

Given the stagnation of the patent filings seen in the 10-year period 2006-2015, it is important to consider the reasons advanced by Sibanda (2007:27) for the stagnation and drop in domestic patent filings, particularly given that South Africa is a deposit system and that domestic filing is relatively inexpensive, these being:

- *"a stagnant innovation system;*
- *a decline in research output within the Science and Technology sector;*
- *a perception that a non-examining or deposit system is inadequate for effective protection of IPRs;*
- *low IPR awareness; and*
- *the costs of filing complete patent applications being prohibitive to a large part of the population…"*

It would appear that the issue of cost and the fact that South Africa's patent system is non-examining have little to do with the decline and stagnation, as these two factors have not changed much over the years, in any event. In particular, Pouris and Pouris (2011:10) note that *"the registration approach makes the South African regime one of the cheapest in the world (20 to 30 times cheaper than other patent regimes)".*

In addition, this study shows that the research output has not declined, as can be seen from the increase in publication outputs by the HEIs (**Figure 7.2.**). Instead, there has been a significant increase in research outputs within the Science and Technology sector.

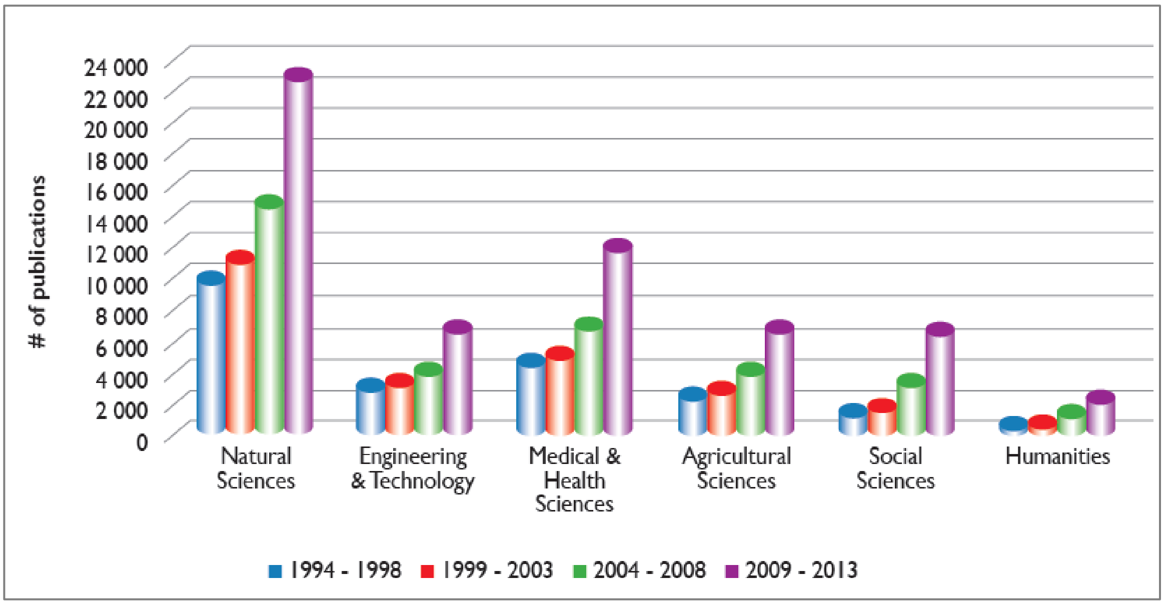


Figure 7.2: South African Trends in Scientific Publications in Various Research Fields [Source: NACI (2014)]

According to Sibanda (2009:117), patenting by institutions at the South African patent office has been marked by increases since the creation of the NRDS (2002), particularly in respect of provisional patent applications and granted patents, as illustrated in **Figure 7.3.**

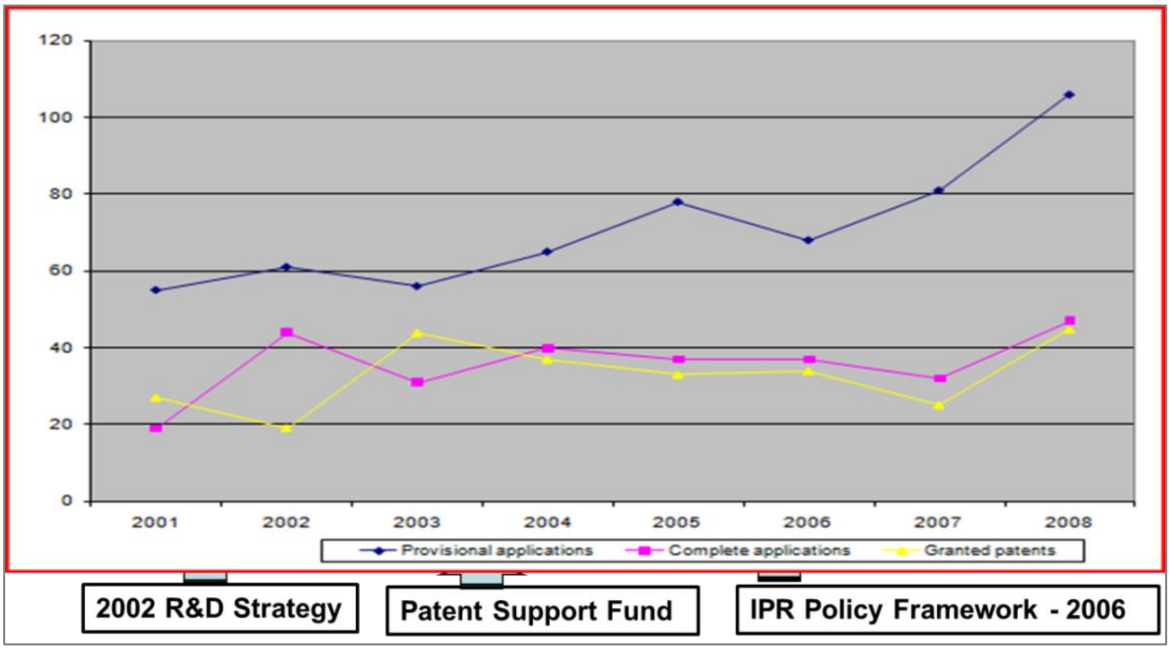


Figure 7.3: Domestic Patenting by Publicly Financed Institutions in South Africa [Source: updated from Sibanda (2009:117)]

Other than the NRDS (2002), as illustrated in Figure 7.3, two other interventions have been attributed to these increases, firstly the Patent Support Fund, put in place by the then Innovation Fund, which provided subsidies to institutions to obtain patent protection and, secondly, the IP Policy (2006), which was the precursor to the IPR-PFRD Act.

It would thus appear that there has instead been a decline in patenting by a couple of traditionally prolific patenting private companies, such as De Beers Industrial Diamond (which later changed its name to Element Six), Anglo American, for example. Accordingly, the stagnation could be attributed, *inter alia*, to *"a stagnant innovation system"* in which there is very little nett gain when assessing the outputs versus the inputs to the system. In the case in point, this is characterised by low participation of the private sector (including entrepreneurs) in innovation and patenting, and *"low IPR awareness,"* which is critical to broadening the participation of local entrepreneurs and enterprises in the patent system. This is consistent with findings by Bansi and Reddy (2015:194), who found that *"respondents indicated that … the IP registration procedure and process was difficult to understand."* Another observation made by Sibanda (2007:27) was the need for *the dti* and CIPRO (now CIPC) to increase capacity to *"build capacity within the country … to effectively support and promote patenting activities."*

Unfortunately, very little has been done in this regard over the past 10 years, other than the recruitment and training of patent examiners by CIPC in 2015/2016, in anticipation of South Africa implementing a substantive patent search and examination system. Pouris and Pouris (2011:10) recommend that:

> *"the relevant authorities should make available to the public through a website all the information disclosed in the patent applications. In this way, the benefits to the public, other inventors and society at large will also be supported."*

7.3 PCT PATENT APPLICATIONS

An analysis of PCT applications filed by South Africans (based on South African priority application) indicates that, between 1996 and 2015, a total number of 6 264 and 7 503 PCT applications were filed, claiming priority from a South African (ZA) application, and with an inventor with a South African address, respectively.

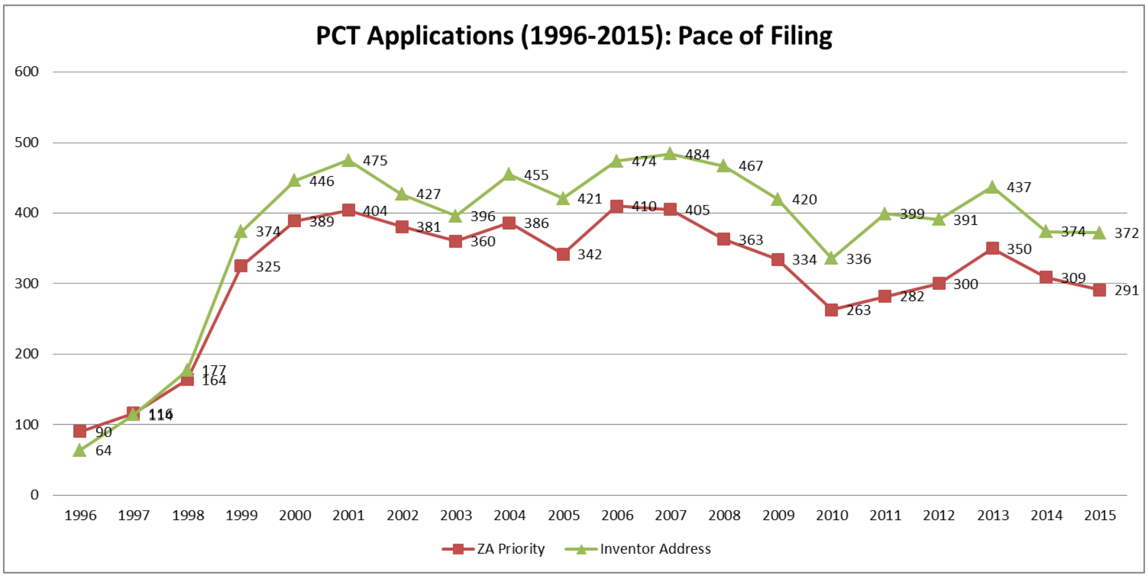


Figure 7.4: PCT patent applications in the period 1996 - 2015 (with South African priority) [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

Figure 7.4 shows the distribution of these applications by the year of filing. Naturally, there are more applications with a named South African inventor compared to those that claim priority from a South African application, as the former includes those PCT applications that were filed directly with the PCT International Bureau and those that claim priority from a non-South African prior application. Included in the applications with a named inventor are those applications filed in the first instance without claiming priority from an earlier patent application. Applications not included in the data are those that still have to be published (18 months from earliest priority). A PCT patent application would generally be published 18 months from the earliest priority date, thus, an application filed on 31 December 2015 as a first application without a prior claim would still not have been published by the date of this thesis, but would become legible for publication 18 months later, in June 2017.

An analysis of **Figure 7.4** shows an increase in the number of PCT applications filed from 90 in 1996 to a maximum of 410 in 2005 (in the case of priority-based filings) and from 64 in 1996 to a maximum of 484 in 2007 (in the case of inventor address based filings). In general, the pace of filing has been on a downward trend from both peaks identified above, and in 2015 stood at 291 (priority-based applications) and 372 (inventor address based applications). This decrease equates to approximately 30% (priority-based applications) and 23% (inventor-based applications). The low number of applications in 1996 can be explained by South African's accession to the PCT on 16 March 1999 (see Sibanda, 2007:7).

Figure 7.5 shows the Top Assignees/Applicants over the same period, with the top 10 being Sasol (180) followed by the CSIR (119), the University of Stellenbosch (95), the University of Cape Town (78), Handelman Joseph H (64), the University of the Witwatersrand (62), Element Six (59), the University of Pretoria (39), Discovery Holdings (38) and Detnet South Africa (37).

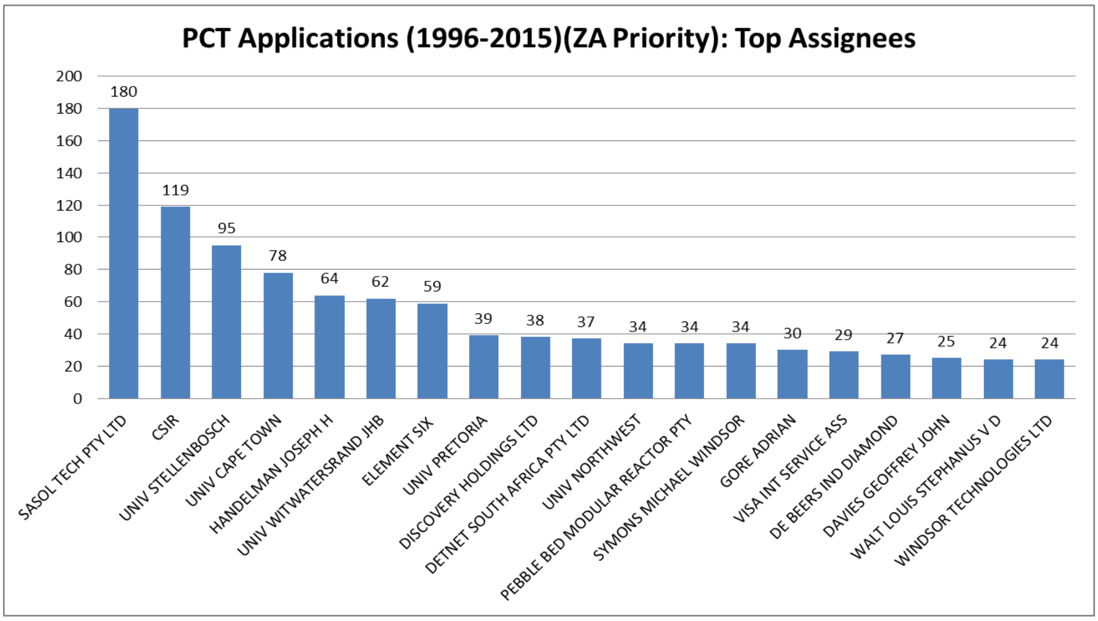


Figure 7.5: PCT patent applications in the period 1996 - 2015 (with South African priority filing), by Top Assignee/Applicant [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

Figure 7.6 shows the Top Assignees/Applicants over the same period, for inventor address based applications. Other than the higher number of patent applications and the changes in positioning of some of the applicants, the top 10 applicants/assignees are the same.

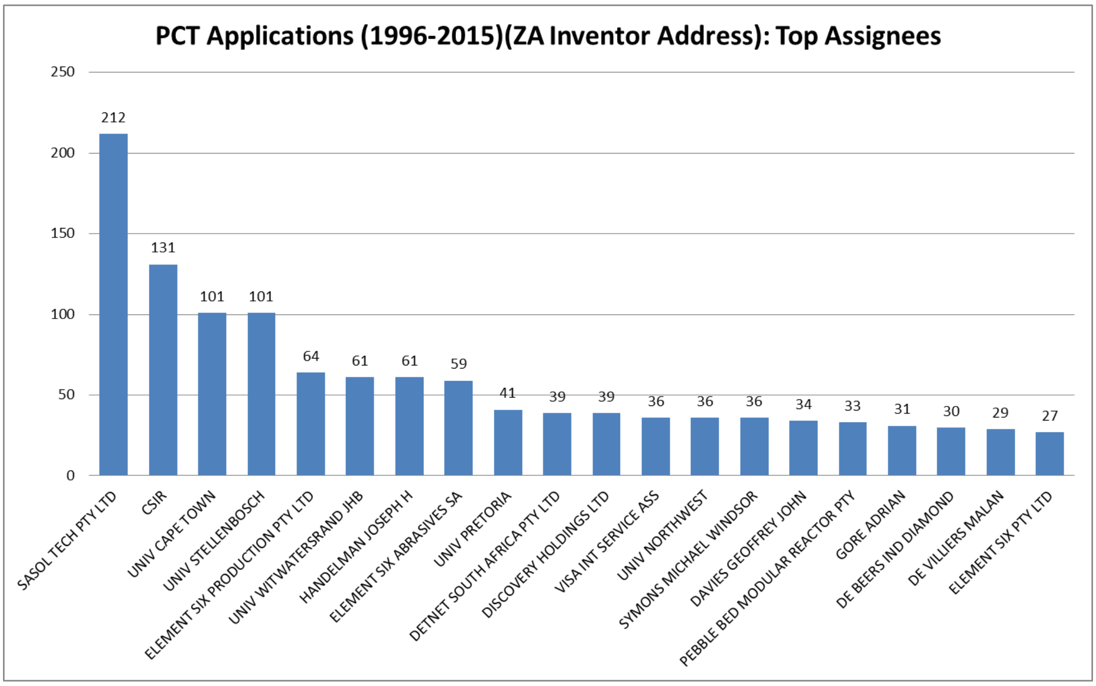


Figure 7.6: PCT patent applications in the period 1996 - 2015 (South African Inventor Address), by Top Assignee/Applicant [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

Figures 7.7 and **7.8** show the top technologies represented by Top IPCs for the priority based and inventor address based applications, respectively.

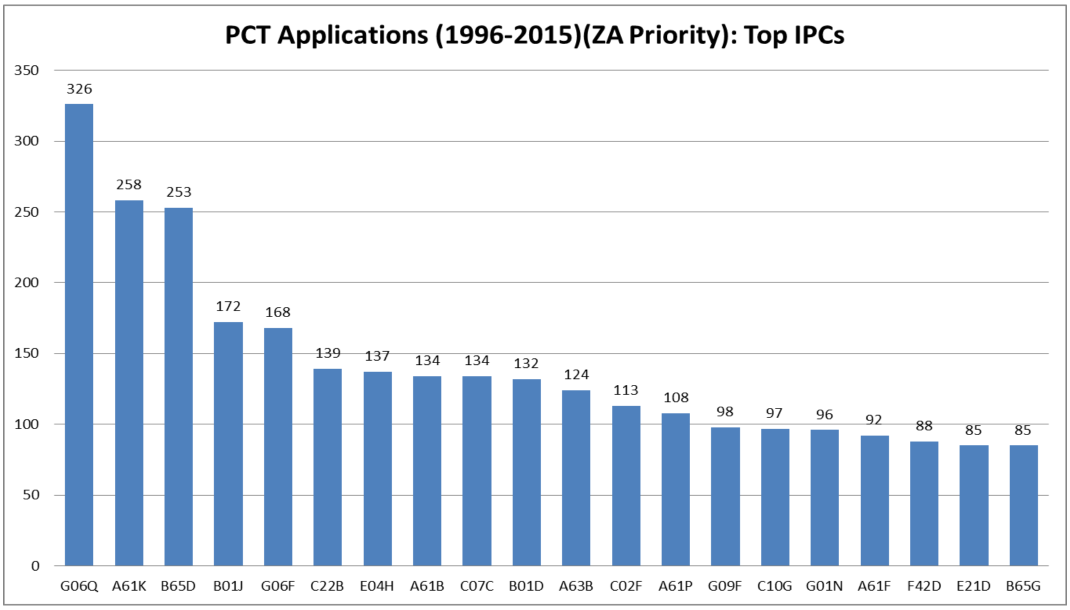


Figure 7.7: PCT patent applications in the period 1996 - 2015 (with South African priority filing), by Top IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

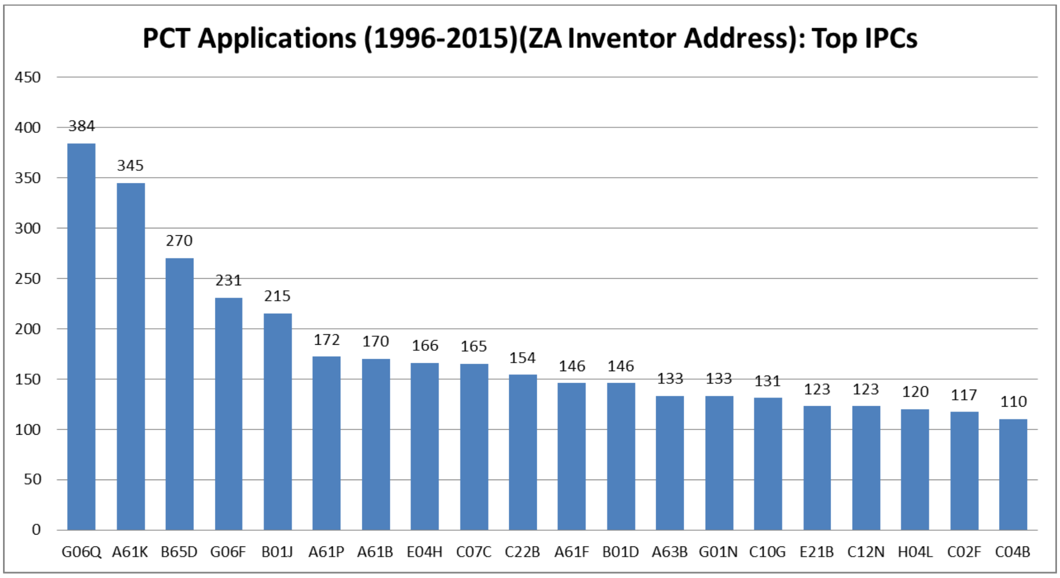


Figure 7.8: PCT patent applications in the period 1996 - 2015 (South African Inventor Address filing), by Top IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

The top 10 IPCs are essentially the same, save for A61P, which is 6th in the inventor address based list but 13th in the priority-based list, and B01D, which is 10th in the priority-based list but 12th in the inventor address based list. The top technology areas in which South African file PCT applications, as represented by the top 10 IPC lists (including the two outliers mentioned above) are:

- G06Q (Data processing systems or methods, specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes; systems or methods specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes, not otherwise provided for); - at least half of these are in payment architecture and protocols (G06Q 20/00);
- A61K (preparations for medical, dental, or toilet purposes);
- C07C (heterocyclic compounds);
- A61B (diagnosis; surgery; identification);
- A61P (specific therapeutic activity of chemical compounds or medicinal preparations);
- B65D (containers for storage or transport of articles or materials, e.g. bags, barrels, bottles, boxes, cans, cartons, crates, drums, jars, tanks, hoppers, forwarding containers**;** accessories, closures, or fittings therefor; packaging elements**;** packages);
- G06F (electric digital data processing);
- B01J (chemical or physical processes);
- B01D (separation);
- C22B (production or refining of metals**,** pre-treatment of raw materials);
- E04H (Buildings or like structures for particular purposes**;** swimming or splash baths or pools**;** masts**;** fencing**;** tents or canopies, in general, specially adapted for cleaning (cleaning devices peculiar to vessels);
- B01D (separation).

Figures 7.9 and **7.10** show the ThemeScape® Map of the PCT applications filed in the periods 1996-2015, for priority based and inventor address based filings.

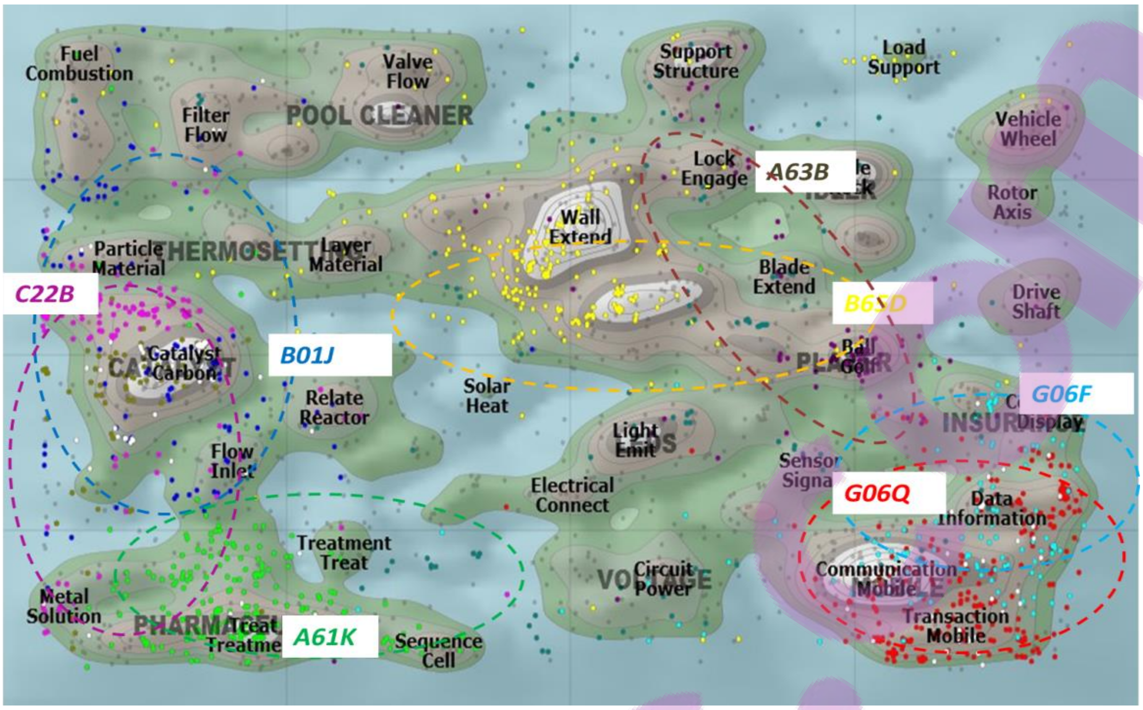


Figure 7.9: ThemeScape® Map of PCT patent applications in the period 1996 - 2015 (with South African priority filing) with patents by top IPCs [Source: Author generated from Thomson Innovation patent database analytics, 2016]

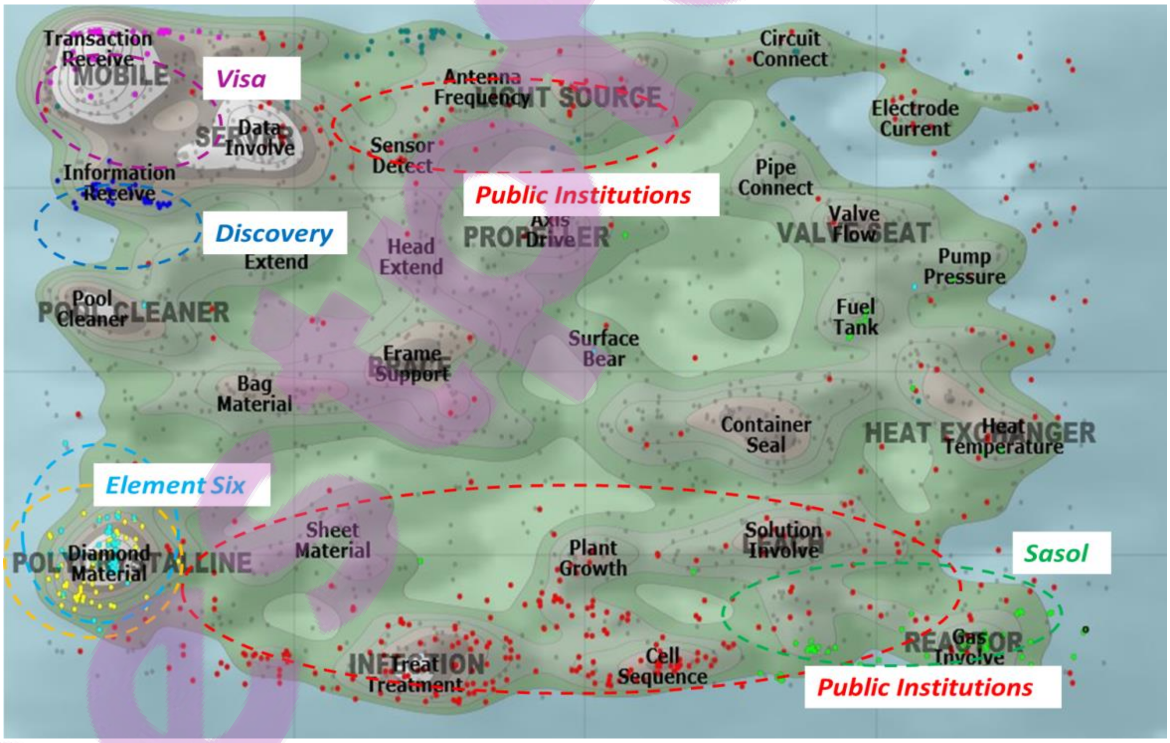


Figure 7.10: ThemeScape® Map of PCT patent applications in the period 1996 - 2015 (with South African Inventor Address) with patents by top private sector [Source: Author generated from Thomson Innovation patent database analytics, 2016]

Each black dot in the contour map indicates a patent document. The relative distances between the black dots denote relationships between the patent documents; unrelated documents are further apart from each other, and documents that are more closely related are placed closer together on the contour map. The contours on the map represent groupings of similar patent documents. One is able to zoom in and show further similarities at a granular level. Density of documents is illustrated by different colours, with the highest density of documents or key themes being illustrated by white or "snow-capped peaks". Thus, one is able to get an objective indication of a certain technology landscape based on such a map. Such a landscape thus gives an indication of the technology strength or comparative advantage based on patenting. An analysis of **Figures 7.9** and **7.10** reveals a number of technology clusters associated with the following applicants/assignees (**Figure 7.10**):

(i) Financial Services (G06Q and G06F) (Discovery Holdings and VISA),
(ii) Diamonds and Abrasives B01J (Element Six/De Beers),
(iii) Catalysis and Fuel B01J (Sasol),
(iv) Therapeutics/pharmaceuticals (A61K, A61P, A61B) (Public Institutions – universities and the CSIR),
(v) Mineral Processing and Separation (C22B) (public institutions and a number of mining companies, including BHP Billiton).

Whereas the Discovery patent applications are in insurance and related services, the VISA applications are in payment systems, in line with their respective core businesses. Other than Public Institutions, the focus areas of patenting by the leading assignees/applicants appear to be in the area of their core business. Public Institutions, notwithstanding a widespread portfolio, appear to have only one dominant cluster in therapeutics/pharmaceuticals, with some small clusters in mineral processing, separation, analytics and water treatment.

In order to better understand the shifts in the innovation ecosystem and, in particular, the patenting trends over the 20-year period and also in order to identify possible areas for South Africa to capitalise on (based on existing strengths, as indicated by patent filings in the past 10 years in particular, given the 20-year life of a patent), analysis was done for the two periods 1996-2005 and 2006-2015, and the results are detailed below. In this regard, **Figure 7.11** and **7.12** show the top applicants/assignees for the period 1996-2005 and 2006-2015, in respect of priority-based applications, respectively.

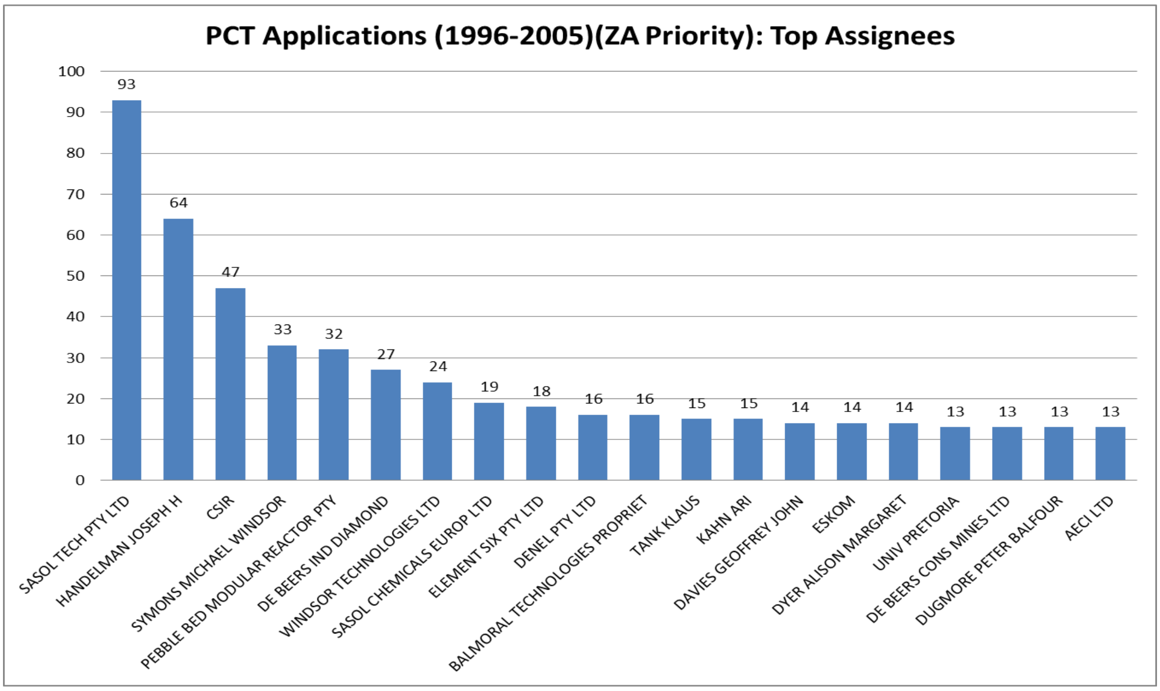


Figure 7.11: PCT patent applications in the period 1996 - 2005 (South African Priority), by Top Assignee/Applicant [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

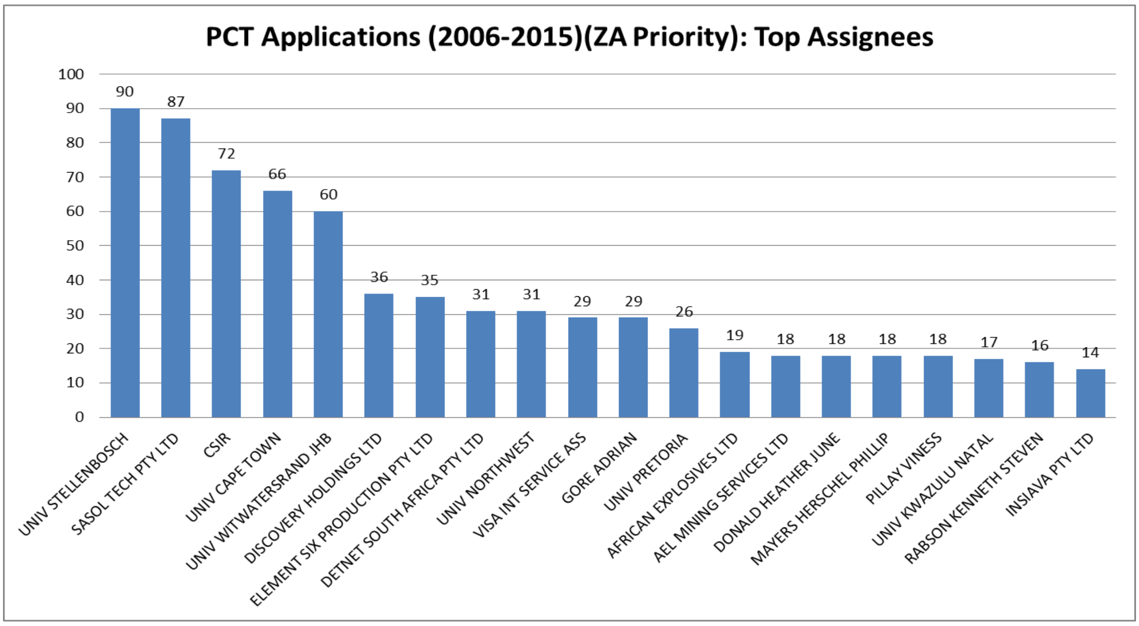


Figure 7.12: PCT patent applications in the period 2006- 2015 (South African Priority), by Top Assignee/Applicant [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

Figures 7.13 and **7.14** show the top applicants/assignees for the period 1996-2005 and 2006-2015, in respect of inventor address based applications, respectively.

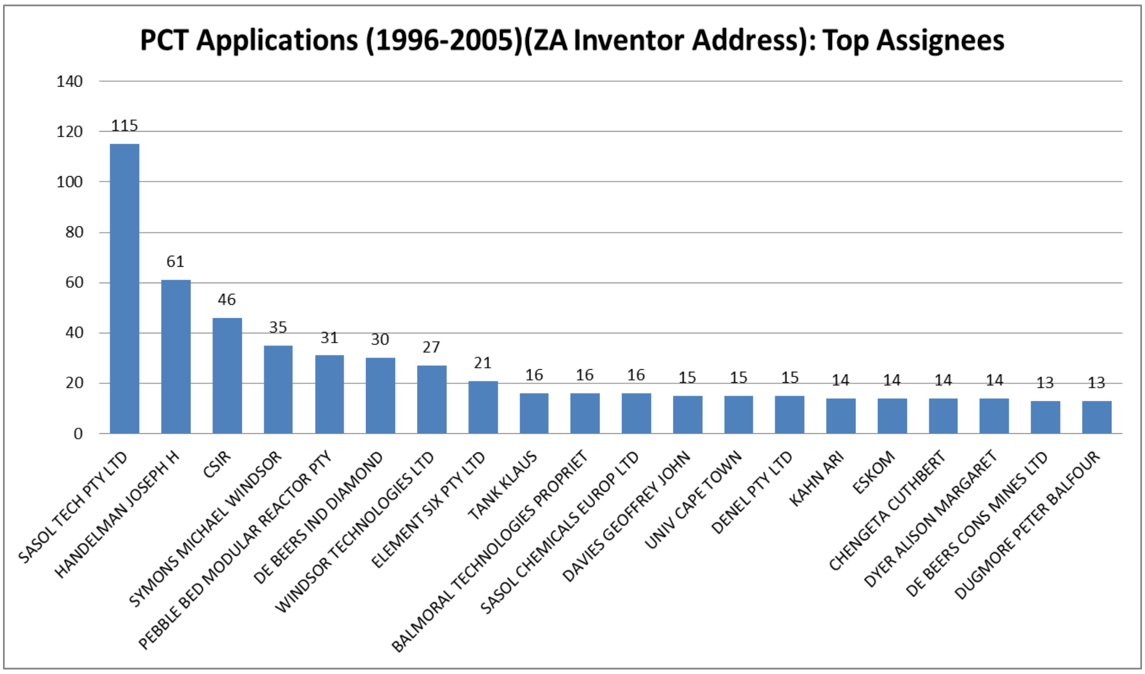


Figure 7.13: PCT patent applications in the period 1996 - 2005 (South African Inventor Address), by Top Assignee/Applicant [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

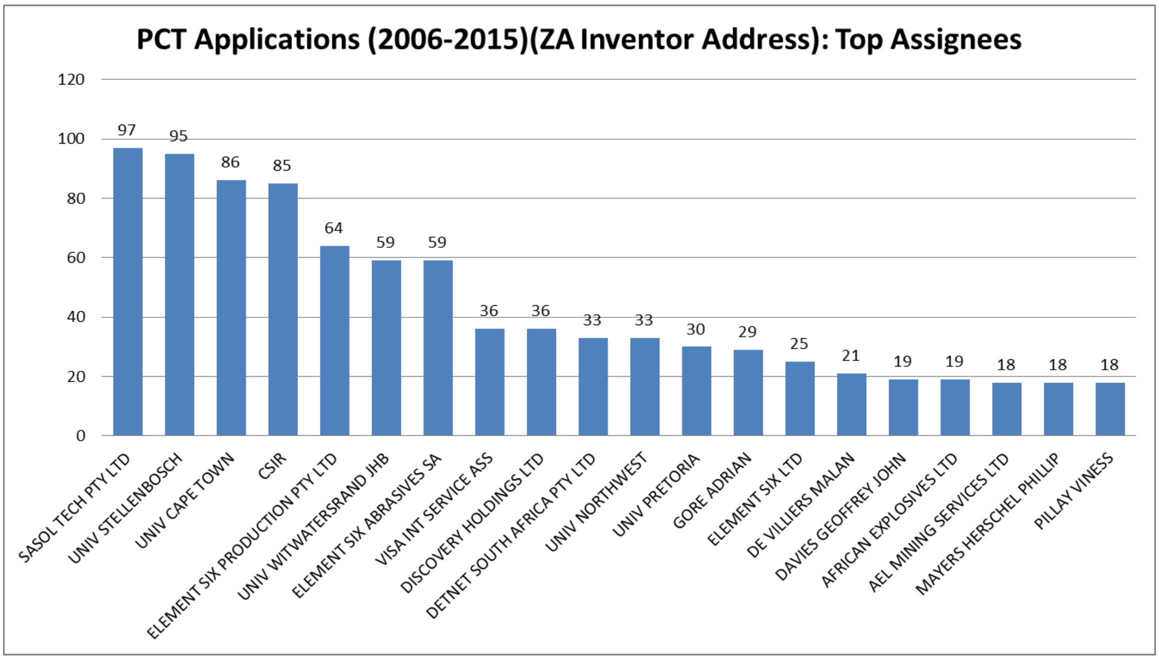


Figure 7.14: PCT Patent applications in the period 2006 - 2015 (South African Inventor Address), by Top Assignee/Applicant [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

The analysis of the patenting trends over the 20-year period shows that (i) in the period 1996-2005, 2 957 applications were filed with a South African priority, and 3 349 applications were filed with a South African named inventor, (ii) in the period 2006-2015, 3 307 applications were filed with a South African priority, and 4 154 applications were filed with a South African named inventor. In both cases, there has been an increase of 12% in the case of priority-based applications compared to 24% in the case of inventor address based applications. The higher increase in the case of inventor address based applications could be attributed to an increased use of foreign jurisdictions to claim priority as well as filings in the first instance at the International Bureau without a South African priority claim.

A review of **Figures 7.11** and **7.13** shows similar applicants/assignees. Similar observations are made in terms of **Figures 7.12** and **7.14.** Review of assignees in the two periods indicates that:

- Whereas Sasol, the CSIR, and the University of Cape Town feature in the top 20 applicants/assignees lists in both periods, they have also increased their pace of filing, in the period 2006-2015, to maintain positions in the top five applicants/assignees;

- De Beers Industrial Diamonds featured prominently as the sixth top applicant/assignee in 1996-2005, but does not feature in 2006-2015, mainly because as has already been mentioned, changed its name to Element Six. In this regard, if one combines the patent applications for De Beers Industrial Diamonds and Element Six in the two periods, we can conclude that, whereas Element Six (the successor in title to De Beers Industrial Diamonds) still features in the top ten applicants/assignees, the number of applications that claim priority from a South African application has decreased, whereas the number of applications with a South African inventor address has almost doubled, from 51 to 99. This suggests changes of filing strategy, which is in line with Element Six divesting most of its R&D from South Africa to offshore locations, with some South African researchers locating to offshore research sites.
- The following applicants/assignees that featured in the period 1996-2005 list do not feature in the top applicant/assignee list for the period 2006-2015: Handelman Joseph, Pebble Bed Modular Reactor, Symons Michael Windsor, Windsor Technologies, Balmoral Technologies, De Beers Consolidated Mines, AECI, Denel, and Eskom. The individual inventors are not considered, as they generally would have filed the application in their name instead of their company to take advantage of discounts on search and examination fees offered to individuals by the PCT. For example, Adrian Gore is part of Discovery Holdings; Klaus Tank, Heather Donald and Geoffrey Davies, for example, were part of Element Six. It is thus assumed that the applications would have later been assigned to the respective corporate entity, in the case above, to Discovery and Element Six. The Pebble Bed Modular Reactor was a publicly funded institution that was established in 1999, but was shut down in 2010.[179] Accordingly, it is to be expected that they would have filed a lower number of applications in the period 2006-2010 before they were shut down.

179 *"PBMR facing massive cuts". World Nuclear News. 18 February 2010.* Available at http://www.world-nuclear-news.org/C_PBMR_facing_massive_cuts_1802101.html [Last accessed on 4 December 2016]

- The University of Pretoria features on both lists and has doubled its number of applications in the 10-year period from 13 in 1996-2005 to 26 in 2006-2015.
- The following applicants/assignees did not feature in the 1996-2005 period; however, they feature prominently in the top assignees for the period 2006-2015: the University of Stellenbosch, the University of the Witwatersrand, Visa International Services, Discovery Holdings, Detnet South Africa, NorthWest University, the University of KwaZulu-Natal, African Explosives, AEL Mining Services, and Insiava.
- Whereas, in the 1996-2005 period, only one university (according to the inventor address based list and the priority-based list) featured prominently in the top 20 assignees list, six universities (priority-based applications) and five universities (inventor address based applications) feature in the period 2006-2015.
- The growth in the filing of patent applications by institutions, and in particular by universities, could be attributed to an increased awareness of the importance of intellectual property and in particular, of patenting amongst institutions because of the IPR Framework Policy (DST, 2006) and consequently the IPR-PFRD Act.

Figures 7.15 and **7.16** show the top IPCs (South Africa priority filing) for the two periods, 1996-2005 and 2006-2015, respectively.

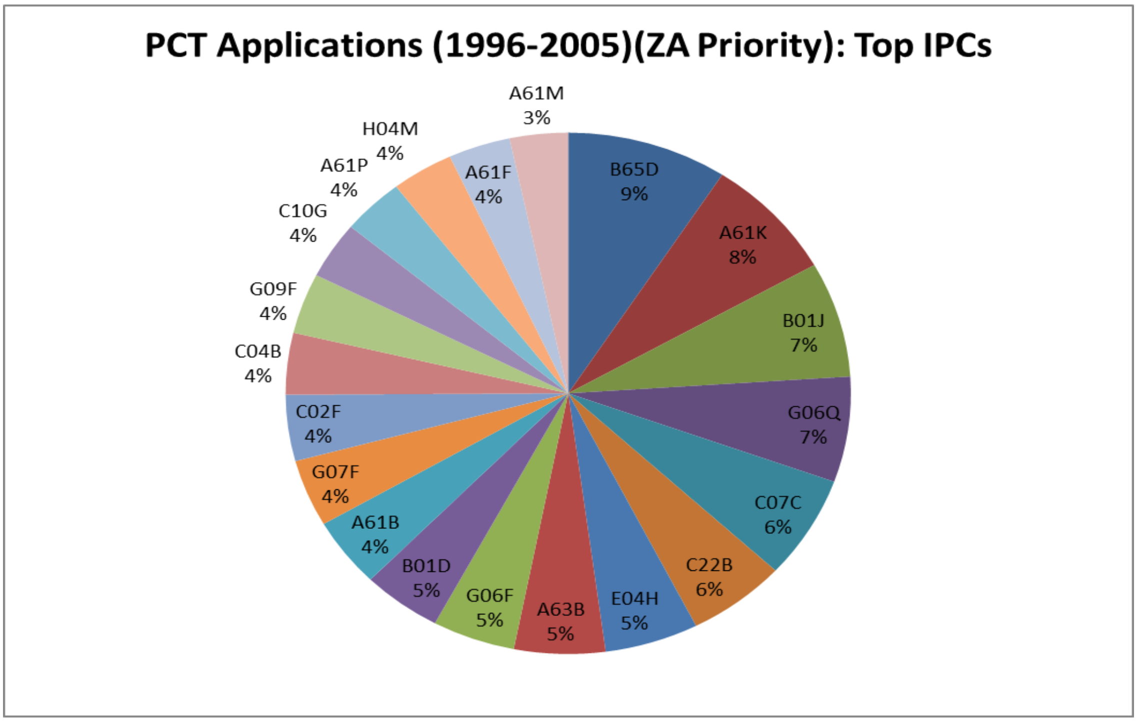


Figure 7.15: PCT patent applications in the period 1996 - 2005 (South African priority), by Top 20 IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

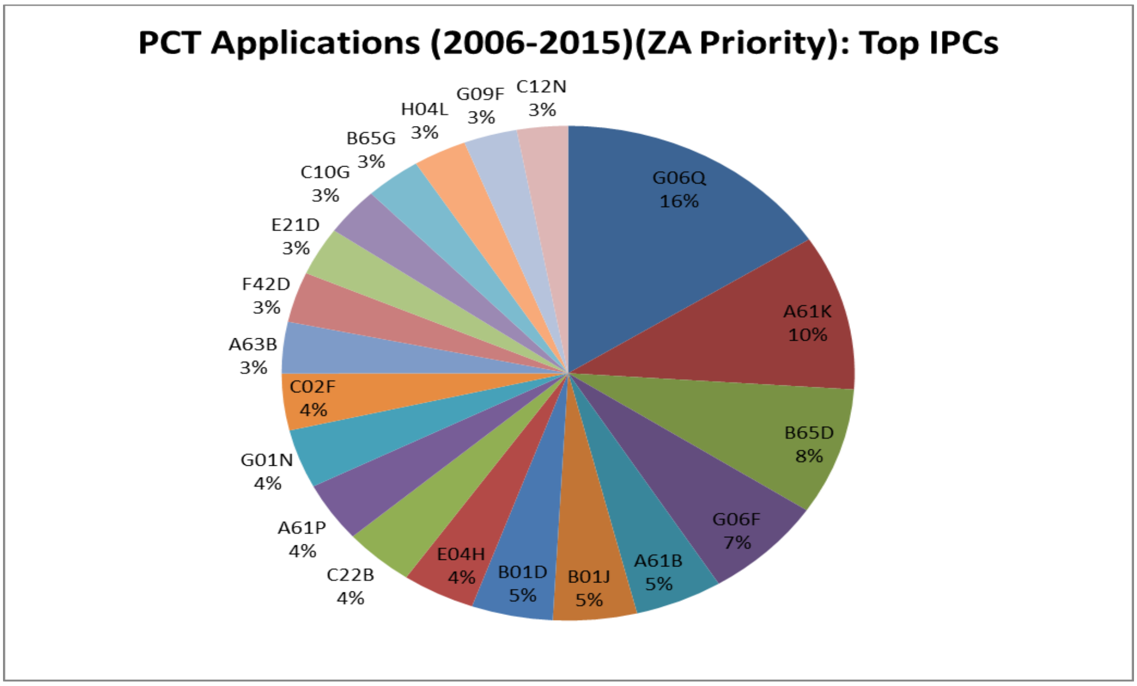


Figure 7.16: PCT patent applications in the period 2006 - 2015 (South African priority), by Top 20 IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

Figure 7.17 and **7.18** show the top IPCs for the period 1996-2005 and 2006-2015, in respect of inventor address based applications, respectively.

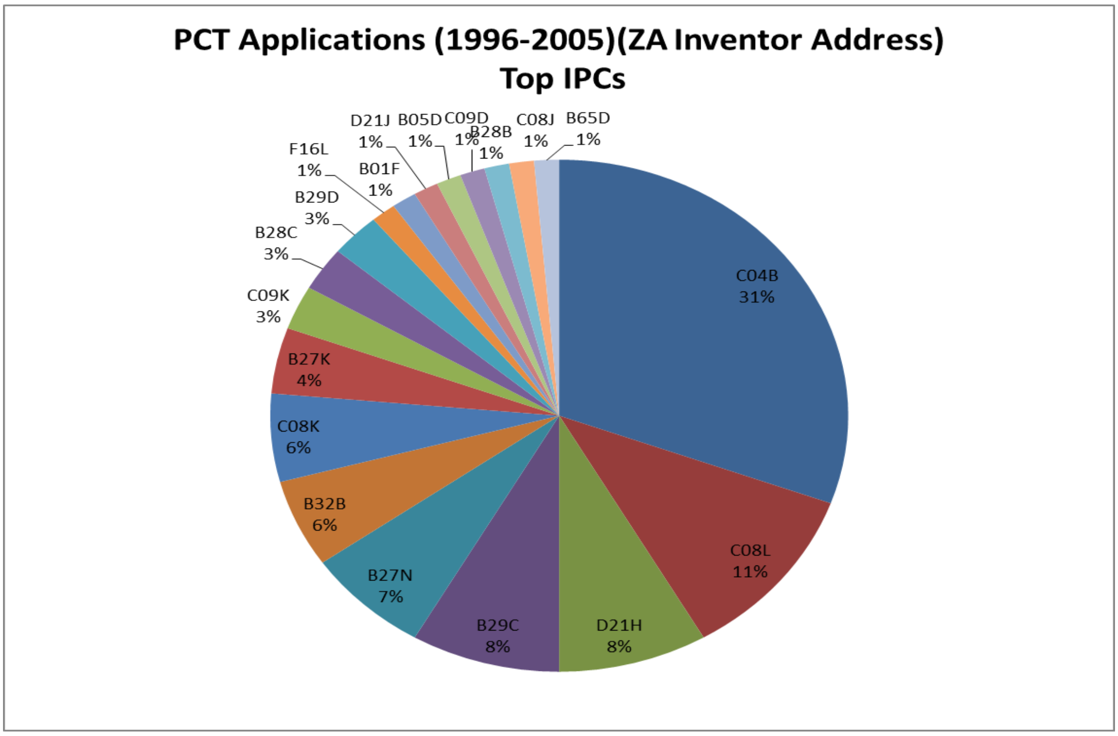


Figure 7.17: PCT patent applications in the period 1996 - 2015 (South African Inventor Address), by Top 20 IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

It is evident from **Figures 7.15** to **7.18**, that there has been a significant shift in terms of technology fields in which PCT applications were filed by South Africans from one period to the next.

- In the period 1996-2005, B65D (containers for storage or transport of articles or materials, e.g. bags, barrels, bottles, boxes, cans, cartons, crates, drums, jars, tanks, hoppers, forwarding containers; accessories, closures, or fittings therefor; packaging elements; packages) was the dominant technology area.

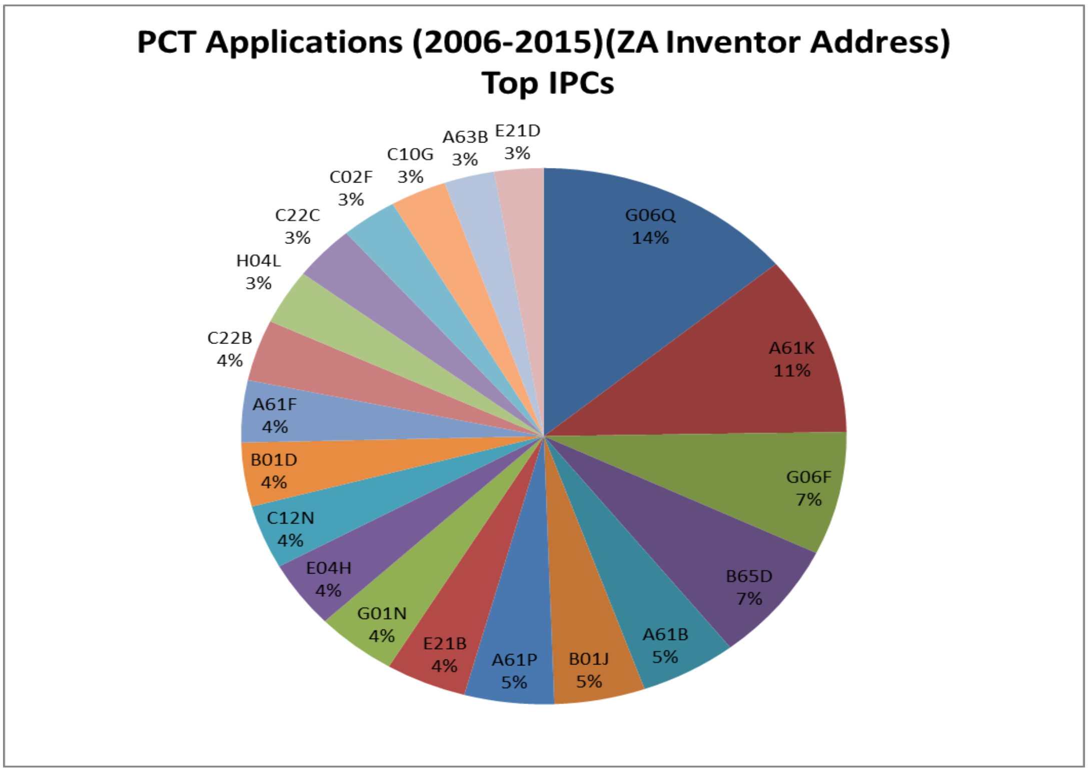


Figure 7.18: PCT patent applications in the period 2006 - 2015 (South African Inventor Address), by Top 20 IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

- In the period 2006-2015, G06Q (Data processing systems or methods, specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes; systems or methods specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes, not otherwise provided for), was the dominant technology field. Although G06Q featured in the period 1996-2005, the number of patent applications filed increased during 2006-2015.
- A61K (preparations for medical, dental, or toilet purposes) retained its position as being the second IPC in which most PCT patent applications were filed.
- Other dominant technology fields in 1996-2005 that do not feature prominently in patent applications filed in 2006-2015, are C07C (acyclic or carbocyclic compounds), G07F (coin fed or like apparatus), C02F (water treatment), H04M (telephone communications), C04B (lime, magnesia, slag, cements and compositions), and A61F (prosthesis and other medical devices).
- New dominant technology fields in the period 2006-2015, include:

- E04H (buildings or like structures for particular purposes; swimming or splash baths or pools; masts; fencing; tents or canopies, in general);
- G01N (investigating or analysing materials by determining their chemical or physical properties);
- F42D (blasting);
- E21D (shafts; tunnels; galleries; large underground chambers);
- B65G (transport or storage devices, e.g. conveyors for loading or tipping, shop conveyor systems or pneumatic tube conveyors);
- H04L (transmission of digital information, e.g. telegraphic communication);
- C12N (micro-organisms or enzymes; compositions thereof; propagating, preserving, or maintaining micro-organisms; mutation or genetic engineering; culture media).

C12N and G01N are part of biotechnology[180] and thus the shift in terms of new technology fields appears to be towards biotechnology, telecoms (H04L), blasting and explosives (F42D), and building structures.

An analysis of the data demonstrates shifts in terms of technology areas, as illustrated by the top five IPCs, which are plotted onto the contour maps. An apparent shift is the reduction of the cluster of patents related to production and refining of metals (C22B) and the emergence of dominant clusters related to data processing and the financial services sector (G06Q/G06F).

Figures 7.19 shows the ThemeScape® Map of the PCT applications filed in the period 2006-2015. Dominant patent clusters belong to the following applicants: Sasol, Element Six, Discovery Holdings, Visa, and Public Institutions (red dots).

180 OECD Patent Databases Identifying Technology Areas for Patents, available at https://www.oecd.org/sti/inno/40807441.pdf [Last accessed on 9 November 2016]

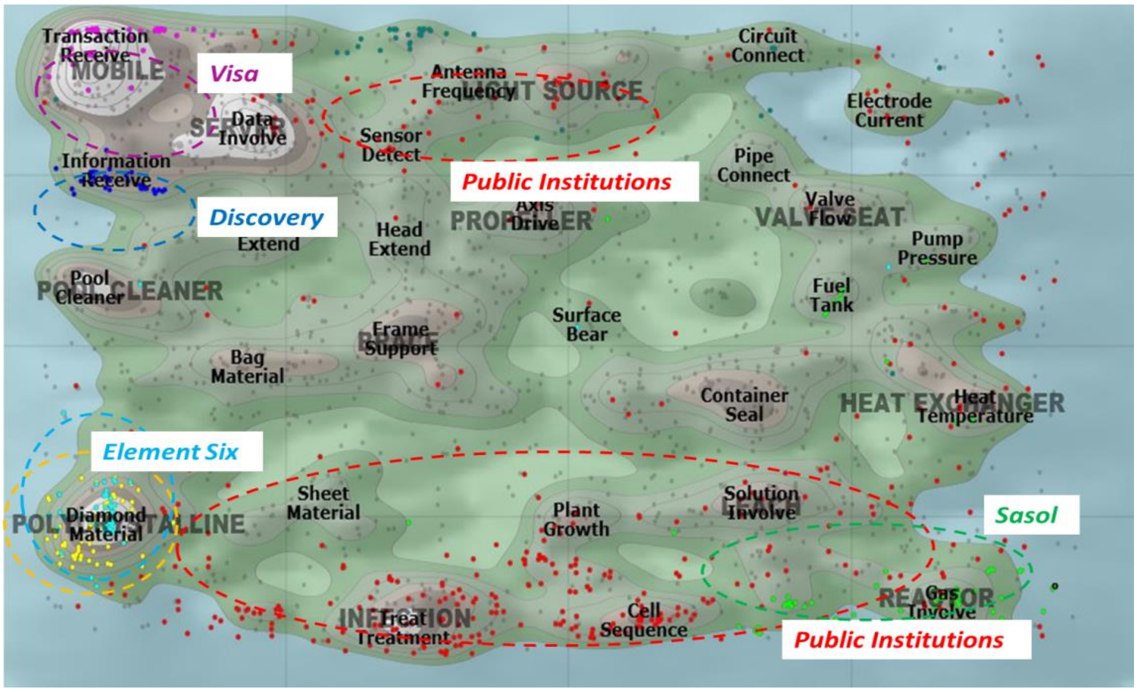


Figure 7.19: ThemeScape® Map of PCT patent applications in the period 2006 - 2015 (South African Inventor) [Source: Author generated from Thomson Innovation patent database analytics, 2016]

The patent filing rate by publicly financed institutions over the period 2006-2015 shows a general increase, as shown in **Figure 7.20.** In the period 2006-2015, 536 and 455 applications, respectively, were filed with South African inventor address and South African Priority. Whereas the general trend is a decline in PCT patent filings, the reverse is true for publicly financed institutions, which appear to have increased their patent filings over the period 2006-2015, almost doubling their pace of patenting over the 10-year period. It would thus appear that the decline in PCT patent filing is rather attributed to decline in patent filing by corporates. This finding is also supported by the disappearance in 2006-2015 of some of the corporates identified as top assignees in the period 1996-2005 (**Figure 7.13** and **7.14**).

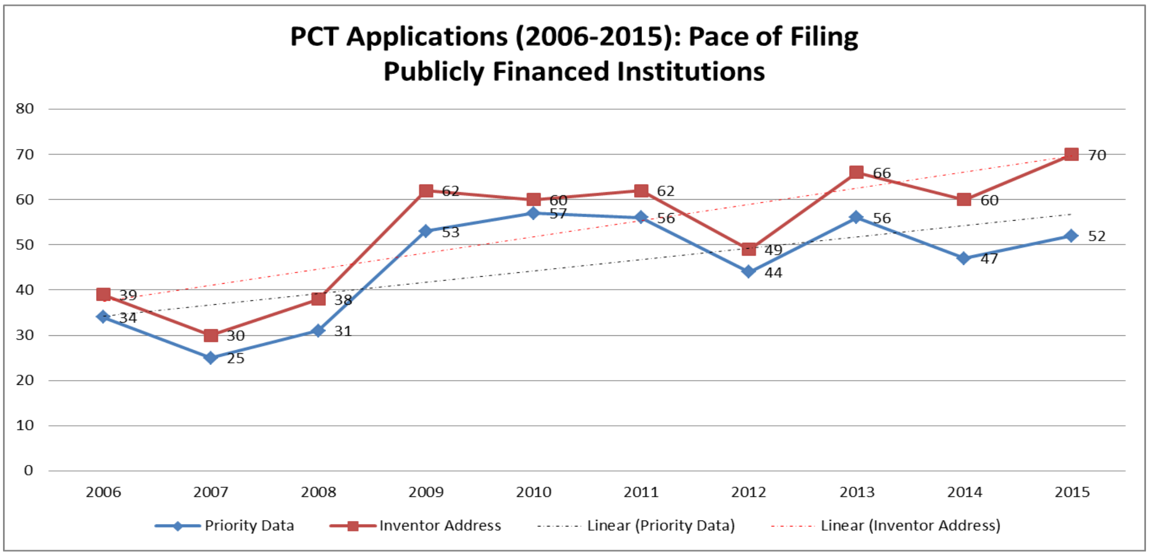


Figure 7.20: Pace of filing PCT patent applications by Publicly Financed Institutions in the period 2006 - 2015 [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

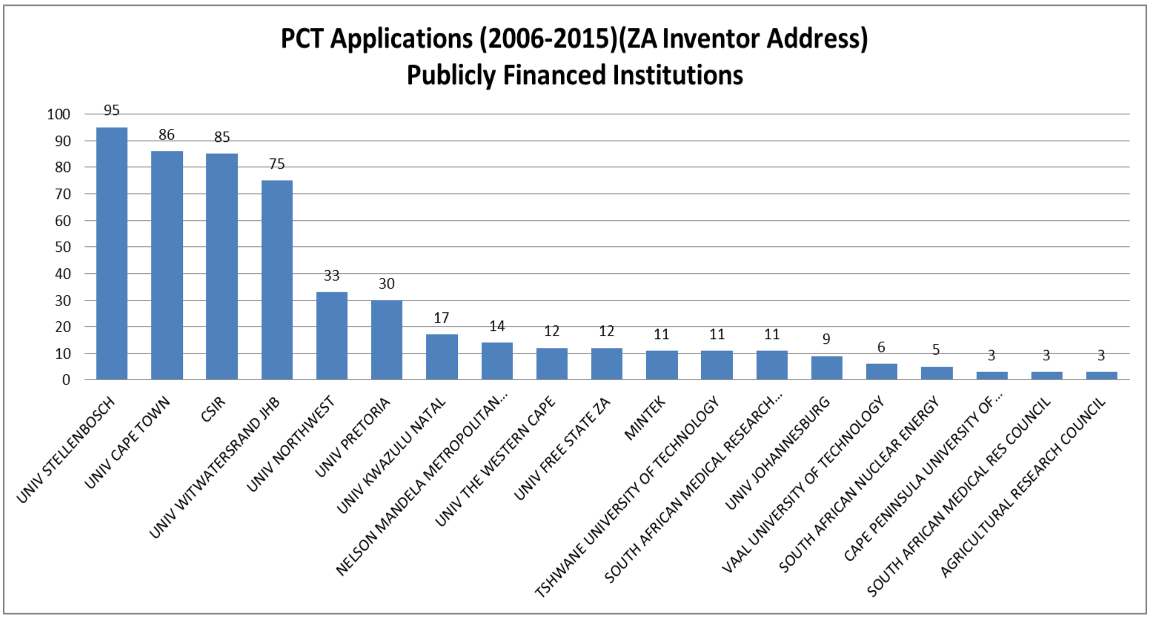


Figure 7.21: PCT patent applications in the period 2006 - 2015 (South African Inventor Address), by Top Assignee/Applicant [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

The applications filed by inventors at institutions increased over the period 2006-2015. Other than the CSIR, most of these applications originated from universities (**Figure 7.21** and **7.22**). Science Councils such as Mintek and the Medical Research Council filed, on average, one PCT application per year. At least half of South Africa's universities have filed, on average, at least one PCT application per year, with the University of Stellenbosch filing, on average, almost 10 PCT applications per year.

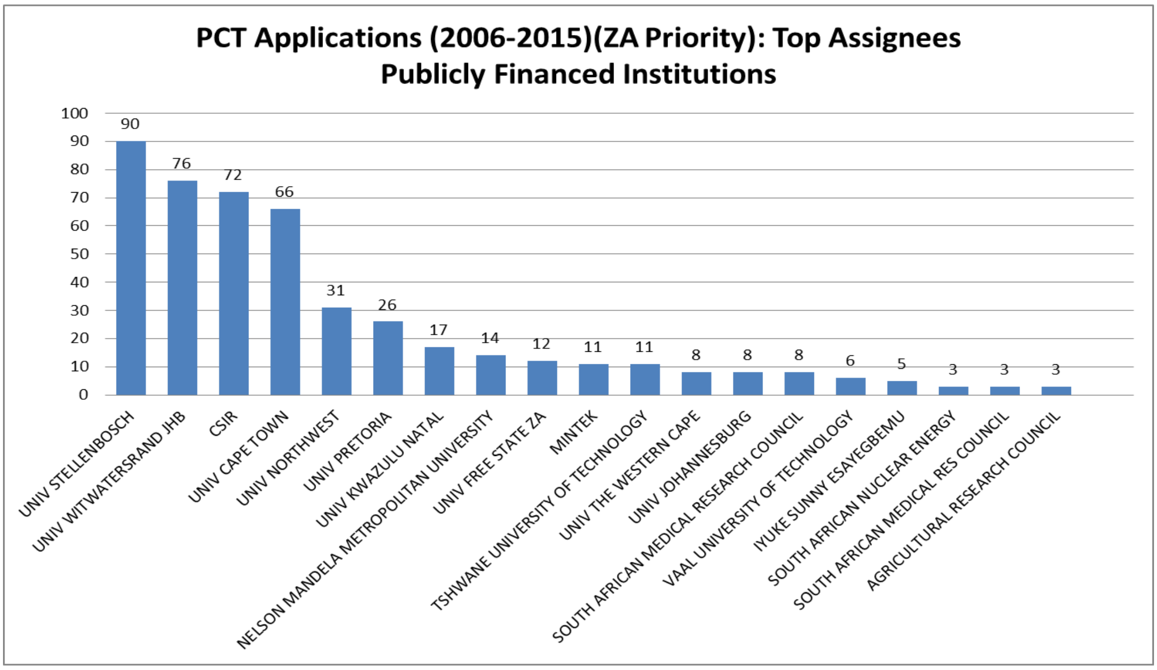


Figure 7.22: PCT patent applications in the period 2006 - 2015 (South African Priority), by Top Assignee/Applicant [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

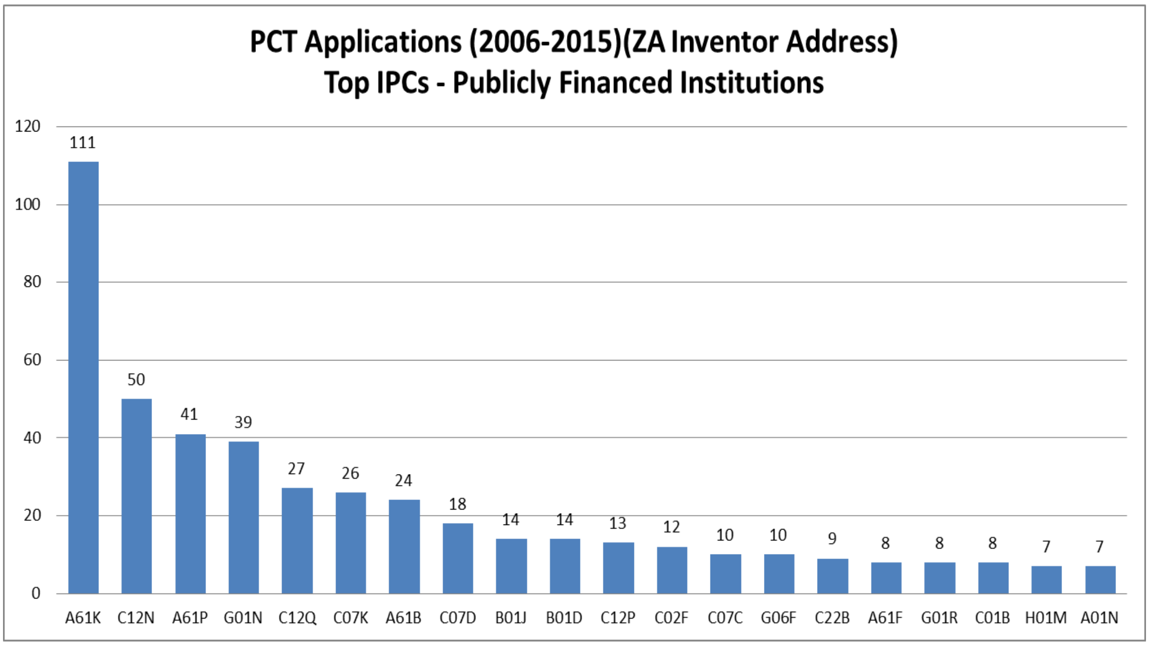


Figure 7.23: PCT patent applications by Publicly Financed Institutions in the period 2006 - 2015 (South African Inventor), by Top 20 IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

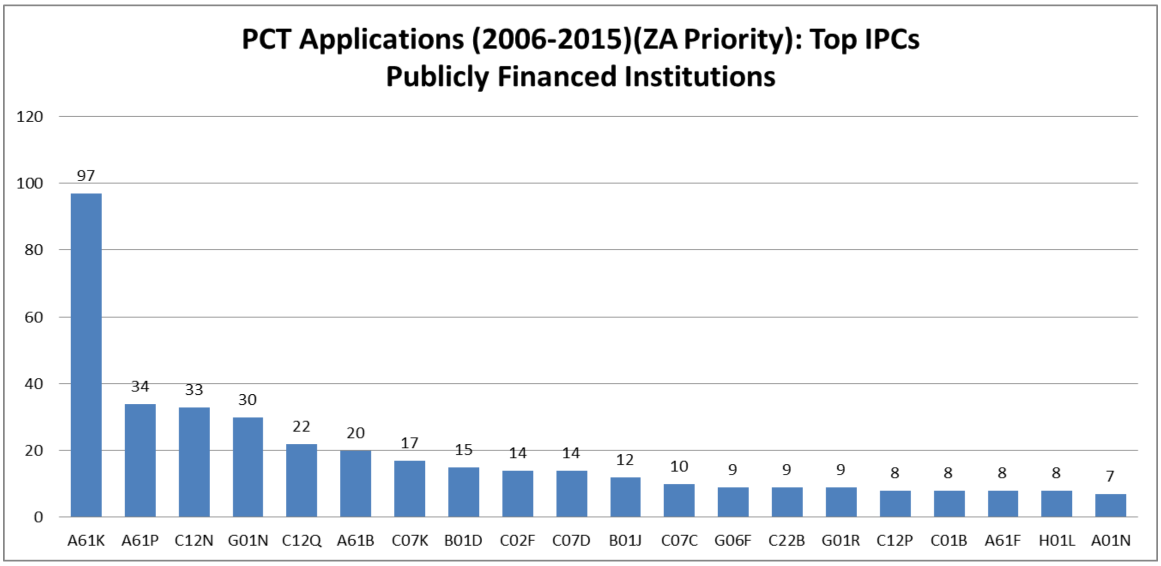


Figure 7.24: PCT patent applications by Publicly Financed Institutions in the period 2006 - 2015 (South African Priority), by Top 20 IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

The technology fields in which the publicly financed institutions filed PCT applications in the period 2006-2015, are summarised in **Figures 7.23** and **7.24** and demonstrate a general decline. Most of the patents relate to biopharmaceutical/health related inventions, as can be seen by the ThemeScape analysis provided in **Figure 7.25**.

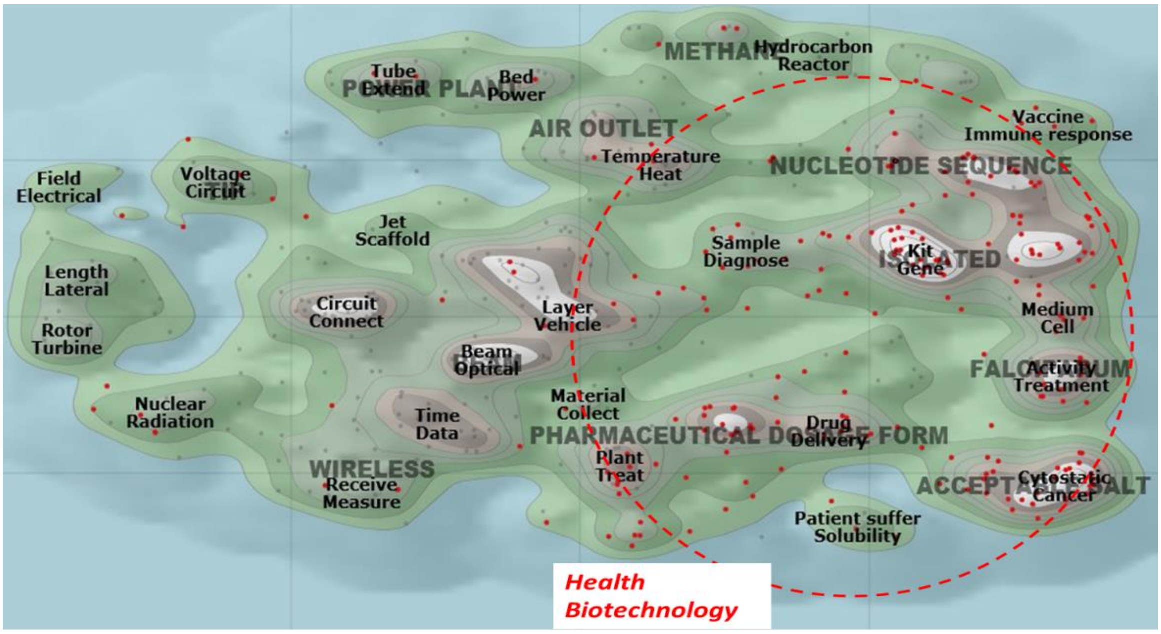


Figure 7.25: ThemeScape® Map of PCT patent applications in the period 2006 - 2015 (South African Inventor), for Publicly Financed Institutions [Source: Author generated from Thomson Innovation patent database analytics, 2016]

From an analysis of **Figure 7.25**, it would appear that there are opportunities for publicly financed institutions, in particular, for the universities and the CSIR, to support industry development based on the technology fields in which their PCT applications are filed. For example, an analysis of **Figures 7.23 to 7.25** suggests that the universities and the CSIR (**Figure 7.26**) could be the basis of patent portfolio for emerging high growth companies, in medical devices (based on patents in imaging) and health biotechnology/pharmaceuticals (based on patents in sequencing and treatment).

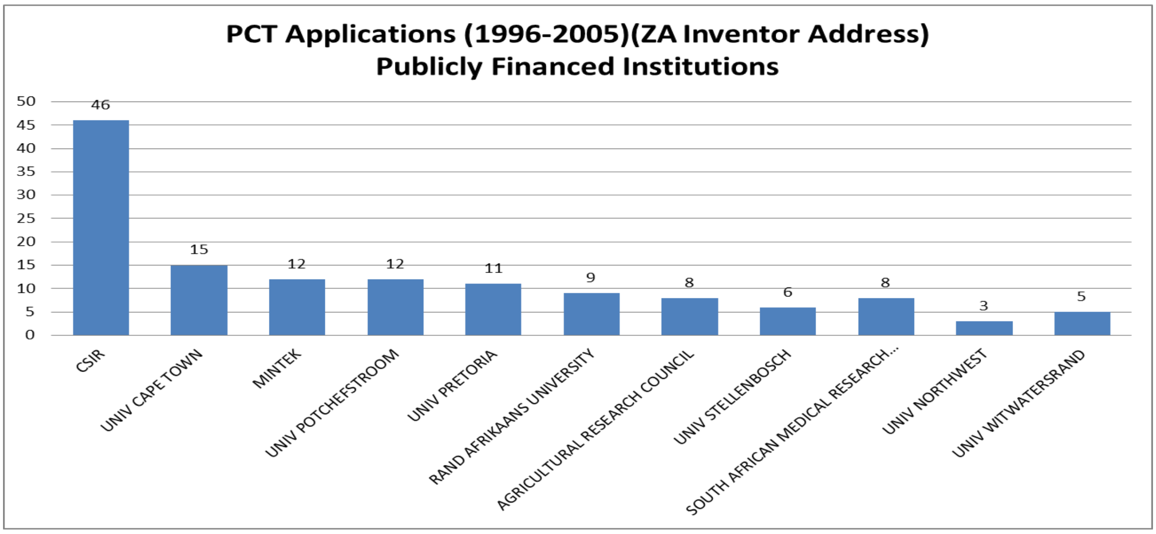


Figure 7.26: PCT patent applications in the period 1996 - 2005 (South African Inventor Address), by Top Assignee/Applicant [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

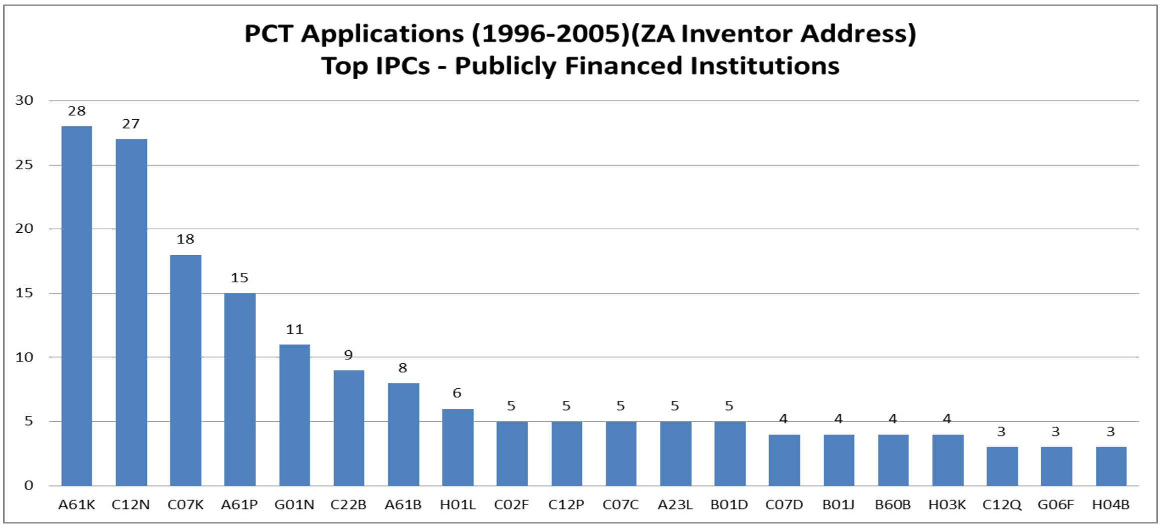


Figure 7.27: PCT patent applications by Publicly Financed Institutions in the period 1996 - 2005 (South African Inventor), by Top 20 IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

The top IPCs filed by the institutions in the period 1996-2005 are shown in **Figure 7.27**. When comparing the IPCs in respect of 1996-2005 and 2006-2015, it would appear that there are essentially similar. However, the distribution of patent applications amongst the different IPCs is different, with more patents being distributed in at least the top 10 IPCs than is the case for 1996-2005, where the number is low. This is consistent with findings by Sibanda (2007:30) that:

> *"A review of Schedule IV using the IPC codes for Biotechnology provided in Schedule IX, shows that at least 18 of the patent applications emanating from South African universities from January 1991 to September 2005, (i.e. 27% of the 67 applications), fall within the classification of Biotechnology. From this analysis, it can be concluded that there is potential for developing a strong Biotechnology sector in South Africa, using existing expertise at the Universities of Cape Town, Stellenbosch and Witwatersrand, where the 18 applications originated. Furthermore, the analysis of the South African patent landscape reveals that a small number of patent applications are filed originating from South Africa in the area of Biotechnology (A61K, C07C). Thus, there is potential to support commercialisation of associated technologies by boosting the patent applications in this area."*

7.4 USPTO GRANTED PATENTS

A similar approach was followed in understanding the patenting by South Africans in the USPTO, based on both a South African priority filing as well as an Inventor South African address. A detailed analysis of USPTO patents associated with South Africa is documented in this section. **Figure 7.28** shows the distribution of the USPTO granted patents over this period, based on patent applications filed in the period 1996-2015.

The number would be different to an analysis of patents granted in the same period, irrespective of the filing date; these are essentially the official statistics given annually by the patent offices, which would be similar to the distribution shown in **Figure 7.29**.

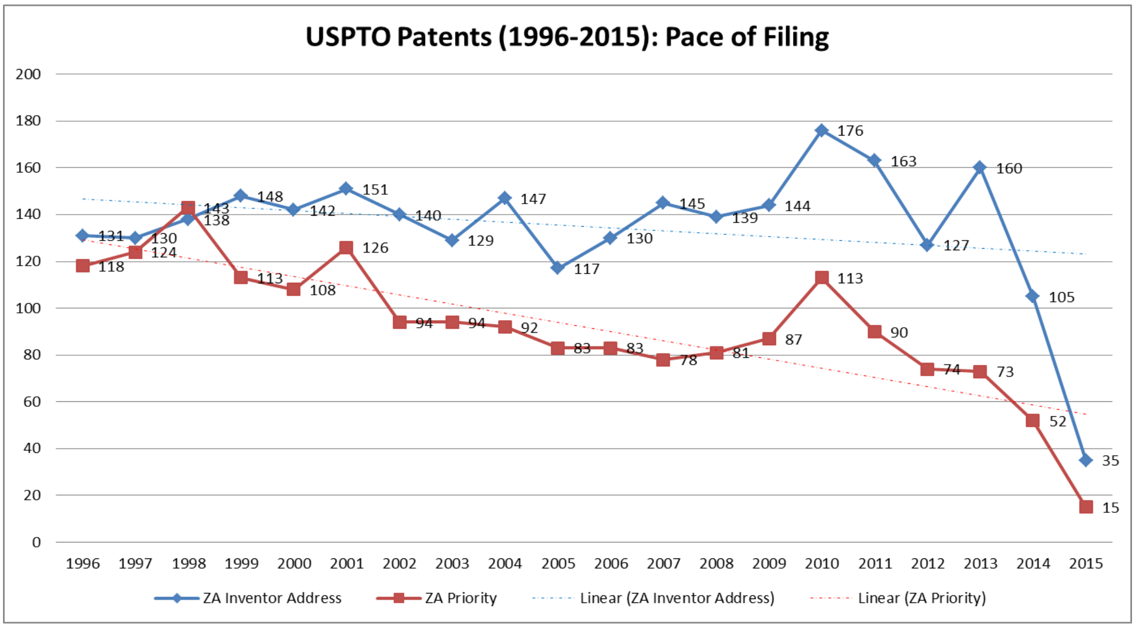


Figure 7.28: US Granted patents based on patent applications filed in the USPTO in the period 1996 – 2015 [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

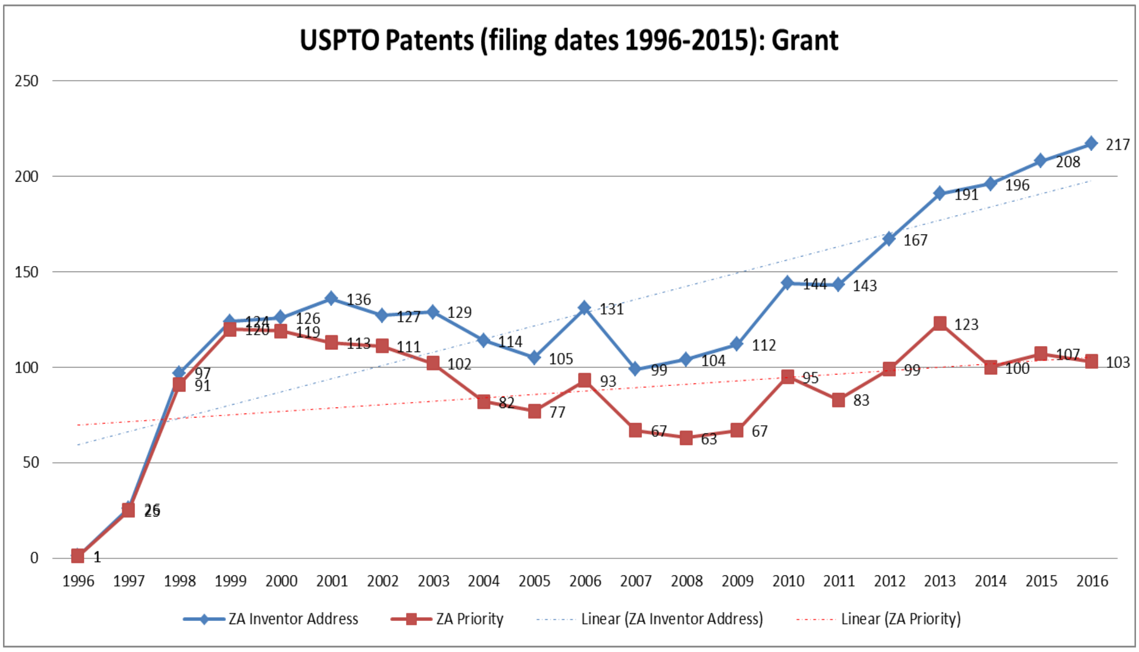


Figure 7.29: US Granted patents based on patent applications filed in the USPTO in the period 1996 - 2015 (with South African priority) [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

A total number of 2 697 and 1 841 US patents were granted based on inventor address and South African priority, respectively. In the period 1996-2005, 1 373 and 1 095 patents were granted from applications filed in the same period, with South African Inventor address and South African Priority, respectively. Comparatively, fewer patents were granted in the period 2006-2015, being 1 324 (with Inventor address) and 746 (South African priority). This could perhaps be attributed to the fact that patent applications filed in the later part of the period 2006-2015, may not yet have proceeded to grant, or that they could still be under prosecution and not yet have proceeded to grant. For example, an application will become published 18 months from the earliest priority, and as such, applications filed in 2015 and possibly even in the later part of 2014, may not have become publishable and could still be under examination. Moreover, the difference between the patents granted in the two periods is too large for this to account for the lower numbers in total and, as such, it is submitted that the pace of patenting has declined over the 20-year period.

Figures 7.30 and **7.31** show the top assignees in respect of the granted patents for the period 1996-2015, for inventor address and priority applications.

The inventor address assignees list comprises at least 30% institutions, headed by the CSIR (57), the University of Cape Town (36), Stellenbosch University (18), the University of the Witwatersrand (16), NorthWest University (15), and the Technology Finance Cooperation (13).

Other than the few individual inventors mostly linked to corporates in the top 20 assignees list, the leading private sector assignees include Sasol (135), Amazon Tech (89), Spinal Motion (29), Azoteq (28), Element Six (25), Detnet South Africa (19), Joy MM Delaware (14), Cork Group Trading (14), Baker Hughes Inc (13) and IBM (12).

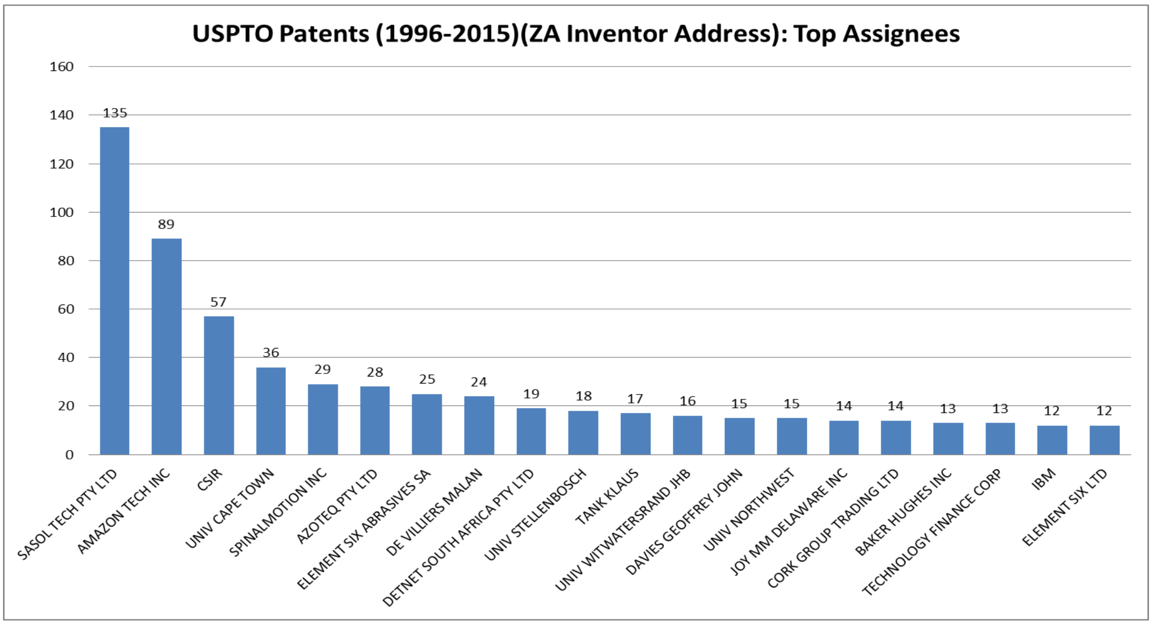


Figure 7.30: US Granted patents based on applications filed at the USPTO in the period 1996 - 2015 (Inventor address), by Top Assignee/Applicant [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

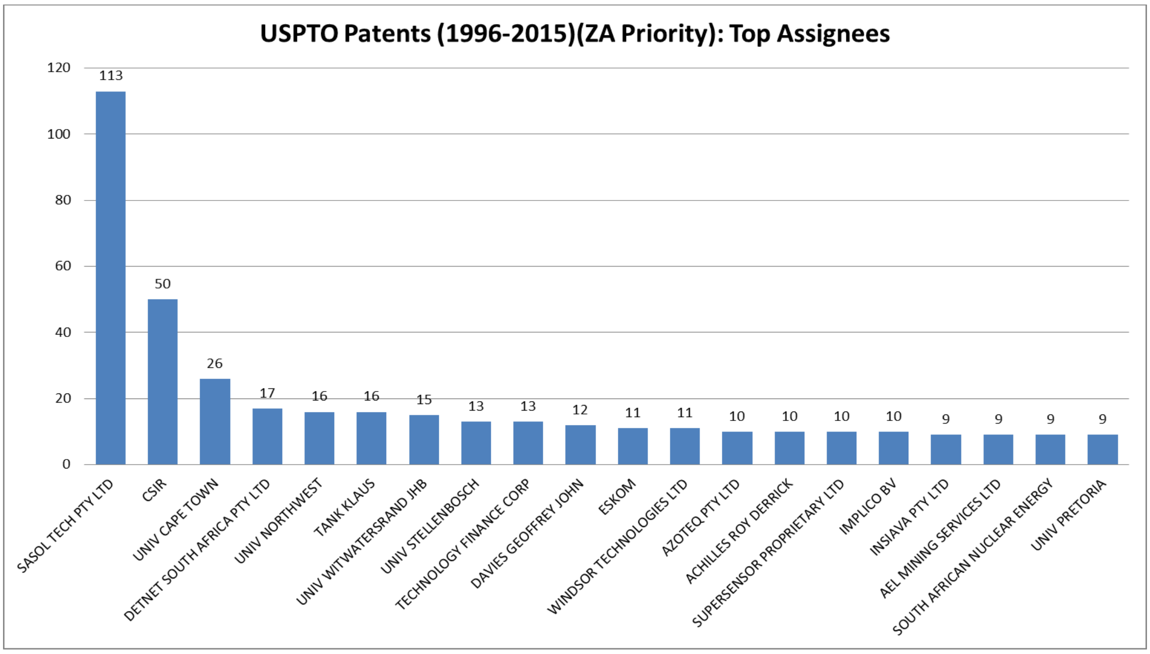


Figure 7.31: US Granted patents based on applications filed at the USPTO in the period 1996 - 2015 (South Africa Priority), by Top Assignee/Applicant [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

A comparison of the inventor address and priority assignees lists shows that the following assignees only feature in the inventor address list; their applications did not claim priority from South African application, and in fact, none of these is a South African company:

Amazon Tech, Spinal Motion, Joy MM Delaware, Cork Group Trading, Baker Hughes Inc. and IBM. In fact, all of them are USA companies, with South African inventors named in their patents. A review of **Figures 7.30** and **7.31** shows that:

(i) the top 20 assignees list (for the full 1996-2015 period) comprises at least seven publicly financed institutions or state owned enterprises (Eskom), namely, the CSIR, the University of Cape Town, the University of Stellenbosch, the University of the Witwatersrand, NorthWest University, the University of Pretoria, and the South African Nuclear Energy Corporation, and three spin-outs from publicly financed institutions, namely, the Technology Finance Corporation, Implico BV, and INSIAVA (University of Pretoria spinout);

(ii) Sasol and the CSIR retain their leading positions;

(iii) whereas Element Six features in the inventor address assignees lists, it does not feature in the top 20 assignees list of patents granted based on South African priority, however, some of its inventors such as Geoffrey Davies, Klaus Tank, Roy Achilles, do feature prominently in the priority assignees lists;

(iv) the numbers of patents granted to assignees appearing on both top 20 assignees lists are lower in the case of priority-based patents, indicating that some of the patents did not claim priority from a South African application.

A review of the top 20 assignees lists for the period 1996-2005 shows the following:

(i) the University of Pretoria had the highest number of patents filed by any university, with 6 patents (ZA Inventor Address patents, **Figure 7.32**), in this period;

(ii) Sasol Tech and the CSIR feature prominently in first and second positions;

(iii) state owned enterprises that feature include Eskom and Denel;

(iv) the following spin-outs of the CSIR, the Technology Finance Corporation and Implico BV are in the list of top 20 assignees;

(v) Element Six identified in the list of top 20 assignees for the 20-year period does not feature in the 1996-2005 list;

(vi) the Water Research Commission, a research council with a mandate to fund and foster innovations in water, features in both lists.

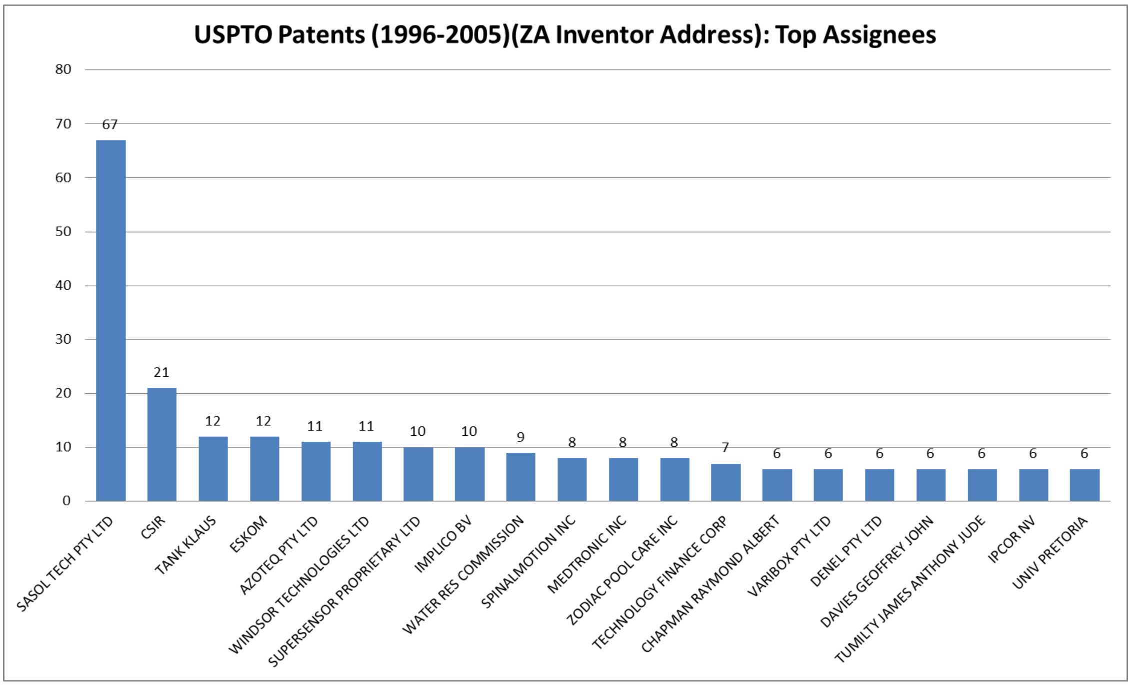


Figure 7.32: US Granted patents based on applications filed at the USPTO in the period 1996 - 2005 (Inventor Address), by Top Assignee/Applicant [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

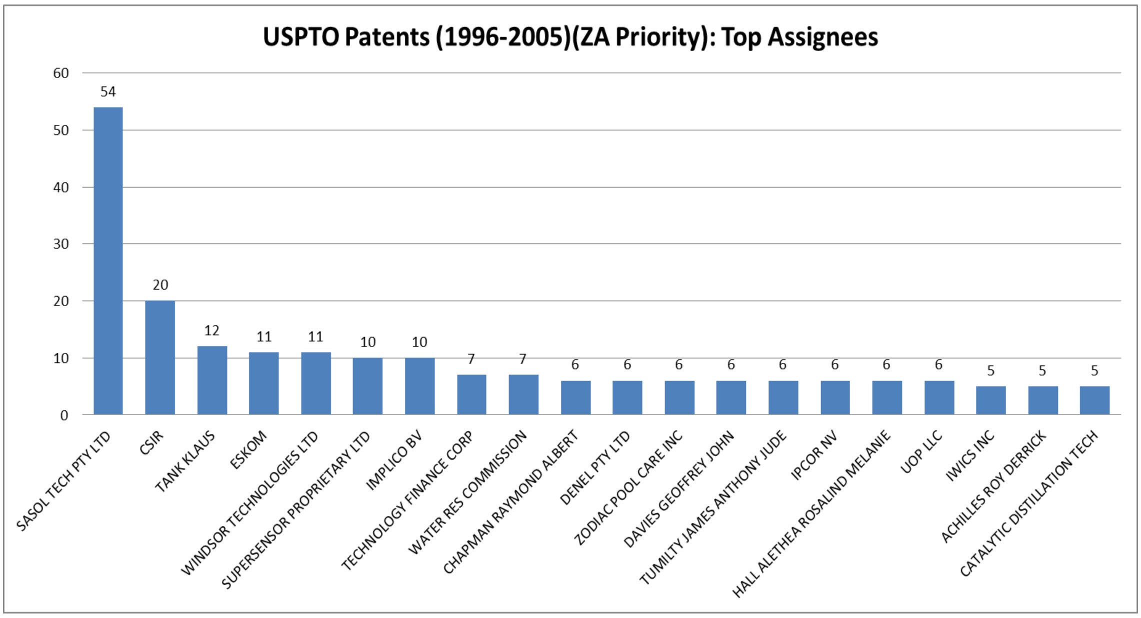


Figure 7.33: US Granted patents based on applications filed at the USPTO in the period 1996 - 2005 (with South African priority filing), by Top Assignee/Applicant [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

Figures 7.32 and 7.33, show the top assignees for the period 1996-2005. Similarly, to the PCT applications, in the period 1996-2005, there is only one institution (the University of Pretoria) amongst the top assignees. Of interest are a number of state owned enterprises

(SOEs) that had patents during this period (in particular, Eskom, WRC, Denel), which show a low propensity towards patenting in the later period of 2006-2015.

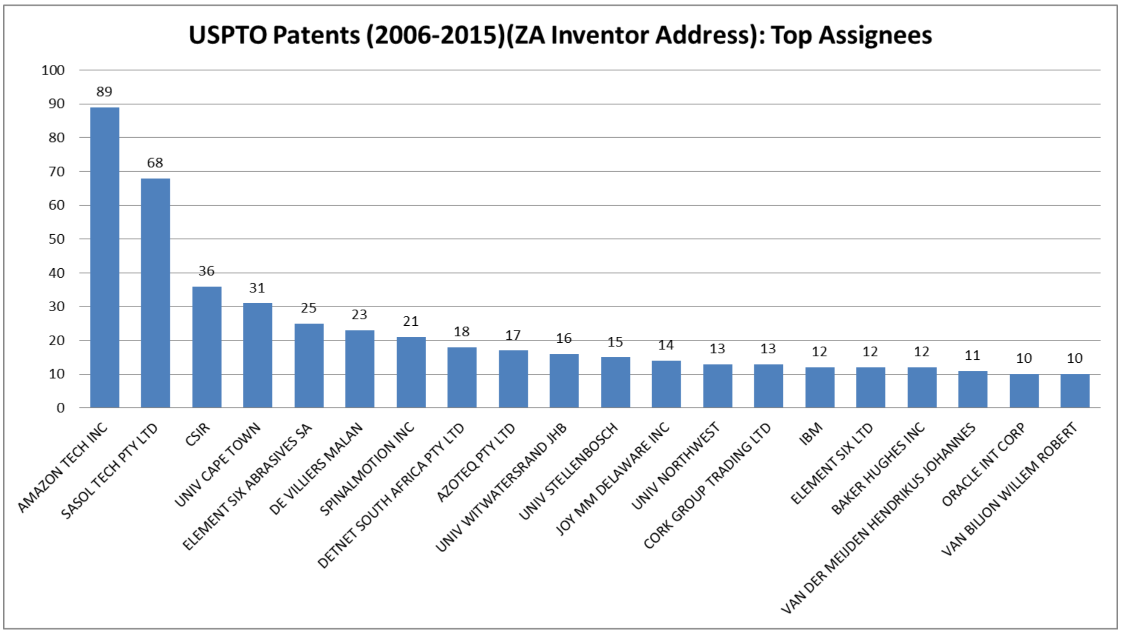


Figure 7.34: US Granted patents based on applications filed at the USPTO in the period 2006 - 2015 (Inventor Address), by Top Assignee/Applicant [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

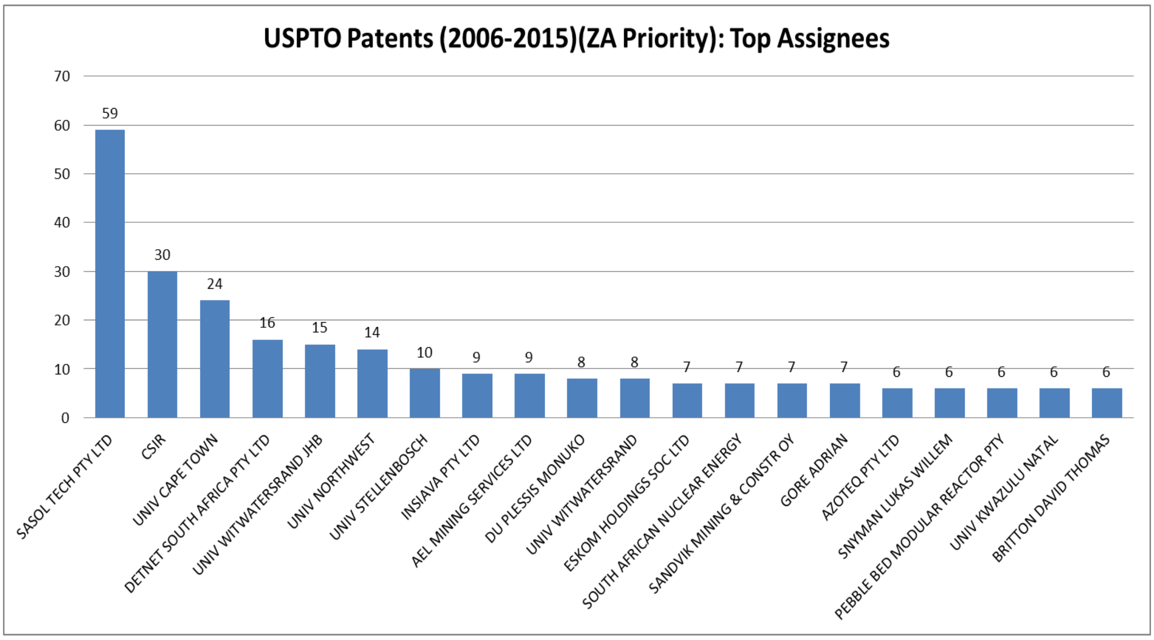


Figure 7.35: US Granted patents based on applications filed at the USPTO in the period 2006 - 2015 (South African priority filing), by Top Assignee/Applicant [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

In the case of the period 2006-2015, what is evident from **Figures 7.34** and **7.35**, is the following:

(i) at least five universities, namely the University of Cape Town, the University of the Witwatersrand, the University of Stellenbosch, NorthWest University, the University of KwaZulu-Natal, the University of Pretoria feature in the top 20 assignees lists;

(ii) Sasol Tech and the CSIR have maintained their leading patenting positions from the period before;

(iii) the US based companies identified in the list of top 20 assignees for 1996-2015, feature for the first time in the period 2006-2015;

(iv) other publicly financed institutions featuring include the Pebble Bed Modular Reactor and Eskom Holdings;

(v) whereas Element Six features in the inventors' address assignees list, it does not feature in the priority-based patents, suggesting that the US patents were either filed in the first instance without claiming priority from a South African application or they claimed priority from another foreign application;

(vi) South African companies featuring in the top 20 assignees lists include Detnet South Africa, AEL Mining, and Azoteq.

The following conclusions can be drawn from the analysis of the list of top 20 assignees:

(i) the period 2006-2015 was characterised by the growth in foreign owned companies having patents which had at least one South African inventor;

(ii) there was increase in patenting activity by publicly financed institutions;

(iii) Sasol and the CSIR remain the largest patentees;

(iv) many of the patents are in the name of inventors, presumably because of USPTO practice of filing in the first instance, patent applications in the names of the inventors; and

(v) in the energy sector, two prominent assignees included the Pebble Bed Modular reactor and South African Nuclear Energy Corporation. Whereas Denel featured among the top assignees for the period 1996-2005, it does not feature in the period 2006-2015. It is also possible that the Denel patents prior to 2006, could be part of legacy investments in defence prior to 1994.

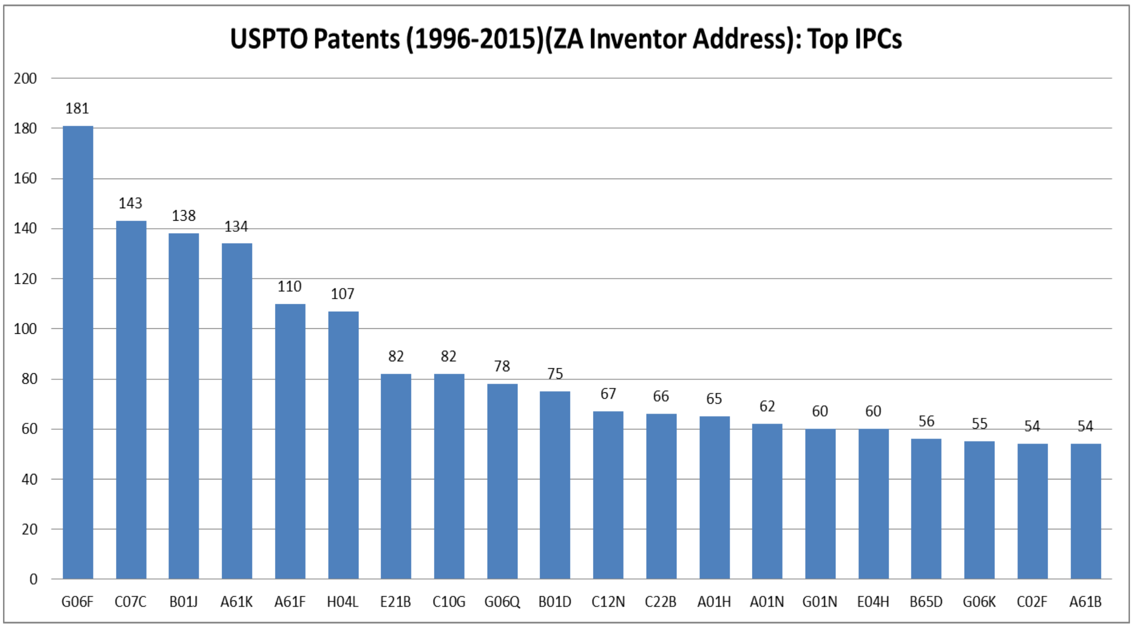


Figure 7.36: US Granted patents based on applications filed at the USPTO in the period 1996 - 2015 (Inventor Address), by Top IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

The patents were analysed to determine the top technology fields in which South Africans were patenting in the USA (see **Figures 7.36** - **7.41**).

An analysis of the 20-year period shows that, whereas G06F and G06Q (financial services) are prominent in the top 10 of the top assignees list of patents based on inventor address, they are at the bottom of the top 20 top assignees list of patents based on a South African priority (**Figures 7.36** and **7.37)**. This suggests that most of these patents would have been filed without claiming priority from a South African application. Indeed, these can be related to assignees that feature in the top inventor address list but not on the priority data list, as detailed above. Technology fields C07C, A61K, B01J, and G01N feature prominently in the top 10 list in both inventor address and priority application-based patents, for the period 1996-2015.

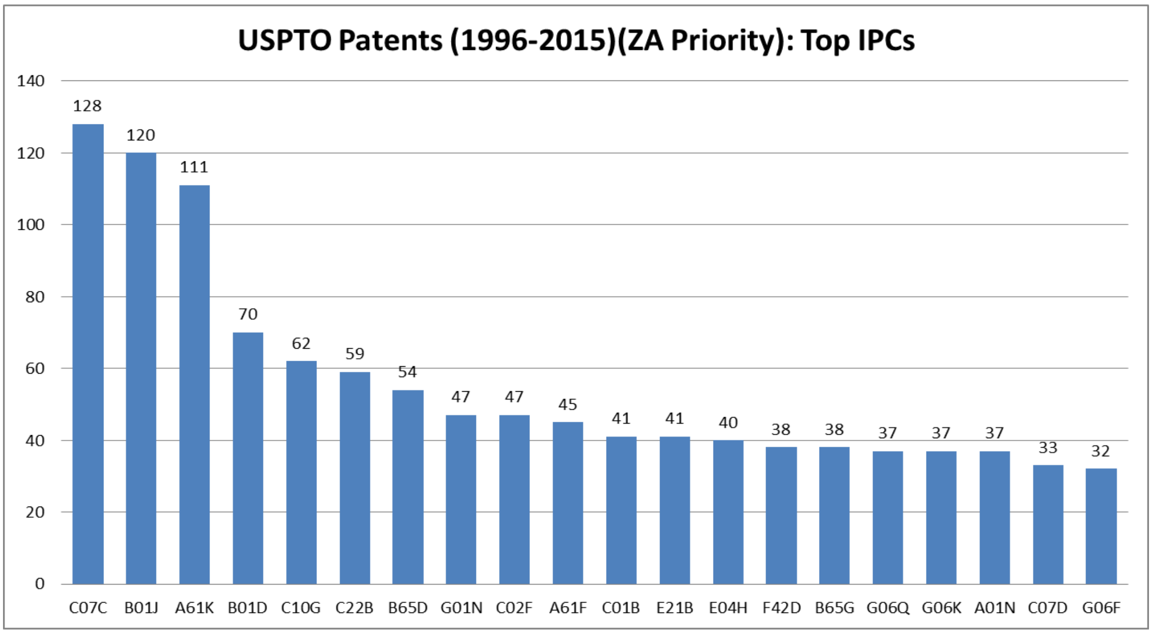


Figure 7.37: US Granted patents based on applications filed at the USPTO in the period 1996 - 2015 (with South African priority filing), by Top IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

Comparison of the top 10 assignees in respect of patents with inventor address and those from priority data shows the same IPCs, for the period 1996-2005 (**Figures 7.38** and **7.39**), namely: C07C, B01J, A61K, B01D, C10G, B65D, G01N, C22B, E04H.

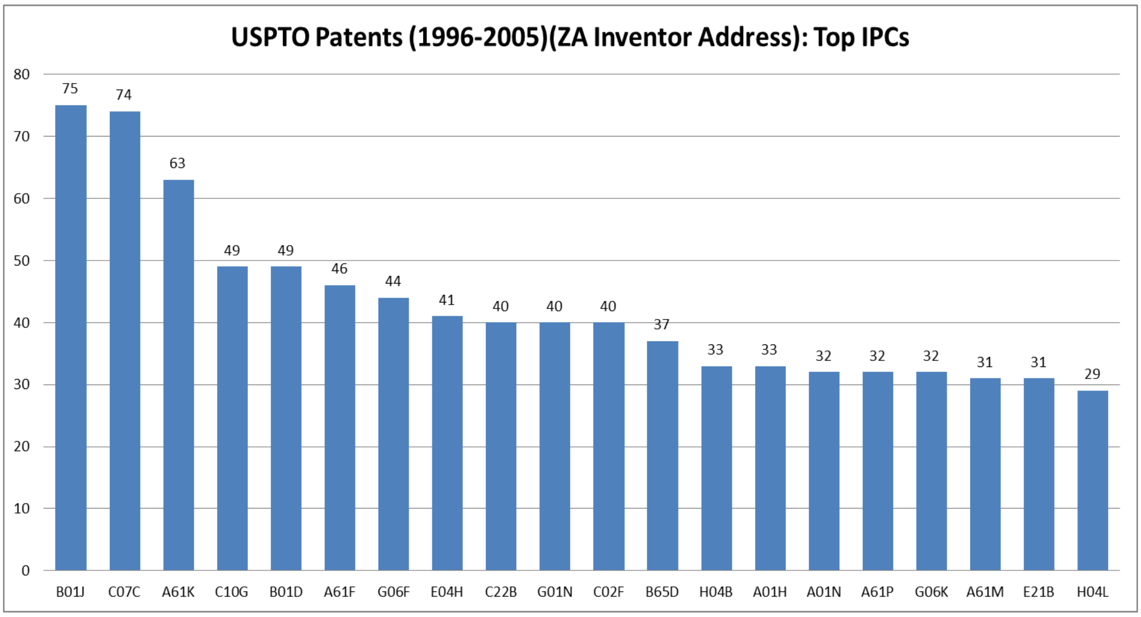


Figure 7.38: US Granted patents based on applications filed at the USPTO in the period 1996 - 2005 (Inventor Address), by Top IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

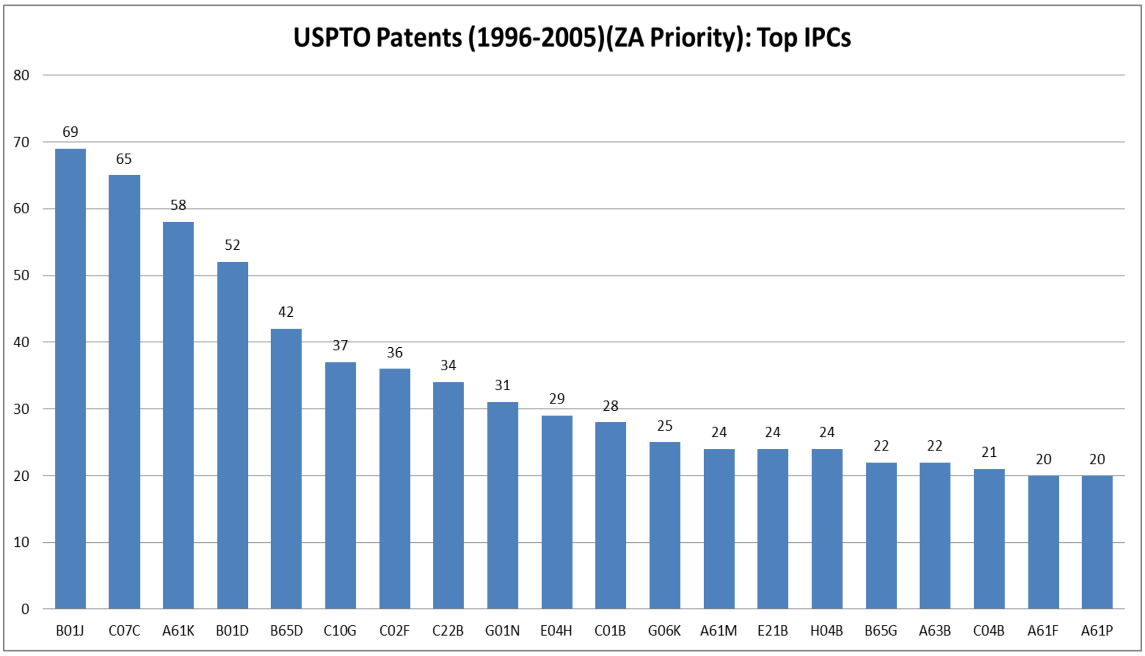


Figure 7.39: US Granted patents based on applications filed at the USPTO in the period 1996 - 2005 (South African priority), by Top IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

A review of top IPCs for the period 2006-2015, shows that the following IPCs feature in the top half of the top 20 IPCs lists of patents with inventor address and those from priority data (**Figures 7.40 and 7.41**): C07C, A61K, B01J, C10G, A61F, G06Q, C22B, and C12N.

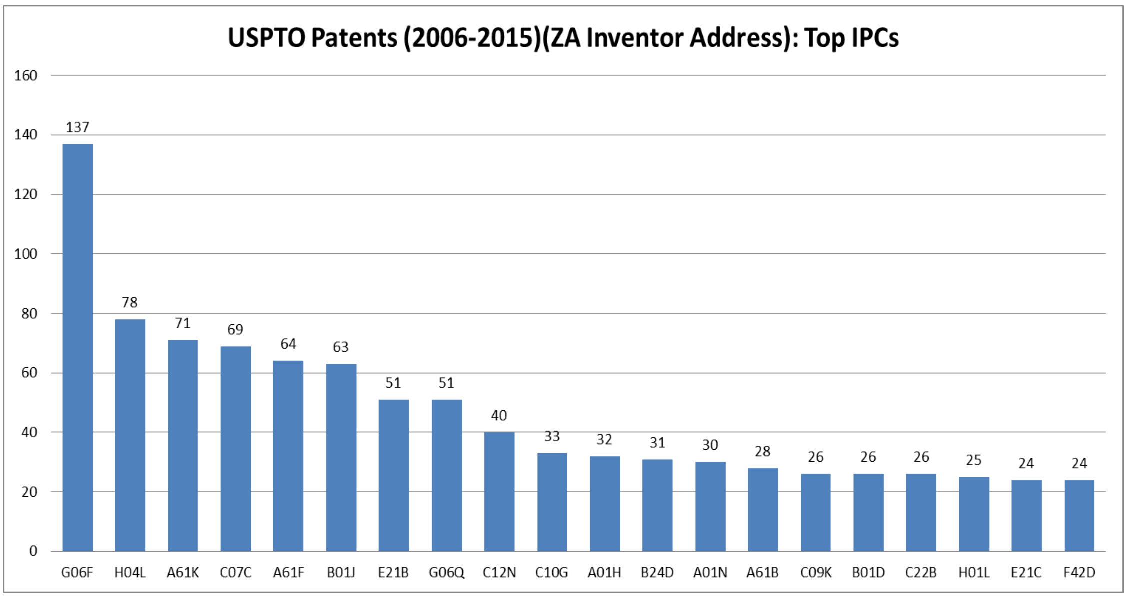


Figure 7.40: US Granted patents based on applications filed at the USPTO in the period 2006 - 2015 (Inventor Address), by Top IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

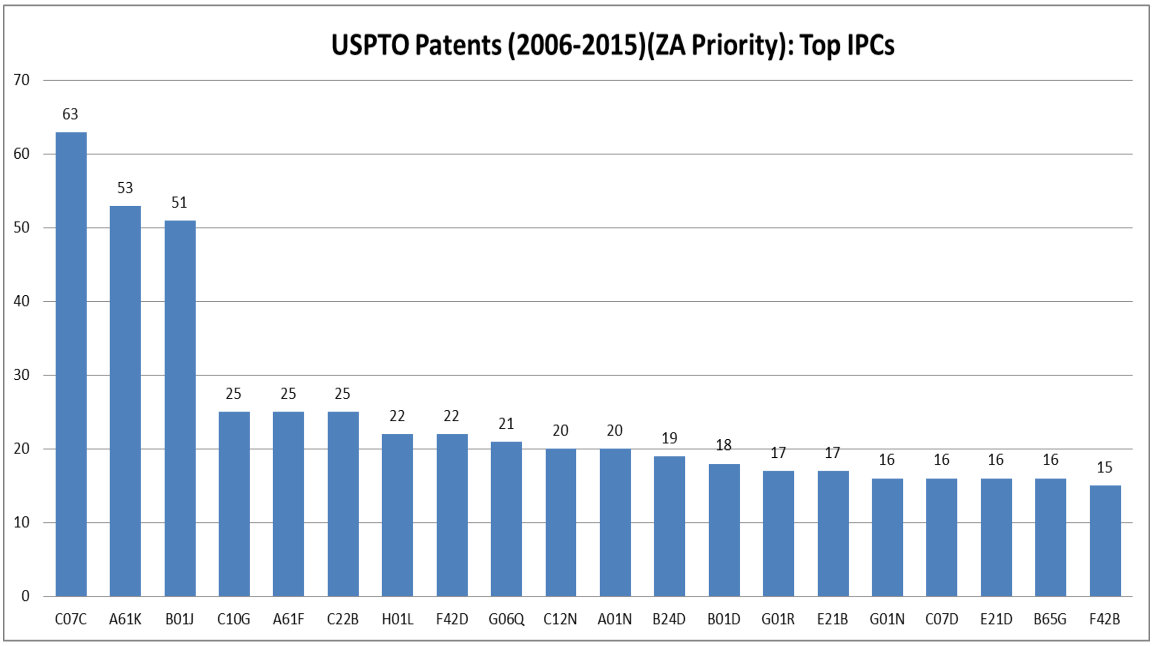


Figure 7.41: US Granted patents based on applications filed at the USPTO in the period 2006 - 2015 (South African priority), by Top IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

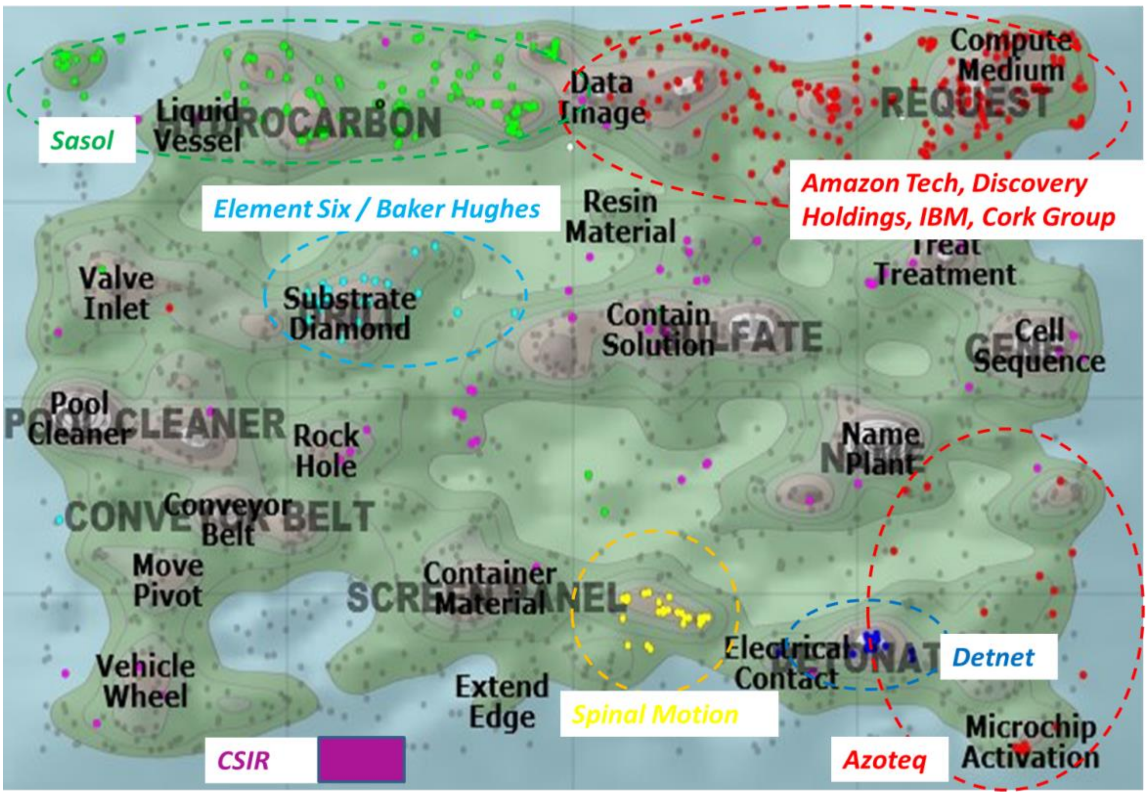


Figure 7.42: ThemeScape® Map of USPTO patents in the period 1996 - 2015 (South African Inventor) [Source: Author generated from Thomson Innovation patent database analytics, 2016]

Figures 7.42 shows a ThemeScape contour map of patents granted based on applications filed in the period 1996-2015, in which at least one of the inventors has a South African address. Clusters belonging to named corporates can be seen. The major patent clusters are in the following fields: Chemicals and Fuel (Sasol), Diamonds and Abrasives (Element Six and Baker Hughes), ICT and Services (Amazon, Discovery Holdings, IBM, Cork Group, Azoteq), and Mineral Processing and Explosive (Detnet and Spinal Motion). In the case of the CSIR, although there appears to be some concentration of patents in the areas of biotechnology, mining and mineral processing, distinct clusters are missing. The absence of specific cluster themes in respect of the CSIR patent portfolio (purple), which is a dominant Assignee, although indicative of its diverse R&D areas, also suggests little success in orchestrating multi-disciplinary and cross-sectorial R&D towards common organisational, national and global objectives.

An analysis of patents based on applications filed in the period 2006-2015 by publicly financed institutions was done, for both inventor address and priority data. **Figure 7.43** and **7.44** show the top assignee list for inventor address and priority data results, respectively. Patents granted to publicly financed institutions account for 13% and 19% of all patents originating from patent applications filed in the period 2006-2015, with South African inventor address and South African priority, respectively.

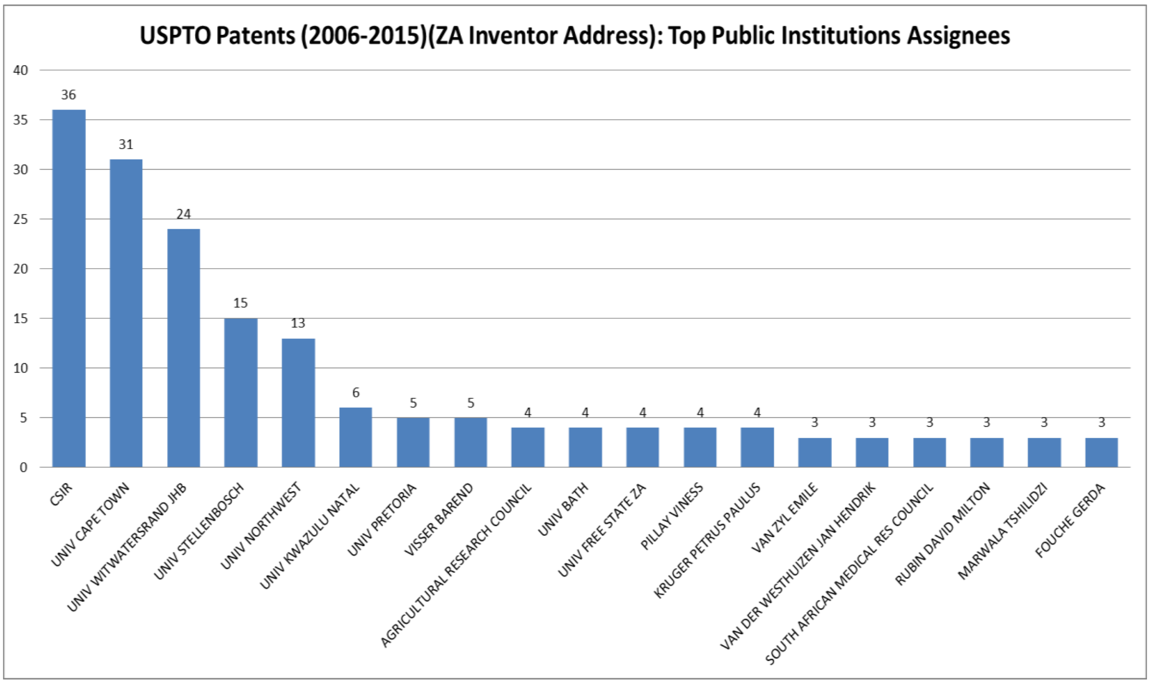


Figure 7.43: US patents to publicly financed institutions based on applications filed at the USPTO in the period 1996 - 2015 (South African inventor address), by Top 10 IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

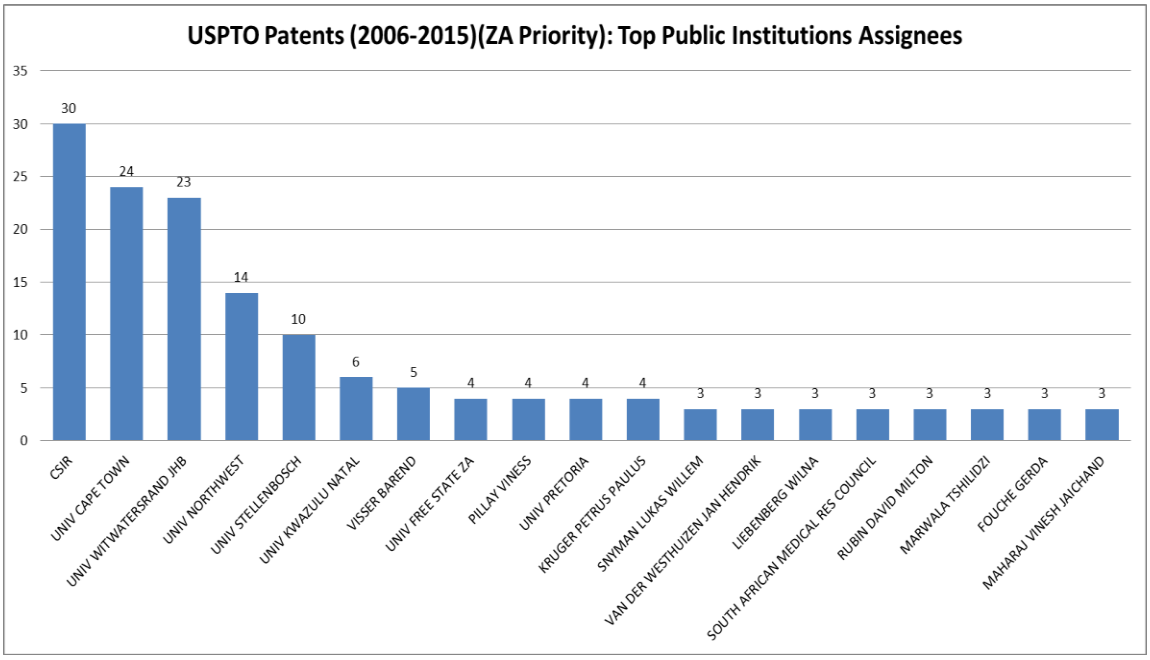


Figure 7.44: US patents to publicly financed institutions based on applications filed at the USPTO in the period 1996 - 2015 (South African priority), by Top 10 IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

It is evident that, during the period 1996-2015, the most active institutions in terms of patenting in the USPTO, based on South African priority filings, comprised two science councils, namely, the CSIR (30) and the South African Medical Research Council (3). In addition, there were seven universities, namely, the University of Cape Town (24), the University of the Witwatersrand (23), NorthWest University (14), the University of Stellenbosch (10), the University of KwaZulu-Natal (6), and the University of Pretoria (4).

In the case of inventor address based patents, the number of science councils increased to three, with the addition of the Agricultural Research Council (4).

Figure 7.45 and **7.46** show the top IPCs for inventor address and priority data results for USPTO patents granted in the period 2006-2015, respectively.

A review of **Figures 7.45** and **7.46** shows that at least 60% of the patents classified in the top half of the top 20 IPCs are in the biotechnology sector, with the second technology area, where institutions are filing patents, being the ICT sector.

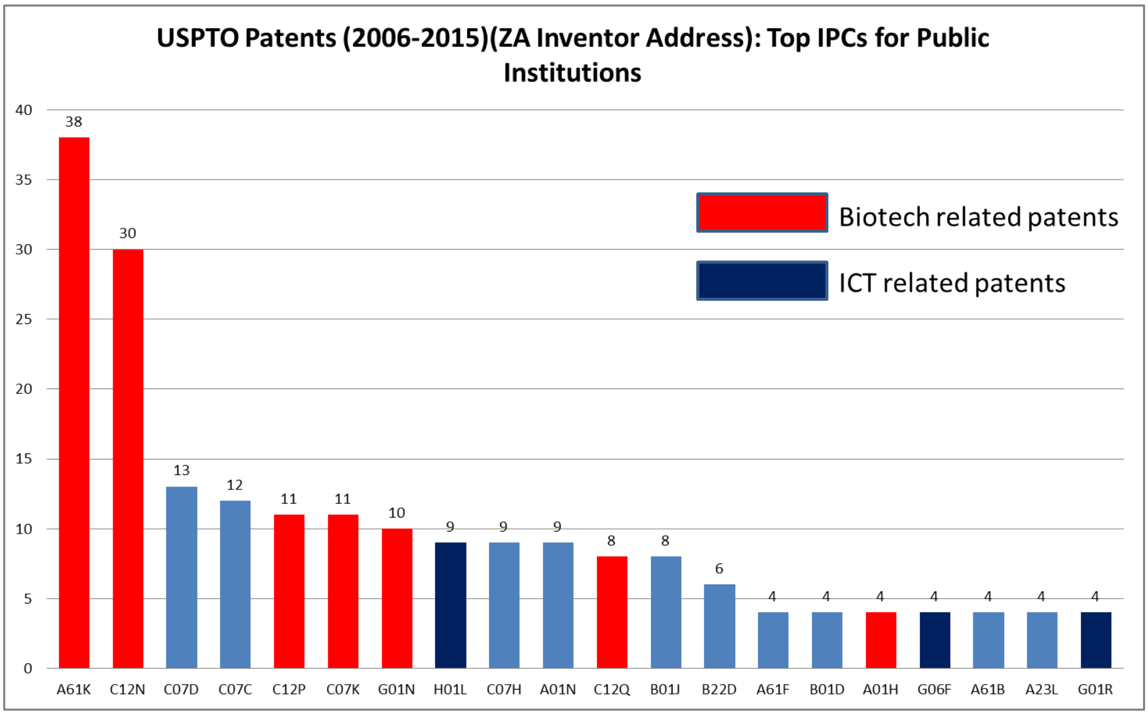


Figure 7.45: US patents to public institutions based on applications filed at the USPTO in the period 2006 - 2015 (South African inventor address), by Top IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

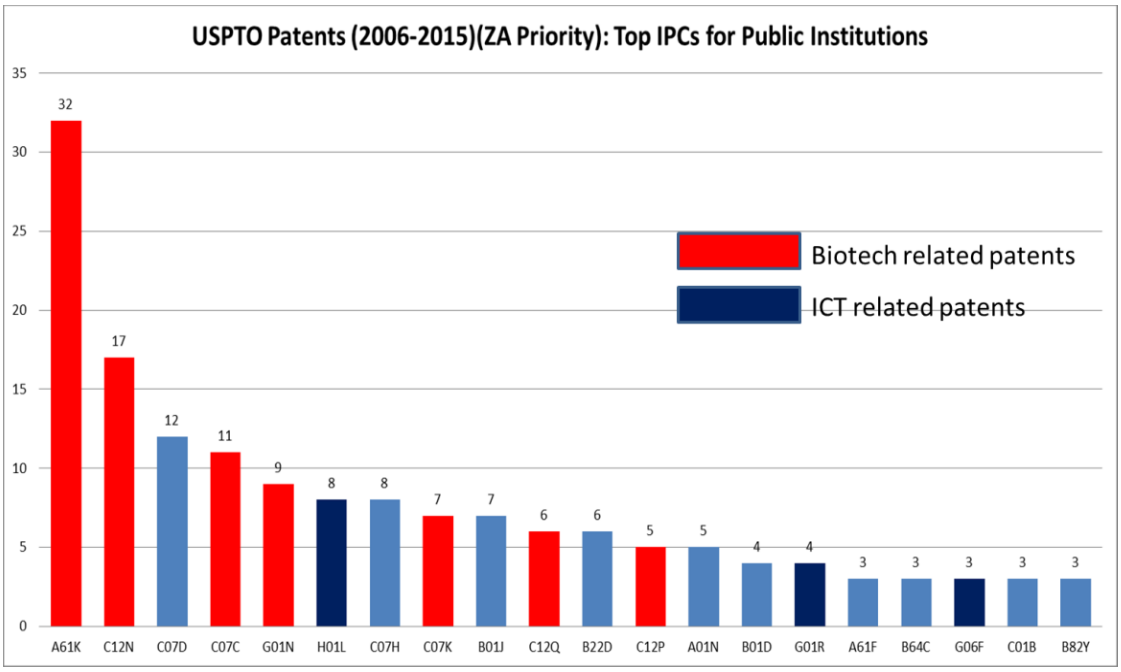


Figure 7.46: US patents to public institutions based on applications filed at the USPTO in the period 2006 - 2015 (South African priority), by Top IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

A review of the patenting by publicly financed institutions over the entire period of 1996-2015, shows growth of patenting activity over the entire period, **Figure 7.47**.

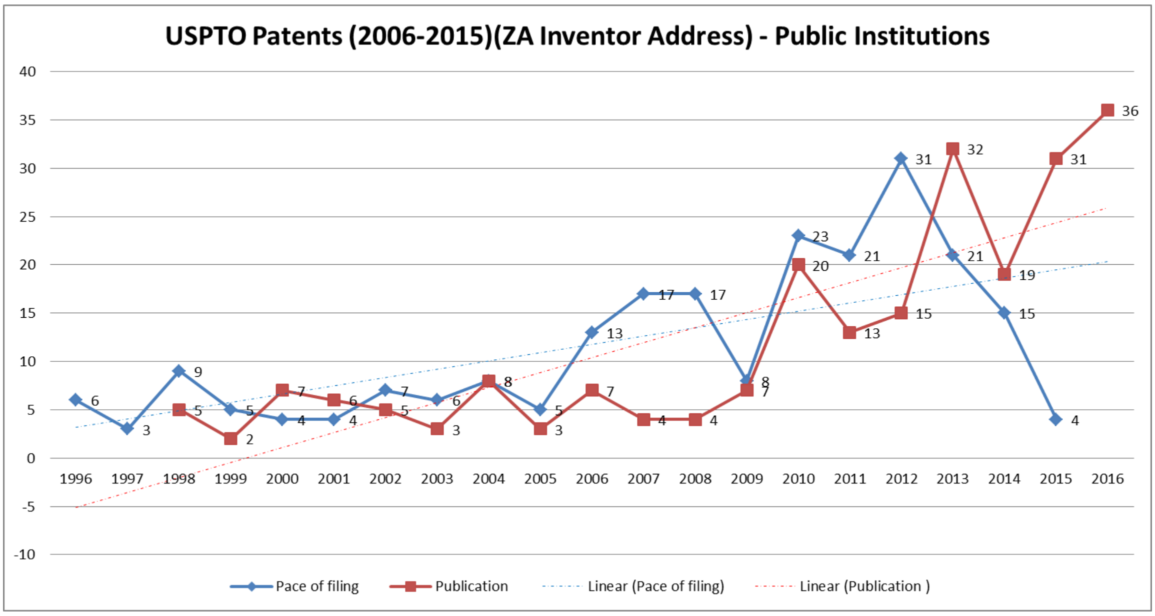


Figure 7.47: US patents to public institutions based on applications filed at the USPTO in the period 1996 - 2015 (South African Inventor Address) [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

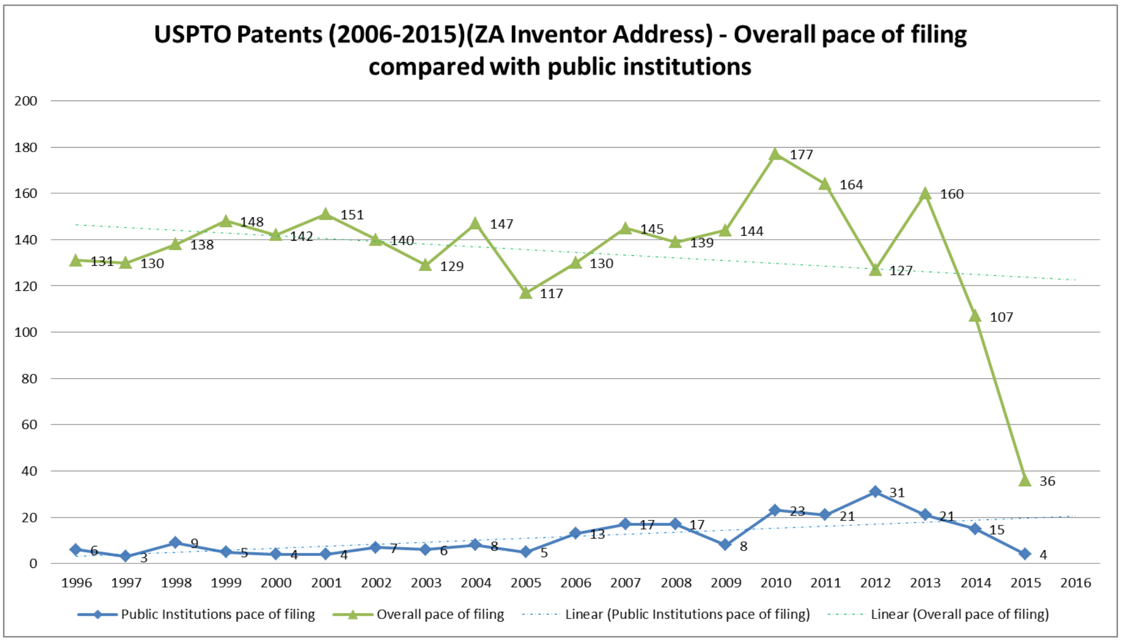


Figure 7.48: US patents based on applications filed at the USPTO in the period 1996 - 2015 (South African Inventor Address) – Pace of filing [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

In contrast, **Figure 7.48** shows that, whereas the pace of filing by publicly financed institutions at the USPTO appears to have increased, the overall pace of filing by South African inventors appears to have been on a decline.

7.5 EPO PATENTS

Analysis of patents granted to South Africans based on patent applications filed at the EPO between 1996 and 2015, revealed that there were 1 371 and 988 patents, respectively, based on South African inventor address and South African priority data. The distribution of these patents in respect of publication year and pace of filing is shown in **Figures 7.49** and **7.50**, respectively.

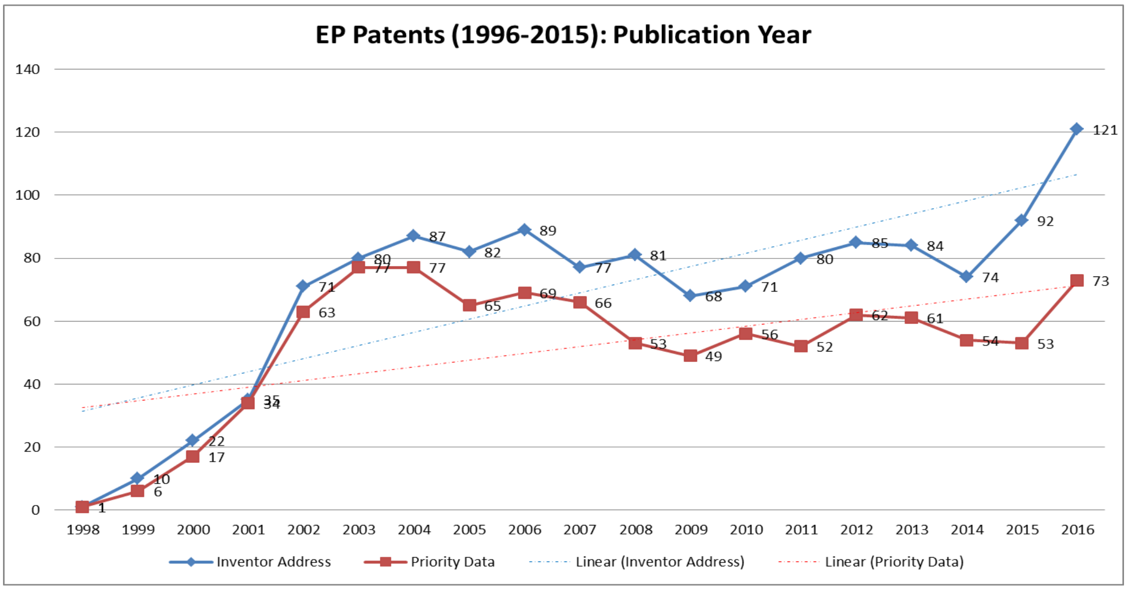


Figure 7.49: Granted patents based on patent applications filed at the EPO in the period 1996 - 2015 (by publication year) [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

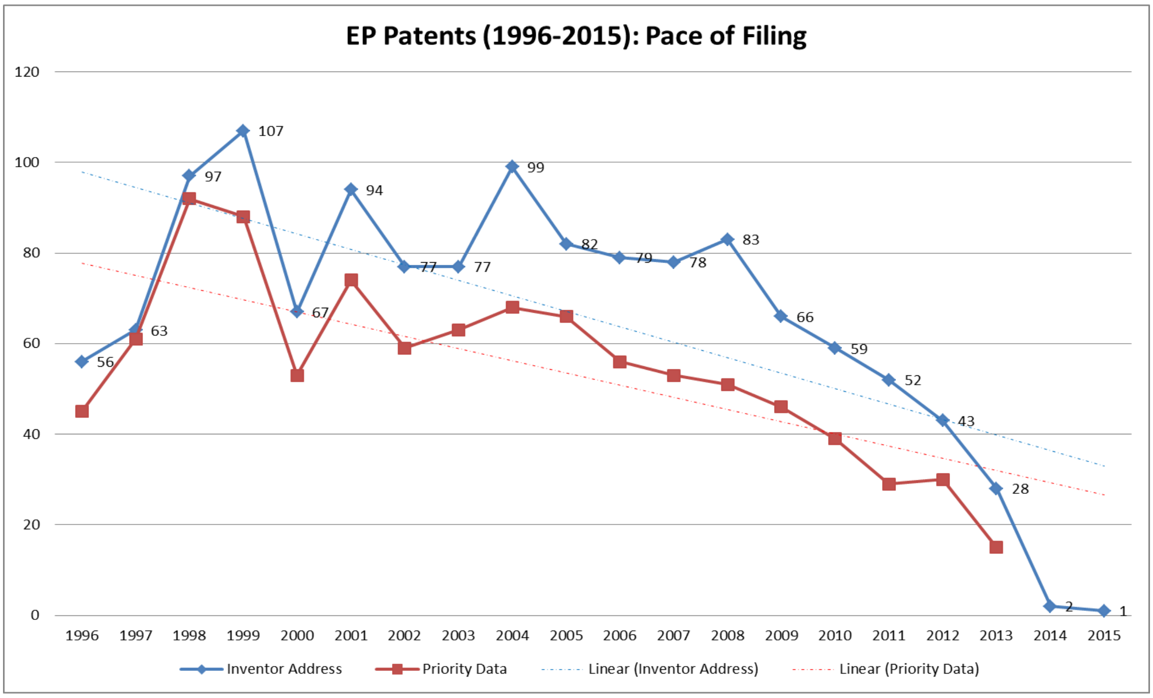


Figure 7.50: Granted patents based on patent applications filed at the EPO in the period 1996 - 2005 (by Pace of Filing) [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

Further sub-searches revealed that, in the period 1996-2005, there were a total of 819 and 669 patents on the basis of searches based on South African inventor address and priority data, respectively. For the period 2006-2015, there were 491 and 319 patents, on the basis of searches based on South African inventor address and priority data, respectively. It would appear from **Figure 7.50** that the pace of filing has been on the decline over the 20-year period, notwithstanding what appears to be an increase in the publications per year in **Figure 7.49**; such increase could be because of patents.

The top assignees during this period are shown in **Figure 7.51.** From **Figure 7.51**, it is evident that the Top 20 assignees list comprises both private and public sector organisations. Private sector assignees include Sasol, Element Six, De Beers Industrial Diamonds, AEL Mining Services, BHP Billiton, Windsor Technologies, Anglo Operations, Supersensor, Pfein Smith, and Medtronic.

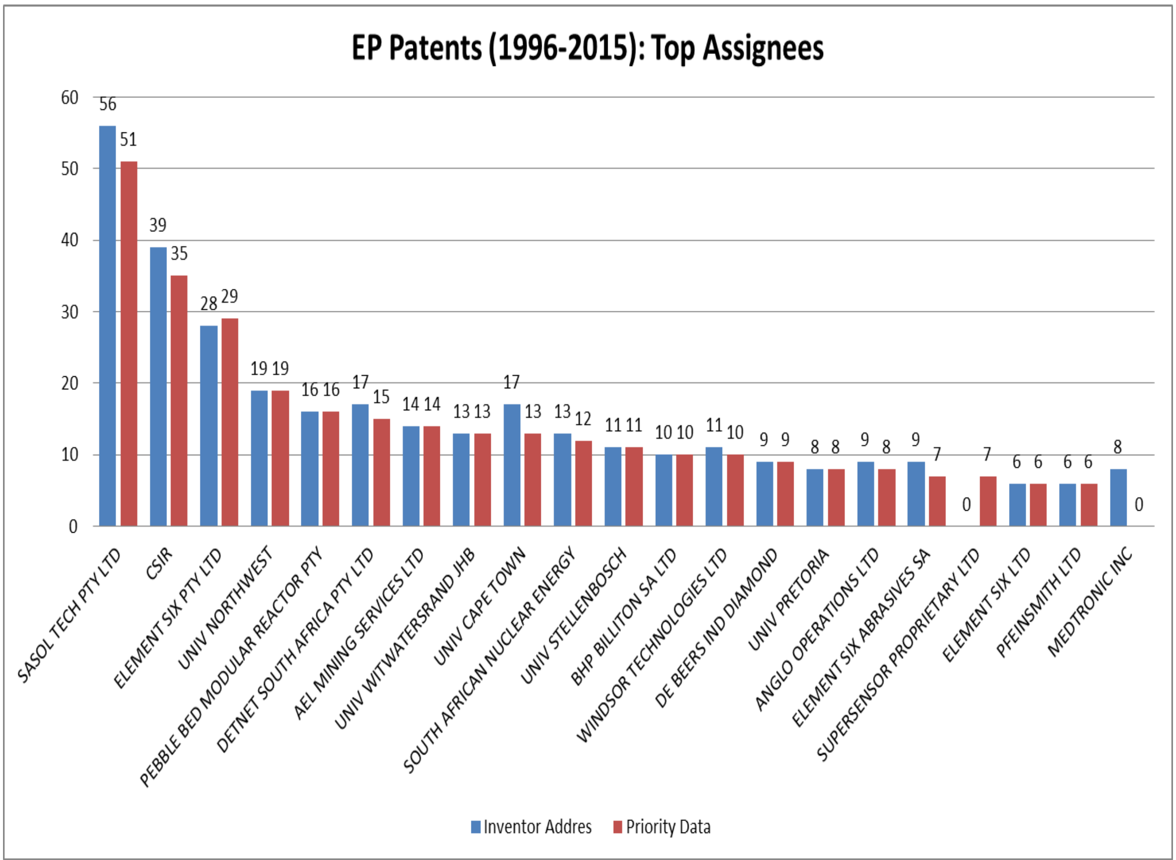


Figure 7.51: Granted patents based on patent applications filed at the EPO in the period 1996 - 2005 (by Top Assignees/Applicants) [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

Figures 7.52 and **7.53** show the top 20 assignees lists, based on inventor address and priority data, respectively, for the period 1996-2005.

Top assignees for the period 2006-2015 are shown in **Figures 7.54** and **7.55**.

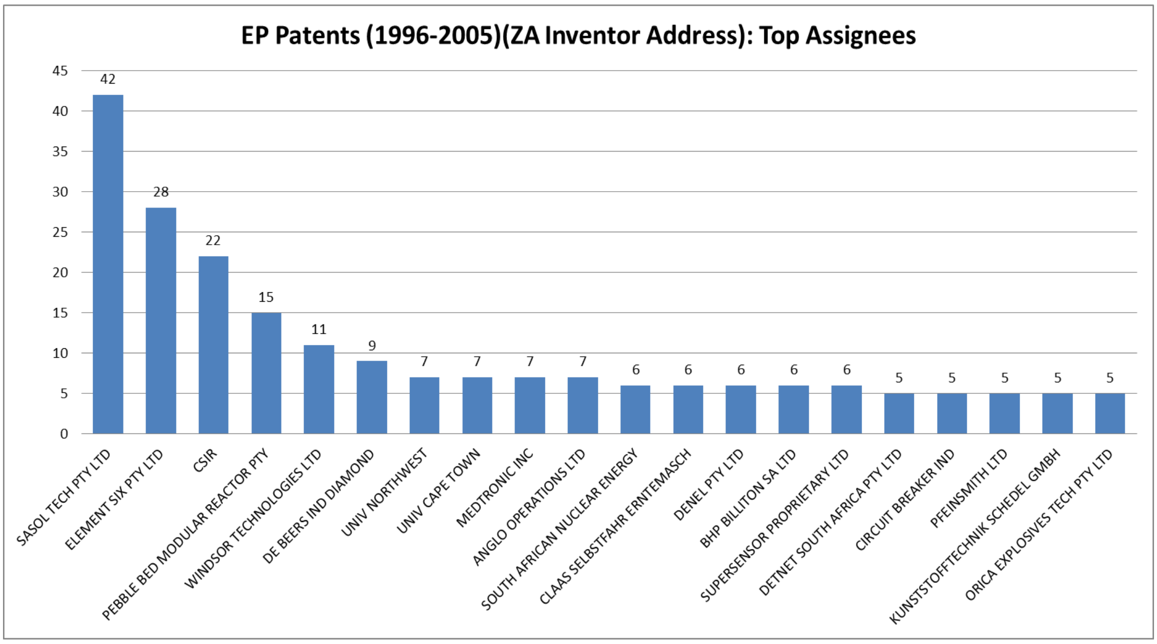


Figure 7.52: Granted patents based on patent applications filed at the EPO in the period 1996 - 2005 (South Africa Inventor Address) [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

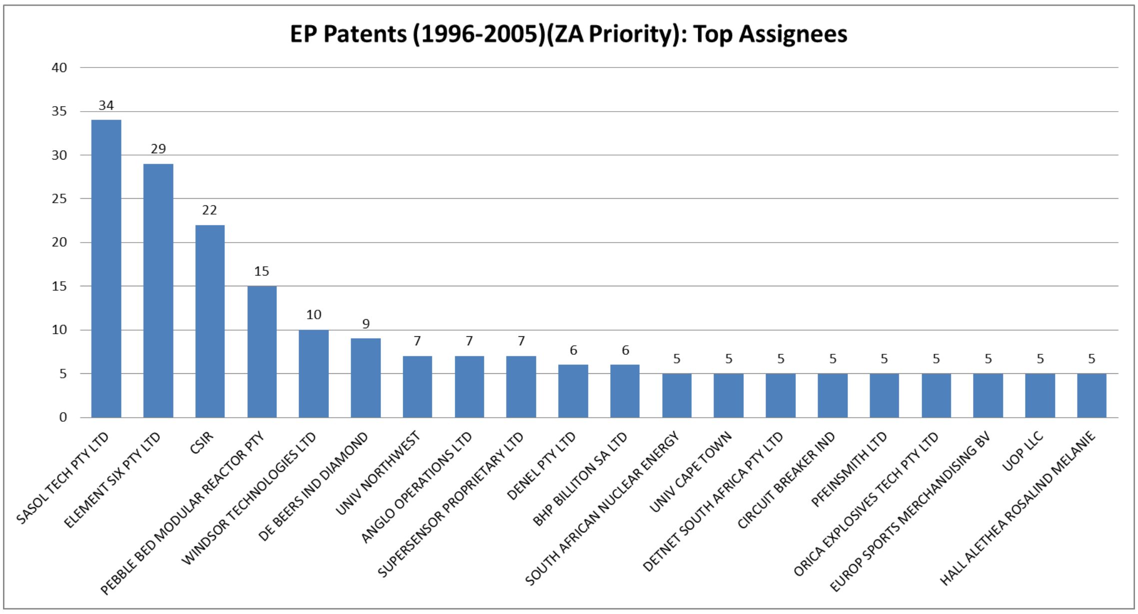


Figure 7.53: Granted patents based on patent applications filed at the EPO in the period 1996 - 2005 (South Africa Priority Data) [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

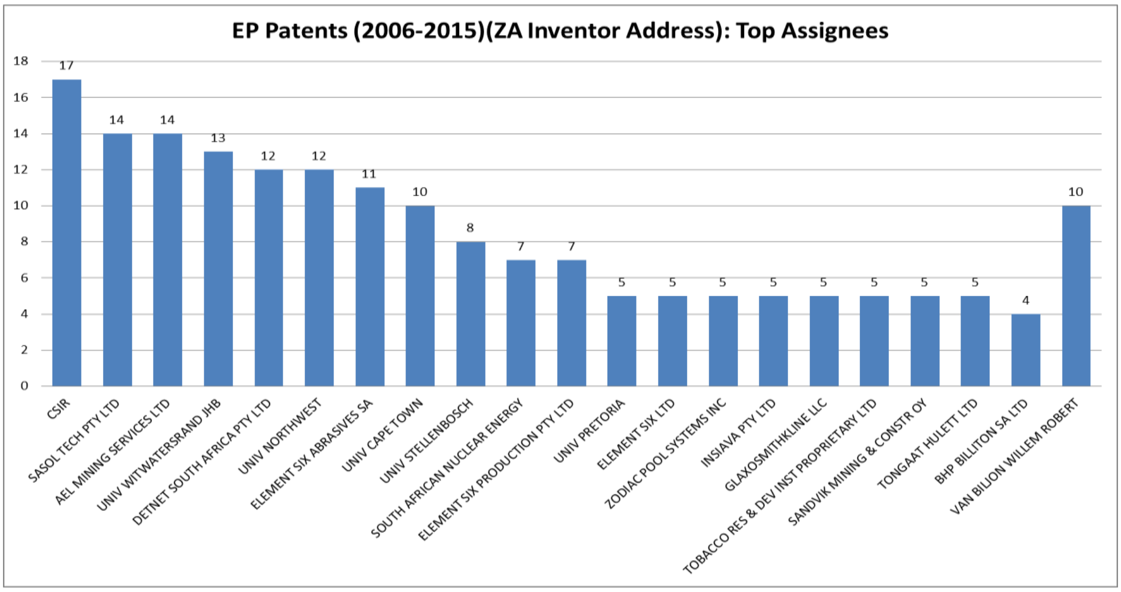


Figure 7.54: Granted patents based on patent applications filed at the EPO in the period 2006 - 2015 (South Africa Inventor Address) [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

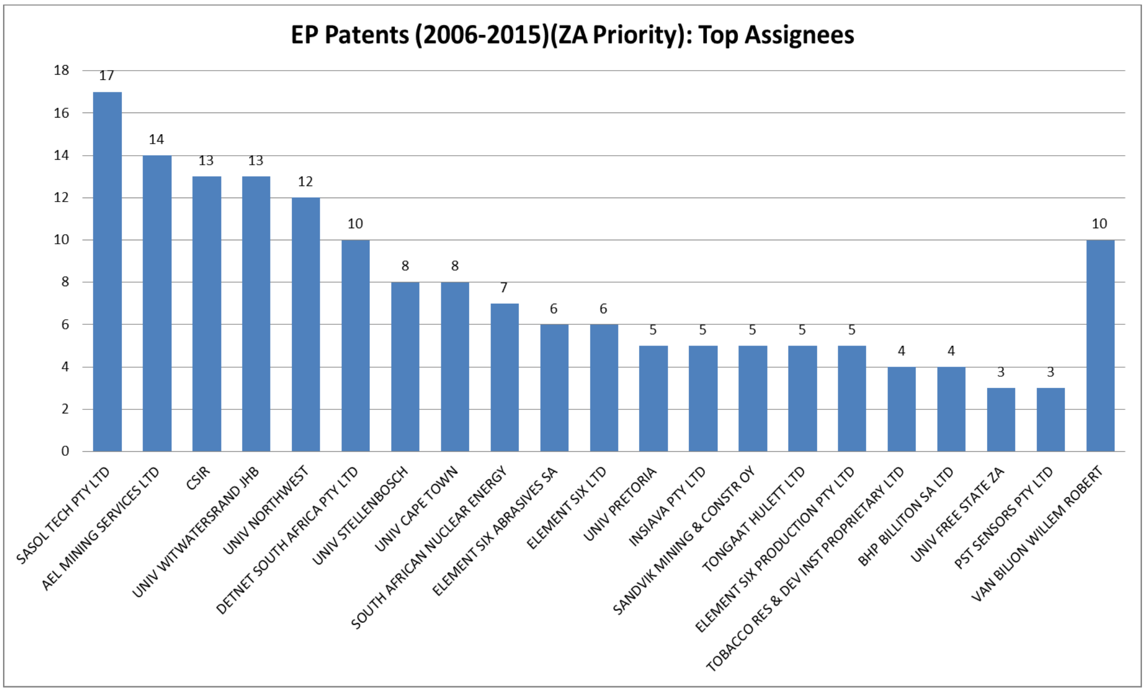


Figure 7.55: Granted patents based on patent applications filed at the EPO in the period 1996 - 2005 (South Africa Priority Data) [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

A review of the top assignees in the two periods 1996-2005 and 2006-2015 shows a doubling of the number of publicly financed institutions with patents in the later period, to 8 with three or more patents, based on priority data. In the case of the assignees list based on patents with South African inventors, in the period 1996-2005, only two universities, namely NorthWest University and the University of Cape Town, had five or more patents. However, this number increased to five, with the inclusion of the following: the University of the Witwatersrand, the University of Stellenbosch, the University of the Free State and the University of Pretoria, in addition to NorthWest University and the University of Cape Town. In the later period, the following organisations increased their patenting activities: the CSIR, Detnet South Africa, and the South African Nuclear Energy Corporation.

In contrast, the following organisations either decreased their patenting activity or disappeared from the top assignees lists: Sasol Tech, Element Six, De Beers Industrial Diamonds, BHP Billiton, Anglo Operations, Pebble Bed Modular Reactor, Circuit Breaker Industries, Supersensor, Orica Explosives, Europ Sports Mechandising, Pfein Smith, Denel, and Medtronic Inc. Sasol remains at the top of the lists. Other than the universities already mentioned above, other new entrants in the top 20 assignees lists included AEL Mining Services, Zodiac Pool Systems, Insiava, GlaxoSmithKline, Tobacco Research and Development Institute, Tongaat Hulett, PST Sensors, and Sandvic Mining and Construction. Of these, Insiava[181] is a spin-out of the University of Pretoria, whereas GlaxoSmithKline and Sandvic are multinationals. PST Sensors[182] is a spinout by researchers from the University of Cape Town.

The technology fields and corporate clusters, in which the patent applications filed in the period 1996-2015 resulted in an EP0 patent, are illustrated in **Figures 7.56** and **7.57.**

181http://www.up.ac.za/media/shared/Legacy/sitefiles/file/44/1026/2163/8121/innovate5/commercialisingtheinsiavaintellectualproperty.pdf [Last accessed on 10 December 2016]
182 http://www.pstsensors.com/about_us.htm [Last accessed on 10 December 2016]

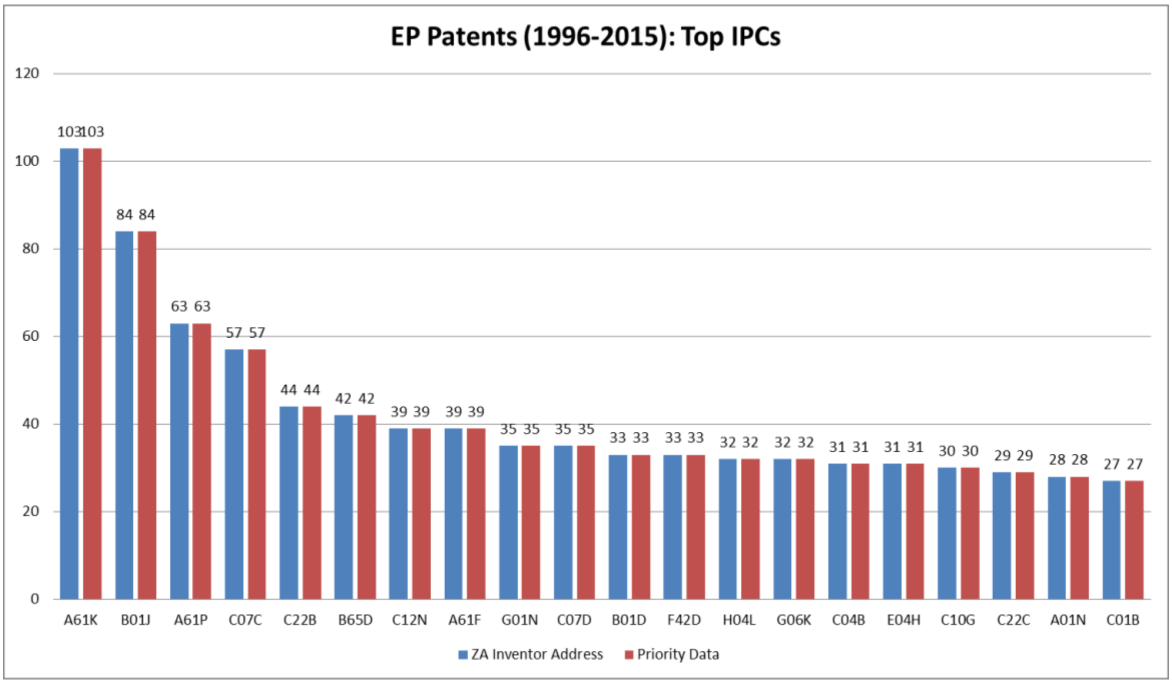


Figure 7.56: Granted patents based on patent applications filed at the EPO in the period 2006 - 2015 by public institutions, by IPCs [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

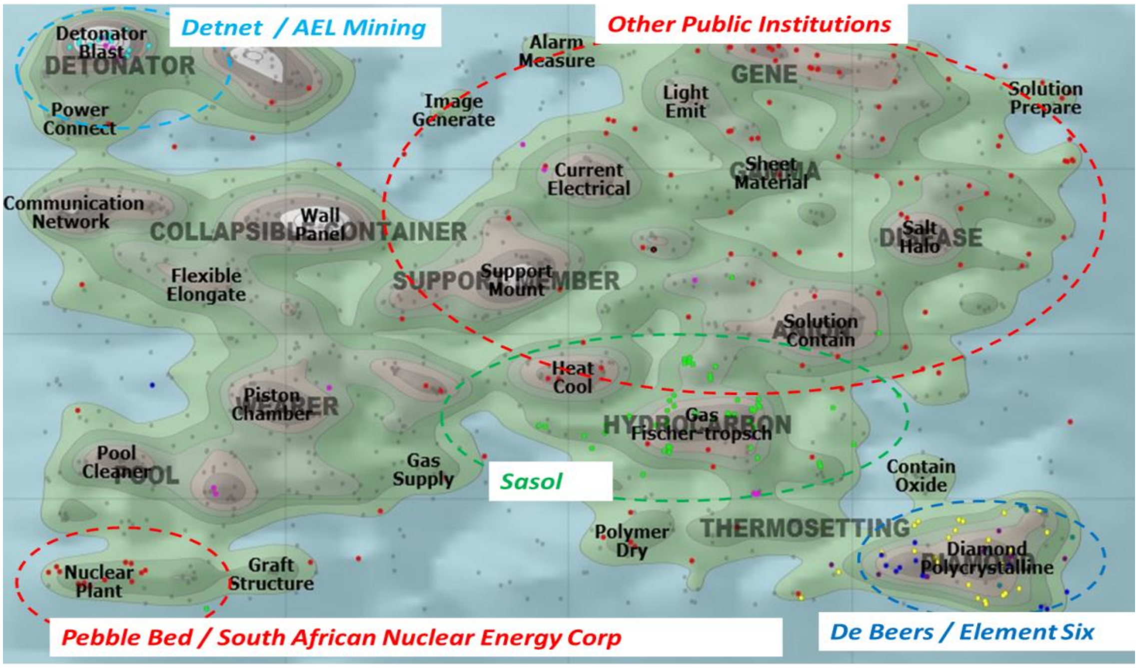


Figure 7.57: ThemeScape® Map of granted patents from applications filed at the EPO in the period 1996 - 2015 (South African Inventor) [Source: Author generated from Thomson Innovation patent database analytics, 2016]

The distinct clusters are in the following areas: diamonds and abrasives (De Beers/Element Six), Nuclear Energy (Pebble Bed Modular Reactor/South African Nuclear Energy

Corporation), Explosives/Detonators (AEL Mining and Detnet), and Hydrocarbons and Fischer Trop Process (Sasol). Unlike the case of PCT and USPTO, the biotechnology cluster attributable to institutions (largely the CSIR and universities) does not appear to be very strong, **Figure 7.57**.

In order to understand any technological changes over the 20-year period, a review of the ThemeScape maps of the patents in the period 1996-2005 (**Figure 7.58**) and 2006-2015 (**Figure 7.59)** was undertaken. Firstly, it would appear that, whereas in the period 1996-2005, there appeared to be a nuclear energy patent cluster (comprising public institutions' patents (red)) developing this cluster of patents is missing in the period 2006-2015; and can be explained by the mothballing of the Pebble Bed Modular reactor.

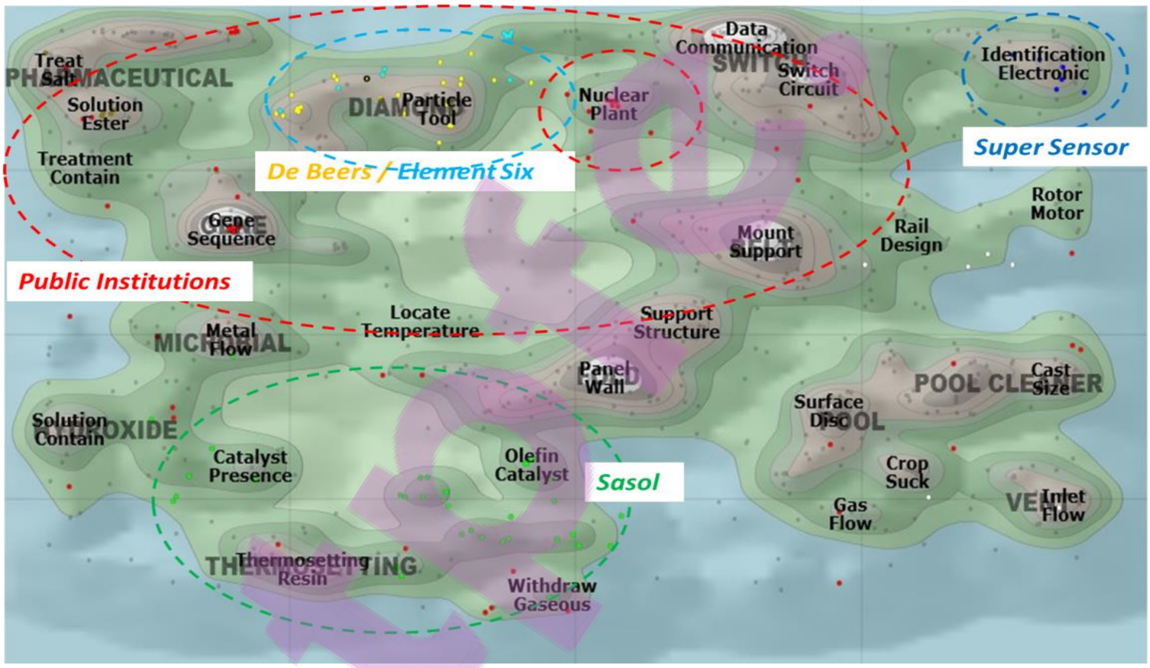


Figure 7.58: ThemeScape® Map of granted patents filed at the EPO in the period 1996 - 2005 (South African inventor address) [Source: Author generated from Thomson Innovation patent database analytics, 2016]

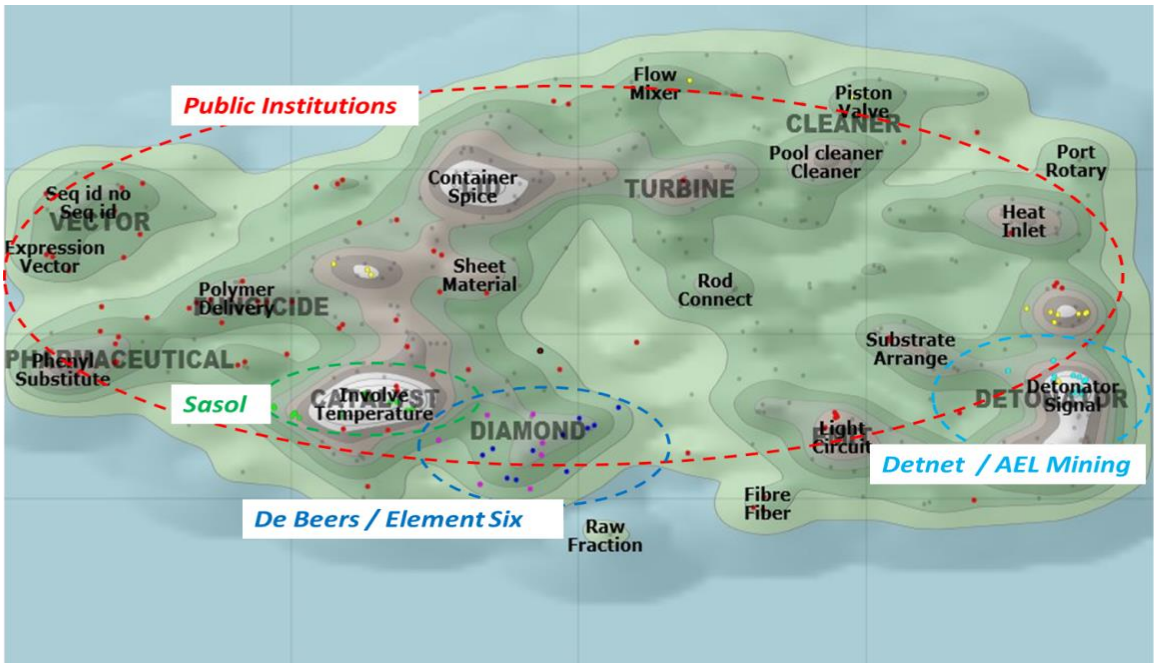


Figure 7.59: ThemeScape® Map of granted patents filed at the EPO in the period 2006 - 2015 (South African inventor address) [Source: Author generated from Thomson Innovation patent database analytics, 2016]

Secondly, the main clusters anchored by De Beers Industrial Diamonds/Element Six as well as Sasol, can be seen in both maps. However, the rate of patenting by Element Six appears to have slowed down (essentially a reduction of 40% from 38 patents in 1996-2005 to 23 in 2006-2015 – see **Figures 7.53** and **7.54**) and this may be due to this organisation moving most of its R&D abroad. Thirdly, although in the period 1996-2005 there appears to have been a small cluster of patents in electronic identification belonging to Super Sensor, this company would appear to have been liquidated and the patent portfolio presumably taken over by international parties, such as BTG. Fourthly, there appear to be fewer patents in the biotechnology sector, compared to that seen in the case of US patents. Lastly, a cluster of patents in explosives and detonators appears to have surfaced in the period 2006-2015 (**Figure 7.59**), which was not there in the period 1996-2005. A review of the EPO patents shows that, over the period 1996-2015, at least 20% were by publicly financed institutions, starting at 7% over the period 1996-2015 and rising to 22% in the period 2006-2015.

The publications per year and the pace of filing in this regard for 2006-2015 are shown in **Figure 7.60** and **7.61**, respectively.

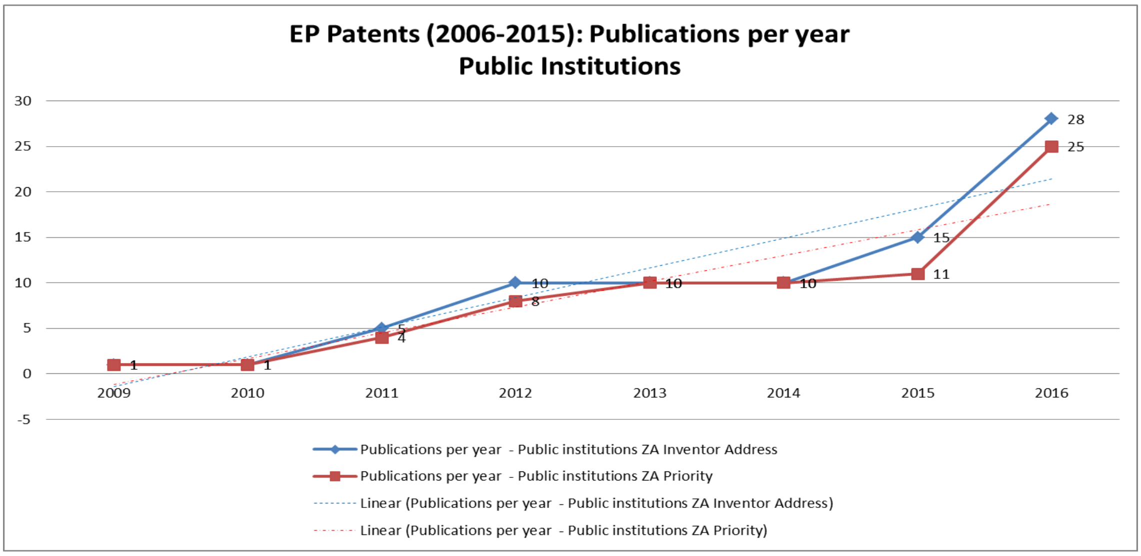


Figure 7.60: Granted patents to public institutions based on patent applications filed at the EPO in the period 2006-2015 (by publication year) [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

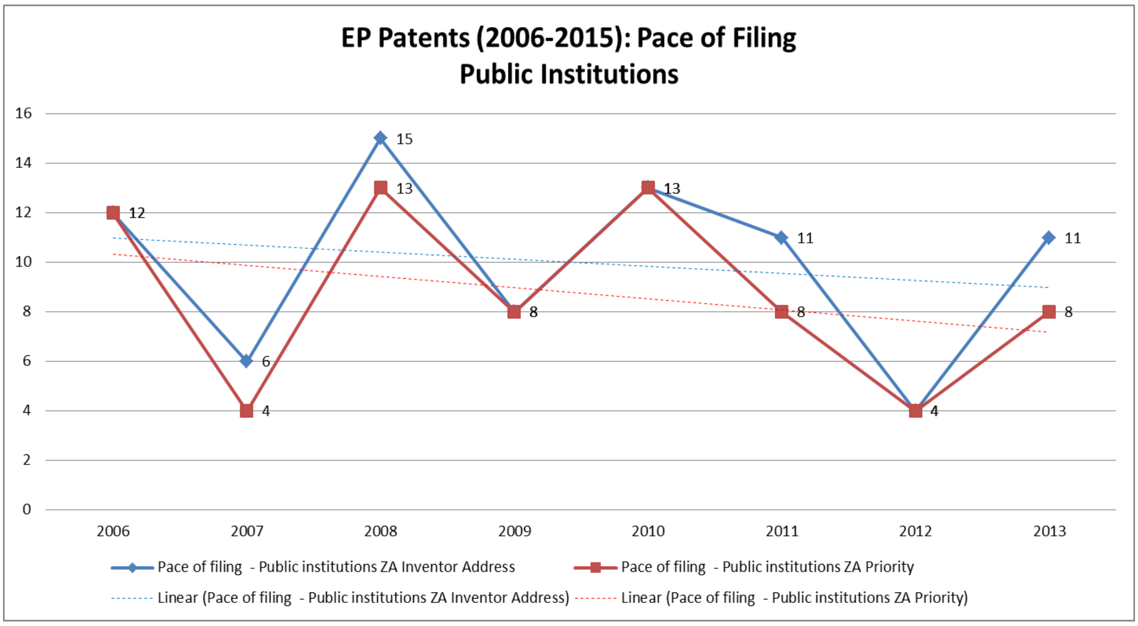


Figure 7.61: Granted patents to institutions based on patent applications filed at the EPO in the period 2006-2015 (by Pace of Filing) [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

The leading public institutions accounting for the patents in the period 2006-2015 are set out in the top assignees list (**Figure 7.62**), and essentially comprise 10 universities and four science councils (the CSIR, the Medical Research Council, the South African Nuclear Energy Corporation, and Mintek). Most of the patents can be attributed to the top six institutions namely, the CSIR, NorthWest University, the University of Stellenbosch, the University of the Witwatersrand, the University of Cape Town, and the University of Pretoria. The top 10 technology areas that institutions filed their patents are shown in **Figure 7.63** and **7.64.**

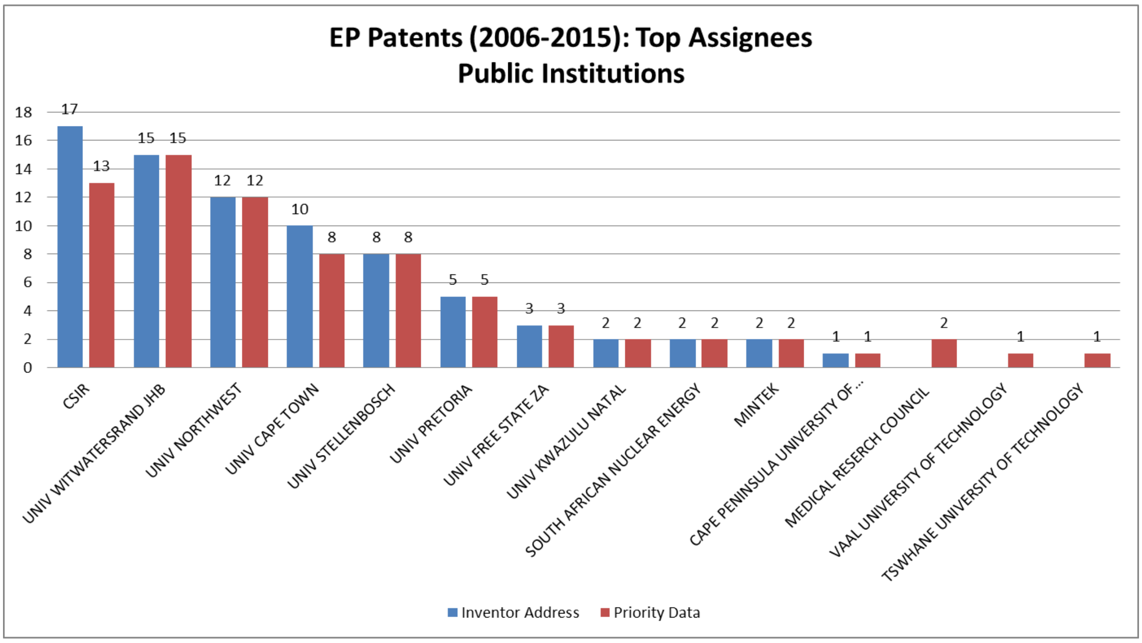


Figure 7.62: Granted patents based on patent applications filed at the EPO in the period 2006 - 2015 by public institutions, by Top Assignees [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

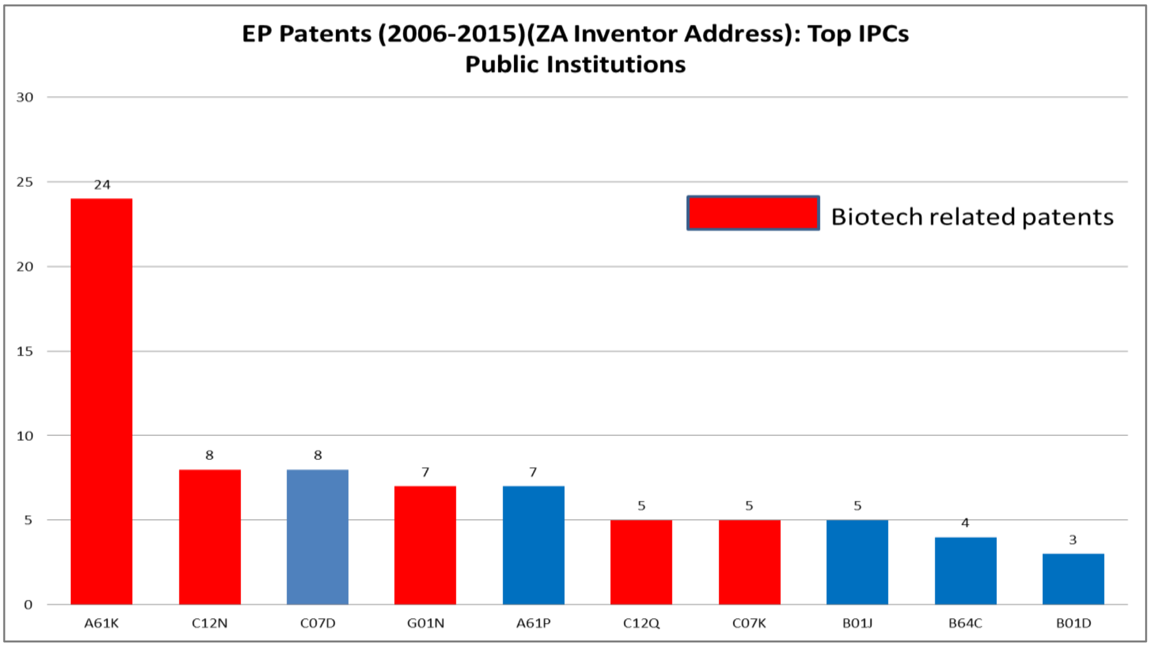


Figure 7.63: Top IPC fields of EPO patents in the period 2006 - 2015 (South African Inventor address), for Public Institutions [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

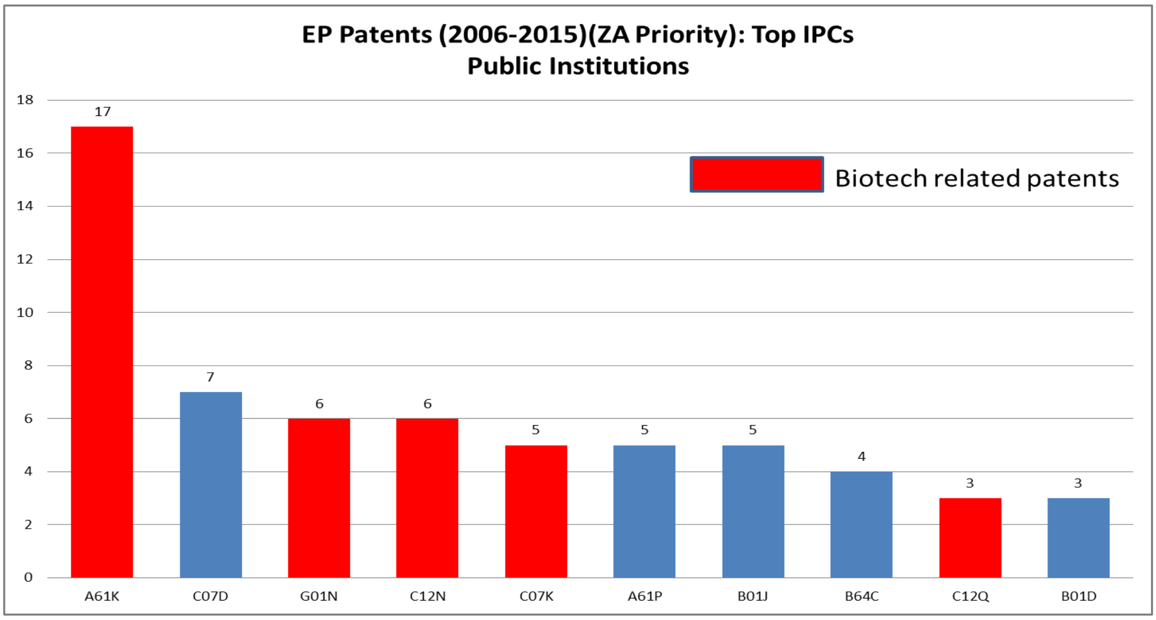


Figure 7.64: Top IPC fields of EPO patents in the period 2006 - 2015 (South African priority), for Public Institutions [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

Biotechnology related patents by publicly financed institutions account for at least 60% of the top 10 IPCs (see **Figure 7.63** and **7.64**).

7.6 COMPARATIVE PERFORMANCE AMONGST THE BRICS COUNTRIES

In this section, the performance of South Africa in respect of patenting is compared to its peers within the BRICS countries. South Africa is the most recent member of the BRICS country, and arguably the smallest member, as can be seen from **Figure 7.65**.[183] As documented by Straus (2012:655), the BRICS countries are an important market place and economic group, given that they comprise:

> *"more than forty-one percent of the world's population and contribute more than twenty percent of the global economy ... And trade within BRICS amounted to $212 billion USD in 2010 and some estimates predicted Intra-BRICS trade of over $500 billion USD by 2015."*

183 Could new BRICS bank rival IMF for top spot? 1 August 2014, available at http://likebulb.blogspot.co.za/2014/08/could-new-brics-bank-rival-imf-for-top.html [Last accessed on 10 March 2017]

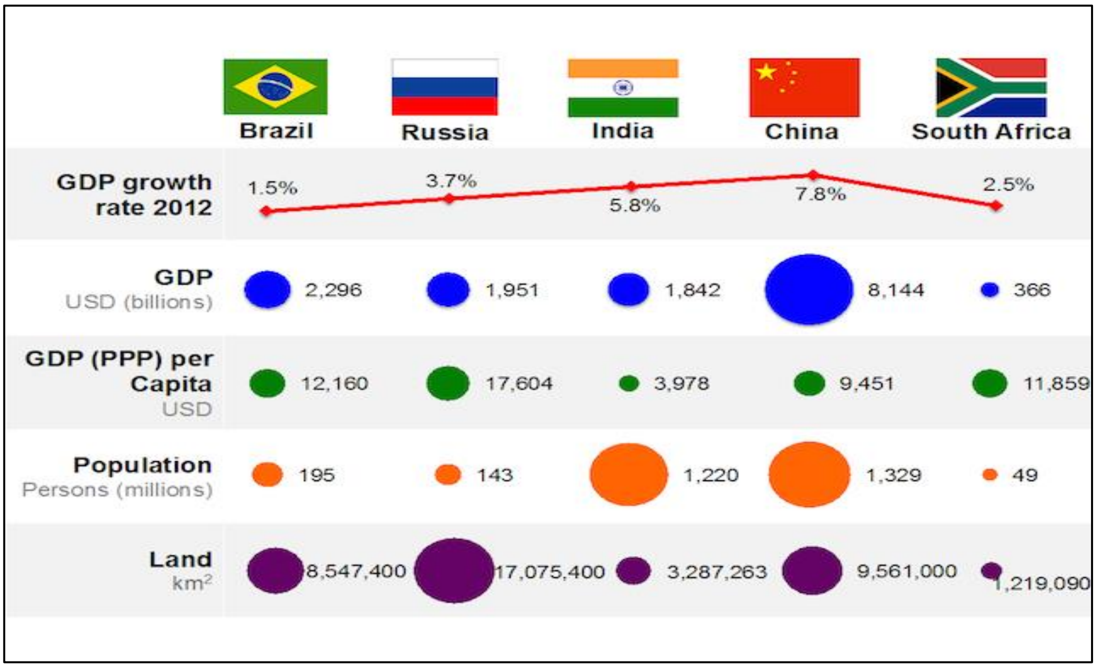


Figure 7.65: Comparative Analysis of the BRICS countries by various indicators[184]

All the BRICS countries are members of the WTO and hence signatories to the TRIPS Agreement. Whereas Brazil, India and South Africa became members on 1 January 1995, China and the Russian Federation became members on the 11 December 2001 and 22 August 2012, respectively.[185]

In this section, the performance of South Africa in respect of patenting is compared to its peers within the BRICS countries. In undertaking a comparative analysis of the BRICS countries, use has been made of available statistics where these are available, in addition to some analytical studies in terms of patent filings and granted patents at the USPTO and EPO, over the period 2006-2015.

184 *ibid*

185 https://www.wto.org/english/tratop_e/trips_e/amendment_e.htm [Last accessed on 10 November 2016]

7.6.1 PCT Patent Applications

Table 7.1 below summarises the PCT filings over the period 2006 – 2015 according to WIPO official statistics.

Table 7.1 PCT Patent applications of BRICS countries

COUNTRY	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Brazil (BR)	333	398	471	492	498	562	588	657	580	548
Russia Federation (RU)	696	735	802	736	814	1009	1114	1191	948	876
India (IN)	833	904	1073	960	1276	1323	1309	1320	1428	1412
China (CN)	3930	5455	6119	7896	12300	16398	18620	21515	25548	29837
South Africa (ZA)	424	406	394	375	291	309	313	351	313	313

Source: WIPO statistics database. Last updated: October 2016[186]

The results in **Table 7.1** are represented in **Figures 7.66** and **7.67**. It is evident from **Figure 7.66** that China is no comparison to the rest of the BRICS countries in terms of the number of PCT applications filed over the 10-year period (2006-2015). There has been exponential growth in terms of its PCT applications. With about 30,000 applications filed annually, this is two orders of magnitude greater than South Africa's 300.

186 http://ipstats.wipo.int/ipstatv2/index.htm [Last accessed on 30 October 2016]

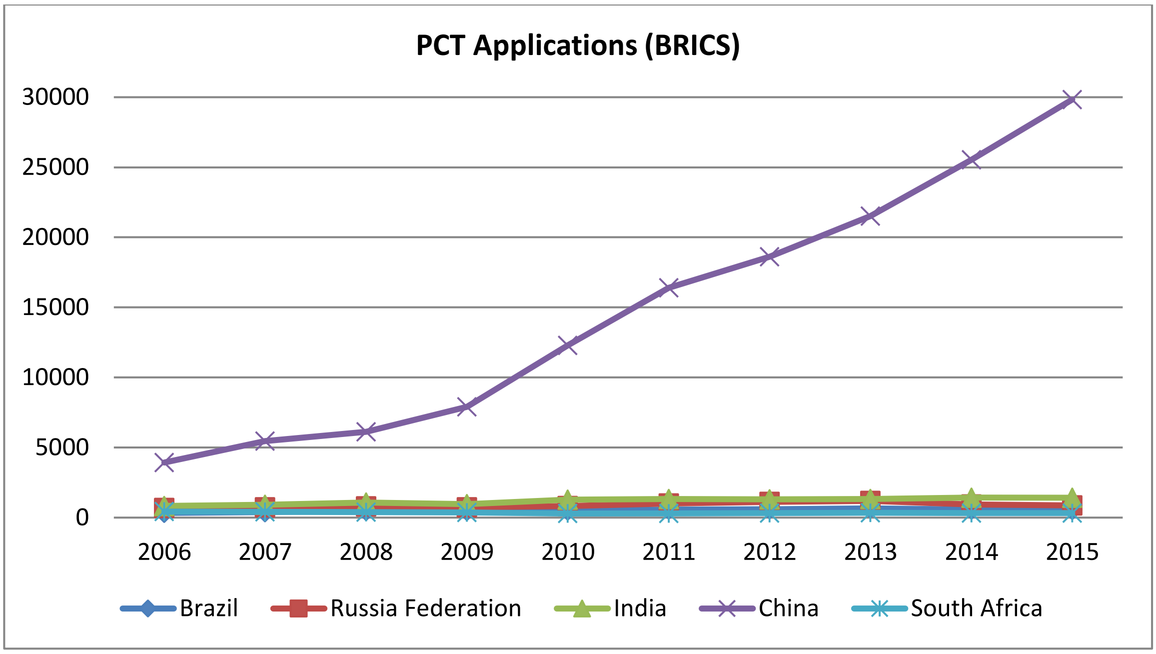


Figure 7.66: Comparative PCT patent applications for the BRICS countries over the period 2006-2015 [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

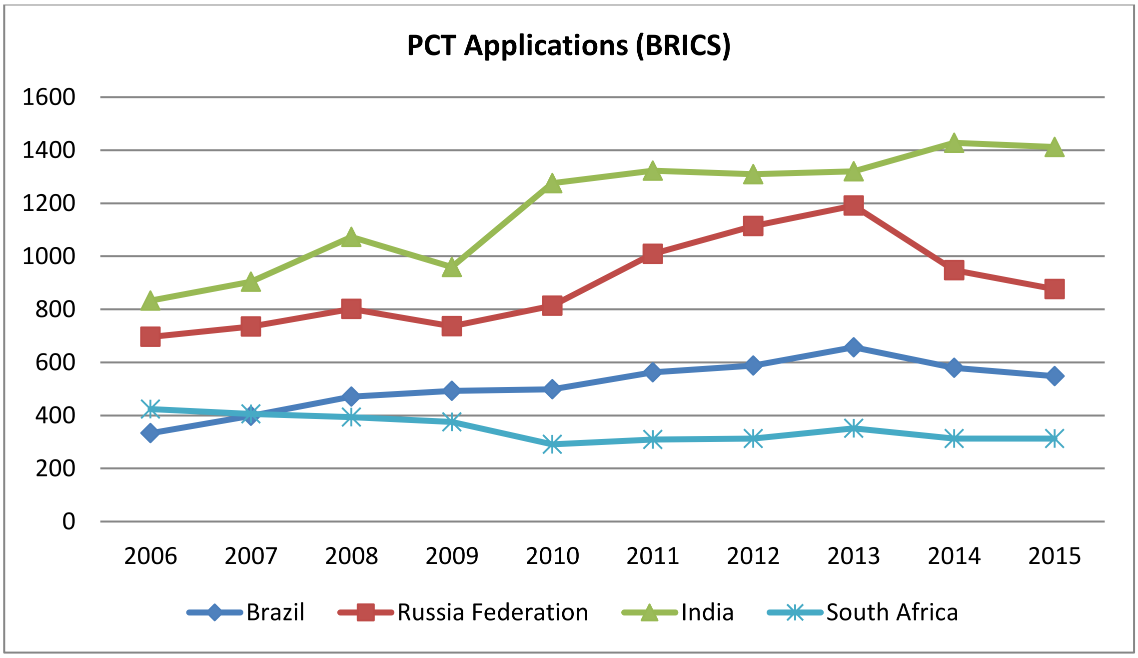


Figure 7.67: Comparative PCT patent applications for the BRICS countries (without China) over the period 2006-2015 [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

An analysis of the filing trends without China (**Figure 7.67**) reveals the following:

- South Africa's patent applications have not grown and have been on the decline;

- Whereas South Africa (424) had a head start compared to Brazil (333) in 2006, it appears to have lost this competitive edge beyond 2007; Brazil now files almost twice as much patent applications as South Africa.
- Both Russia and Brazil have increased their patent applications; they seem to have peaked in 2013, and have declined thereafter, with Russia having a greater decline than Brazil, presumably owing to the global economic downturn. Up until 2013, Russia had increased its patent applications by 70% from 600 (2006) to 1 200 (2013).
- India has experience incremental growth, almost doubling its patent applications over the 10-year period.

The findings in terms of China's PCT patenting filing trends are consistent with Straus' (2012:668) observations that:

> *"Other BRICS countries are not comparable. They have not adopted specific, all-encompassing IP strategies like China and have not had a similar output in patent applications."*

Straus (2012:671) further points out that:

> *"In terms of policy, South Africa comes closest to China. It was the first developing country to recognise innovation as an important element of economic development and, by 1994, introduced a national innovation system."*

It is the author's view that China's progress in respect of implementation of IP and innovation policy can be attributed to a number of reasons that include: larger innovation system, deliberate industrialisation strategy that integrated manufacturing by large multinationals with establishment of local capabilities, more coordinated approach to policy implementation, a long term strategy on human capital development for R&D and innovation, as well as government led establishment and growth of large technology companies. South Africa on the other hand has had a plethora of apartheid era legacies to also deal with, one of the key ones being a dysfunctional educational system that excluded a large part of the population.

7.6.2 USPTO Patent Applications and Granted Patents

Figures 7.68 and 7.69 illustrate the patent filing trends in the period 1994-2015 in respect of the BRICS countries, with **Figure 7.69**, excluding China and India in order to illuminate the differences in patenting trends amongst Brazil, Russia and South Africa. The actual data is included as **Appendix 1**.[187] As is evident from **Figure 7.68**, both China and India have exhibited high growth rates in terms of the filing of patent applications at the USPTO. Whereas both China and India seemed to exhibit similar number of applications per year until about 2003, China's growth after 2003 was higher than that of India, and on an exponential basis compared to the rest of the BRICS countries.

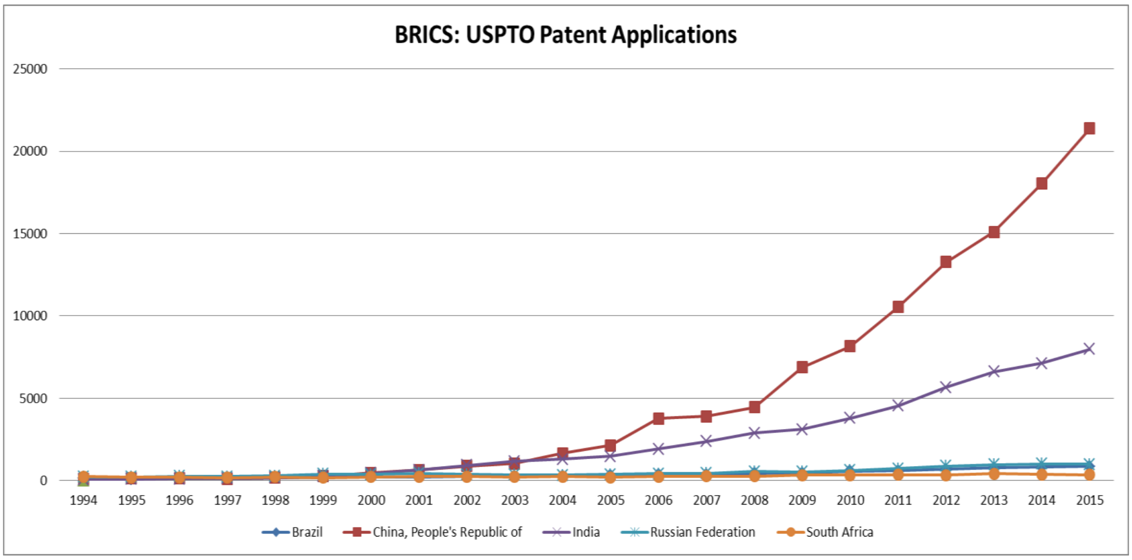


Figure 7.68: Comparative USPTO patent applications for the BRICS countries [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

187 https://www.uspto.gov/web/offices/ac/ido/oeip/taf/appl_yr.htm [Last accessed on 10 November 2016]

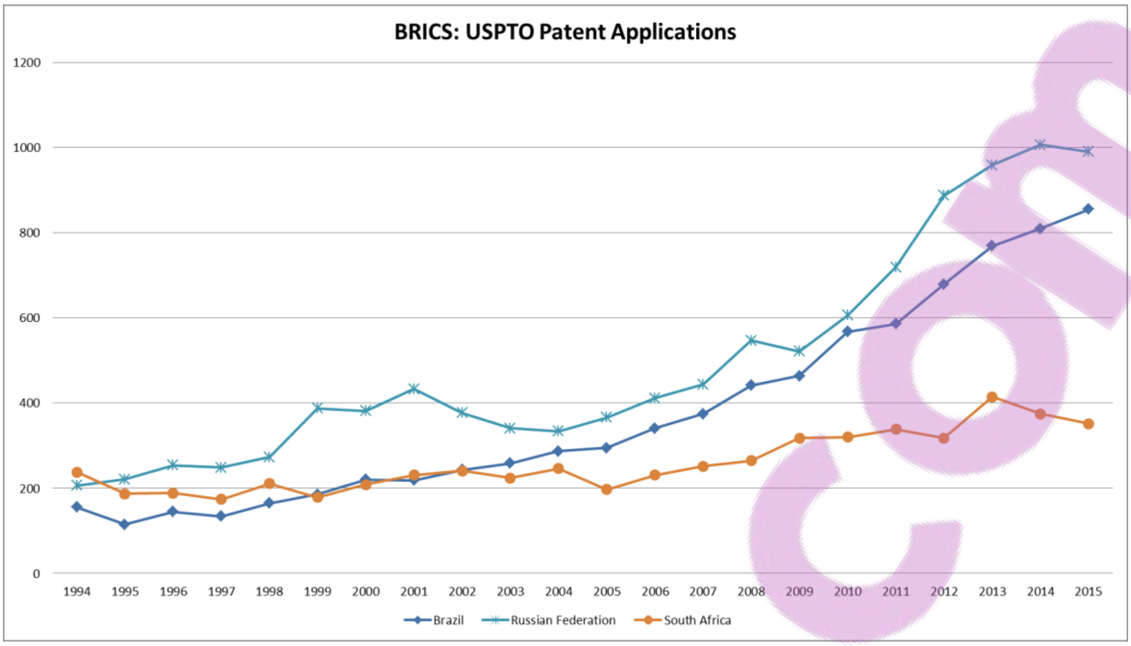


Figure 7.69: Comparative PCT patent applications for the BRICS countries (without China and India) [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

A review of **Figure 7.69** shows that, until about 1999, South Africa used to file more USPTO patent applications compared to Brazil, which had the lowest number of patent applications. In the period 1999-2002, Brazil appears to have been filing as many patent applications as South Africa. After 2002, notwithstanding growth in number of patent applications by Brazil, Russia and South Africa, the rate of growth of patent applications filed was higher for both Brazil and Russia than for South Africa.

Figures 7.70 and **7.71** illustrate the trends in respect of patents granted by the USPTO to BRICS countries in the period 2006-2015, based on data provided in **Appendix 2**.[188]

188 https://www.uspto.gov/web/offices/ac/ido/oeip/taf/reports_stco.htm [Last accessed on 10 November 2016]

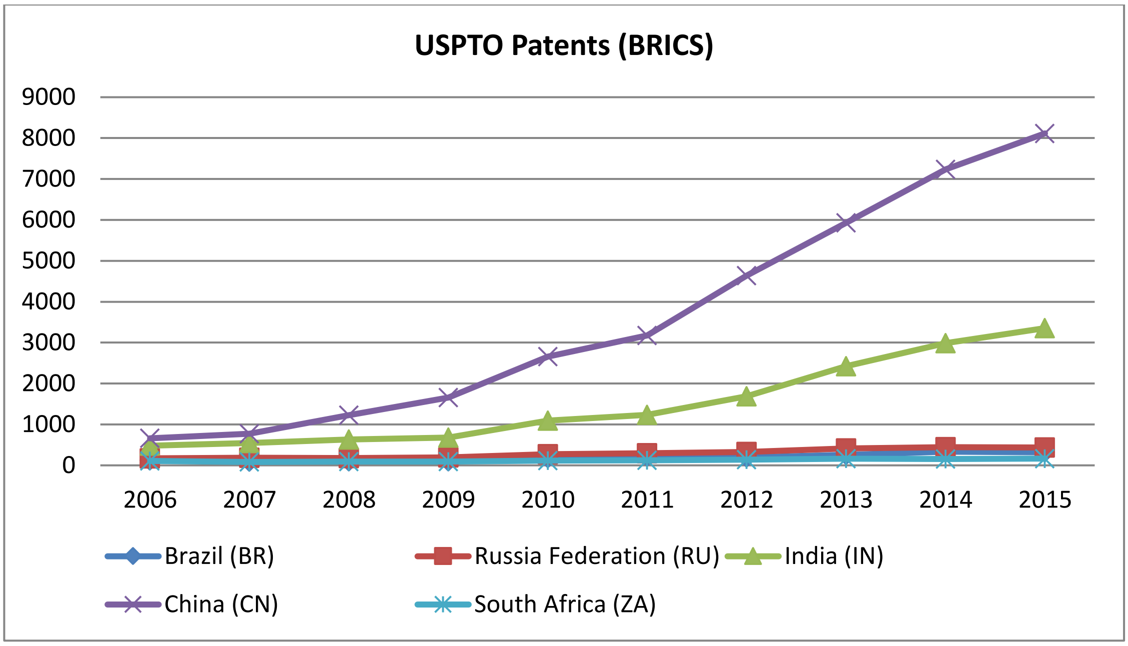


Figure 7.70: Comparative USPTO granted patents for the BRICS countries over the period 2006 - 2015 [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

The following observations can be made from **Figure 7.71**:

- South Africa has the lowest number of patents granted by the USPTO, albeit a marginal increase (50%) over the period 2006-2015.
- Similarly, to the PCT applications:
  - Whereas Brazil had more or less similar numbers of patents (about 10% more than South Africa) in 2006, it has more than doubled its patents over the period and now has twice as many patents granted by the USPTO as South Africa.
- Russia is granted three times more patents than South Africa;
- South Africa and Brazil have the lowest number patents granted by the USPTO amongst the BRICS countries, though Brazil is higher than South Africa.

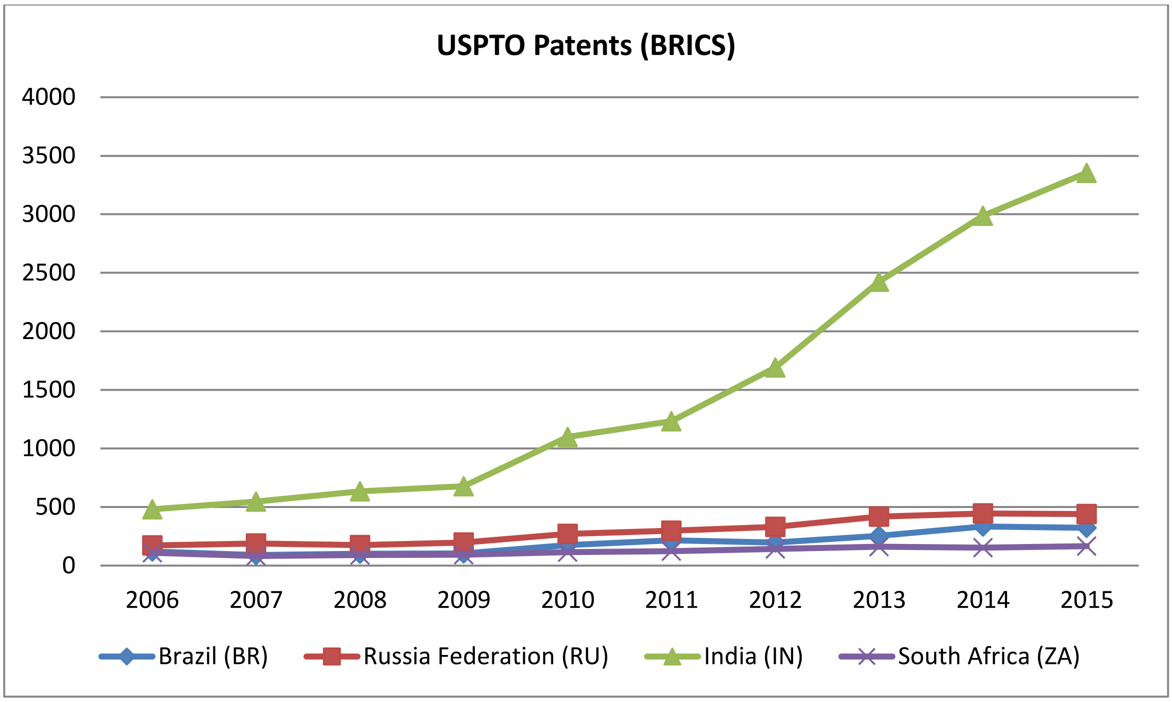


Figure 7.71: Comparative USPTO granted patents for the BRICS countries (without China) over the period 2006 - 2015 [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

USPTO data[189] was analysed for patents granted to the BRICS countries in the period 2011-2015,[190] and the results in terms of the dominant technology fields according to the patent classifications are shown in **Figures 7.72 to 7.76**. The top five technologies for each of the BRICS countries are compared in **Table 7.2.**

Table 7.2: Comparison of Top Technology Fields of BRICS countries in terms of USPTO Patents granted (2011 - 2015) [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

	Brazil (BR	Russia Federation (RU)	India (IN)	China (CN)	South Africa (ZA)
1	Drug, Bio-Affecting and Body Treating Compositions	Information Security	DP: Database and File Management or Data Structures (Data Processing)	Multiplex Communications	Drug, Bio-Affecting and Body Treating Compositions
2	Organic Compounds	Drug, Bio-Affecting and Body Treating Compositions	Multicomputer Data Transferring (Electrical Computers and Digital Processing Systems)	Telecommunications	DP: Financial, Business Practice, Management, or Cost/Price Determination (Data Processing)

189 https://www.uspto.gov/web/offices/ac/ido/oeip/taf/stctec/regions_stcl_gd.htm [Last accessed on 10 November 2016]
190 Only data for this period was available by technology field

3	Pumps	Pulse or Digital Communications	Drug, Bio-Affecting and Body Treating Compositions	Electricity: Electrical Systems and Devices	Prosthesis (i.e., Artificial Body Members), Parts Thereof, or Aids and Accessories Therefor
4	Multicellular Living Organisms and Unmodified Parts Thereof and Related Processes	Image Analysis	Organic Compounds	Electrical Connectors	Ammunition and Explosives
5	Paper Making and Fiber Liberation	Radiant Energy	Multiplex Communications	Active Solid-State Devices (e.g., Transistors, Solid-State Diodes)	Chemistry: Molecular Biology and Microbiology
6	Aeronautics and Astronautics	Chemistry: Molecular Biology and Microbiology	Information Security	Computer Graphics Processing and Selective Visual Display Systems	Amusement Devices: Games
7	Surgery	Multicomputer Data Transferring (Electrical Computers and Digital Processing Systems)	DP: Software Development, Installation, and Management (Data Processing)	Multicomputer Data Transferring (Electrical Computers and Digital Processing Systems)	Abrasive Tool Making Process, Material, or Composition
8	Wells (shafts or deep borings in the earth, e.g., for oil and gas)	DP: Database and File Management or Data Structures (Data Processing)	Error Detection/Correction and Fault Detection/Recovery	Drug, Bio-Affecting and Body Treating Compositions	Chemistry: Fischer-Tropsch Processes; or Purification or Recovery of Products Thereof
9	Synthetic Resins or Natural Rubbers	Error Detection/Correction and Fault Detection/Recovery	Memory (Electrical Computers and Digital Processing Systems)	Pulse or Digital Communications	Mining or In Situ Disintegration of Hard Material
10	Multicomputer Data Transferring (Electrical Computers and Digital Processing Systems)	DP: Software Development, Installation, and Management (Data Processing)	Telecommunications	Semiconductor Device Manufacturing: Process	Organic Compounds

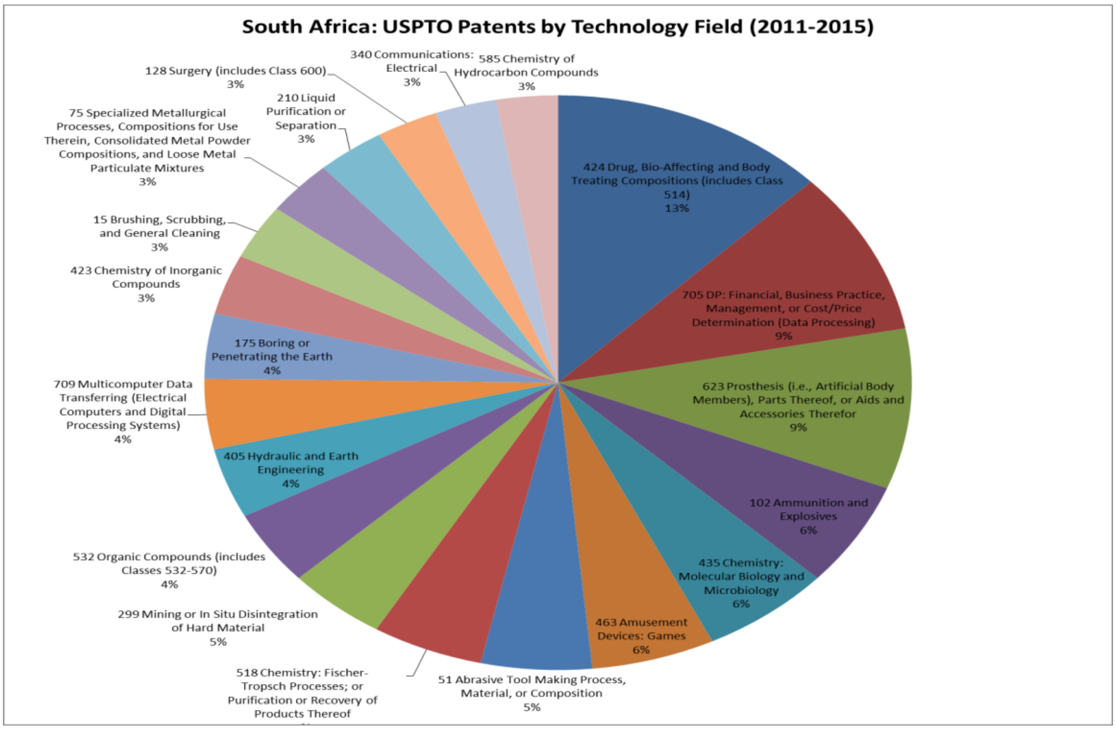


Figure 7.72: USPTO Patents granted to South Africans (2011-2015) by Top Technology Field [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

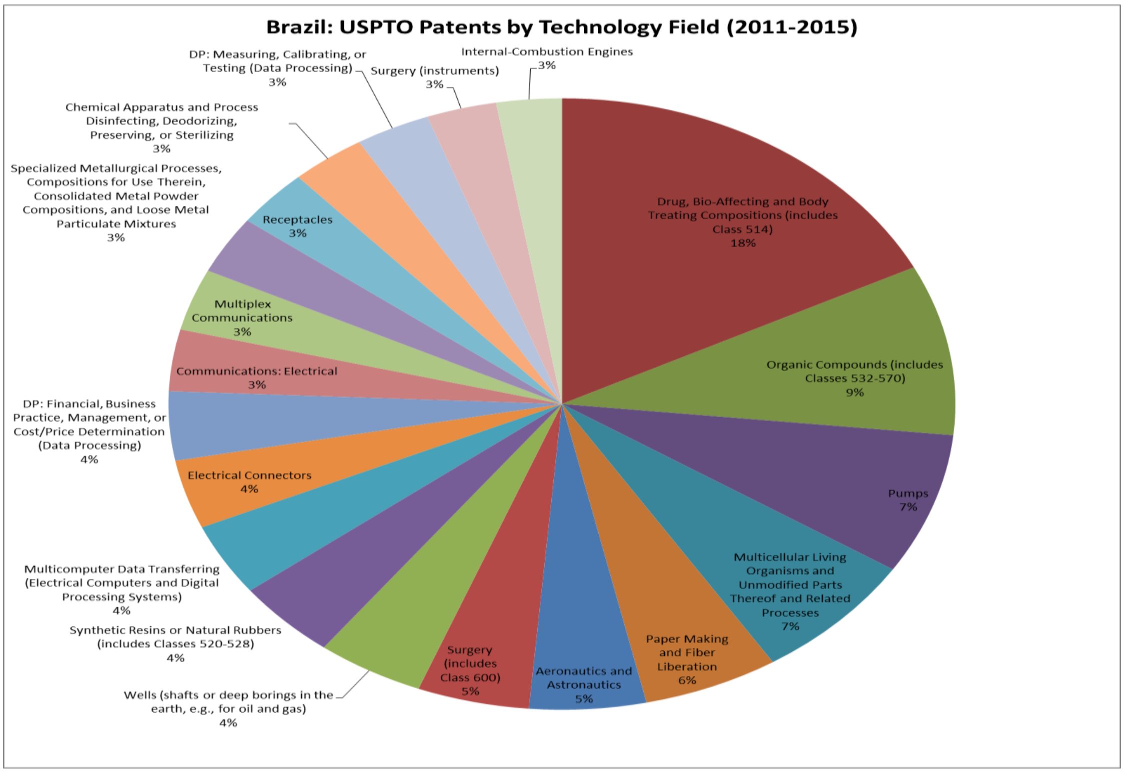


Figure 7.73: USPTO Patents granted to Brazil (2011 - 2015) by Top Technology Field [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

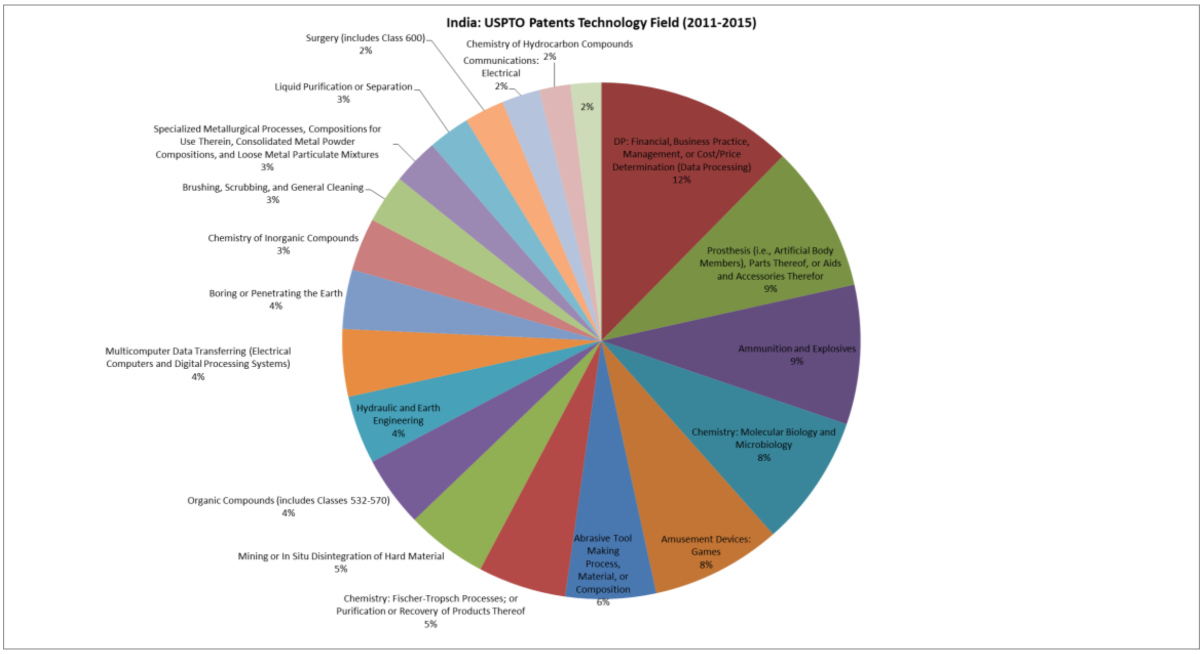


Figure 7.74: USPTO Patents granted to India (2011 - 2015) by Top Technology Field [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

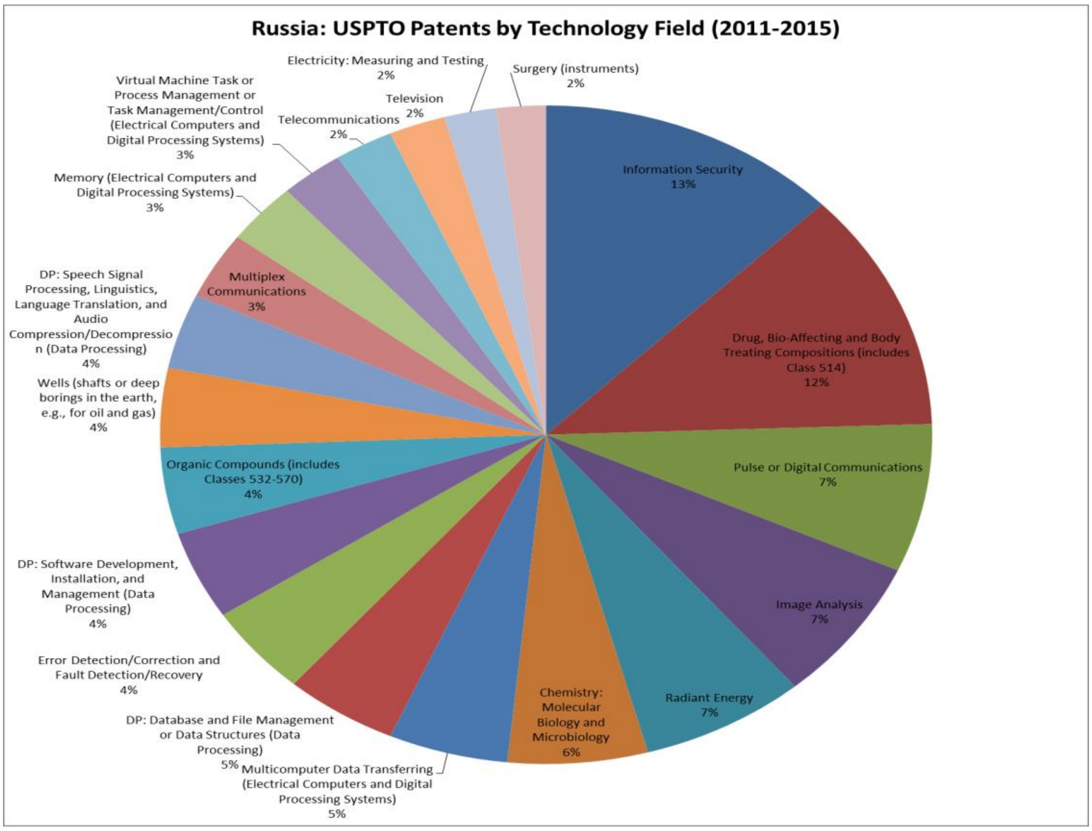


Figure 7.75: USPTO Patents granted to Russia (2011 - 2015) by Top Technology Field [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

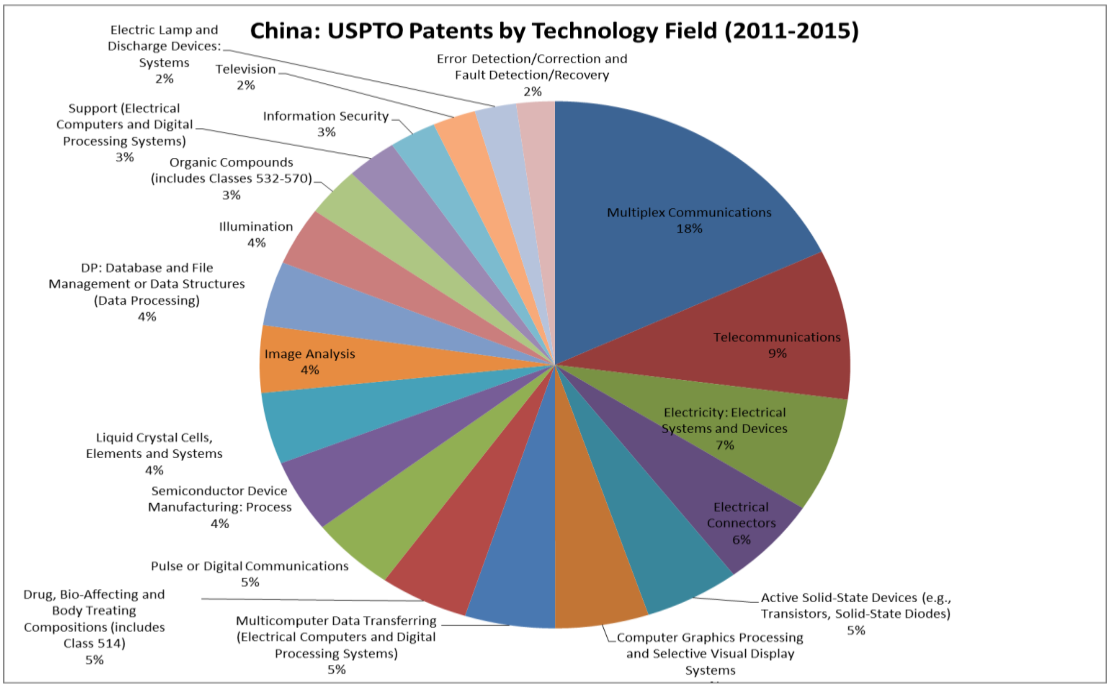


Figure 7.76: USPTO Patents granted to China (2011 - 2015) by Top Technology Field [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

7.7 DISCUSSIONS

Patenting at the South African patent office has remained stagnant over the 20-year period, hovering around 10 000 provisional and complete patent applications, of which about 3 000 are complete patent applications. In essence, the lack of growth of domestic patents points to a lack of effective use of the patent system by South Africans. Given the fact that (i) the costs of filing a provisional patent application are nominal, below US$100 and that such applications can be self-filed by an inventor without the costly services of a patent attorney, and the fact that (ii) South African patents are not examined, there is a need to increase awareness of use of the patent system (protection of inventions, patent information disclosed in a patent document, and licensing in third party patents) to drive competitiveness. It is submitted that efforts to institute SSE procedures will not benefit South Africa, unless efforts are made to broaden the participation of locals in the patent system. The low level of domestic patenting also translates into very few small and medium sized companies patenting globally through the PCT system, or the USPTO and the EPO, as the preceding sections have shown. Whereas there has been stagnation in the system in general, publicly financed institutions have increased their patenting, largely spurred by the IPR-PFRD Act, by subsidies provided by the South African government through NIPMO for patenting related costs, and by R&D investments into targeted sectors, in particular, biotechnology. The IPR-PFRD Act obliges IP creators working on any publicly financed R&D to protect any IP emanating from their research, and in cases where the IP creator is at a public institution for such institution to be the assignee of the IP. In addition, the IPR-PFRD Act makes provision for financial support for patenting by institutions. In this regard, NIPMO has reported that, since the enactment of the IPR-PFRD Act, it has provided a total of R62m to publicly financed institutions towards patent subsidies (see Faul, 2015). Ictu and Essop (2012) also note that:

> *"between 2004 and 2007, government allocated R450 million in public funding for biotech development. Most of this funding was directed towards promotion of the development of biotechnology knowledge, skills, capacities and tools in South Africa."*

In general, South Africa had an average filing rate of about 300 PCT applications per year over the 20-year period. In terms of PCT applications, publicly financed institutions increased their patenting from just under 5% of all PCT applications in 1996-2005, to almost 15% of all PCT applications made by South Africans in the period 2006-2015. In as far as the USPTO is concerned, the patenting rate based on patents granted so far, is in the region of 100 per annum. In this case, publicly financed institutions increased their patenting from 4% (1996-2005) to almost 20% (2006-2015). What is particularly interesting is the fact that the numbers of patents in the 2006-2015 period appear to be far less than in the period 1996-2015, in the case of priority-based applications, but almost the same in the case of named South African inventor addresses. When it comes to the EPO patents, the average level of patenting over the 20-year period was about 50 patents per annum, with far less patents in the 2006-2015 compared to 1996-2005. This could be attributed to more of the applications still to be granted. Alternatively, it would appear that there is a growing use of other foreign jurisdictions for claiming priority and/or direct filing without claiming priority by South Africans. In the case of EPO patents, publicly financed institutions again exhibited growth of their patenting activities from about 7% to about 22% (Inventor address) and 16% (priority data) in the periods 1996-2005 and 2006-2015, respectively.

An analysis of both local and international patent applications or patents emanating from South Africa has clearly demonstrated an increase in terms of filings by publicly financed institutions, although this has tapered off in the last couple of years, in line with the tapering off in general of overall data. A number of reasons that can be advanced for this include (i) growing pains in the implementation of the IPR-PFRD Act (as documented by Bansi and Reddy (2015:194), (ii) the financial crisis, (iii) changes in institutional arrangements within South Africa's innovation landscape, and (iv) sluggish growth in R&D output. It is also submitted that the decline can be largely attributed to the financial crisis facing the South African economy and in particular to the higher education sector as well as institutional rearrangements, and in particular, the vacuum created by the challenges that TIA faced in recent years. The Innovation Fund that used to support patenting activity within South Africa's innovation ecosystem was merged into TIA at its establishment in 2010, at the same time that NIPMO was also established. Whereas there had been certainty in terms of financial support being provided to public institutions for patent protection during the Innovation Fund era, a lacuna appears to have been created in the transition to TIA and NIPMO, both of which assumed different IP related functions of the then Innovation Fund. This view appears to be supported by the Ministerial Review (2012:129), which found that:

> *"The Technology Innovation Agency has taken too long to become operationalized and has thus introduced further delays and uncertainties for beneficiaries…"*

Whereas the institutions other than the CSIR, i.e. particularly HEIs, did not do much patenting in the period 1996-2005, their patenting activity has dramatically increased since then. The lack of evidence of patenting activity by publicly financed institutions in 1996-2005 could be attributed to a number of reasons, which include:

(i) most of the patents were filed in the name of the inventors;
(ii) the funders claimed rights to the intellectual property and as such the patents were in their name (a case in point is the Water Research Commission, which was an assignee/applicant to a number of patents in the period 1996-2005 – see **Figures 7.32** and **7.33**;

(iii) the R&D conducted by these institutions did not lend itself readily viable for patenting; and
(iv) there was a low appreciation of the importance of patenting.

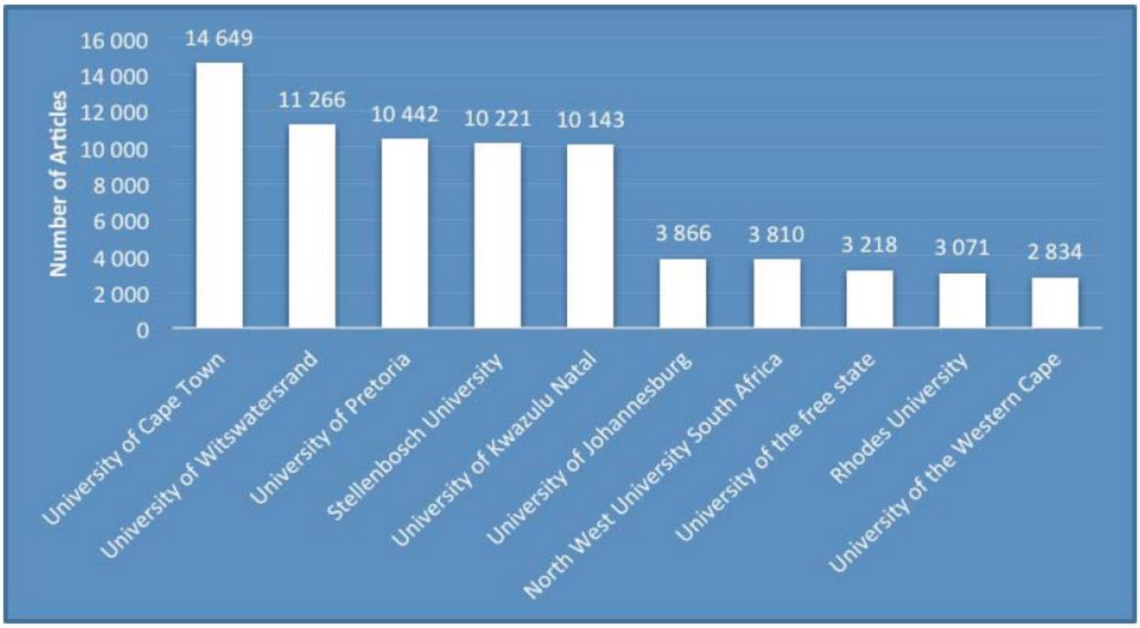


Figure 7.77: Most Prolific Universities by publications in the period 2005 – 2014 [Source: NACI (2015)]

The patenting activity appears to be aligned with the publication output of the top ten HEIs (**Figure 7.77**). The following universities with the most publications also feature as being prolific in patenting: Stellenbosch University, the University of the Witwatersrand, the University of Cape Town, NorthWest University, the University of Pretoria, the University of the Free State, and the University of KwaZulu Natal. Other than the above, other emerging universities with the potential to have high patenting activity (based on PCT filings – see **Figure 7.21** and **7.22**), include the University of Johannesburg, Tshwane University of Technology, the University of the Western Cape, Vaal University of Technology, Nelson Mandela Metropolitan University, and the Cape Peninsula University of Technology. Whereas the University of Johannesburg filed nine PCT applications in the period 1996-2005, essentially more than the University of Stellenbosch, NorthWest University, and the University of the Witwatersrand, in the period 2006-2015, it filed fewer patent applications, whereas these other universities significantly increased their PCT patent applications, compared to 1996-2005. With the exception of Rhodes University, which does not seem to have any patents (EPO and USPTO) or PCT patent applications in the period 2006-2015, the other universities, which are considered to be the most research-intensive universities, have in essence demonstrated an increase in their R&D outputs in the form of publications, patent applications and patents. The increase in patenting by publicly financed institutions can be attributed to the implementation of the IPR-PFRD Act, which is aligned with the objectives of the NRDS (2002), in particular, with ownership of IP emanating from publicly financed R&D. The IPR-PFRD Act is similar in form to the USA Bayh-Dole,[191] particularly in respect of the ownership rights and a preference for licensing of IP emanating from publicly financed R&D as the preferred mode of commercialisation. However, unlike the Bayh-Dole, it contains specific provisions relating to assignment of IP, thus providing a means for the private sector to own IP directly that had been initially owned by publicly financed institutions.

The CSIR's dominance in the list of top assignees/applicants is not surprising, given its status as the largest multi-disciplinary cross-sectorial public research institution.[192] However, the CSIR does not have very distinct technology clusters anchored by a high concentration of patents or patent applications. When one considers the CSIR patent portfolio together with that of the universities, there are some indications that biotechnology could be a potential area where the CSIR could build such clusters.

Conversely, Sasol's dominance is also not surprising given its significant R&D investments,[193] and its stature as a leading global petrochemical company. Element Six (formerly De Beers Industrial Diamonds), still features as a major assignee in PCT applications, EPO and USPTO patents. Its patent activity seems to have slowed down in the period 2006-2015. This may be attributed to significantly reduced business activity and

191 The Bayh-Dole Act of 1980 (Patent Rights in Inventions Made with Federal Assistance) - 35 U.S.C. § 200-212; 37 C.F.R. Part 401

192 www.csir.co.za [Last accessed on 5 June 2017]

193 According to a press release dated 09 November 2012, *"Sasol's current combined capital and operational expenditure for Sasol Technology's R&D function is over R1 billion a year, of which over 90% is invested in South Africa."* Available at http://www.sasol.co.za/media-centre/media-releases/sasol-boosts-research-and-technology-south-africa [Last accessed on 8 November 2016]

in particular to R&D being undertaken in South African by Element Six, following its relocation of its R&D laboratories from Johannesburg to its production centre in Springs, east of Johannesburg, in 2001/2002. What is perhaps significant is that, other than Sasol and Element Six, there appears to be a paucity of large private sector companies patenting through the PCT process, the EPO, or the USPTO.

An important development is the emergence of Discovery Holdings in the Top 20 Assignees, both in terms of PCT applications and USPTO patents. However, Discovery does not exhibit the same patenting activity in the EPO, and to date, no patents appear to have been granted by the EPO to Discovery Holdings. This could be explained by market or commercial decisions by Discovery Holdings and/or differences in rules between the EPO and USPTO in terms of the patenting of subject matter related to business methods or computer implemented inventions.

Another important finding is the increased number of patents owned by non-South African companies, which cite one or more South African inventors. This is very evident when comparing the Inventor Address to Priority Country data, with most of these assignees not relying on a South African priority filing for their subsequent patenting activities. Some of these companies include: Amazon Tech, VISA International Services, IBM, Oracle In Corp, Joy MM Delaware Inc., and Baker Hughes Inc. This finding suggests that South Africa has pockets of excellence or capabilities in the areas in which these companies are patenting. There are opportunities for South African institutions to partner with these foreign companies so as to strengthen their capabilities in the relevant research areas, and thus enhance South African owned IP, that could then see value being created through South Africa licensing its own IP abroad, or attracting these companies to establish local R&D centres.

An interesting observation relates to the differences in patent applications and/or patents between those claiming priority and those that cite an inventor with a South African address. The later patents that have a non-South African assignee (i.e. address of assignee not in South Africa), are often not included in official patent statistics and therefore account for the discrepancy between the official statistics and the results of the analysis undertaken in this study. An example of such patents is WO2009082379A2, where the company is based in the US; this is where they filed first, but all their inventors are based in South Africa. Clearly, in this case, the research was done in South Africa but the organisation the inventors were working for is a non-South African organisation.

The level of patenting by spinouts of publicly financed institutions appears to be insignificant; only the following have at least three (3) PCT applications and/or EPO/USPTO patents associated with such institutions: Technology Finance Corporation and Implico BV (see Sibanda, 2007:23) (CSIR), Insiava (University of Pretoria), PST Sensors (University of Cape Town). It is possible that most spinouts from publicly financed institutions either do not have any patents but rather rely on copyright, trade secrets and designs or they may have fewer than two PCT applications, or USPTO or EPO patents. For example, Sibanda (2009: 128) observed that:

> *"Generally, less than half of the start-up companies are based on patents, with know-how and technology packages playing a more significant role in their establishment."*

The lower number of start-ups based on patents compared to other forms of intellectual property could be attributed to a variety of possible reasons, including but not limited to, patent-based start-ups requiring significantly more investments to take their products to market, ease of formation of non-patent-based businesses, need for strong patent portfolio, and growing appreciation of patenting.

IPCs can act as a proxy for areas of technological strength and, in the case of the PCT applications and EPO and USPTO patents, the top IPCs across these portfolios were examined. **Schedule A** summarises all the top 20 IPCs in which South African patent applications were filed and the EPO/USPTO patents granted in the period 1996-2015. These IPCs have been reviewed in light of the OECD categorisation of technologies by IPCs, **Table 7.3**, as well as proposed categorisation by Schmoch (2008) (see **Table 7.4**).

Table 7.3: Top IPCs of South African PCT patent applications and EPO/USPTO patents matched to OECD patent database classification of ICT and Biotechnology Fields[194]

TECHNOLOGY FIELD ACCORDING TO OECD PATENT DATABASE		IPCs	TOP IPCs BY PCT APPLICATIONS AND EPO/EPO PATENTS BY SOUTH AFRICANS
BIOTECHNOLOGY	Biotechnology	A01H1/00,A01H4/00,A61K38/00,A61K39/00,A61K48/00,C02F3/34,C07G(11/00,13/00,15/00),C07K(4/00,14/00,16/00,17/00,19/00),C12M,C12N,C12P,C12Q,C12S,G01N27/327,G01N33/(53*,54*,55*,57*,68,74,76,78,88,92)	A61K, C07K, C12M, C12N, C12Q, G01N
ICT SECTOR	Consumer electronics	G11B,H03F,H03G,H03J,H04H,H04N,H04R,H04S	
	Computers, office machinery	B07C,B41J,B41K,G02F,G03G,G05F,G06,G07,G09G,G10L,G11C,H03K,H03L	
	Telecommunications	G01S,G08C,G09C,H01P,H01Q,H01S3/(025,043,063,067,085,0933,0941,103,133,18,19,25),H1S5,H03B,H03C,H03D,H03H,H03M,H04B,H04J,H04K,H04L,H04M,H04Q	H04M
	Other ICTs	G01B,G01C,G01D,G01F,G01G,G01H,G01J,G01K,G01L,G01M,G01N,G01P,G01R,G01V,G01W,G02B6,G05B,G08G,G09B,H01B11,H01J(11/,13/,15/,17/,19/,21/,23/,25/,27/,29/,31/,33/,40/,41/,43/,45/),H01L	H01L

Table 7.4: Top IPCs of South African PCT patent applications and EPO/USPTO patents matched to the technology fields proposed by Schmoch (2008)

TECHNOLOGY FIELD ACCORDING TO SCHMOCH (2008)		IPCs	TOP IPCs BY PCT APPLICATIONS AND EPO/EPO PATENTS BY SOUTH AFRICANS
CHEMISTRY, PHARMACEUTICALS	Organic fine chemistry	C07C, D, F, H, J, K	C07C, C07D, C07H, C07K,
	Macromolecular chemistry, polymers	C08B, F, G, H, K, L; C09D, J	C08K, C08L, C09D
	Pharmaceuticals, cosmetics	A61K, A61P	A61K, A61P
	Biotechnology	C07G; C12M, N, P, Q, R, S	C12M, C12N, C12Q,

194 https://www.oecd.org/sti/inno/40807441.pdf [Last accessed on 12 December 2016]

	Agriculture, food chemistry	A01H; A21D; A23B, C, D, F, G, J, K, L; C12C, F, G, H, J; C13D, F, J, K	
	Chemical and petrol industry, basic materials chemistry	A01N; C05; C07B; C08C; C09B, C, F, G, H, K; C10B, C, F, G, H, J, K, L, M, N; C11B, C, D	A01N, C09K, C10G
	Surface technology, coating	B05C, D; B32; C23; C25; C30	B32B
	Materials, metallurgy	C01; C03C; C04; C21; C22; B22, B82	C01B, C04B, C22B, C22C
ELECTRICAL ENGINEERING	Electrical machinery and apparatus, electrical engineering	F21; G05F; H01B, C, F, G, H, J, K, M, R, T; H02; H05B, C, F, K	
	Audio-visual technology	G09F, G; G11B; H03F, G, J; H04N-003, 005, 009, 013, -015, -017, R, S	G09F
	Telecommunications	G08C; H01P; Q; H03B, C, D, H, K, L, M; H04B, H, J, K, L, M, N-001, 007, -011, Q	H04L
	Information Technology	G06; G11C; G10L	G06F, G06K, G06Q
	Semiconductors	H01L, B81	H01L
INSTRUMENTS	Optics	G02; G03B, C, D, F, G, H; H01S	
	Analysis, measurement, control technology	G01B, C, D, F, G, H, J, K, L, M, N, P, R, S, V, W; G04; G05B, D; G07; G08B, G; G09B, C, D; G12	G01N, G01R,
	Medical technology	A61B, C, D, F, G, H, J, L, M, N	A61B, A61F
	Nuclear engineering	G01T; G21; H05G, H	G21C
PROCESS ENGINEERING, SPECIAL EQUIPMENT	Chemical engineering	B01B, D (without -046 to -053), F, J, L; B02C; B03; BO4; B05B; B06; B07; B08; F25J; F26	B01D, B01F, B01J
	Materials processing, textiles, paper	A41H; A43D; A46D; B28; B29; B31; C08J; C14; D01; D02; D03; D04B, C, G, H; D05; D06B, C, G, H, L, M, P, Q; D21	B28C, B29C, B29D, C08J, D21H, D21J
	Handling, printing	B25J; B41; B65B, C, D, F, G, H; B66; B67	B65D
	Agricultural and food processing, machinery and apparatus	A01B, C, D, F, G, J, K, L, M; A21B, C; A22; A23N, P; B02B; C12L; C13C, G, H	
	Environmental technology	A62D; B01D-046 to -053; B09; C02; F01N; F23G, J	B01D, C02F
MECHANICAL ENGINEERING,	Machine tools	B21; B23; B24; B26D, F; B27; B30	B27K, B27N,
	Engines, pumps, turbines	F01B, C, D, K, L, M, P; F02; F03; F04; F23R	
	Thermal processes and apparatus	F22; F23B, C, D, H, K, L, M, N, Q; F24; F25B, C; F27; F28	
	Mechanical elements	F15; F16; F17; G05G	F16L

	Transport	B60; B61; B62; B63B, C, H, J; B64B, C, D, F	B64C
	Space technology, weapons	B63G; B64G; C06; F41; F42	F42B, F42D
CONSUMPTION	Consumer goods and equipment	A24; A41B, C, D, F, G; A42; A43B, C; A44; A45; A46B; A47; A62B, C; A63; B25B, C, D, F, G, H; B26B; B42; B43; B44; B68; D04D; D06F, N; D07; F25D; G10B, C, D, F, G, H, K	A63B,
	Civil engineering, building, mining	E01; E02; E03; E04; E05; E06; E21	E04H, E21C, E21D

It is evident from the above that there are a number of technology areas in which South Africans are patenting in. B01J represents the bulk of the patents by both Element Six and Sasol Tech (the latter also accounting for patents in C07C, C10G). Of particular relevance is the patent portfolio in biotechnology broadly (comprising almost 20% of all patents in the top 20 IPCs in the period 2006-2015, see **Figures 7.16, 7.18, 7.40** and **7.41** on the basis of the OECD technology field classification, c.f. **Table 7.1**), including pharmaceuticals and cosmetics as well as macromolecular chemistry, polymers, organic fine chemistry, materials and metallurgy.

Whereas the ICT technology field represented by G06F, G06K and G06Q features prominently in the PCT applications and USPTO patents (comprising almost 25% of all patents in the top 20 IPCs in the period 2006-2015, see **Figures 7.16, 7.18, 7.40** and **7.41**), these IPCs are missing in the top 20 IPCs of EPO patents for the same period. However, they comprise less than 4% of the top IPCs in the period 1996-2015 (see **Figure 7.56**). Reasons for this include the fact that (i) patentees in the PCT and USPTO include USA based companies that did not extend the patents to Europe; (ii) Europe is not seen as an attractive market for the technologies covered by these patents, and (iii) the patent rules at the EPO may be more restrictive than those of the USPTO in respect of patenting of ICT and in particular financial services inventions. A particular finding from the analysis of the patent data reveals a number of patent applications and patents not owned by South African corporates but with an inventor with a South African address. Most of these are in the ICT sector.

When one considers the various policy and strategy frameworks that South Africa has put into place, what one would expect is to see significant patent portfolios in the technology fields covered by these policies and strategies. The distinct biotechnology sector, and in particular, pharmaceuticals and medical technology, largely anchored by publicly financed institutions (comprising the CSIR and a handful of universities), could be attributed to the implementation of the Biotechnology Strategy (2001), the 10-Year Innovation Plan (i.e. one of the five Grand Challenges, Farmer to Pharma). These strategies are driven by the DST and its agencies. Another technology field, where there are some patent clusters, is nuclear energy.

A comparative analysis of USPTO patents granted to BRICS countries in the five-year period 2011-2015 (**Table 7.2**), illustrates that the top five technology fields in the BRICS countries other than China comprise the *"drug, bio-affecting and Body Treating composition",* thereby providing opportunities either for collaboration or licensing. The data processing field features as the second technology field by number of patents granted to South Africans. At least half of the top 10 technology fields in which South Africa has patents in the USPTO in the period 2011-2015, would appear to be niche areas for South Africa:

(i) Abrasive Tools making process, material, or composition;
(ii) Chemistry: Fischer-Tropsch processes; or purification or recovery of products thereof;
(iii) mining or in-situ disintegration of hard material; and
(iv) ammunition and explosives.

Others are potential niche areas, since none of the BRICS countries have these technology fields featuring in their top 10 technology fields of patents granted by USPTO in the period 2011-2015 (see **Table 7.2**) include:

(i) amusement devices: games; and
(ii) prosthetics.

7.8 CONCLUSIONS

Although patenting by South Africans has remained fairy stagnant over the past 20 years, there would appear to be some promising changes over the past 10 years (2006-2015) with particular regard to both top assignees as well as top IPCs. There are pockets of excellence that can be developed further and strengthened. However, South Africa does lag behind the other BRICS countries in terms of patenting in the USPTO and PCT.

The stagnation of patenting at the local South African office, particularly by South Africans, over the period 1996-2015 needs to be addressed urgently through increased awareness and use of the patenting system, in order to build niche technology clusters in South Africa. Patenting by institutions has increased, particularly in the period 2006-2015. This would appear to be due to heightened awareness of the benefits of IP because of the IPR-PFRD Act and the accompanying support provided by NIPMO, as we will see in the next two chapters. Notwithstanding this development, commercialisation of IP by the institutions should be prioritised in order for IP to be able to influence the NSI.

The study reveals the presence of both strong and emerging technology clusters, as detailed in **Table 7.2**. The three strong clusters also happen to be industry led and comprise the following: Abrasives/Diamonds and Chemistry/Petrochemicals, and Financial Services. The patent landscape also reveals a nascent Biopharmaceuticals/Biotechnology cluster, anchored by institutions, with very little private sector involvement, at least in as far as the patent analysis could reveal. The investment into the Biotechnology sector as part of the Biotechnology Strategy (2001) as well as the TYIP (2008) would appear to have resulted in an increased patent portfolio. Whereas the second most prominent area of patenting by institutions appears to be in Electronics/ICT, this area also has some industry participation. Other growth areas based on the patent data in this **Chapter 7** would appear to be in the services sector, in particular ICT, amusement devices and games, and prosthetics.

The study has thus far shown that there are a significant number of PCT applications, EPO and USPTO patents with a South African resident inventor but assigned to a non-South

African domiciled corporate. These tend to be largely in the financial services sectors, and to have an inventor with a South African address.

In the next chapter, the study explores the commercialisation of the IP portfolio and changes in the NSI because of both the IP system as well as looking at the innovation policies detailed in **Chapter 6**.

SCHEDULE A: Main IPCs in which South African Applications filed PCT Applications and had USPTO and EPO Patents [Source: Author generated from analysis using Thomson Innovation patent database, 2016]

SECTION (SUB-SECTION)	SUB-CLASS (DESCRIPTION)
A (HUMAN NECESSITIES)	A01N (preservation of bodies of humans or animals or plants or parts thereof; biocides, e.g. as disinfectants, as pesticides or as herbicides; pest repellants or attractants; plant growth regulators) A61B (diagnosis; surgery; identification) A61F (*filters implantable into blood vessels*; *prostheses*; *devices providing patency to, or preventing collapsing of, tubular structures of the body, e.g. stents*; *orthopaedic, nursing or contraceptive devices*; *fomentation*; *treatment or protection of eyes or ears*; *bandages, dressings or absorbent pads*; *first-aid kits*) A61K (*preparations for medical, dental, or toilet purposes)* A61P (specific therapeutic activity of chemical compounds or medicinal preparations)
B (PERFORMING OPERATIONS; TRANSPORTING)	B01D (separation) B01J (*chemical or physical processes, e.g. catalysis, colloid chemistry*; *their relevant apparatus)* B64C (aeroplanes; helicopters) B65D (containers for storage or transport of articles or materials, e.g. bags, barrels, bottles, boxes, cans, cartons, crates, drums, jars, tanks, hoppers, forwarding containers; accessories, closures, or fittings therefor; packaging elements; packages)
C (CHEMISTRY; METALLURGY)	C01B (*non-metallic elements*; *compounds thereof)* C04B (*lime*; *magnesia*; *slag*; *cements*; *compositions thereof, e.g. mortars, concrete or like building materials*; *artificial stone*; *ceramics*; *refractories*; *treatment of natural stone* C07C (*acyclic or carbocyclic compounds*) C07D (*heterocyclic compounds)* C07K (peptides) C07H (*sugars*; *derivatives thereof*; *nucleosides*; *nucleotides*; *nucleic acids*) C10G (cracking hydrocarbon oils; production of liquid hydrocarbon mixtures, e.g. by destructive hydrogenation, oligomerisation, polymerisation; recovery of hydrocarbon oils from oil-shale, oil-sand, or gases; refining mixtures mainly consisting of hydrocarbons; reforming of naphtha; mineral waxes)

	C12N (micro-organisms or enzymes; compositions thereof) C12Q *(measuring or testing processes involving enzymes or micro-organisms*; *compositions or test papers therefor*; *processes of preparing such compositions*; *condition-responsive control in microbiological or enzymological processes)* C22B (*production or refining of metals*, *pre-treatment of raw materials)* C22C (alloys)
D (TEXTILES; PAPER)	D21H (pulp compositions; impregnating or coating of paper; paper not otherwise provided for) D21J (fibreboard; manufacture of articles from cellulosic fibrous suspensions or from papier-mâché)
E (FIXED CONSTRUCTIONS)	E04H (*Buildings or like structures for particular purposes*; *swimming or splash baths or pools*; *masts*; *fencing*; *tents or canopies, in general, specially adapted for cleaning (cleaning devices peculiar to vessels)* E21B (*earth or rock drilling; obtaining oil, gas, water, soluble or meltable materials or a slurry of minerals from wells)* E21D (shafts; tunnels; galleries; large underground chambers)
F (MECHANICAL ENGINEERING; LIGHTING; HEATING; WEAPONS; BLASTING)	F42B (explosive charges, e.g. for blasting; fireworks; ammunition) F42D (blasting)
G (PHYSICS)	G01N (*investigating or analysing materials by determining their chemical or physical properties* G06F *(*electric digital data processing) G06K (recognition of data; presentation of data; record carriers; handling record carriers) G06Q (Data processing systems or methods, specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes; systems or methods specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes, not otherwise provided for) G21C (nuclear reactors)
H (ELECTRICITY)	H01L (electronics/semi-conductors) H04L (transmission of digital information, e.g. telegraphic communication)

APPENDIX 1: USPTO patent applications by the BRICS countries [Source: USPTO database statistics]

BRICS COUNTRY	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Brazil	156	115	145	134	165	186	220	219	243	259	287	295	341	375	442	464	568	586	679	769	810	855
China, People's Republic of	100	144	142	117	181	257	469	626	888	1034	1655	2127	3768	3903	4455	6879	8162	10545	13273	15093	18040	21386
India	70	91	115	137	180	271	438	643	919	1164	1303	1463	1923	2387	2879	3110	3789	4548	5663	6600	7127	7976
Russian Federation	206	221	254	249	273	388	382	433	377	341	334	366	412	444	547	522	606	719	888	959	1007	991
South Africa	238	187	189	174	211	179	209	231	241	224	246	197	231	252	265	318	320	339	318	415	375	352

APPENDIX 2: USPTO granted patents of BRICS countries [Source: USPTO database statistics]

BRICS COUNTRY	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Brazil (BR)	121	90	101	103	175	215	196	254	334	323
Russia Federation (RU)	172	188	176	196	272	298	331	417	445	440
India (IN)	481	546	634	679	1098	1234	1691	2424	2987	3355
China (CN)	661	772	1225	1655	2657	3174	4637	5928	7236	8116
South Africa (ZA)	109	82	91	93	116	123	142	161	152	166

CHAPTER 8: PERFORMANCE OF THE SOUTH AFRICAN INNOVATION SYSTEM

"It is not the strongest of the species that survive, nor the most intelligent, but the ones most responsive to change." – Charles Darwin

8.1 INTRODUCTION

Patent statistics on their own are a misleading indicator of innovation, unless there is a proper understanding of the extent to which the patents are commercialised, as insightfully explained by Johnson (2005:22):

> *"'the value of patent varies widely. The vast majority of patents are worth relatively little, but a few are incredibly valuable. Second, the skewed distribution of patent values make patents counts an imperfect measure of innovation; however, patent renewal data can be used to weight[sic] the more valuable patents to help reduce the measurement error. Survey data and other methods can also be developed to improve the precision of patent counts as a measure of innovation.*

Given the low number of patents that South Africa has registered in the period covered by the study, it is important to emphasise the use of patents as a tool for potential competitiveness. In time once patents are seen as a tool for development within the NSI and a culture of patenting has been inculcated, this study is of the view that the emphasis within the NSI should then shift towards more quality patents. These patents could then be commercialised through licensing and start-up formation (particularly in the case of institutions and non-corporate inventors), as well as their strategic use by corporates to sustain growth and ensure the competitiveness of their products and processes, including warding off infringements. Within this context, the performance of South Africa's innovation system over the 20 years from 1996 to 2015 is reviewed, with a particular emphasis on the more recent past ten years (2006 to 2015). The review considers South Africa's investments in R&D over the same period and, in an effort to establish a linkage between the IP and innovation systems, also looks at the extent of commercialisation of IP, and in particular, at the performance of publicly financed institutions that fall within the ambit of the IPR-PFRD Act. This Chapter will also review commercialisation outcomes in respect of publicly financed R&D as well as the relevance of institutional frameworks that have been established to date, at publicly funded academic and research institutions. In order to also understand the performance of South Africa innovation system, it is important to look at the trends in respect of a number of indicators, in particular, the competitiveness index, entrepreneurship and innovation indices.

A proper analysis of South Africa's performance requires a much longer period, viz. at least five years, as investments in R&D take much longer to become outputs in terms of publications and patents. In addition, the conversion of these outputs into real products and services will also require a much longer period. Another important aspect of assessing South Africa's performance is the extent to which it has been able to bridge the *"innovation chasm"* mentioned in the NRDS (2002), **(Figure 8.1)** in the three main areas of skills, culture, and funding, to be able to ensure the translation of R&D outputs into South African products and services.

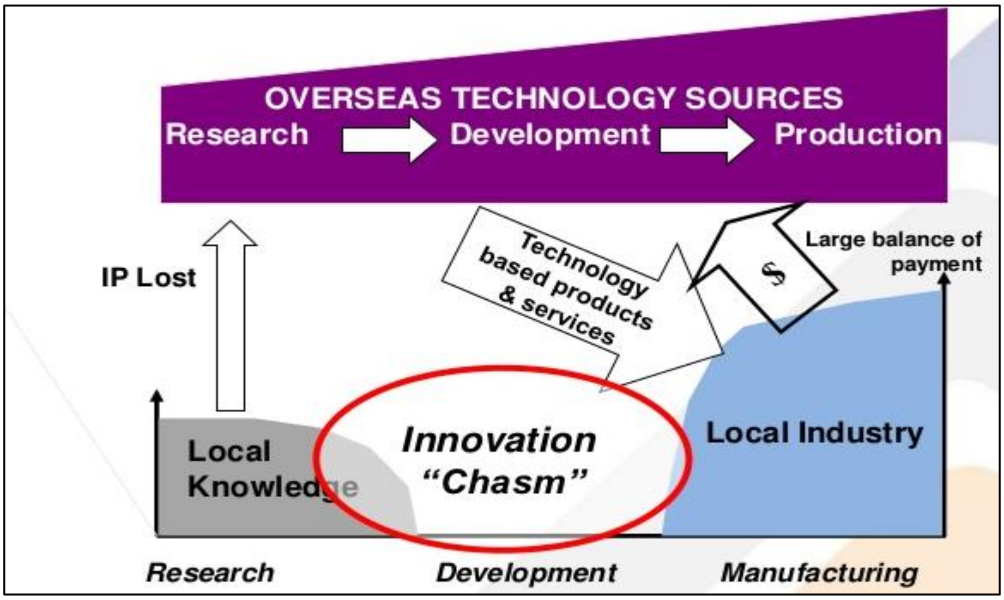


Figure 8.1: Diagrammatic Representation of "the Innovation Chasm" [Source: NRDS (2002: 35)]

Where relevant, this chapter will also provide a comparative analysis of South Africa's performance in relation to the other BRICS countries, particularly where there are global indicators in place.

8.2 KNOWLEDGE PRODUCTION AND R&D EXPENDITURE

Over the period 1997 to 2015, there has been a threefold increase in *Web of Science* publications by South Africans from 4 585 in 1997 to 14 996 in 2015 (see **Figure 8.2)**. Much of the growth occurred during the ten-year period (2006-2015). This may be attributed to the emphasis on building knowledge production skills, through the focus on PhDs as a key driver for a knowledge economy (DST 10 Year Plan, 2007).

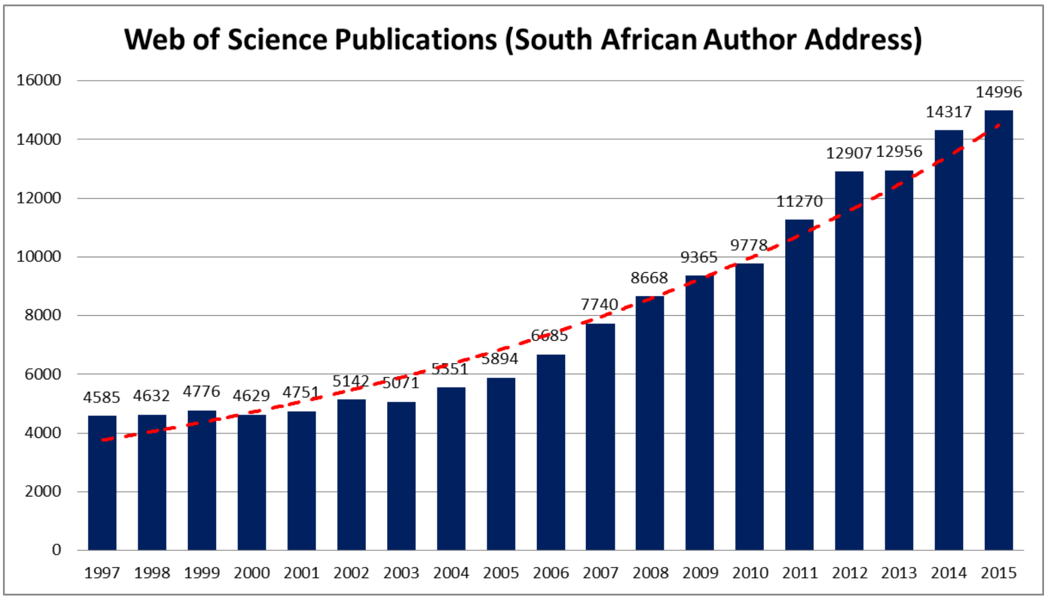


Figure 8.2: *Web of Science* Publications with at least one South African resident author, for the period 1997-2015 [Source: Author-generated from analysis using *Thomson Innovation Web of Science* publications database, 2017]

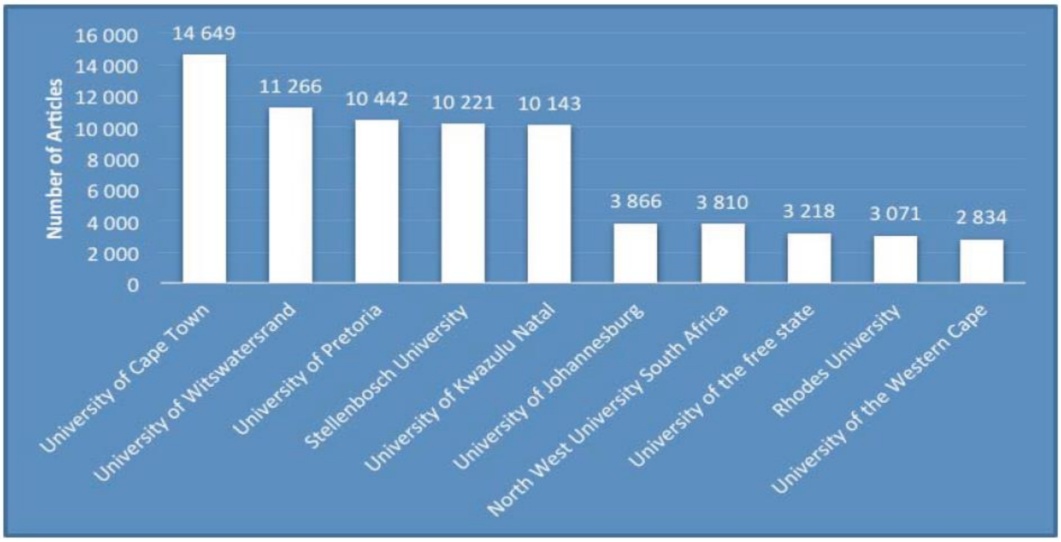


Figure 8.3: Most Prolific HEIs by Publications [Source: NACI (2015:20)]

According to the South African STI Indicators (2015:20), the most dominant HEIs by number of publications are University of Cape Town (UCT), University of the Witwatersrand (WITS), University of Pretoria (UP), Stellenbosch University (SUN), University of KwaZulu (UKZN), University of Johannesburg (UJ), NorthWest University (NWU) and University of Free State (UoFS), as shown in **Figure 8.3**. These results are consistent with the findings of Dudhia *et al.* (2017:), who have interrogated the *Web of Science* publication records shown in **Figure 8.2** to show the distribution of publications over a 20-year period (2006-2015) per HEI, as illustrated in **Figure 8.4**. According to the South African STI Indicators (2015:20), as well as Dudhia *et al.* (2017:4), there has been a linear growth of publications by the top HEIs over the period 2006-2015, with all the HEIs at least doubling their publication rate between 2006 and 2015.

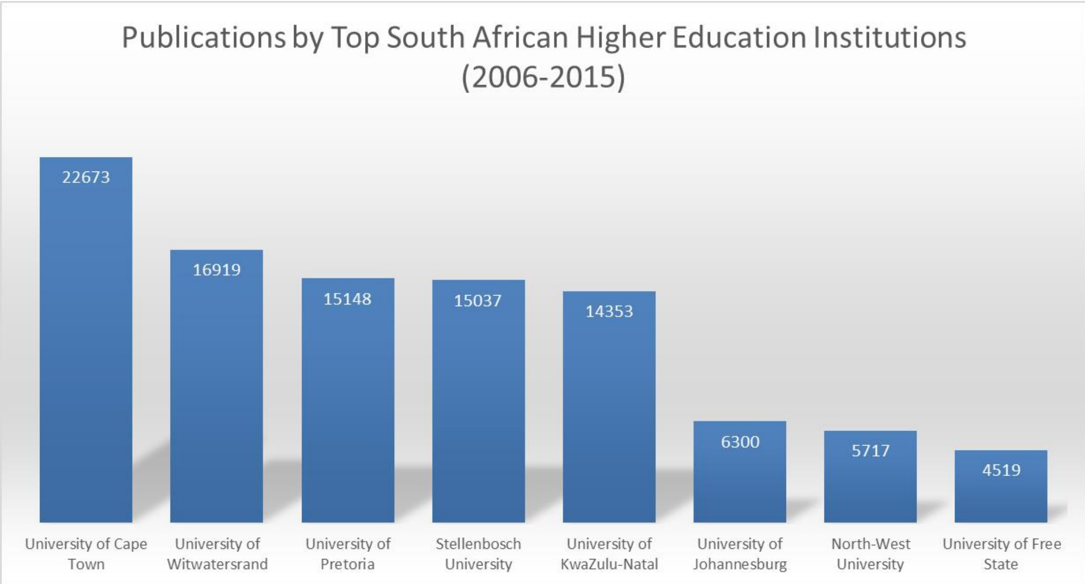


Figure 8.4: Top South African HEI according to publications in Web of Science Core Collection in the period 2006-2015 [Source: Dudhia *et al.* (2017:4)]

Winnink (2016), in a study of scientific 'breakthroughs' in South Africa over the period 1996-2015 (which is the same period covered by this study), documents that South Africa has significantly increased its breakthrough publications since 1996, with Medical and Life Sciences being the dominant areas of these publications (**Figure 8.5**). Three universities, namely UCT, SUN and WITS, accounted for most of these breakthrough publications.

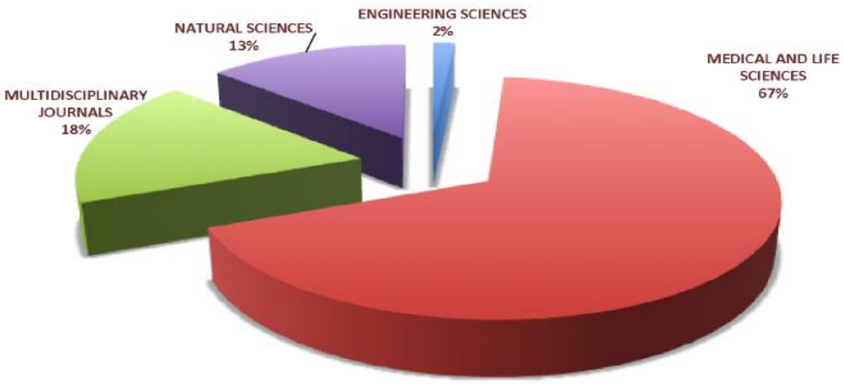


Figure 8.5: Breakthrough publications across science fields (1996-2015) [Source: Winnink (2016)]

Research outputs, as measured by the publications detailed in the NACI (2015:16-17), suggest that South Africa's strengths are in the Natural Sciences, followed by the Medical and Health Sciences and then in the Humanities, when benchmarked on the basis of citations with the BRICS countries, Japan, South Korea, United Kingdom and the United States (see **Figure 8.6**). This is consistent with the findings of this study relating to South Africa's patenting trends abroad (see **Chapter 7**), where most patents of publicly financed institutions are in the Biopharmaceutical/Biotechnology/Natural Sciences/Medical & Health Sciences fields.

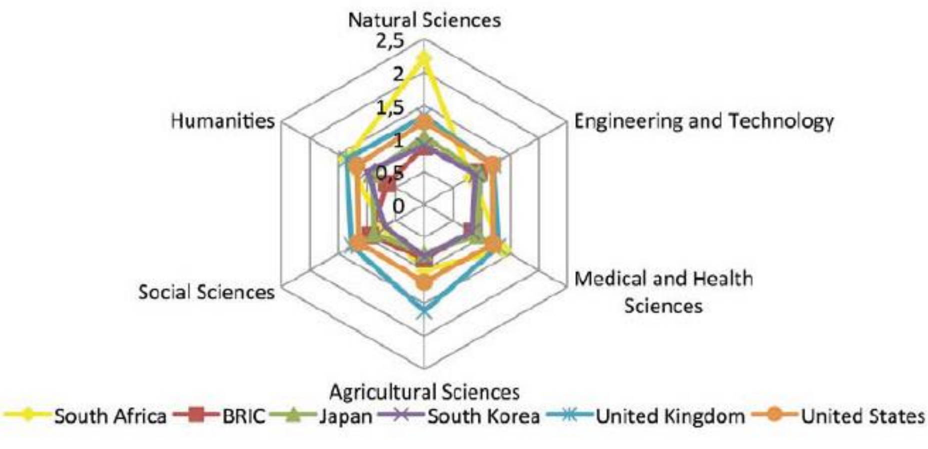


Figure 8.6: Benchmarking of South African Research Impact for Various Fields, 2014 [Source: NACI (2015)]

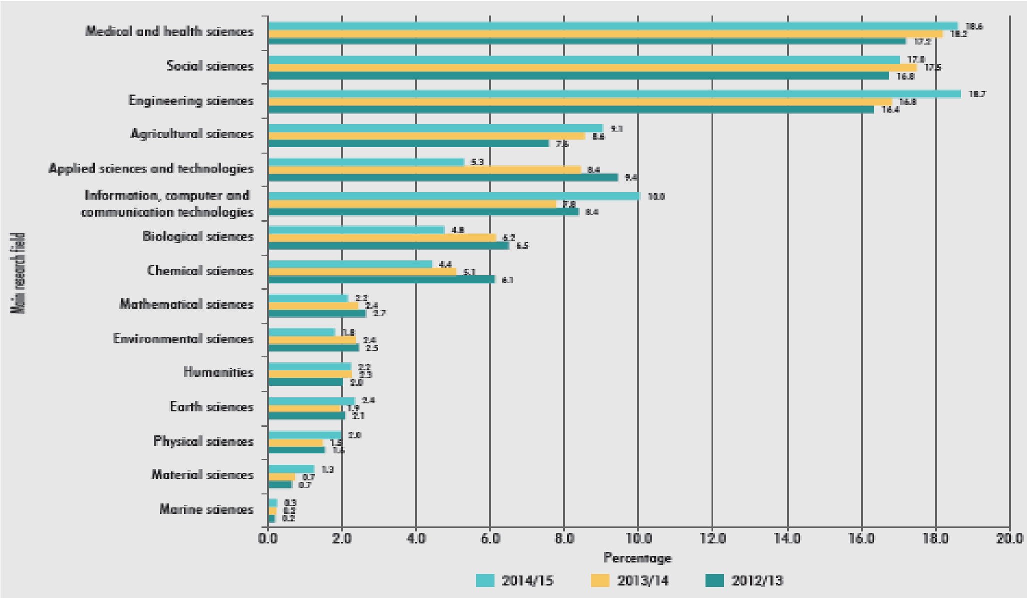


Figure 8.7: GERD by research field (percentage), South Africa 2012/13 to 2014/15 [Source: CeSTII, 2017]

Figure 8.7 shows the Gross Expenditure on Research & Development (GERD) expenditure by research field from data by CeSTII (2017: 17) for the period 2012/13 to 2014/15. The dominant fields in descending order are: (i) Medical and Health Sciences, (ii) Social Sciences, (iii) Engineering Sciences, (iv) Computer and Communications Technologies and Applied Sciences, (v) Agricultural Sciences Information (vi) Biological Sciences and (vii) Chemical Sciences. These areas are aligned with the fields in respect of which South Africa's publications and patents are positioned.

An analysis of the patents granted by USPTO to South Africans in various fields in the period 2005-2014, in terms of the revealed technology advantage (RTA) index,[195] in the NACI (2015:36), is shown in **Figure 8.8**.

195 The revealed technology advantage (RTA) index provides an indication of the relative specialisation of a given country in selected technological domains. Based on patent applications filed under the PCT, it is a country's share of patents in a particular technology field divided by the country's share in all patent fields. The index is equal to zero when the country holds no patent in a given sector; is equal to 1 when the country's share in the sector equals its share in all fields (no specialisation); and above 1 when a positive specialisation is observed. – see https://www.oecd-ilibrary.org/science-and-technology/data/oecd-science-technology-and-industry-outlook/revealed-technology-advantage-in-selected-fields_data-00673-en (last accessed 12 October 2017)

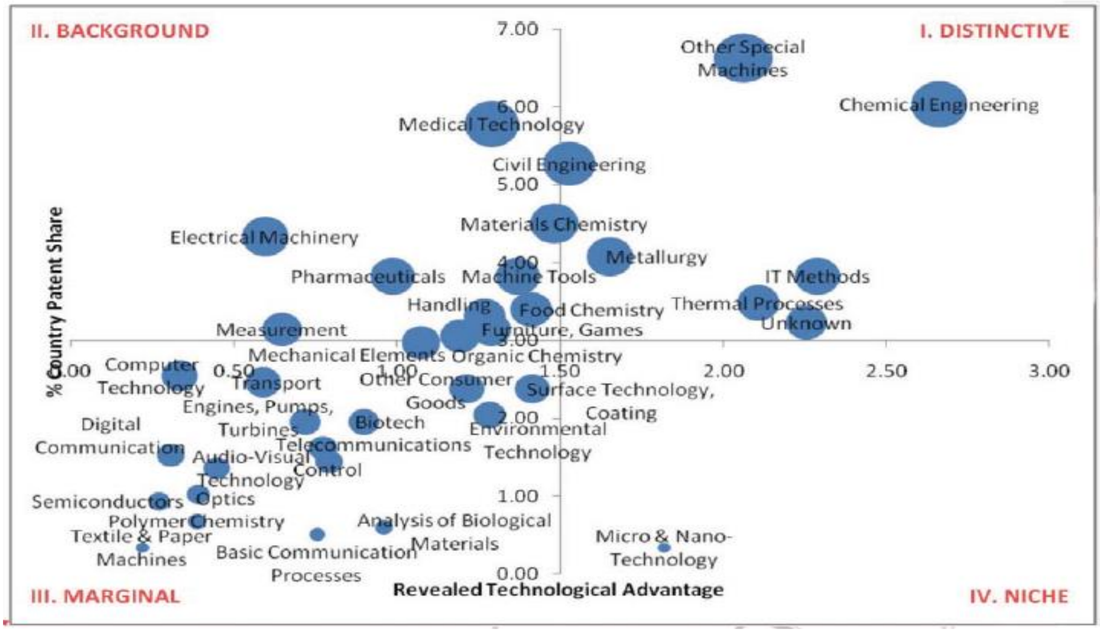


Figure 8.8: Benchmarking of South African Technology Sectors [Source: NACI, 2015]

According to the NACI (2015):

> *"RTA is a country's share of patents in a particular technology field divided by the country's share in all patent fields, such that a value of zero is allocated where there are no patents, and a value of 1 where the country's share in the sector equals its share in all fields and above 1 for positive specialisation."*

The findings in **Chapter 7** in terms of South Africa's performance with regard to patenting internationally are aligned with the South African Science, Technology and Innovation Indicators (SASTI Indicators) benchmark shown in **Figure 8.8**. In reviewing the current South African publication outputs and IP portfolios, as represented by the patent statistics in this study, it is important to interrogate the extent to which these outputs align with South Africa's potential or desired future growth sectors of the economy, as detailed in **Chapter 3**.

Firstly, from an analysis of **Figure 8.8**, this study observes that there are a number of suggestions for South Africa to use its patent portfolio in the *"Background"* quadrant to build strong *"Distinctive"* and *"Niche"* areas, which would provide real competitiveness to South Africa's economy. This may mean deliberate or increased funding by government of projects in the *"Distinctive"* and *"Niche"* quadrants, with a view to developing real capabilities, as supported by larger patent portfolios in these quadrants than in the *"Marginal"* and *"Niche"* quadrants. Secondly, either alternatively and/or in addition, South Africa could adopt an *"in-bound technology transfer"* strategy of licensing in and/or acquiring patent or technology portfolios from elsewhere in these quadrants as a way of strengthening the current patent portfolio, thus building, strengthening and maintaining competitiveness, where there are already existing industries. Thirdly, the review of the Business Expenditure on R&D (BERD) by Standard Industrial Classification (SIC codes) in **Figure 8.7** against overall Gross Expenditure on R&D (GERD), suggests a need for alignment within the NSI.

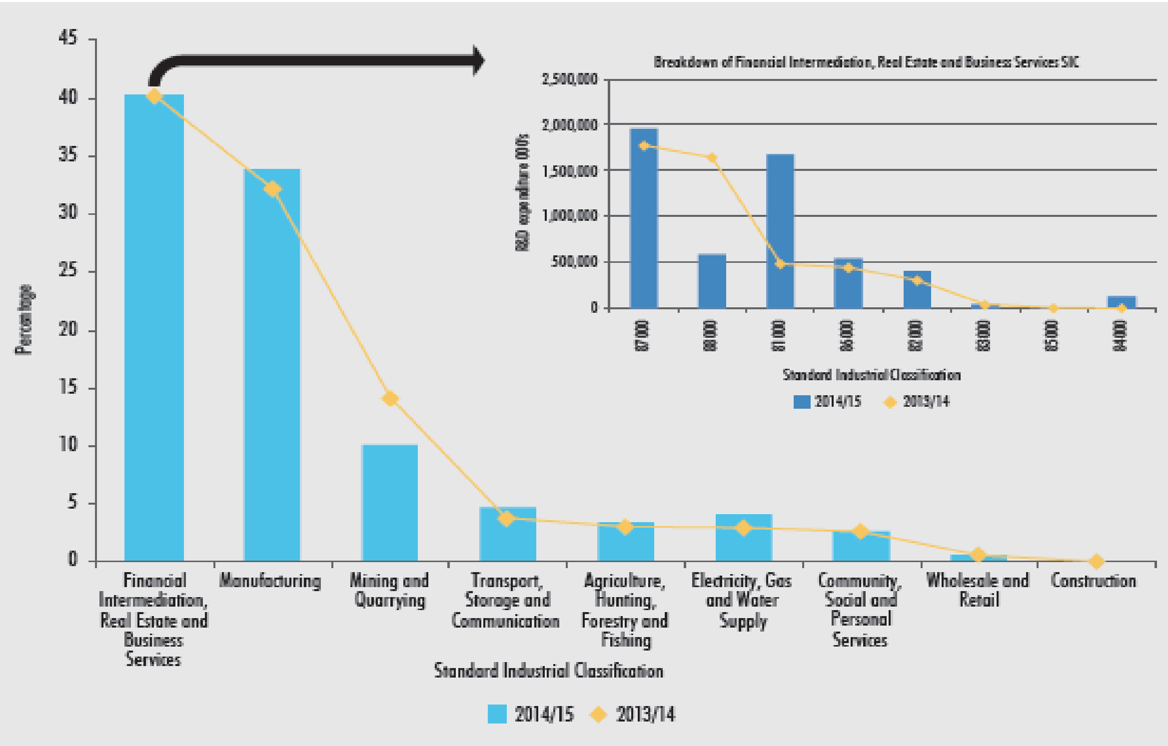


Figure 8.9: BERD by SIC category (percentage), South Africa 2012/13 to 2014/15 [Source: CeSTII, 2017]

In particular, it would appear that there is a need for coherence in terms of what is important in respect of R&D expenditure. BERD has largely been in the services sector (40.1%), where it is aligned with the contribution of the services sector to South Africa's GDP (see **Chapter 3**), with manufacturing accounting for 32.2% of BERD (CeSTII, 2017:20), see **Figure 8.9**.

From the insert in **Figure 8.9**, it can be seen that the largest R&D expenditure in the services sector has been in Research and Development[196] (87 000), in Financial Intermediation, except Insurance and Pension Funding (81 000), in other non-classified business activities (88 000), in Computer and Related Activities (86 000), and in Insurance and Pension Funding, except Compulsory Social Security (8 200). Mining and Quarrying account for a significant portion of BERD, at third place behind Manufacturing.

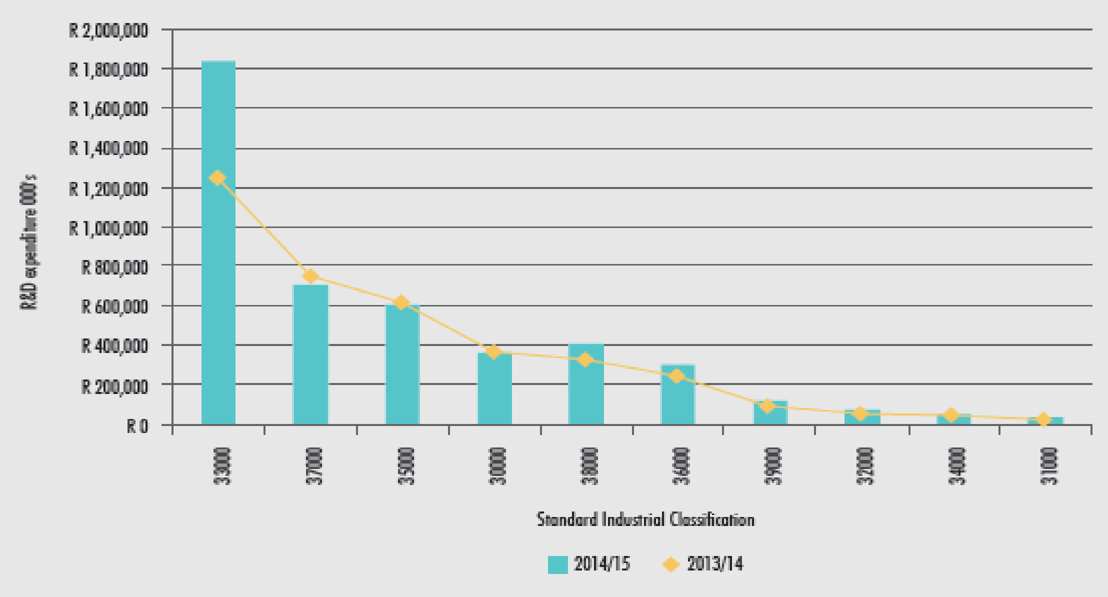
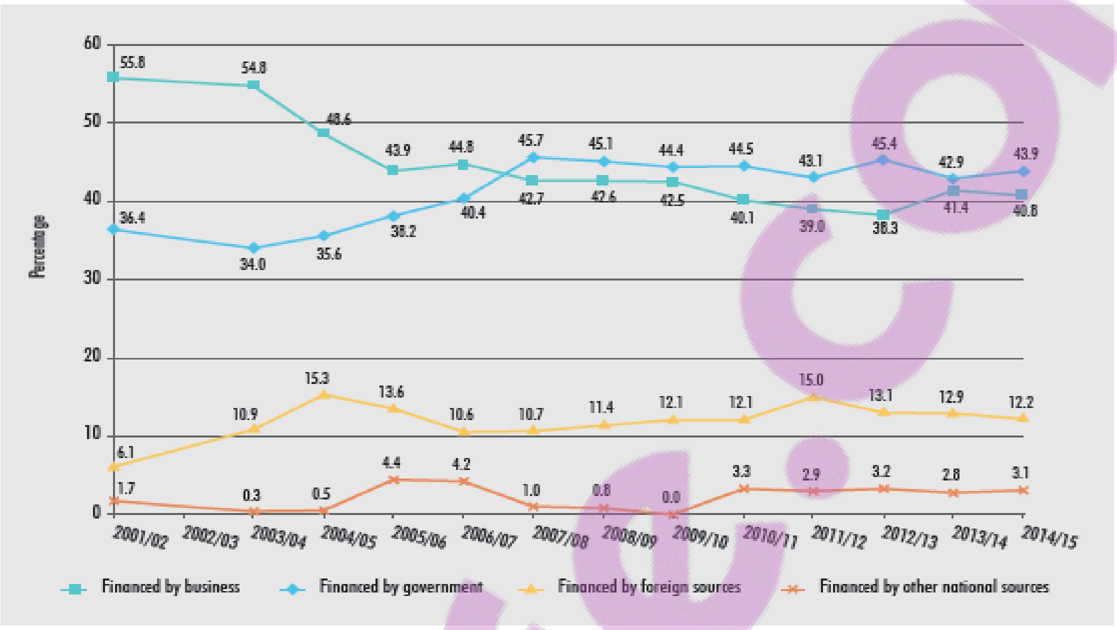


Figure 8.10: BERD by SIC Manufacturing Category (percentage), South Africa 2012/13 to 2014/15 [Source: CeSTII, 2017]

The biggest contributors in the manufacturing sector are shown in **Figure 8.10**. Refined Petroleum, Nuclear Fuel, Chemical Products incl. Pharmaceuticals, Rubber, and Plastics (33 000) comprise the dominant SIC category, which is not surprising, given the significant R&D activities and the dominance of local manufacturing by Sasol, a large South African company that has developed internal strategic IP management competencies. This is supported by the patent statistics set out in **Chapter 7**, where Sasol is the leader in international patent filings and patents by South Africans. Other key Manufacturing SIC Categories in decreasing expenditure are: 37 000 (Communications Equipment & Apparatus, Medical & Precision Instruments), 35 000 (Basic and Fabricated Metal products, Machinery & Equipment, Office, Accounting and Computing), 38 000 (Transport and

196 This is a very broad classification with very little meaning other than to ascribe activities under this category to feasibility studies and work of an exploratory nature

Equipment), 36 000 (Food Products, beverages and Tobacco Products), 39 000 (Furniture, Recycling and Manufacturing not catered for elsewhere), 32 000 (Wood Products, except for furniture, paper products, publishing & printing material), 34 000 (Non-metallic Mineral Products), and 31 000 (Textiles, Clothing and Leather Goods).



Data note	*Other national sources include contributions from higher education, not-for-profit organisations and individual donations. **Government includes science councils.
Data source	National Survey of Research and Experimental Development, 2001/02 to 2014/15

Figure 8.11: GERD by Source of Funding (2001-2015) [Source: CeSTII, 2017]

However, BERD has been on the decline, as can be seen from **Figure 8.11** (CeSTII, 2017:9). Whereas business has traditionally had a higher proportion of GERD, this gap has been narrowing: in 2007/8, government surpassed business, and as of the end of 2014/15, government funding was 43.9% compared to 36.4% (2001/02), and in the case of business, 40.8% (2014/15) compared to 55.8% (2001/02). The other sources of funding have to all intents and purposes remained fairly constant, having grown to a maximum of 18.9% (2011/12). Comparing GERD over the entire period also shows that, whereas government had the second highest expenditure since 2001 in 2012/13, at 45.4%, this has declined slightly since then, accompanied by an increase in business expenditure from 38.3% (2012/13) to 40.8% (2014/15). The latest increase in GERD by business can be attributed to the 150% R&D tax incentive introduced by the Taxation Laws Amendment Act 2011, which came into effect in October 2012.[197].

8.3 HUMAN CAPITAL DEVELOPMENT

The TYIP (2008:34) identified human capital and knowledge generation as being at the very core of knowledge-based economies, and advocated for:

> *"a need to expand R&D activities and to grow research capacity. The goal is an economy in which new knowledge-based industries, and knowledge workers and systems, fuel stronger economic growth."*

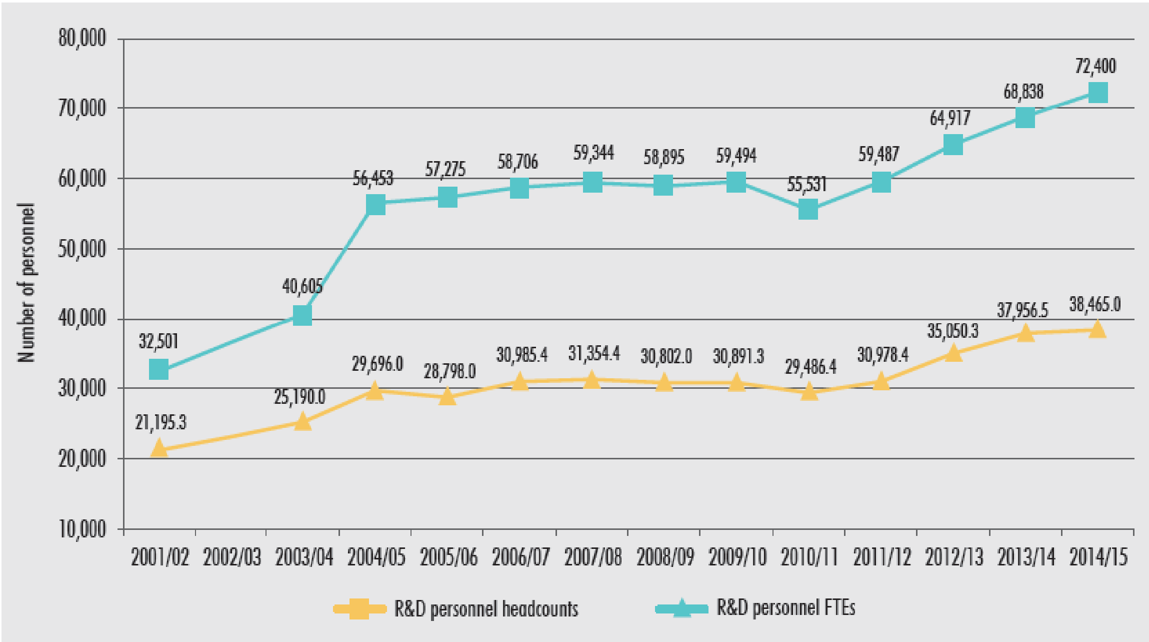


Figure 8.12: South Africa R&D Personnel (headcount and FTEs) (2001-2015) [Source: CeSTII, 2017]

Some of the interventions proposed included growing the number of PhD graduates year on year. Although CeSTII (2017) details what seems to be a depressing picture of stagnation in South Africa's R&D personnel, with no growth in personnel numbers in the period 2004 – 2011, and only slight growth in 2012 – 2013 (**Figure 8.12)**, it would appear that the PhD intervention might be starting to bear fruit, as it is a medium- to long-term investment.

197 http://www.sapvia.co.za/wp-content/uploads/2015/04/R-D-Tax-Incentive.pdf [Last accessed on 3 June 2017]

This view is supported by an assumption that most publication outputs are linked to a researcher with a PhD. On the basis of this assumption, **Figure 8.2** has illustrated an impressive increase in the publications with at least one South African resident author, in the period 1997-2015, with substantial increases from about 2008 onwards.

The upward trend started in about 2011, presumably because of the implementation of initiatives to grow relevant human personnel, as proposed in the TYIP (2008). As already mentioned, this includes a core understanding that significant emphasis on development of PhD graduates should be accelerated, if South Africa is to have a vibrant innovation ecosystem. It should be noted, however, that plans to grow innovation-enabling personnel, as opposed to R&D capacity, have not received as much focus as plans to increase numbers of knowledge-generation personnel.

Critical to a dynamic innovation ecosystem is an appropriate mix of both knowledge generating and knowledge enabling or commercialisation skills sets. The TYIP (2008) focuses greatly on the knowledge generating skills sets and falls short in advocating specific interventions for growing the knowledge enabling and commercialisation skills. The importance of the enabling skills set and commercialisation is further echoed in one of TIA's Strategic Goals to facilitate the development of innovation skills to support technology innovation and commercialisation.

The Ministerial Review (2012:12) notes that:

> *"The shortfall in human capital development is the key weakness of the NSI …. Measures to optimise the availability of highly skilled individuals remain a vital framework condition;"*

It concludes that, *"without the 'feedstock' of trained and able people, the NSI will be a hollow aspiration"* (Ministerial Review, 2012:90).

This dire state of South Africa's human resources capacity also scores South Africa a ranking of 77 in the Higher Education and Training sub-index B of the Global Competitiveness, and a score of 123 in the Health and Primary Education sub-index A, according to the GCI (2006-17:324). It would thus appear that, until South Africa addresses the underlying foundational challenges in its education system, very little benefit can be derived from its IP and Innovation systems. Notwithstanding the above observations, WEF (2016: 324), points out that there has been *"a small but important upgrade in the quality of education (up five places), with primary school enrolment also now passing 97 percent."*

Simkins (2014:27) teaches us that:

> *"it is apparent that South Africa is not about to experience a rapid increase in the pace of innovation. The supply of high level human capital is too precarious, the fiscal position will not permit a rapid expansion of resources for science and technology, and South African business is oriented towards technological advance abroad much more than to domestic research. Progress in innovation will be spotty and relatively slow."*

The precarious supply of human personnel in the NSI calls for an urgent need to strengthen the quality of South Africa's education system. This is necessary in order to expand on the pool of human capitalnot only in knowledge production, in order to increase the pool of patents and other forms of IP, but also in commercialisation so as to enhance competitiveness. The focus should be on a long-term approach starting at primary schools, embedding the right culture, and at HEIs to ensure that South Africa progressively develops adequate human resources to support domestic innovation, at both knowledge production and innovation enabling stages in the continuum of converting ideas to tangible products and services. It is submitted that every project undertaken by students at HEIs must include an IP/Patent literature search and that students must be obliged to think about how their project outcomes contribute to new IP and how they could contribute to job creation through start-up formation. In this way, a culture of IP commercialisation and innovation could start to be inculcated.

The critical role of education and development of appropriate human capital for a NSI is underscored by the developments in South Korea in the past 60 years, aptly captured by McKay (2005):

> *"Within the education field itself, the Korean experience suggests that some important priorities include: the recognition of the importance of education as a national priority for economic as well as social development; the*

> *building of manpower planning capacities to ensure that situations of skill shortage or surplus in particular areas do not arise; the development of capacity for vocational training as well as for more academic forms of education; the stressing of a broad base to education, … and the cultivation of a capacity to search and interrogate the external environment, and draw locally-applicable lessons from international trends."*

Chung (2010) echoes McKay (2005) in advancing the view that the Korean experience offers important lessons for policy makers in respect of technology development in developing countries. The role of education in particular is evident from the following extract:

> *"There is no doubt that education builds a nation's ability to absorb new knowledge and technology. Education gives rise to individual's initial tacit knowledge, which is an essential building block in technological learning. So, the government should assume full responsibility for the promotion of human resource development. Investing in education in advance, as Korea did in the 1960s and 1970s, is essential in laying a foundation for industrial development. As an economy develops toward an advanced level, technological competence becomes a critical factor. To build up the competence, it is required to nurture high-caliber scientists and engineers who are capable of dealing with the developments at scientific and technological frontiers. In other words, advanced education in science and technology should come first in preparing for entrance into a developed world. In the case of Korea, education and industrialization helped each other in sustaining and accelerating mutual development. Education made technological learning and therefore industrialization possible, while industrialization enhanced the rate of return on investment in education, further promoting demand for education. Korea's industrialization evolved from imitation to innovation."*

It is thus apparent from South Korea's journey since the 1960s that education is critical, not only in increasing R&D outcomes and thus growing an IP portfolio, but also in technology transfer and IP commercialisation using imported technologies and IP as well as IP generated in HEIs, respectively. The lesson for South Africa is that, in order to grow the IP portfolio, it is imperative to have a critical mass of R&D personnel that can enable increased knowledge production. In addition, there is a need to focus on the skills required to convert the IP into useful products and services, in particular translational or technology transfer skills. Such a focus will ensure that South Africa makes use not only of its own R&D outcomes but also that it enhances its absorptive capacity to adapt foreign developed technologies to the local environment. This approach is not new as it was first mooted in the NRDS (2002), as a mechanism for bridging the *"innovation chasm."* There has not, however been any deliberate strategies or plans to institutionalise the adaptation of foreign developed technologies or IP despite this having been one of the key interventions mentioned in the NRDS (2002). It is the author's view that this is a missed opportunity, which many other countries took advantage of in their economic transitions. It is submitted that, despite many suggestions to the contrary by South African policy makers, perhaps there is lack of appreciation of the central role that IP and, in particular, the patent system and/or technology can play in driving economic growth. As was the case in similar economies, such as South Korea, Japan and China, South Africa's economic development must rely both on its own-generated IP and technologies as well as on foreign developed IP and technologies, which can either be licensed-in or acquired, to supplement its own IP and technology portfolio. This approach is now more relevant today, in a globally connected world, than it was in the past, given the ease of movement of knowledge, and the benefits that have been shown of adopting open innovation approaches, according to Chesbrough (2005:2):

> *"The open innovation paradigm treats research and development as an open system. Open Innovation suggests that valuable ideas can come from inside or outside the company and can go to market from inside or outside the company as well. This approach places external ideas and external paths to market on the same level of importance as that reserved for internal ideas and paths to market in the earlier era."*

Chesbrough (2005:14) suggests a new more proactive and nuanced role of IP management because of Open Innovation, which sees the critical role of IP in innovation as being to facilitate access to markets through the exchange of valuable knowledge.

8.4 COMMERCIALISATION AND TECHNOLOGY TRANSFER SUPPORT AT INSTITUTIONS

Reflecting on the WPS&T (1996) and the NRDS (2002), there are a number of policy and institutional arrangements that were proposed, mostly aimed at providing requisite capacity for the NSI. The establishment of a framework for handling IP emanating from publicly financed R&D was one of these. This framework has led to creation of a legal framework in the form of the IPR-PFRD Act, the policy arrangements in the form of institutional IP management policies, and the establishment of NIPMO to ensure effective implementation of the IPR-PFRD Act and to provide OTT/TTO capacity at the institutions, with the latter pertaining to innovation-enabling skills. The work of the Innovation Fund (established in 2002), particularly in the period 2006-2008, played a critical role in preparing institutions for the implementation of the IPR-PFRD Act, and is commended by the Ministerial Review (2012:180), which states that:

> *"The operation of the Innovation Fund has been accompanied by its own innovations, such as institutional development involving staff capacity in intellectual property management, which laid the basis for the establishment of what is now the National Intellectual Property Management Office (NIPMO), as well as the IPR capability of the new TIA."*

For example, the Innovation Fund established a Patent Incentive Fund, which rewarded inventors at HEIs and Science Councils with monetary incentives for South African granted patents deemed to be novel and inventive. Owing to budgetary constraints, unfortunately this particular incentive has not been continued. In addition, as referenced in Straus (2012:671), the Innovation Fund established the Patent Support Fund, to subsidise the costs associated with obtaining and maintaining patent registrations by HEIs and Science Councils. This fund has, since 2010 (following the dissolution of the Innovation Fund as part of the TIA establishment), been institutionalised by the IPR-PFRD Act and is now being implemented by NIPMO as part of its responsibilities to support IP activities at publicly financed institutions. A specific condition for claiming under the Patent Support Fund was the establishment of institutional IP Policies, which had to be submitted to the Innovation Fund. This requirement for institutional IP Policies has been integrated into the IPR-PFRD Act and is being enforced by NIPMO, which requires institutions to submit their IP policies for its approval. Sibanda (2009:129) notes that, as of 2007:

> *"It is evident that most of them do not have the required infrastructure to manage the process of invention disclosures, filing of patent applications and technology transfer. Of particular concern is the lack of relevant policies in respect of IP issues at most of them, particularly at the higher-education institutions."*

In particular, Sibanda (2009:132) concluded that there was correlation between patenting activity and institutional IP policies. Institutions that had established technology transfer offices and had an IP policy, demonstrated higher patenting activity than those that did not have.

As can be seen in **Table 8.1**, as of 2009, a year after the IPR-PFRD Act had been passed by Parliament and just a year before it came into effect, other than the CSIR and Medical Research Council (MRC) who had full capacity, R&D intensive HEIs had only limited capacity. The rest of the institutions had no capacity at all.

Table 8.1: Summary of Institutional Policies and Arrangements for IP Management, Commercialization and Technology Transfer [Source: Sibanda, (2009:130)]

Institution	IP Policy	Tech. Transfer Capacity (Year Established)	Institution	IP Policy	Tech. Transfer Capacity (Year Established)
University of Cape Town	Yes	Limited (2002)	University of Pretoria	Yes	Limited (1996)
University of Stellenbosch	Yes	Yes (1999)	North West University	Yes	Yes (2003)
Nelson Mandela Metropolitan University	Yes	Limited (2007)	University of the Witwatersrand	Yes	Limited (2003)
Rhodes University	Yes	No	University of Limpopo	No	No
Walter Sisulu Metropolitan	Yes	No	Tshwane University of Technology	Yes	Limited (2005)
Durban University of Technology	No	No	University of KwaZulu-Natal	No	In process of establishment
University of Fort Hare	No	No	UNISA	No	No
Cape Peninsula University of Technology	No	No	University of Western Cape	No	No
Vaal University of Technology	No	No	CSIR	Yes	Yes (2001)
University of Johannesburg	Yes	Limited (2004)	Water Research Commission (WRC)	Yes	Limited (2003)
Central University of Technology	No	No	University of Fort Hare	No	No
Mangosuthu University of Technology	No	No	University of Zululand	No	No
Vaal University of Technology	No	No	Agricultural Research Council (ARC)	Yes	No
Medical Research Council (MRC)	Yes	Yes (2004)	Mintek	Yes	Limited

The situation has since changed, as is apparent from the findings by Nyatlo (2015:118), illustrated in **Figure 8.13**: whereas at the start of implementation of IPR-PFRD Act, in 2010, only 82% of HEIs had IP Policies, by 2013 [three years after the Act had come into effect], all the HEIs had IP policies approved by NIPMO.

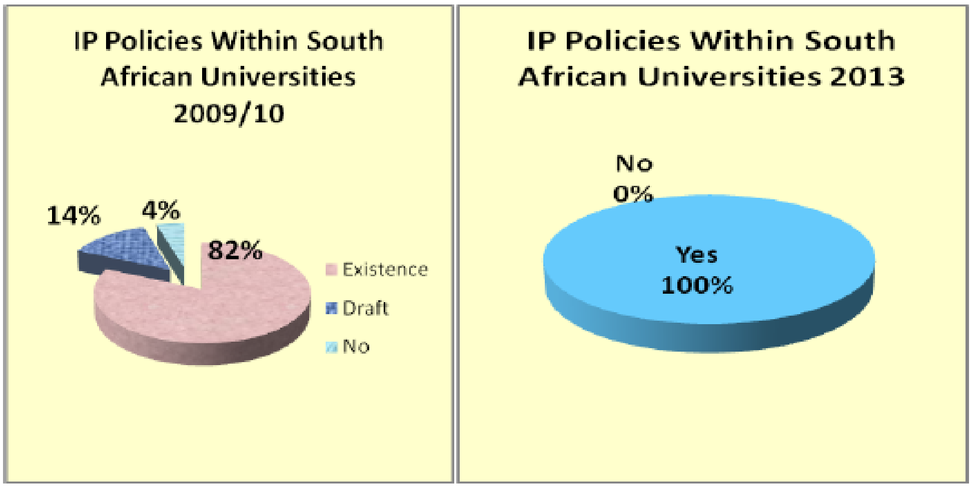


Figure 8.13: IP Policies within South African Universities (2009/10 and 2013 Comparison) [Source: Nyatlo (2015:118)]

The importance of the technology transfer offices and their relationship to the patenting trends at publicly financed institutions, detailed in Sibanda (2009), is consistent with the findings by Nyatlo (2015) that the institutions with strong technology transfer capacity (staff and budgets), **Figure 8.14**, produced higher invention disclosures.

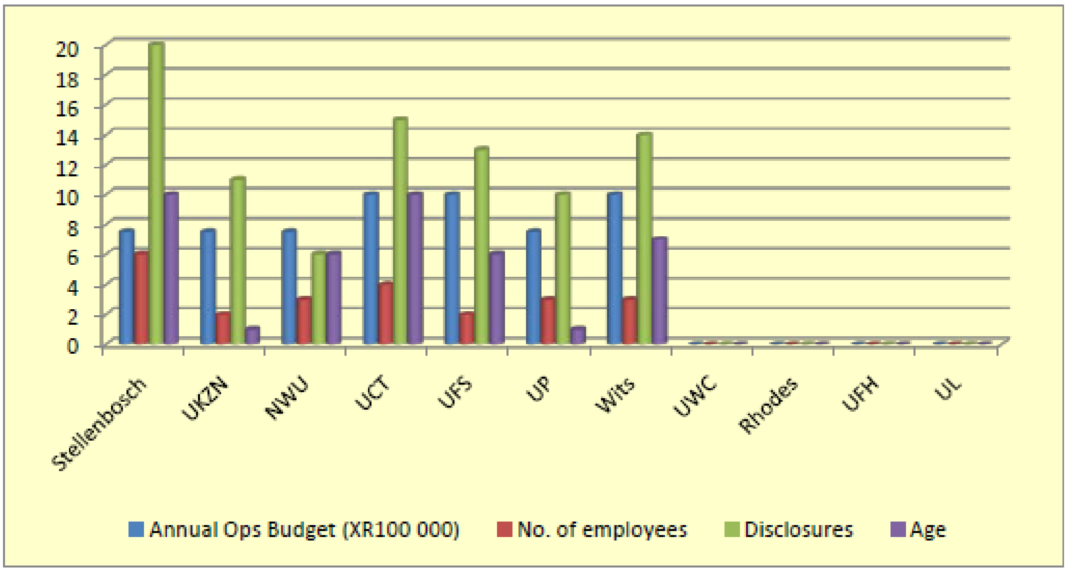


Figure 8.14: HEIs Technology Transfer Inputs and Qualitative Outputs (2009/10) [Source: Nyatlo (2015)]

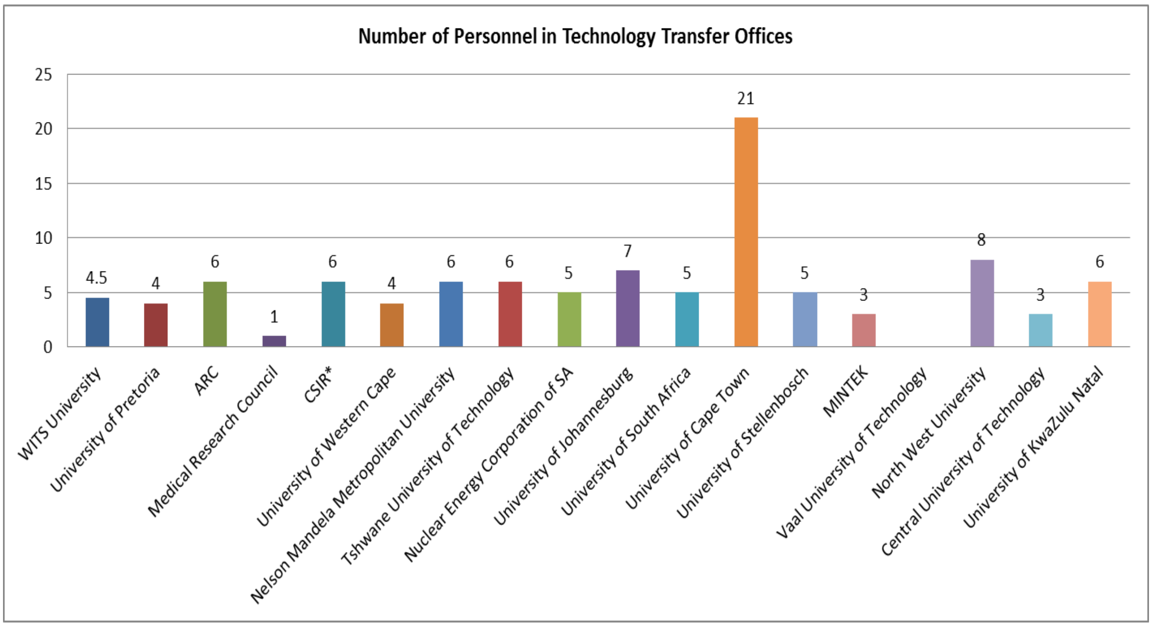


Figure 8.15: Number of personnel at Technology Transfer Offices in public institutions [Source: Author-generated from respondents of commercialisation survey, 2017]

Figure 8.15 shows the number of personnel at TTOs, according to respondents to the Commercialisation Questionnaire that formed part of the current study. Most of the capacity is in traditionally strong research institutions (see **Figure 8.14**). Other than at UCT, the average staff complement for the TTOs seems to be between three and six people. The number of personnel disclosed by the CSIR is likely higher if one considers the commercialisation specialists who form part of the various business units, which were not included in the CSIR's response to the Commercialisation Questionnaire.

A review of invention disclosures in **Figure 8.14** from Nyatlo (2015) appears to be aligned with the patenting by publicly financed institutions dealt with in **Chapter 6**. This showed that the HEIs with the highest levels of patenting were the University of Stellenbosch, the University of the Witwatersrand, the University of Cape Town, the University of Pretoria, and North-West University, which are traditionally strong research academic institutions. It would also appear that the very same institutions are the most prolific publishers (**Figure 8.3 and 8.4**). This is also consistent with Alessandrini *et al.* (2013), whose study found that:

> *"Anecdotal evidence from the study further suggests that the combination of under resourced TTOs and low levels of awareness have contributed to*

the low number invention disclosures and patenting rates and also to the low conversion of patents to commercial products or licenses."

All of the above findings are consistent with the findings of the *Inaugural Baseline Study: 2008-2014* of the South African National Survey of Intellectual Property and Technology Transfer at Publicly Funded Research Institutions, Baseline Study (2008-2014:41), in its conclusion that:

> *"a key determinant is the capacity and capability of the Technology Transfer Functions (TTFs). The capacity of TTFs to identify, protect and translate technologies to successful commercialisation outcomes is a direct contributor to the quality and maturity of the portfolio … and all institutions are at varying stages of building capability and capacity."*

8.5 INSTITUTIONAL ARRANGEMENTS IN COMMERCIALISATION

Knowledge generation and patent filings mean very little unless there are new products, methods and processes that are introduced into the economy pursuant thereto. In this regard, there has been progress in ensuring that South Africa has the right institutional arrangements to facilitate commercialisation and start-up formation. The establishment of TIA, as the institution envisaged in what the NRDS termed the FTI, has been of great importance. It would also be important to understand how the IP System has affected the NSI, and in particular how responsive the NSI has been *"to issues that affect quality of life, economic growth and the environment"*, as nuanced in the NACI (2014:xiv). Given the projected economic growth areas discussed in **Chapter 3**, a complete analysis of the areas of patenting by South African residents both domestically and abroad has to occur within the context of developments in the commercialisation arena within the NSI to ensure that IP is utilised within business for strategic defensive reasons and to sustain competitiveness. It must further be developed to ensure competitiveness in certain growth areas, whilst addressing South Africa's challenges and issues as nuanced in NACI (2014:xiv).

Given that respondents of the Commercialisation Questionnaire were of the view that the major challenges often faced in IP commercialisation are those of access to finance, markets/industry receptors and skilled human capacity, it is important to look at how the NSI is performing in this regard, particularly in respect of commercialisation of South Africa's domestic and global patent portfolio. A number of instruments, such as SPII[198] and THRIP, established by *the dti*, have played an important role in terms of translating R&D outputs into products and services. These institutions are enablers of innovation. As mentioned in **Chapter 6**, until 2015, the operational management of SPII and THRIP was assigned to the IDC and the NRF, respectively. A 2014 Impact Evaluation of SPII (SPII Report (2014)) commissioned by *the dti*[199] found that:

(i) SPII funded projects had directly created or retained approximately 3 000 permanent jobs, at a cost of approximately ZAR207 560 per job (see SPII Report (2014:viii));

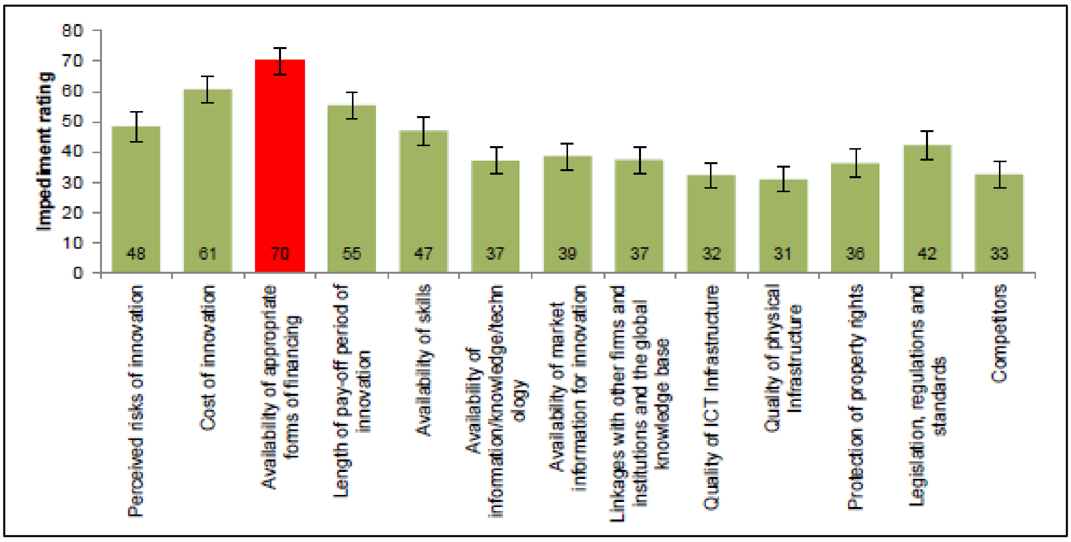


Figure 8.16: Perceived Impediments to Innovation in South Africa [Source SPII Report (2014:32)]

(ii) SPII played an important role in the innovation landscape, and had a direct impact on innovation with a potential indirect impact on long-term job creation and increased competitiveness (see SPII Report (2014:ix)). SPII's contribution was in respect of addressing the most-cited factor that hampers innovation, being access to finance (See **Figure 8.16**);

198 https://www.thedti.gov.za/financial_assistance/financial_incentive.jsp?id=48&subthemeid [last accessed on 20 November 2016]

199 Genesis Analytics, Impact Evaluation of Support Programme for Industrial Development, Final Report submitted to DPME, 24 April 2014 (hereinafter referred to as SPII Report, 2014)

(i) The South African innovation landscape was highly fragmented (see SPII Report, 2014:34). This echoes the findings of the Ministerial Review (2012) of lack of coordination between the different government departments that form part of the NSI;

(ii) The demand for SPII funding far exceeded the amount of money that it was allocated with limitations in terms of its real impact (see SPII Report, 2014:41); and

(iii) There was a need for SPII to continue to contribute to stimulation of the innovation landscape by stimulating innovation in products/services and in geographical areas where opportunities are the greatest (see SPII Report, 2014:53).

It is evident from the above analysis that SPII has been an important funding mechanism for early stage innovation, at prototype stage, particularly in translating R&D outputs into prototypes and products that could then be scaled up. As far as IP considerations were concerned, the general position with SPII funded projects was that ownership of IP vested in the funded party, who must reside in South Africa until at least three years after the completion of the project. In one of the larger funding schemes, the SPII Report (2014:45) notes that, although there was co-ownership of IP with the IDC, this was for the duration of the project; thereafter, the funded party was entitled to full ownership of the IP. So, in essence, until the IPR-PFRD Act came into effect, IP could still be disposed of offshore after a period of three years or after completion of the project, as the case might be.

The THRIP Review (2015) presents the outcomes of a review of the THRIP programme undertaken in 2015, which show that THRIP has had an important and unique role in the NSI – in particular, given the requirement for an industry partner to lead a THRIP funded project, and identify key human resources skills that it would require for its business, is attributed for its success. As a result, the THRIP Review (2015:1-2) finds that THRIP-funded projects have formed the basis of the development of a critical mass of highly skilled researchers and technology managers for industry. As far as the IP regime is concerned, the THRIP Review does not provide evidence-based insights but it nonetheless suggests that IP issues were seen as a major challenge for improving the programme's performance, given the significant contribution by industry to THRIP projects, and the requirements of the IPR-PFRD Act. In the main, the concerns raised were regarding the applicability and effect of the IPR-PFRD Act to THRIP projects. Notwithstanding these concerns, in excess of 600 local and international patents were generated through the THRIP projects in the period 2001/02 to 2012/13. The THRIP Review (2015:24) notes that most of this IP was relevant to industry and hence the importance of the industry partner in its commercialisation, in making an important observation that:

> *"…the country's innovation system produces a limited number of international patents. It can be argued that this is the result of the structure of the economy (lack of high-technology industries and large multinationals) and probably a lack of appropriate government support."*

In the main, most large multinationals do not conduct R&D in South Africa as they rely on established research facilities located in developed countries largely in Europe or North America. As a result, most large foreign originating multinationals do not contribute to knowledge production in South Africa. This is evidenced by the low number of patents belonging foreign originating multinationals in the patent applications or patents with a South African priority or with an inventor with a South African address.

THRIP projects have tended not to be beyond basic R&D and more applied but further upstream than projects under the SPII programme. Although most THRIP projects are not directed at very innovative R&D outcomes, leading to the formation of new companies like those funded by TIA, some of them do have such near-market stage outcomes, with prospects to transition into TIA and IDC portfolios of projects.

During its 2015/16 financial year, TIA reportedly disbursed a total of R371 million in project- and programme-related funding.[200] Much remains to be done in terms of impact funding by TIA, which can more closely support the commercialisation of South African IP, working together with other players in the NSI, in particular, IDC, NIPMO, THRIP, SPII, provincial

200 http://www.tia.org.za/uploaded_docs/TIA-Annual-Report-2015.pdf [last accessed on 13 November 2016]

innovation agencies such as The Innovation Hub, incubators and science parks. One of the important new instruments that TIA has established, which has the potential to spur commercialisation of IP from HEIs, in particular, is its Seed Fund, modelled around the Start-Up Support Programme (SSP) run by The Innovation Hub. The Seed Fund[201] is operationally managed by HEIs technology-transfer offices and regional innovation agencies and centres (such as The Innovation Hub) that screen the applications from researchers/applicants and obtain approval from TIA before disbursing funds. In its first two years of operation since its inception in 2014, 215 projects received total funding of ZAR73m, through 21 HEIs; and a further ZAR38.5m was disbursed to 82 projects through seven organisations, including The Innovation Hub. These regional centres[202] also contributed almost ZAR32m to the programme in non-financial support, such as incubation services. Although the total funding that each project may receive from the Seed Fund is capped at ZAR500k, this amount of funding is critical, as it addresses the *"missing middle"* type of funding that is essential for piloting projects and moving them closer to the market.

8.6 IP COMMERCIALISATION IN INSTITUTIONS

Patents by their very nature are an expression of the creative endeavours and as such measure inventions. In order to extract value out of a patented invention, it has to be commercialised. Innovation occurs when the invention is being used in society, when it is providing value to its owner and when it confers benefit onto society. For the most, in order for optimal value to be extracted, business is best positioned to commercialise IP compared to publicly financed institutions, whose real competence lies in R&D and education. Nevertheless, the missions of both the TIA Act and the IPR-PFRD Act emphasise the importance of commercialisation of IP emanating from publicly financed R&D, most of

201 TIA Annual Report, 2015. See also TIA 2010/11 - 2015/16 Economic Impact Assessment Report [Available at www.tia.org.za – last accessed on 4 June 2017]

202 The Centres include: Cape Craft Design Institute, The Innovation Hub, Smart Exchange, Invotech, the Free State Development Corporation, the Eastern Cape Development Corporation and the Limpopo Economic Development Agency

which is undertaken by institutions. The potential outcomes of commercialisation are also inspired by the outcomes of the Bayh-Dole Act enacted in the USA in 1980.

As illustrated in **Chapter 7**, there has been an increase in the level of patenting by institutions, which is also aligned with increases in publications, as seen earlier in this chapter. Patenting by itself does not equate to an increase in innovation, however, unless supported by explicit commercialisation and use outcomes. One form of IP commercialisation is its actual use by the corporates to protect and maintain the competitiveness of their products and methods of processes, including defensive use, to ward off competition. The other form of commercialisation, mostly used by institutions as shown by the Commercialisation Questionnaire undertaken as part of this study, is typically through licensing, start-up company formation and outright sale/assignment. South Africa's IPR-PFRD Act favours the licensing of publicly financed IP on a non-exclusive basis as the preferred commercialisation mechanism and discourages outright sale of IP emanating from publicly financed R&D, by requiring NIPMO to review and approve such IP transactions.[203] Non-exclusive licences grant the IP owner the right to provide additional licences to other third parties and, appropriately managed, would thus provide more prospects for the IP to be commercialised. As disclosed by Nyatlo (2015:11), commercialisation of IP is relatively new to most institutions, particularly to HEIs whose primary missions have traditionally been education and research. As such, success has been isolated, and confined to those HEIs and Science Councils with adequate capacity in their TTOs. At the same time, commercialisation is limited by a variety of challenges. Sibanda (2009:136) identifies the three most important factors affecting commercialisation, at that time, as being:

> *"(i) stage of development of the technology; (ii) availability of human resources and infrastructure to screen invention disclosures for commercial potential; and (iii) the extent to which the patent addresses a large potential market."*

203 Section 11 of IPR-PFRD Act

Bansi (2016:353-355), in a more recent study on commercialisation of university IP in South Africa, identifies the following as being some of the more important challenges:

> ***"(i)*** ***Detecting commercially viable innovation …*** *University structures are found to be lacking in advisory committees for decision-making on innovation and commercial potential;*
>
> *(ii)* ***Incentive to participate in commercial activity*** *… [given that] academic performance appraisal is frequently based on publication and scholarships, while efforts to commercialize seem to be disregarded;*
>
> *(iii) A**cademic researchers lack the essential ingredient of an entrepreneurial culture** to expedite commercialization, and therefore require expert advice to market innovation;*
>
> *(iv)* ***Funding the commercialisation route****. The absence of funds for the various stages of commercialization hampers innovation growth … The proof-of-concept stage is also found to require substantial funding for product development. Innovation in its embryonic stage finds greater challenges in attracting funds;*
>
> *(v)* ***The lack of local industry receptors*** *… [including] innovators to engage in international markets, hence the loss of IP to off-shore jurisdiction; and*
>
> *(vi)* ***Market focus.*** *The absence of market focus in research emerged. Collaboration in the triple helix arena of the Government, industry and university necessitates increased entrepreneurial talent to effectively enhance transformation in the science and technology research landscape. It is essential that the research focus is directed by industry requirement and relevance, which justifies the usage of public R&D funds. The absence of a research focus on industry and societal needs was found to reduce success in commercialization, which is largely dependent on industry requirements."*

The abovementioned commercialisation and technology transfer challenges identified by both Sibanda (2009) and Bansi (2016) are also confirmed by Nyatlo (2015:159) in her study of the effectiveness of technology transfer offices at South African universities.

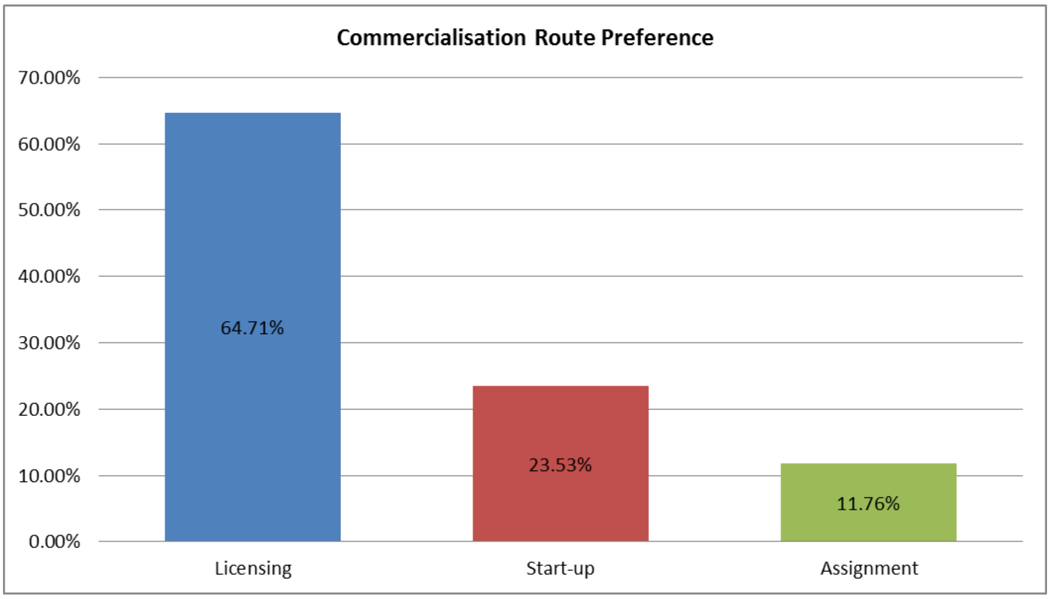


Figure 8.17: Commercialisation Preferences of Publicly Financed Institutions [Source: Author-generated from respondents of commercialisation survey, 2017]

This study reveals that licensing is the most preferred IP commercialisation mechanism by at least 64.71% of the respondents to the Commercialisation Questionnaire, followed by start-up formation (23.53%) and lastly assignment (11.76%), as illustrated by the findings shown in **Figure 8.17.** Although start-up formation is a second preference, this often involves licensing in the IP by the institution, invariably on an exclusive basis, to facilitate commercialisation fund-raising by the start-up company.

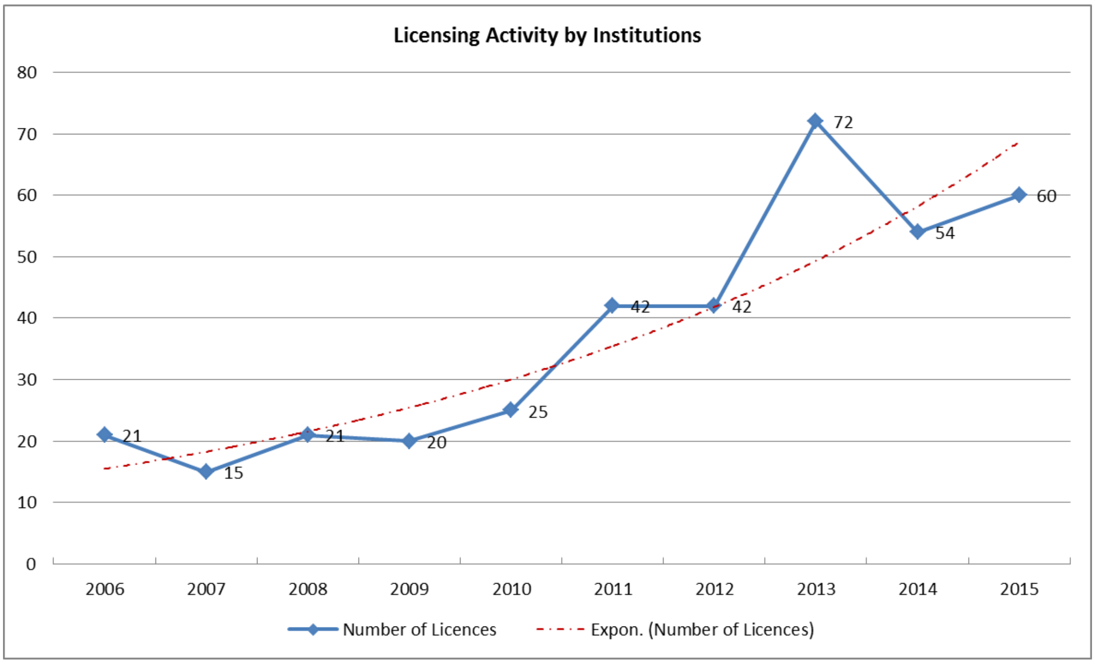


Figure 8.18: Number of licences granted by Institutions for IP Commercialisation [Source: Author-generated from respondents of commercialisation survey, 2017]

As can be seen from **Figure 8.18**, there has been a significant increase in the number of licences granted by institutions in the period 2006-2015. A total number of 372 licences were granted by the institutions over this period. Whereas in 2006 only 21 licences were granted by institutions, this peaked at 72 in 2013 and stood at 60 licences in 2015. These findings from this study have been compared to those of the Baseline Study (2008-2014:36), illustrated in **Figure 8.19**.

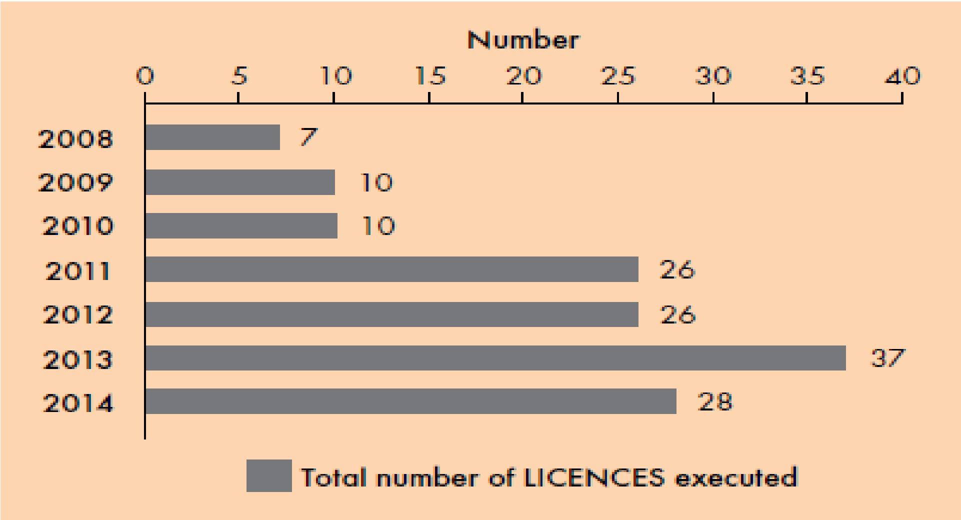


Figure 8.19: Number of licences granted by Institutions for IP Commercialisation [Source: Baseline Study, 2008-2014]

The Baseline Study (2008-2014:36) suggests that the number of licences have quadrupled over the period (2008-2014) from 7 in 2008 to 28 in 2014, with a peak at 37 in 2013 largely as a result of one institution (presumably UCT – see **Figure 8.20**) having higher licensing activity in that year. The trend is similar to the findings of this study, as shown in **Figure 8.18**. The numbers from this study are higher than those in the Baseline Study (2008-2014), however, i.e. almost double. The difference could be attributed to a number of reasons. The first could be the wider time period of the present study compared to the Baseline Study. The second is a higher participation rate by institutions in the present study, coupled with the fact that more information was made available during the present study than was the case at the time the Baseline Study was undertaken. This is further supported by the fact that the Baseline Study (2008-2014:41) points to a paucity of data about commercialisation activities from the 24 institutions that responded to the survey, and attributes this partly to the commercialisation capacity of the TTOs as well as the quality and maturity of the IP portfolio.

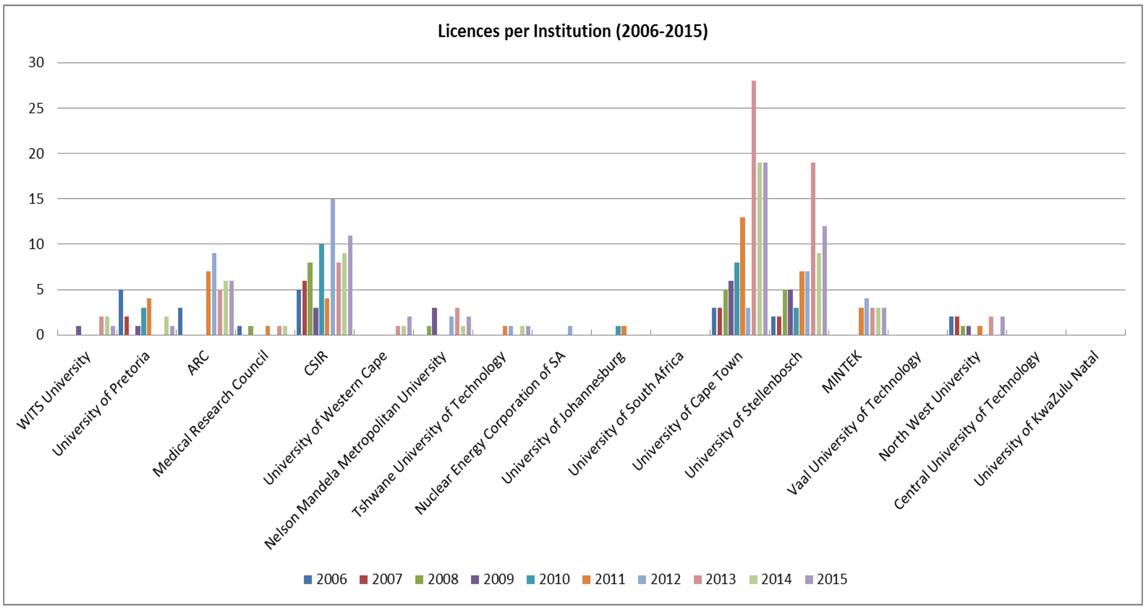


Figure 8.20: Commercialisation Licences Granted by Publicly Financed Institutions in the period 2006-2015 [Source: Author-generated from respondents of commercialisation survey, 2017]

Figure 8.20 shows the distribution of licensing activity by the institutions, with the most active institutions, in descending order being: UCT, SUN, CSIR, ARC, UP, Mintek, NMMU, NWU, WITS, and TUT. Another model that is employed by NECSA, for example, is where the IP is self-exploited. This is particularly the case where, in 2003, NECSA incorporated a wholly owned subsidiary company, NTP Radioisotopes (SOC) Ltd[204] to commercialise IP related to a range of products that have applications in the world's healthcare, life science and industrial markets. Prior to 2003, NECSA had ring-fenced this activity as part of its realigned business in the 1990s. Today, NTP services both domestic and global markets and is one of the world's top three radiochemical producers.

This study finds that most of the licences by Institutions reported as part of the Commercialisation Questionnaire were granted to South Africans with only a few being granted to foreign licensees.

204 http://www.ntp.co.za/ [Last accessed on 24 April 2017]

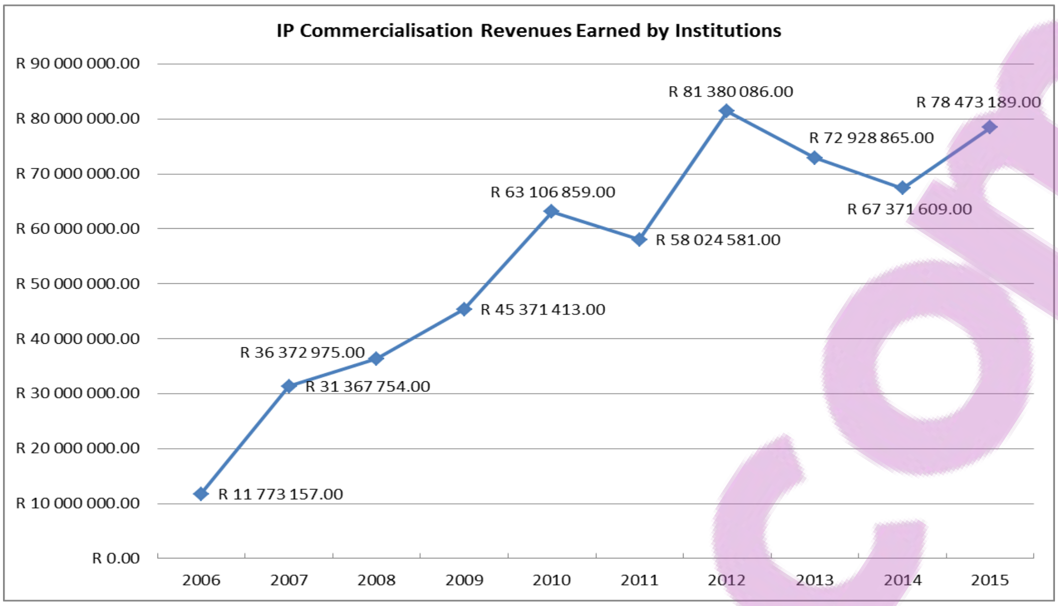


Figure 8.21: Commercialisation Revenues Earned by Institutions (2006-2015) [Source: Author-generated from respondents of commercialisation survey, 2017]

Figure 8.21 shows revenues earned by the institutions from IP commercialisation in the period 2006-2015. A total of ZAR546.2m was earned by institutions over the 10-year period, thus averaging ZAR54.62m per annum. In addition, these findings show that IP commercialisation by the institutions has increased almost eight-fold since 2006, when revenues earned were almost ZAR11.77m to ZAR78m in 2015. The distribution of these revenues per institution is shown in **Figure 8.22**, which shows that most of it was earned by the Science Councils, namely NECSA, CSIR, and the ARC.

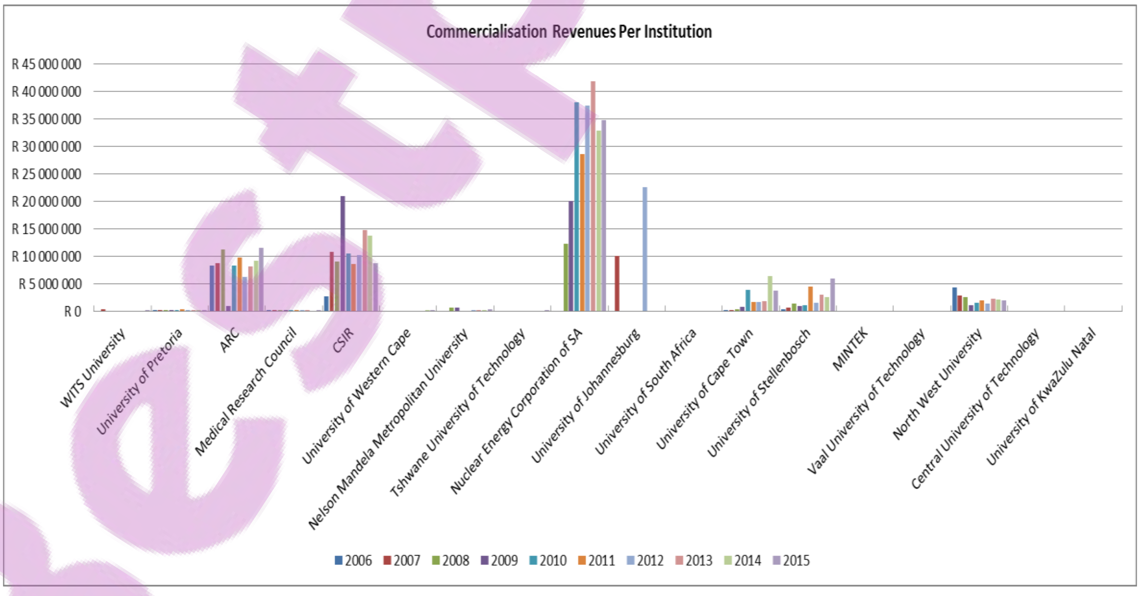


Figure 8.22: Distribution of Commercialisation Revenues per Institutions (2006-2015) [Source: Author-generated from respondents of commercialisation survey, 2017]

The other Science Councils, Mintek and MRC show very little commercialisation success. This study suggests that the low commercialisation outcomes of these other Science Councils may be related to their limited patenting activities, as was seen in **Chapter 7**. Whereas the University of Johannesburg has had the most revenues in the form of two large milestone payments from one licence or technology, viz. the photovoltaic technology described in **Section 8.7** below, the other HEIs (in particular, the University of Stellenbosch, North-West University, and the University of Cape Town) have had a spread of the licensing revenues from multiple technologies or licences. Other than NECSA, which appears to be an outlier, there is a correlation between the licensing activity and the revenues generated. In the case of NECSA, as explained above, the model has been to self-exploit its IP through NTP, and this has largely proven to be a successful model, because of the complexity of the nuclear industry. From the interactions with the relevant personnel at NECSA, Mphahlele (2017) found that NECSA is exploring licensing of some of its technologies through NTP, including joint ventures internationally. In general, there has been varied success, with those institutions having large patent portfolios (and also, coincidentally, high publication rates, other than the CSIR whose publications are not included) as well as good TTO capacity, being more successful, as we have seen earlier in this chapter.

This study is of the view that the CSIR, being the largest multidisciplinary public R&D organisation in South Africa, with a strong history of patenting and a successful commercialisation track record to date, could play a more strategic enabling role in respect of IP commercialisation within the NSI. As we will see later in this chapter, the CSIR's contribution to start-up formation is very low; this is an area where the CSIR could have a more meaningful impact, were it to choose to prioritise start-up formation, in partnership with entrepreneurial supporting organisations such as The Innovation Hub.

In **Chapter 7**, one of the findings of this study is that there has been an increase in patenting particularly by HEIs. The total revenues earned by HEIs over the period 2006-2015 is ZAR99 929 837.

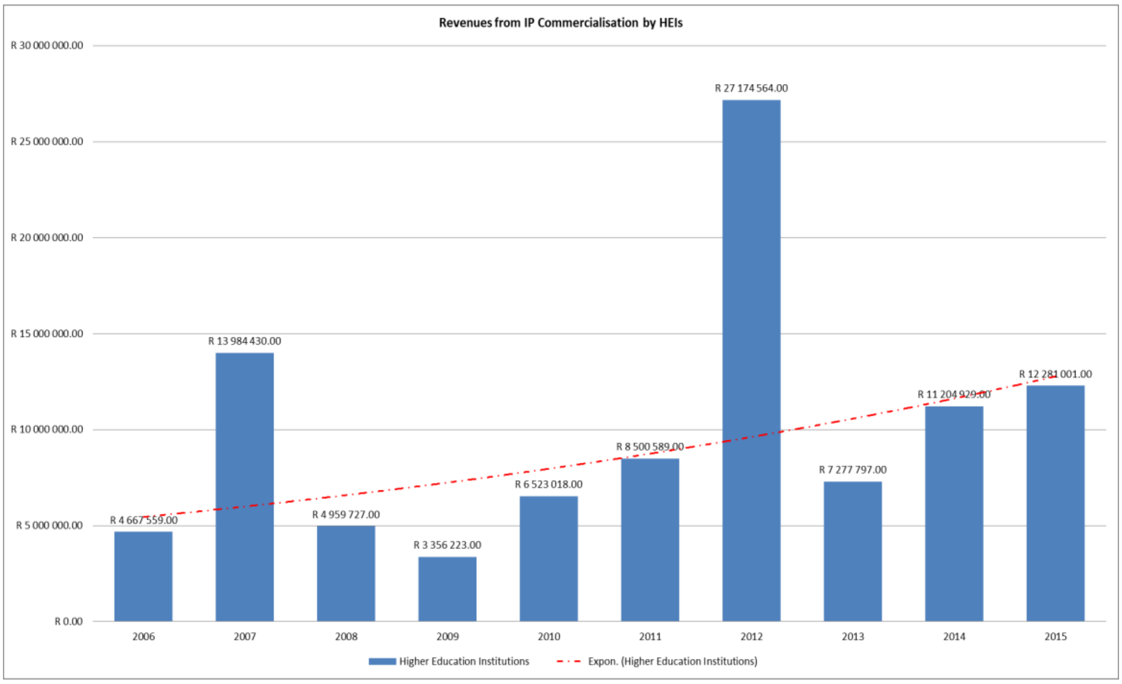


Figure 8.23: Commercialisation Revenues Earned by HEIs (2006-2015) [Source: Author-generated from respondents of commercialisation survey, 2017]

As can be seen from **Figure 8.23**, this has increased almost three-fold, from ZAR4.67m (2006) to ZAR12.3m (2015), having peaked at ZAR27.17m in 2012, largely owing to a large second milestone payment accruing to the University of Johannesburg. Similarly, the peak in 2007 is attributed to the first milestone payment to the University of Johannesburg.

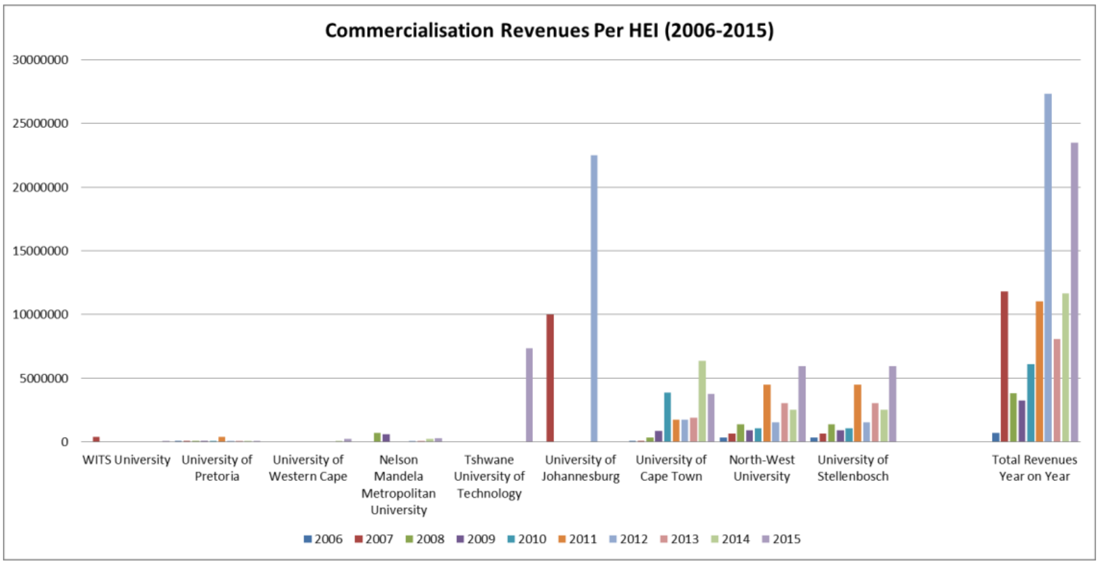


Figure 8.24: Distribution of Commercialisation Revenues per HEI (2006-2015) [Source: Author-generated from respondents of commercialisation survey, 2017]

This study has thus explored the correlation between high patenting activity for specific HEIs and revenues earned. Nine HEIs earned revenues from IP commercialisation. The distribution of revenues earned by these HEIs is shown in **Figure 8.24**. As illustrated in **Figure 8.24**, this study also discloses that, of the nine HEIs that earned commercialisation revenues from their IP portfolio, the most successful have been the University of Johannesburg (ZAR32 500 000), the University of Stellenbosch (ZAR21 795 039), NorthWest University (ZAR21 772 373), the University of Cape Town (ZAR20 656 359), and Nelson Mandela Metropolitan University (ZAR1 867 508). Collectively, the nine HEIs earned R107 231 093 in commercialisation revenues over the 10-year period 2006-2015, with most of that in the later years.

As was seen in **Chapter 7**, these HEIs had very high numbers of both patent applications (PCT) and patents (EPO and USPTO). We can thus conclude that the most successful HEIs have a higher conversion rate of their patents into revenues, than the other HEIs. There are some rather concerning outliers, however, such as the University of the Witwatersrand, which had reasonably high patenting activity, ahead of North-West University but behind the University of Cape Town in terms of PCT applications (**Figure 7.6** and **Figure 7.21**) and USPTO patents (**Figure 7.30** and **Figure 7.34**). In the case of EPO patents granted in the period of 1996-2015 (see **Figure 7.51**), the University of Witwatersrand is ranked second behind North-West University; however, the University of Witwatersrand leads all the HEIs for the period of 2006-2015 (**Figure 7.54**). Although no reasons for the low conversion could be adduced from the Questionnaire, possible explanations might include a legacy patent portfolio that has taken too long to find market traction, undisclosed revenues by the TTO in the Questionnaire, poor commercialisation prospects of the patent portfolio, and the structure of the licensing agreements, which may result in low revenues accruing to the HEI than to a start-up company licensing the patents. Suffice to say that this study identified this anomaly but did not investigate it further. As already mentioned, the University of Johannesburg's commercialisation income to date has been as a result of the patented breakthrough photovoltaic technology, which was licensed abroad in about 2006 and has brought in two large milestone payments, the first being in 2007 and the second in 2012.

According to the Baseline Study (2008-2014:29), of the 24 institutions that responded, there was an increase in the number of new technologies[205] developed from 426 (2008) to 1 244 (2014), and an average of 100 new technologies added annually in the period 2011 to 2014, suggesting an increasing number of commercially viable IP portfolio by the institutions.

Figure 8.25 shows the number of start-up companies established by the institutions in the period 2006-2015, viz. a total number of 94, according to the findings of this study.

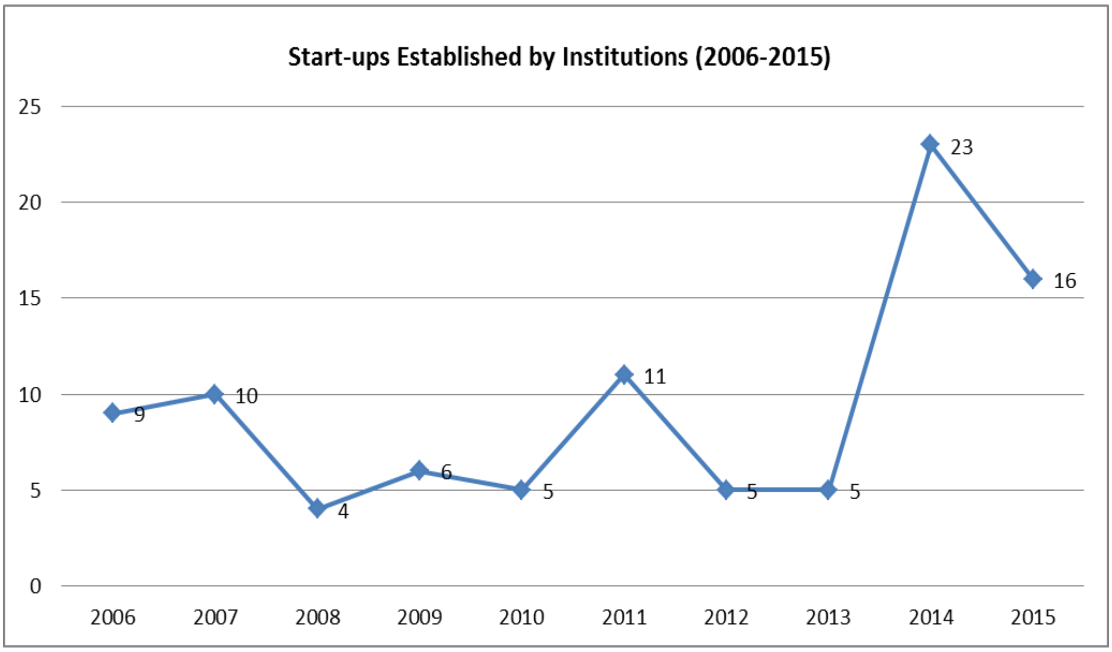


Figure 8.25: Number of start-ups established by Institutions for IP Commercialisation [Source: Author-generated from respondents of commercialisation survey, 2017]

It is evident that there has been an increase in start-up formation over the period, with only 9 start-ups in 2006, and 16 in 2015, having peaked at 23 in 2014. The results of this

205 Technology is defined in the Baseline Study (2008-2014:56) as the embodiment of an idea that results from the creative work performed by faculty, students or staff during research or teaching that are deemed to form part of the portfolio managed by the TTO/OTT. Multiple Technologies can arise from a single invention disclosure or a single Technology can be the result from a number of invention disclosures. A Technology can also take many different forms; the most common are compositions of matter, biological materials, processes, methods, devices, asexually reproduced plants and designs. Also common are works of expression such as software, photos and drawings. A technology is the embodiment of a single innovative idea, no matter how many (i) protection filings (being patents, trademarks, designs, plant breeders' rights or copyrights), or (ii) disclosures that may be associated with/included in the Technology.

study are contrasted with those of the Baseline Study, in **Figure 8.26**, where the numbers are more modest.

In the same period, the Baseline Study (2008-2014:40) (see **Figure 8.26**) discloses that 45 start-ups were established by the institutions (compared to 94, double that number, according to this study). Although the numbers appear to be different, the trends are similar, being an increase in start-up formation by institutions. The difference between the two studies will be addressed later in this section.

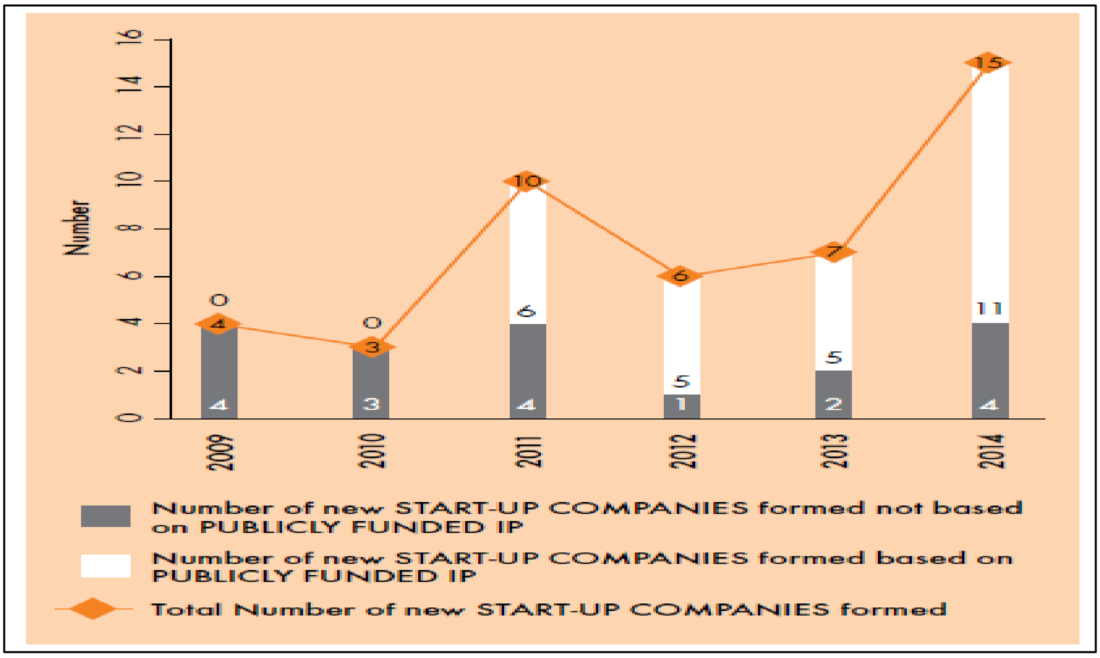


Figure 8.26: Number of start-ups established by Institutions to commercialise Technologies and Institutions' IP [Source: Baseline Study, 2008-2014:40]

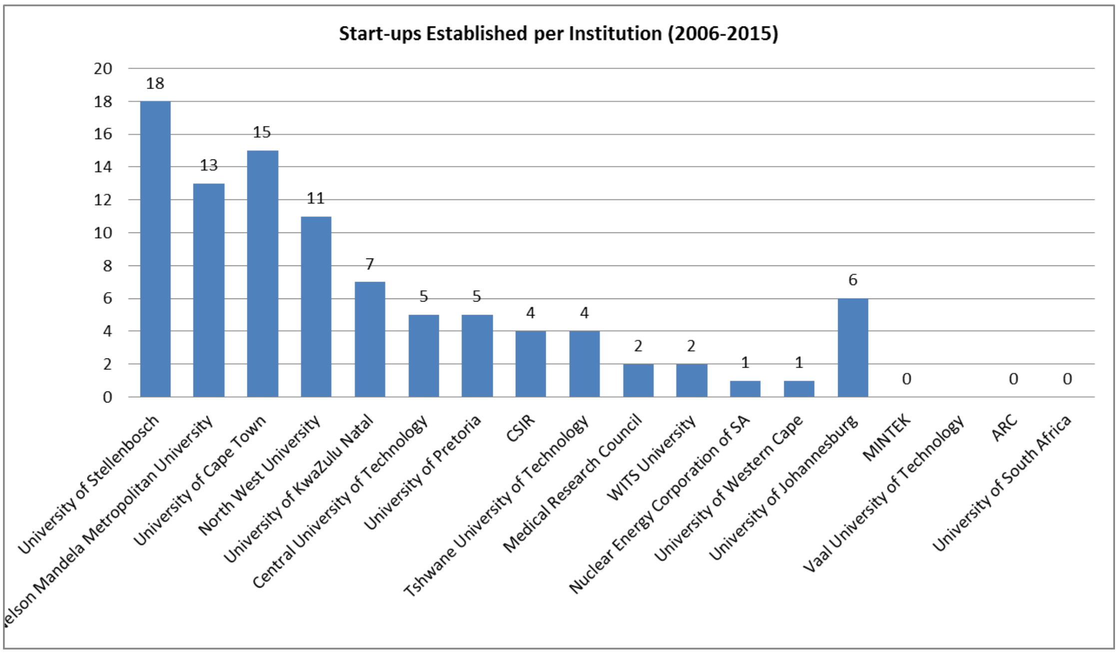


Figure 8.27: Distribution of start-ups established per Institution (2006-2015) [Source: Author-generated from respondents of commercialisation survey, 2017]

This study shows the distribution of the 94 start-up companies established by the institutions over the period 2006-2015, illustrated in **Figure 8.27**. It is evident that start-up formation activity in order of decreasing numbers is as follows: SUN, NMMU, UCT, NWU, UKZN, UJ, CUT, UP, CSIR, TUT, MRC, WITS, NECSA, and UWC.

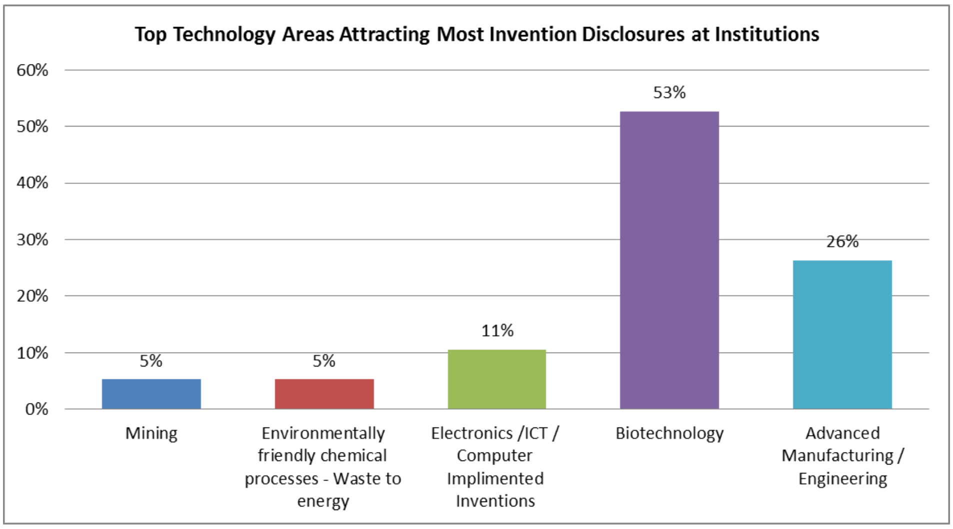


Figure 8.28: Technology Areas for Disclosures at Institutions (2006-2015) [Source: Author-generated from respondents of commercialisation survey, 2017]

The findings of this study regarding the technology fields that attract the most invention disclosures from the institutions are illustrated in **Figure 8.28**. 53% of invention disclosures in institutions were in the area of Biotechnology, with 26% relating to Advanced

Manufacturing/Engineering, and 11% being Electronics/ICT/Computer implemented inventions.

The high number of disclosures in Biotechnology correlates with the increase in patents in the same technology area by institutions, as seen in **Chapter 7**. The increases in patenting in Biotechnology-related fields by institutions would appear to be accompanied by decreases in patenting by the private sector in the same fields. According to Jordaan (2016:41), there has been a decline in relative contribution by the private sector to South Africa's Biotechnology patents over the period 1994-2013, despite a modest growth in number of Biotechnology-related patents in the same period. The decline is illustrated in **Figure 8.29**, which shows an inverse correlation between private companies and universities in respect of their relative contribution to patenting in Biotechnology related fields. According to Jordaan (2016), the relative contribution by the private sector to patenting in Biotechnology related fields declined from almost 60% in 1994 to below 10% in 2013, whereas university relative contributions increased from almost zero in 1994 to above 60% in 2013. Although Jordaan (2016) cites possible reasons for this decline as being related to government policies and, in particular, to changes in funding structure in the NSI, we are of the view that this explanation is not correct, given that the decline has been continuous since 1994.

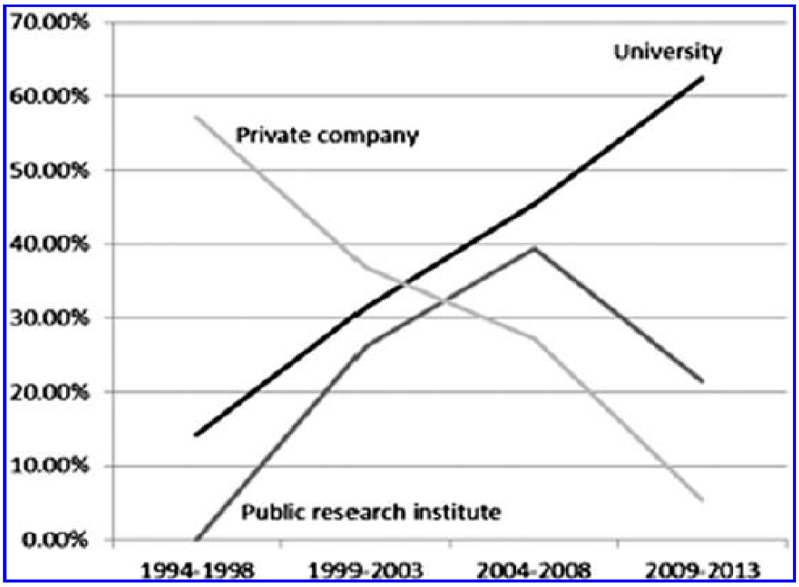


Figure 8.29: Relative contribution of private sector, science councils and universities to PCT patent applications over the period 1994-2013 [Source: Jordaan (2016)]

As seen in **Chapter 6** dealing with the NSI, although the WPS&T (1996) together with the NRDS (2002) mooted transformational fundamental changes to the NSI, none of the proposed changes were to the detriment of the private sector. In fact, the Biotechnology Strategy (2001) provided a whole new suite of funding through the Brics that private sector could access, and indeed did access, as we will see when we examine a few case studies in **Section 8.7** of this chapter. Further changes to the funding structure for Biotechnology were only experienced in the period 2010-2012, owing to the formation of TIA. We are thus of the view that the decline in the patenting by private companies, if indeed it was as acute as depicted in **Figure 8.29**, could be attributed to systemic changes, owing to the end of apartheid, which in turn led to a general decline in the Biotechnology industry over the same period. There is also a relatively low R&D expenditure in the Biotechnology related fields by industry as per manufacturing SIC codes, illustrated in **Figure 8.10**. Also alarming, as seen from Jordaan (2016), is the sharp decline in the contribution of science councils, from 2004-2008, which we are of the view could be attributed to the implementation of the CSIR's Beyond 60 Strategy from about 2004.

In ending this section, which has reviewed the state of IP commercialisation in South Africa, it is important to provide final comments on the Baseline Study (2008-2014). As has been seen, the absolute numbers between this study (for the period 2006-2015) and the Baseline Study (2008-2014) differ, but the trends are the same. Another explanation, viz. that this study provides for the differences in addition to that are already provided when dealing with licensing activity, is the following: whereas the survey for the Baseline Study (2008-2014) was administered in April-June 2015, the Commercialisation Questionnaire was undertaken in February-June 2017. Given the challenges identified in the Baseline Study (2008-14:41) relating to a lack of data and TTO capacity and access to that capacity, where available, to source the required data, it is submitted that this explains the differences between the findings of the two studies, and that capacity at TTOs had either improved processes for information management and caught up with any backlogs or that it had had more time to put together the information that may not have been available in April-June 2015. Consequently, it is submitted that the trends of both studies are of greater importance than the absolute numbers. The author of this study submits that the

Commercialisation Questionnaire provides the most recent and up-to-date data. This study moreover provides the most recent granular data at an institutional level in respect of commercialisation and technology transfer[206] activities at the institutions.

Lastly, it is also important to point out that, although a significant part of this study has provided new insights into IP commercialisation by institutions, commercialisation itself is not limited to institutions nor is it limited to licensing and start-up formation, as already alluded to earlier, but it encompasses use of IP by industry, as has been dealt with by Sibanda (2007) in the case of De Beers and Sasol. It will also become evident in the next section, for example, in the case of KAPA Biosystems Inc. and Shimoda Biotech, that commercialisation of IP by industry also involves acquisitions, or at least has these as an exit strategy.

8.7 SELECTED LIST OF 10 CASE STUDIES OF COMMERCIALISATION OF SOUTH AFRICAN TECHNOLOGIES

This section is not exhaustive in respect of South African IP that has been successfully commercialised. Naturally, very little information is available regarding the commercialisation of IP by South African corporates, other than publicly available information on the importance of IP by corporates such as Sasol and Element Six, which feature prominently in South African patent statistics in **Chapter 7**. The importance of IP and its internal use by Sasol for its business is captured in the following statement:

> *"To deliver the fundamental understanding and technical opportunities to safeguard the group's sustainable growth and profitable operation, we have to continually ensure that our research facilities and systems are of the highest standards. Currently, Sasol's strong intellectual property portfolio includes in excess of 500 registered patent families."*[207]

206 Technology transfer is defined as process of translating promising ideas into products, processes and services in the economy, and involves identification, protection and putting into use (or commercialisation) of promising technology concepts that emanate from research activities, for the benefit of society (see Baseline Study, 2008-2014:13). Commercialisation is to be understood to have a similar meaning.
207 http://www.sasol.co.za/innovation/innovation-sasol [last accessed on 8 June 2017]

Element Six's strategic use and commercialisation of IP is aptly captured in the following statement:

> *"The innovative synthetic diamond solutions delivered by Element Six research and development are robustly protected by intellectual property rights, particularly patents. We believe that our customers' interests are best served by enforcement of our IP rights and entering into favourable licence arrangements where appropriate. Element Six has a dedicated in-house IP team that works closely with the various R&D and commercial teams to protect new synthetic diamond solutions that will deliver value for our customers. Element Six currently owns about 590 granted patents and 850 pending patent applications worldwide, covering all of our businesses, with about 50 new inventions being protected each year."*[208]

Timm (2017)[209] provides a list of largely ICT enabled or digital start-ups that have successfully commercialised their technologies largely through buy-out exits. Given the nature of these technologies, such as Mark Shuttleworth's Thawte, which was sold to internet security firm Verisign for an estimated $575-million in 1999,[210] patenting is not common and is often in fact undesirable, with trade secrets and copyright being better mechanisms of protection.

The selected case studies include those from the institutions that responded to the Commercialisation Questionnaire regarding some of their most promising portfolios, as well as open literature searches conducted on South African innovations:

(i) During the 2014/16 financial year, the TIA Annual Report (2015) discloses a successful TIA substantial monetary exit from a project initially funded in 2006 by the then Cape Biotech, whose portfolio was merged into TIA in 2009-10:

> *"The Technology Innovation Agency (TIA) recently received payment of some ZAR57,9 million from KAPA Biosystems Inc. for the selling of its shares*

208 http://www.e6.com/en/Home/Innovation/Intellectual+property/ [last accessed on 8 June 2017]
209 http://ventureburn.com/2017/06/biggest-sa-exit-deals-digital-all-stars/ [last accessed on 8 June 2017]
210 http://www.itweb.co.za/index.php?option=com_content&view=article&id=108569 [last accessed on 8 June 2017]

in its South African subsidiary, Kapa SA. Kapa SA was established in 2006 with a joint investment from TIA (then Cape Biotech) and Kapa Biosystems Inc., registered in the USA. The TIA investment of ZAR24 million was utilised to establish a research and manufacturing facility in Cape Town for the commercialisation of the company's protein engineering technology platform."

To date, this is the largest exit of any DST funded project during the period of this study.

(ii) Another disclosed transaction based on South African IP developed during the period of this study, occurred in April 2008, when Abraxis BioScience, a fully-integrated US biotechnology company Abraxis acquired Shimoda Biotech and its subsidiary Platco technologies, for an initial upfront payment of US$15m. Whereas Platco had technologies relating to anti-cancer compounds, Shimoda was focused on

"the development of new pharmaceutical products by combining successful off-patent molecules with a novel cyclodextrin drug-delivery platform, seeking to exploit the faster onset and improved bioavailability characteristics of that platform." [211]

Table 8.2 is a summary of Platco's patent portfolio, which forms part of South Africa's Biopharmaceutical/Biotechnology patents in **Chapter 7**. This technology would appear to be a platform technology for oncology applications based on platinum compounds

211 https://www.thepharmaletter.com/article/abraxis-pays-initial-15m-for-shimoda [last accessed on 6 June 2017]

Table 8.2: List of patents in the name of Platco [Source: Author-generated searches]

Item	Publication Number	Assignee/Applicant	Publication Date	Current IPC
1	WO2007085957A1	PLATCO TECHNOLOGIES PROPRIETAR	2007-08-02	C07F 15/00
	Title: PREPARATION OF PLATINUM (LL) COMPLEXES			
2	WO2006024897A1	PLATCO TECHNOLOGIES PROPRIETAR	2006-03-09	C07F 15/00
	Title: PREPARATION OF PLATINUM(II) COMPLEXES			
3	WO2008155727A1	PLATCO TECHNOLOGIES PROPRIETAR	2008-12-24	C07F 15/00
	Title: PLATINUM (IV) COMPLEXES			
4	WO2005051966A1	PLATCO TECHNOLOGIES PROPRIETAR	2005-06-09	C07F 15/00
	Title: PLATINUM(II) COMPLEXES, PREPARATION AND USE			
5	EP1789427B1	PLATCO TECHNOLOGIES PROPRIETAR	2009-05-20	C07F 15/00
	Title: PREPARATION OF PLATINUM(II) COMPLEXES			
6	US7576126B2	PLATCO TECHNOLOGIES PROPRIETAR	2009-08-18	A61K 31/28
	Title: Platinum (II) complexes, preparation and use			
7	WO2010067335A1	PLATCO TECHNOLOGIES PROPRIETAR	2010-06-17	C07F 15/00
	Title: PLATINUM (IV) COMPLEXES FOR USE IN THE TREATMENT OF PROLIFERATIVE DISEASES SUCH AS CANCER			
8	US7589225B2	PLATCO TECHNOLOGIES PROPRIETAR	2009-09-15	C07F 15/00
	Title: Preparation of platinum(II) complexes			

(iii) One of the most promising patented platform technologies in the energy/renewable sector is from the University of Johannesburg. The CIGS (copper indium gallium selenide) thin-film solar technology that *"uses large glass substrates on which a very thin photo-active layer with a thickness of approximately 1.5 to 2.5µm is applied"212* has resulted in a start-up company Photovoltaic Technology Intellectual Property (PTiP), founded by the inventor Prof Vivian Alberts. The following summary from Venter (2016)[213] provides an overview of the commercialisation of this University of Johannesburg patented technology:

"Photovoltaic Technology Intellectual Property (PTiP), a local technology development and intellectual property holding company, and Singulus Technologies, a listed German engineering company, in 2014 opened a ZAR180-million, 3 500m^2 demonstration plant in Stellenbosch. The aim of the plant was to improve Alberts's thin-film solar technology through the use of new-generation production equipment, supplied by Singulus. The plant was financed by UJ, as well as government's Industrial Development Corporation (IDC) and Technology Innovation Agency (TIA). The IDC also holds shares in PTiP. Before PTiP's joint venture (JV) with Singulus there was another suitor at the door, namely Johanna Solar Technology (JST). JST had seven shareholders, including South Africa's State-owned Central

212 http://saplastics.co.za/blog/thin-film-photovoltaic-pilot-plant-is-in-production [Last accessed on 8 June 2017]

213 "A-developed solar panels beat European intellectual property challenge" in Engineering News, 4th March 2016, available in http://www.engineeringnews.co.za/article/sa-developed-solar-panels-beat-european-intellectual-property-challenge-2016-03-04/rep_id:4136 [Last accessed on 8 June 2017]

Energy Fund, as well as private-sector investors Richmont-Venfin, Anglo Coal and the German solar manufacturer, the Aleo group. PTiP granted JST a license to manufacture its thin-film panels in Germany. JST also had the legal right to issue sublicenses for the manufacturing and distribution of the PTiP technology anywhere in the world, excluding Africa and its offshore islands. The JST JV completed a €72-million, 30-MW-a-year production facility, in Brandenburg, near Berlin, in 2007."

Table 8.3 lists PTiP technology patents licensed from the University of Johannesburg.

Table 8.3: List of patents in the name of the University of Johannesburg [Source: Author-generated searches]

Item	Publication Number	Assignee/Applicant	Publication Date	Current IPC	Relevancy
1	US8735214B2	UNIV JOHANNESBURG	2014-05-27	H01L 21/06	100
	Title: Method for the preparation of group IB-IIIA-VIA quaternary or higher alloy semiconductor films				
2	US7744705B2	UNIV JOHANNESBURG	2010-06-29	C22C 9/00	100
	Title: Group I-III-VI quaternary or higher alloy semiconductor films				
3	US7682939B2	UNIV JOHANNESBURG	2010-03-23	H01L 29/93	100
	Title: Method for the preparation of group IB-IIIA-VIA quaternary or higher alloy semiconductor films				

(iv) Part of the University of Cape Town's patent portfolio covers a promising new antimalarial drug candidate, MMV048, as a potential cure for malaria. The candidate has been developed under the leadership of Prof. Kelly Chibale, and has already undergone Phase I clinical trials. Below is a summary regarding this candidate and its commercialisation.

"Today, Science Translational Medicine publishes details of an exciting new antimalarial drug candidate, MMV048, effective against resistant strains of the malaria parasite, and across the entire parasite lifecycle1 with the potential to cure and protect in a single dose. The research was conducted by University of Cape Town's Drug Discovery and Development Centre, H3D and MMV, in collaboration with a team of international researchers. … In 2014, MMV048 became the first new antimalarial medicine to enter phase

I studies in Africa. Today, preparations are being made to begin phase IIa trials on this promising compound as a single-dose cure."[214]

One of the patents covering this compound is US9266842B2, which cites both the University of Cape Town and the Medicines for Malaria Venture (MMV) as assignees.

(v) The CSIR has traditionally been the leader in patenting in South Africa. Probably the most successful patented technology to come out of the CSIR predates the period of this study. According to Thackeray (2011:65), the lithium ion battery technology developed at the CSIR has found use in a wide range of applications, including portable telecommunications, laptop computers, and power tools.

Table 8.4: Selected Lithium ion patents in the name of Technology Finance Corporation (a wholly owned subsidiary of the CSIR [Source: Author-generated searches]

Item	Publication Number	Assignee/Applicant	Publication Date	Current IPC	Relevancy
1	US7964310B2 **Title:** Electrochemical cell	TECHNOLOGY FINANCE CORP	2011-06-21	H01M 4/48	100
2	US7855016B2 **Title:** Electrochemical cell	TECHNOLOGY FINANCE CORP	2010-12-21	H01M 4/48	100
3	US7838149B2 **Title:** Electrochemical cell	TECHNOLOGY FINANCE CORP	2010-11-23	H01M 4/48	100
4	US7824804B2 **Title:** Electrochemical cell	TECHNOLOGY FINANCE CORP	2010-11-02	H01M 4/48	100
5	US7722990B2 **Title:** Electrochemical cell	TECHNOLOGY FINANCE CORP	2010-05-25	H01M 4/48	100
6	US7556890B2 **Title:** Electrochemical cell	TECHNOLOGY FINANCE CORP	2009-07-07	H01M 4/48	100
7	US7452630B2 **Title:** Electrochemical cell	TECHNOLOGY FINANCE CORP	2008-11-18	H01M 4/48	100

The global importance of this foundational research that was undertaken at the CSIR in the 1980s and subsequent patents, some of which are listed in **Table 8.4**, is underscored by the following comments in Thackeray (2011):

"This foundational research at CSIR subsequently paved the way for the later design by Thackeray's team at Argonne National Laboratory of high-capacity composite electrode structures, $xLi_2MnO_3 \bullet (1-x)LiMO_2$*, in which M is predominantly Mn and Ni.34,35 Lithium batteries containing Argonne's patented materials are currently being licensed and commercialized*

214 https://www.mmv.org/newsroom/news/new-publication-highlights-efficacy-mmv048-against-resistant-strains-malaria [last accessed on 9 June 2017]

worldwide, not only for portable electronic devices but also for larger scale transportation applications."

(vi) More recently, patents from the CSIR have resulted in a spin-out, ReSyn Biosciences[215] that offers highly customizable and ultra-high-performance microspheres for life sciences research. This "bead" biotechnology has great potential for medical and research use as can be seen from the following extract:

"While existing companies offer solid or cracked micro beads, Dr. Justin Jordaan, a team leader behind the company's patented design, says Resyn technology featured a polymer matrix with vastly higher surface area for absorption. The beads are also the first to use a compound called PEI as the primary ingredient of the matrix tangle. And, says Jordaan, the patented microspheres are magnetic, which means they can be separated from a substance they're immersed in, like blood, simply with the use of a magnet.[216]

ReSyn Biosciences, a biotechnology spin-out company from the Council of Scientific and Industrial Research, has won a prestigious new product award at the Society for Lab Automation and Screening conference for its range of innovative MagReSyn® products, which help scientists find disease mechanisms faster. The new product award is given to companies that design unique and novel technologies based on the potential impact these products are likely to have in the field of automation, screening and drug discovery. The MagReSyn® products were developed by Jordaan and his team at the CSIR from a proprietary technology platform, which is subject to an international patent application."[217]

215 www.resynbio.com/ [last accessed on June 2017]

216 http://www.sablenetwork.com/inspirations/advancements-achievements/how-south-african-technologies-are-changing-the-world-and-competing-in-the-marketplace [last accessed on 9 June 2017]

217 http://www.engineeringnews.co.za/print-version/csirs-biotechnology-spin-out-company-wins-prestigious-new-product-award-at-an-international-science-exhibition-2015-02-26 [last accessed on 9 June 2017]

(vii) One of the most promising technologies developed by the University of Cape Town, under the leadership of Professors David Britton and Margit Harting, with initial funding from the Innovation Fund, is in electronics and sensors, and printed solar panels. This technology is also the subject of a number of patents included in the PCT patent applications and EPO and USPTO patents in this study; and has been licensed by a start-up PST Sensors.[218] According to Savastano, D. (2012):

"One of the key value propositions for the field of printed electronics is the ability to use printing processes to manufacture semiconductors. There have been some successes in this field, but mass commercialization has yet to emerge. PST Sensors is poised to make a major breakthrough in this field. Led by directors Margit Harting and David Britton, who have been working on this technology as professors at the University of Cape Town (UCT), PST Sensors has developed and proven its technology to print silicon semiconductors at room temperature on any material, including paper, using conventional printing methods. In 2010, the groundwork for PST Sensors was put in place. Harting and Britton negotiated the formation of the company and the assignment of the IP from UCT to PST once the shareholder's agreement was in place; as of 2011, the university is a minority shareholder and the South African government only receives a small royalty for its investment. The sensor technology was independently validated by Soligie, which has printed demonstration thermistors using PST inks. By Nov. 5, 2010, PST Sensors was formally registered as a limited company in South Africa."

(viii) In 2015, the University of the Witwatersrand announced the formation of SmartSport Quality (Pty) Ltd,[219] a start-up established by the university to commercialise technology developed by its researchers, Professors Wendy Stevens and Lesley Scott, which cost-effectively verifies the accuracy of testing for tuberculosis (TB) using GeneXpert diagnostic machines. According to the university:

218 http://www.pstsensors.com [last accessed on 9 June 2017]
219 http://smartspotq.com/ [last accessed on 9 June 2017]

"SmartSport is a game changer for global health by increasing access to TB testing and shortening the time for result to a few hours. When the World Health Organisation (WHO) endorsed this molecular diagnostic test there was no quality assurance in place for checking the accuracy of the testing machines on deployment or for ongoing quality assurance. This led to the invention by Prof Scott, developed further by the team at DMMH and CBTBR, in partnership with the National Health Laboratory Service (NHLS) Priority Programmes. SmartSpot's "spots", can be used to guarantee the quality of the molecular diagnostic tests. This is achieved through knowing the exact amount of inoculated bacteria placed in "spots", deposited onto easily shippable paper cards. The SmartSpot cards are the only simple to use, easy to distribute verification and quality assurance test available, and will in future be sold as "TBCheck". In South Africa, the SmartSpot technology has been used on all 289 GeneXpert instruments in the national TB program, which commenced in 2011. Over the duration of a year, SmartSpot verification found that 2.6% of the tests were inaccurate and test modules needed replacing. Without the use of the SmartSpot technology, 78,000 test results of the 3million tests performed would have been inaccurate leading to some patients remaining undiagnosed. These patients would either die or spread the disease within their communities, whilst others, falsely diagnosed as having TB, would have unnecessarily been put on 6-18 months of costly drugs with many side effects. Currently SmartSpot's product is shipped to 22 countries globally with more countries in the pipeline."[220]

(ix) Another success story of commercialisation of South African patents is Altis Biologics,[221] a biotech company that specialises in the research and development of osteogenic biomaterials for use in skeletal regeneration therapies in man. Founded in 2001 by Dr Nicholas Duneas following his PhD studies at the University of Witwatersrand, Altis, has during its time being located at the Tshwane University of Technology and now at The Innovation Hub, developed commercially available bone morphogenetic proteins (BMPs), which induce new bone

220 http://wits-enterprise.co.za/b/2015/08/20/smartspot-the-first-company-to-be-spun-out-of-wits-in-over-5-years [last accessed on 9 June 2017]

221 www.altisbiologics.com [last accessed on 9 June 2017]

formation in human recipients. Funded initially by the Innovation Fund and then by TIA, the company has received international interest for its USA and European patented technology, which is in the process of exporting its BMPs abroad.

(x) The University of Stellenbosch, which has been increasing its patent portfolio, particularly in the period 2006-2015, has given birth to a number of leading technologies, which have resulted in commercial globally relevant technologies, two of which are summarised below.

a. Funded by TIA, a start-up company Custos Media Technologies is commercialising cutting edge digital content distribution technology, covered by a set of patents including US9595034B2, in the name of the University of Stellenbosch for content owners to:

> *"distribute, manage, and protect sensitive media. The innovative core technology gives a new level of protection to the owners of any project – whether a large ebook publisher, a small indie film producer, or anything in between. Anywhere sensitive digital media moves, Custos can protect it. The underlying technology was invented by an experienced cross-disciplinary team specialising in signal processing, distribution systems, cryptocurrency, machine learning, and media and behavioral economics. Since 2013 the growing team has developed the product and business to service film and ebook customers on three continents."* [222]

b. The other important technology to come from the University of Stellenbosch recently is directed towards large-scale production of nanofibers. A spin-out company, SNC has been established by the university, and according to Kriel *et al.* (2015):

> *"SNC, a materials science company based in Cape Town, South Africa, was formed in November 2011 as a spin-off company from the University of Stellenbosch with the goal of commercializing high throughput electrospinning technology. At the core of SNC's nanofiber technology is a free-surface electrospinning technology*

222 www.custostech.com [last accessed on 9 June 2017]

called Ball Electrospinning or SNC BESTTM. … What is unique about this technology is that the jets self-organize on the ball surface, creating a massively parallel and high-throughput electrospinning system. The technology has been widely patented,"[223] *and some of the patents are listed in* ***Table 8.5****.*

Table 8.5: Some of the Nanofiber technology patents in the name of the University of Stellenbosch [Source: Author-generated searches]

Item	Publication Number	Assignee/Applicant	Publication Date	Current IPC	Relevancy
1	US8916086B2	UNIV STELLENBOSCH	2014-12-23	D01F 1/10	100
	Title: Process for the production of fibers				
2	US9205453B2	UNIV STELLENBOSCH	2015-12-08	D01D 5/16	75
	Title: Method and apparatus for the production of fine fibres				
3	US8778254B2	UNIV STELLENBOSCH	2014-07-15	D01D 5/16	63
	Title: Method and apparatus for the production of fine fibres				
4	US8522520B2	UNIV STELLENBOSCH	2013-09-03	D02G 3/22	1
	Title: Yarn and a process for manufacture thereof				

In closing this section on the commercialisation case studies, it is important to point out that these case studies are not exhaustive but provide a reasonable sample of globally competitive and, in some cases, platform technologies emanating from South Africa's NSI. All the technologies in these case studies have been backed up by patents granted in South Africa, USA, Europe and other jurisdictions. In some of these cases, patents have been the enabler for accessing additional funding and internationalisation. So the role of patenting particularly by institutions cannot be over-emphasised. This is apparent from the Custos case, in which the founder Gert-Jan van Rooyen in his article *"9 ways University Support Can Help Scale Your Startup"*[224] *writes:*

"… there is strategic value to the inventors to initially have IP residing with a stable institutional owner, such as a university, and licensed to the startup. If the startup fails, the IP remains active and can be re-licensed to a next venture or to a third party. Innovus' license agreement makes it easy to transfer the IP to the company when the company reaches a certain stage of investment and growth ... In the meantime, the university maintains and grows the international patent portfolio, something which would have been

223 http://fiberjournal.com/featured-articles/enabling-breakthrough-technologies-using-nanofiber-expertise/ [last accessed on 9 June 2017]

224 http://www.innovus.co.za/archived-news/9-ways-university-support-can-help-scale-your-startup.html [last accessed on 10 June 2017]

> *prohibitively expensive for a startup to do. In short, if your business plan requires a strong IP play, it would be extremely difficult to execute without ample funding, or a large institutional partner like a university."*

What is also evident from these case studies is the role of that initial soft funding from a government agency, which is critical in enabling private and other institutional investors to find the prospects of being involved in the commercialisation more attractive. The TIA Seed Fund has been a greatly welcome development for the institutions, as most would attest. This instrument should be rolled out more widely outside the institutions and be readily available to individual inventors and innovators. South Africa still has a low availability of venture capital funding, and this is an area that the NSI should stimulate, if South African IP is to be successfully commercialised. Lack of larger amounts of funding for scaling up has either delayed commercialisation of South African technologies or, in some cases, has led to their demise. One such example is the Joule, South Africa's first electric car developed by Optimal Energy with initial funding from the Innovation Fund, the DST and IDC, which required US$1,3bn from a potential production partner, to establish an anticipated production run of 350 000 vehicles in the first seven years. Having been urged by the IDC to *"… find a private partner for this investment, since such a large capital commitment falls well outside the scope of its mandate,"*[225] unfortunately Optimal Energy was unable to find such a partner and the whole project spanning a period close to 10 years of development had to be mothballed, as detailed in Eliseev (2012). [226]

The important role of incubation comes across in most of these case studies. Although institutions such as University of Stellenbosch, the CSIR, and NMMU, have established their own incubators, the author is of the view that institutions should be wary of all wanting to set up their own incubators. Rather, they should collaborate and/or enter into strategic partnerships with existing incubators and science parks, where these are within proximity of the institution.

225 https://techcentral.co.za/sas-joule-electric-car-costly-opportunities/23083/ [last accessed on 10 June 2017]
226 https://www.dailymaverick.co.za/article/2012-04-20-lights-go-off-on-sa-electric-car-project/#.WTwEXssgrIU [last accessed on 10 June 2017]

Researchers and inventors often are not the best people to commercialise an idea. In this regard, it is important that South Africa grow its pool of entrepreneurs. Institutions should also engage incubators and science parks to find these entrepreneurs and incentivise them to take their IP and technologies to market. Within the NSI, this calls for greater coordination amongst government departments. For example, *the dti* could provide greater opportunities for internationalisation through their exhibition schemes, and at same time enable access to industrialisation funding. At the same time, the Department of Small Business could better integrate its incubators within the NSI. Other national government departments as well as provincial and local government could enable market access for innovative technologies being developed within the system.

8.8 GLOBAL PERFORMANCE INDICES

8.8.1 Global Competitiveness and Innovation Indices

South Africa's innovation performance, as measured by the Global Competitiveness Index (GCI), is shown in **Figure 8.30**. South Africa's ranking appears to have been on a continuous decline since 2006, when it was ranked 35, having worsened in 2014/15 when it was ranked 56. Since then, South Africa's GCI ranking has shown improvement year-on-year; it stood at 48 at the beginning of 2017. Much of this improvement is linked to its performance on the innovation component of the index, in which South Africa is now ranked 35th globally.

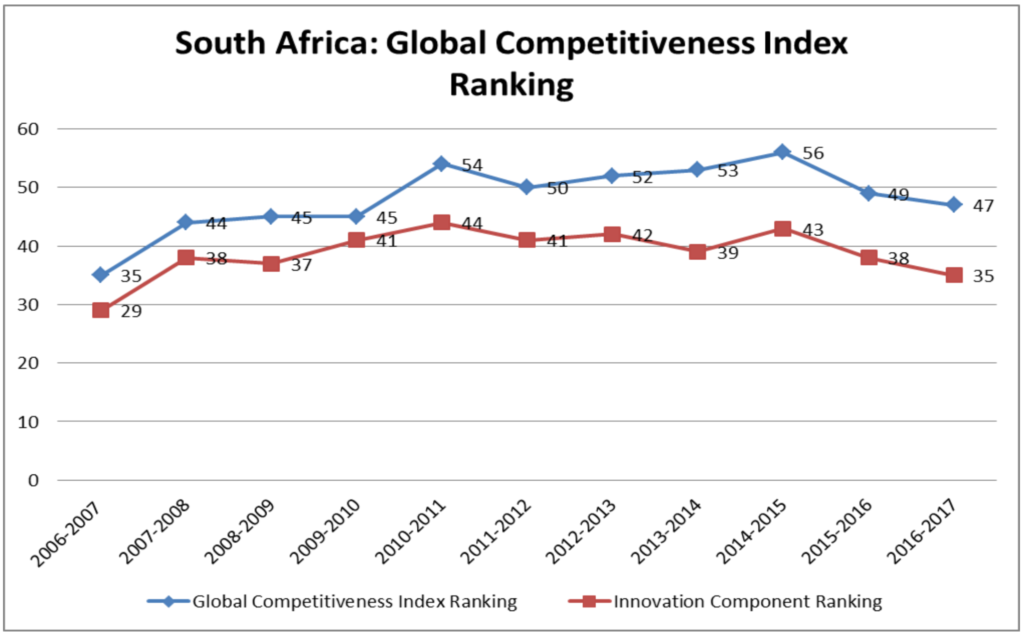


Figure 8.30: Global Competitiveness Index and innovation sub-component performance of South Africa [Source: Global Competitiveness Index, 2006-2016]

Figure 8.31 shows South Africa's performance amongst the BRICS countries. China has continued to maintain its dominance amongst the BRICS countries, being ranked 28th globally on competitiveness. South Africa is ranked in third position amongst the BRICS, down from a best second position in 2013-2014, with improving rankings year-on-year since 2014-15; South Africa has lost the second position it had in 2013-2014, to India. **Figure 8.32** summarises South Africa's performance in terms of the Global Innovation Index (GII) in the period 2011-2016.[227] South Africa (54) ranks second behind Mauritius (53) in terms of African countries, and is placed third amongst the BRICS, behind China (25) and the Russia Federation (43), and ahead of India (66) and Brazil (69).

227 Cornell University, INSEAD, and WIPO (2016): The Global Innovation Index 2016: Winning with Global Innovation, Ithaca, Fontainebleau, and Geneva – available at http://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2016.pdf [last accessed on 13 November 2016]

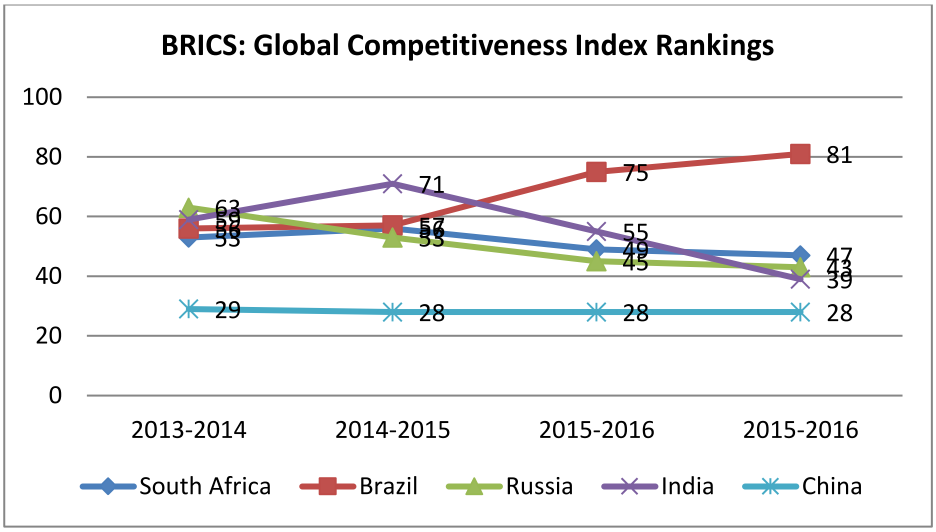


Figure 8.31: BRICS Group of Countries Global Competitiveness Index Rankings [Source: Global Competitiveness Index, 2006-2016]

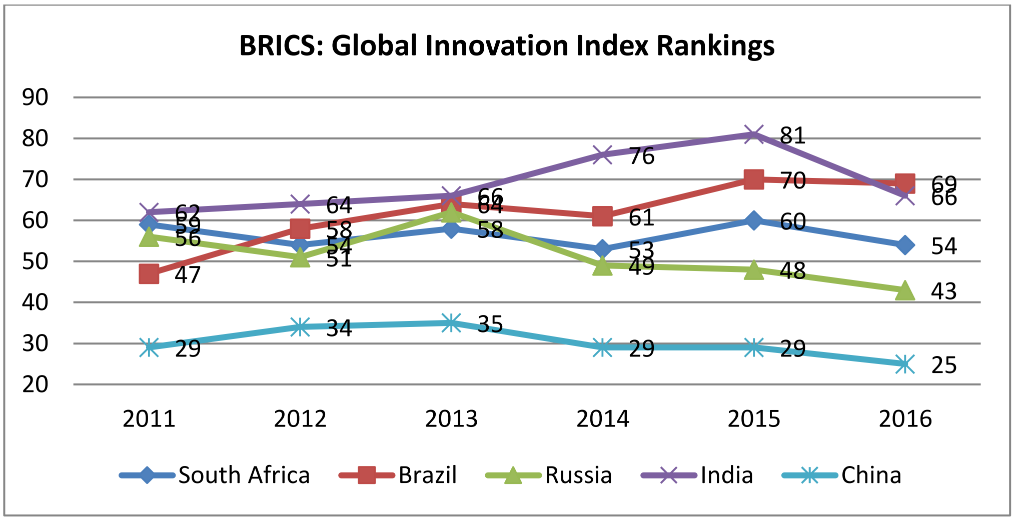


Figure 8.32: Global Innovation Index ranking of BRICS countries [Source: http://www.wipo.int/edocs/pubdocs/en]

According to Cornell *et al*. (2016:xxiv), South Africa, together with countries such as Brazil, Morocco, Mexico, the Philippines, Cambodia and Indonesia, outperform their income group on at least four of the seven GII pillars in Cornell *et al*. (2016:xxiv). South Africa needs to strengthen its positioning in these four pillars, whilst also improving its performance on the other three GII pillars.

8.8.2 Global Entrepreneurship Index (GEI)

Entrepreneurship is an essential component of innovation, as it plays a critical role in transforming any IP into value in the form of products and/or services that can be of use to society. Although NDP (2012:302) states that, *"entrepreneurship complements innovation,"* it fails to elaborate further on how entrepreneurship and innovation would be used to address the numerous challenges, such as unemployment, inequality and poverty. Given the challenges already detailed above, which are faced in the commercialisation journey, it is evident that there is an attendant degree of risk, which demands entrepreneurial flair. This section briefly analyses South Africa's performance in entrepreneurship in general.

Most successful commercialisation by the institutions detailed in **Section 8.7** above has been enabled by entrepreneurial capabilities within the institution and, in some cases, outside the institution. The author of this study holds the view that the focus should not be on turning all researchers coming up with innovative ideas at the institutions into entrepreneurs. In addition to empowering the researchers with entrepreneurship knowledge and skills, for them to manage their research better, the focus must be on building entrepreneurs who can assist with IP commercialisation, whilst the researchers either retain their positions within the institutions by generating additional IP and/or taking up roles of scientific officers within the start-ups. The author further notes that, based on over 12 years of experience in funding innovation and supporting IP commercialisation, the person who comes up with the idea is not necessarily the person best suited to commercialise it efficiently and effectively.

According to Sexton and Kasarda (1992:24), in addition to contribution towards GDP, local manufacturing and exports, critical measures of successes of entrepreneurial activities must of necessity include:

> *"the number of new business formations when coupled with the survival and level of success record, with the contribution to the economy in terms of employment."*

The Global Entrepreneurship Monitor (GEM) report, uses the Early-stage Entrepreneurial Activity (TEA) as an important measure of entrepreneurial activity. GEM (2015/16:26) documents South Africa's performance in entrepreneurial activity as characterised by (i) nascent entrepreneurs, pre-revenue or individuals who have not been paid salaries or wages for more than three months, and (ii) new business owners, whose businesses are at revenue stage and who have paid salaries for more than three months but less than 42 months.

Table 8.6: GEM Economies by geographic region and Economic Development Level, 2015 [Source: GEM, 2015/16]

	Factor- driven economies	Efficiency-driven economies	Innovation-driven economies
Africa	Botswana, Burkina Faso, Cameroon, Egypt, Senegal, Tunisia	Morocco, South Africa	
Asia and Oceania	India, Iran, Philippines, Vietnam	China, Indonesia, Kazakhstan, Lebanon, Malaysia, Thailand, Turkey*	Australia, Israel, Japan*, Republic of South Korea, Taiwan
Latin America and Caribbean		Argentina, Barbados, Brazil, Chile, Colombia, Ecuador, Guatemala, Mexico, Panama, Peru, Puerto Rico, Uruguay	
European Union		Bulgaria, Croatia, Estonia, Hungary, Latvia, Poland, Romania, Macedonia	Belgium, Finland, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom
North America			Canada, United States

*Adult Population Survey (APS) data from Japan and Turkey were not available in time for the global report

GEM (2015/16: 8) classifies South Africa as part of the Efficiency-Driven Economies,[228] alongside China, Brazil, whereas India is listed under Factor-Driven Economies, whilst Russia was not part of the 60 participating countries (see **Table 8.6**). South Africa was ranked 38th out of 60 countries (GEM 2015/16:27). Although South Africa has

228 According to the GEM 2015/16 report, pp. 8:

(i) the factor-driven phase is dominated by subsistence agriculture and extraction businesses, with a heavy reliance on (unskilled) labour and natural resources.

(ii) In the efficiency-driven phase, an economy has become more competitive with further development accompanied by industrialisation and an increased reliance on economies of scale, with capital-intensive large organisations more dominant.

(iii) As development advances into the innovation-driven phase, businesses are more knowledge-intensive, and the service sector expands. See also (http://weforum.org) [last accessed on 9 June 2017].

demonstrated significant improvement, up from its ranking of 53rd out of 70 countries in 2014, it is still below the GEM (2015/16) sample median.

Table 8.7: Average expert ratings for government policies for entrepreneurship in South Africa, 2015 (weighted average, 1 = highly insufficient, 9 = highly sufficient) [Source: GEM 2015/16]

	Mean score, 2015
Government policies (e.g. public procurement) consistently favour new firms	3.5
Support for new and growing businesses is a high priority for policy at national government level	4.6
Support for new and growing businesses is a high priority for policy at local government level	4.2
New firms can get most of the required permits and licences in about a week	1.9
The amount of taxes is NOT a burden for new and growing firms	3.3
Taxes and other government regulations are applied to new and growing businesses in a predictable and consistent way	4.7
Coping with government bureaucracy, regulations and licensing requirements is not unduly difficult for new and growing firms	2.4

An interesting assessment by GEM (2015/16) is the expert rating of South Africa's government entrepreneurship support policies. From the results shown in **Table 8.7**, government's approach to new businesses, both from the point of view of support and the predictability of policies and regulations appears to be moving in the right direction. This is particularly important when considering IP commercialisation and the need to establish a vibrant and critical mass of private sector companies to drive the growth and competitiveness of the South African economy. Notwithstanding the promising ratings, areas relating to licences, permits, and regulations for new businesses could reverse the gains being made in the other areas, and do require attention.

Table 8.8: Entrepreneurial framework conditions scores, 2015 (weighted average, 1 = highly insufficient, 9 = highly sufficient) [*Source:* GEM 2015/16]

EFC	South Africa	Africa	Efficiency-driven economies	GEM average
Financial environment and support	4.0	3.8	3.9	4.2
Concrete government policies: entrepreneurship priority and support	4.1	3.9	3.9	4.2
Government policies: taxes, bureaucracy	3.1	3.7	3.6	3.9
Government entrepreneurship programmes	3.0	3.8	4.1	4.3
Entrepreneurship education: primary and secondary level	3.1	2.4	2.8	3.1
Entrepreneurship education: vocational, professional & tertiary-level	4.2	4.0	4.5	3.6
R&D transfer	3.4	3.1	3.6	3.8
Access to professional & commercial infrastructure	4.9	4.9	4.8	4.9
Internal market dynamics	4.5	4.7	5.0	5.1
Internal market burdens	3.9	3.7	3.9	4.1
Access to physical infrastructure/services	5.9	3.4	6.3	6.3
Cultural and social norms	3.4	4.1	4.5	4.7

A comparison of South Africa's entrepreneurial framework conditions, against other African countries (in Factor-driven economies), the other Efficiency-driven economies and the GEM average, is shown in **Table 8.8**.

Since the GEM average only lags behind the Efficiency-driven economies in entrepreneurship education: vocational, professional and tertiary-level, the comparison is made between South Africa and the GEM average. Accordingly, It would thus appear that South Africa's performance is either on par with or above that of the GEM average in three areas, namely: (i) entrepreneurship education: vocational, professional and tertiary-level, (ii) entrepreneurship education: primary and secondary level, and (iii) access to professional & commercial infrastructure. A comparison with the other African countries shows South Africa to lag behind in four areas, namely: (i) government policies: taxes and bureaucracy, (ii) government entrepreneurship programmes, (iii) internal market dynamics, and (iv) cultural and social norms. Lastly, South Africa lags behind other Efficiency-driven economies in the following seven areas: (i) R&D transfer, (ii) government entrepreneurship programmes, (iii) internal market dynamics, (iv) cultural and social norms, (v) entrepreneurship education: vocational, professional and tertiary-level, (vi) access to physical infrastructure/services, (vi) government policies: taxes and bureaucracy.

It is thus evident that South Africa's performance on entrepreneurship according to GEM (2015/16) is still far from being sufficient, even in the area where South Africa appears to be doing well. The GEM (2015/16: 48) notes that:

> *"The three main areas cited as critical constraints by the experts were government policy (61%), access to finance (44%) and education and training (42%). … These three areas have been highlighted as critical factors since South Africa first participated in GEM in 2001."*

The GEM (2015/16: 5) further highlights that:

> *"Whereas South Africans aged between 25 and 44 years are the most entrepreneurially active, accounting for between 50% and 60% of all early-stage activity, the percentage of 18-24 year olds in South Africa involved in early-stage entrepreneurial activity is considerably lower than the average for Africa as well as the average for other Efficiency-driven economies."*

Noting South Africa's ambitions as spelt out in the NDP to reduce unemployment to below 6% (from levels of about 25%), the low participation of the youth in entrepreneurial activity definitely needs to be addressed. Consequently, unless significant investments are made in this regard, South Africa is unlikely to realise a *"youth dividend"* but rather a *"youth burden"*, owing to the youth looking at Government to create employment for them as opposed to them creating employment opportunities for themselves. This is exacerbated by South Africa being ranked lower than average for Efficiency-driven economies, coupled with the lowest opportunity score since 2011 for the proportion of entrepreneurs who are opportunity-driven, at 63% compared to the Africa average of 68.7%. The GEM (2015/16:31) states that businesses started by opportunity-driven entrepreneurs have higher survival rates and employ more people than those created by necessity-driven entrepreneurs. In this regard, it is important that there be significant emphasis on innovation-enabling skills that would accelerate entrepreneurship in technology-based areas. This is critical if South Africa is to spawn a critical mass of medium- to high-tech start-up companies with potential for scalability to become medium- to large-sized companies that will anchor South Africa's manufacturing base and industry competitiveness.

8.8.3 US Chamber International IP Index

South Africa's ranking on the US Chamber International IP Index detailed in GIPC (2017) is compared with those of a number of countries, including BRICS countries, in **Figure 8.33**.

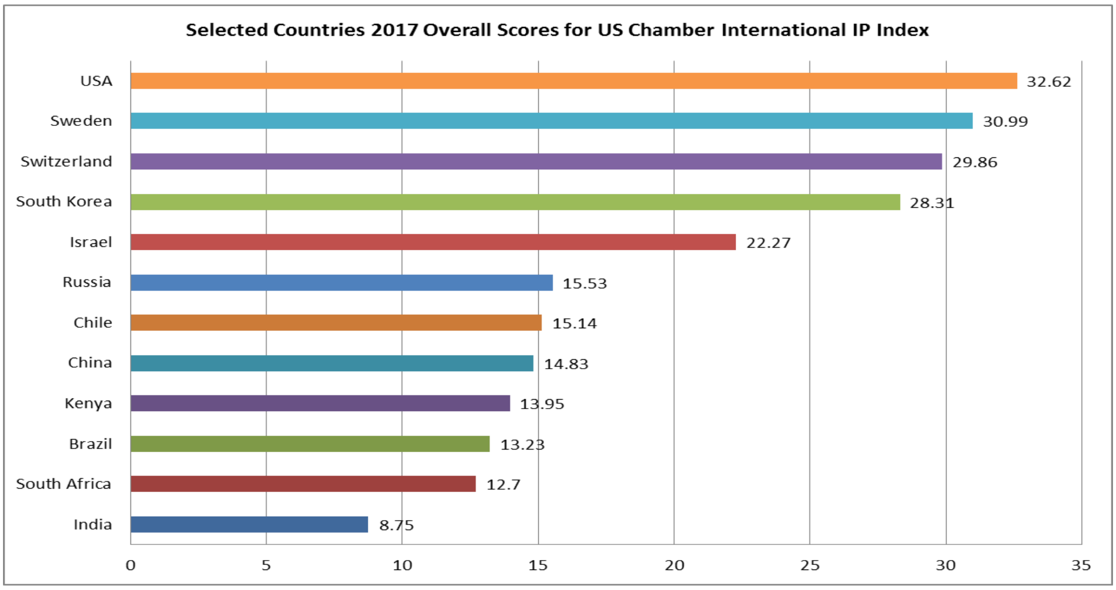


Figure 8.33: US Chamber International IP Index 2017 Overall Scores for Selected Countries [Source: GIPC (2017:19)]

GIPC (2017) discloses the US Chamber International IP Index[229] which represents a broad spectrum of sovereign policy choices by 45 economies globally (including South Africa and the BRICS countries) based on six categories of IP protection, patents, copyrights, trademarks, trade secrets and market access, enforcement, and ratification of international treaties. This index looks into the correlations between IP and a range of inputs to knowledge-based economies and utilises a model that integrates IP in different phases of the innovation and creativity lifecycle.

Figure 8.33 illustrates that Kenya and other BRICS countries (except for India) rank higher than South Africa on the IP Index 2017. The reasons for this low ranking for South Africa summarised in GIPC (2017:89-90) include:

(i) the sole focus of the IP Policy Framework (2016) on one type of IP right, patents and on one sector the biopharmaceuticals,

229 http://www.theglobalipcenter.com/ipindex2017/ [Last accessed on 19 July 2017]

(ii) a primary focus on the transfer of technologies from international rights holders to local companies in terms of the procurement policies that emphasise localisation (and cited is the Industrial Policy Action Plan 2016-17-2018-19), and

(iii) the significant focus of the Bioeconomy Strategy (2015) and the IP Policy Framework (2016) on the use of third party IP and very little emphasis on how IP could be created and commercialised as an industrial asset.

The importance of IP creation and commercialisation is best articulated by the following statement in GIPC (2017:90) that:

> *"For economies – emerging and developed alike – the creation of new forms of intangible assets and IP are what will drive innovation, technological advances, and ultimately, economic development and growth. IP rights are a critical component of this."*

Conversely, GIPC (2017:24) points out that Kenya's policies, particularly in respect of copyright-related matters, are seen as being more progressive; moreover, they have helped to position Kenya above South Africa. It is submitted that, although the index may be useful, it has some limitations, owing to the scoring on the elements contributing to the Index, where the score is either a 1 or a 0. Another limitation of the Index is that the evaluation is policy-biased as opposed to having a strong commercialisation-outcomes bias. It would appear that the commercialisation outcomes are more implied from the policies than evidence-based. Notwithstanding this criticism, there appears to be a high correlation (0.83) between this Index and the scores from the Scientific American WorldView (2015)[230] in respect of the role of IP in fostering Biotechnology-related innovations, as can be seen from **Figure 8.34**.[231]

230 http://www.saworldview.com/ [last accessed on 9 June 2017]
231 http://www.theglobalipcenter.com/wp-content/themes/gipc/map-index/assets/pdf/2016/GIPC_IPIndex_Annex.pdf [last accessed on 9 June 2017]

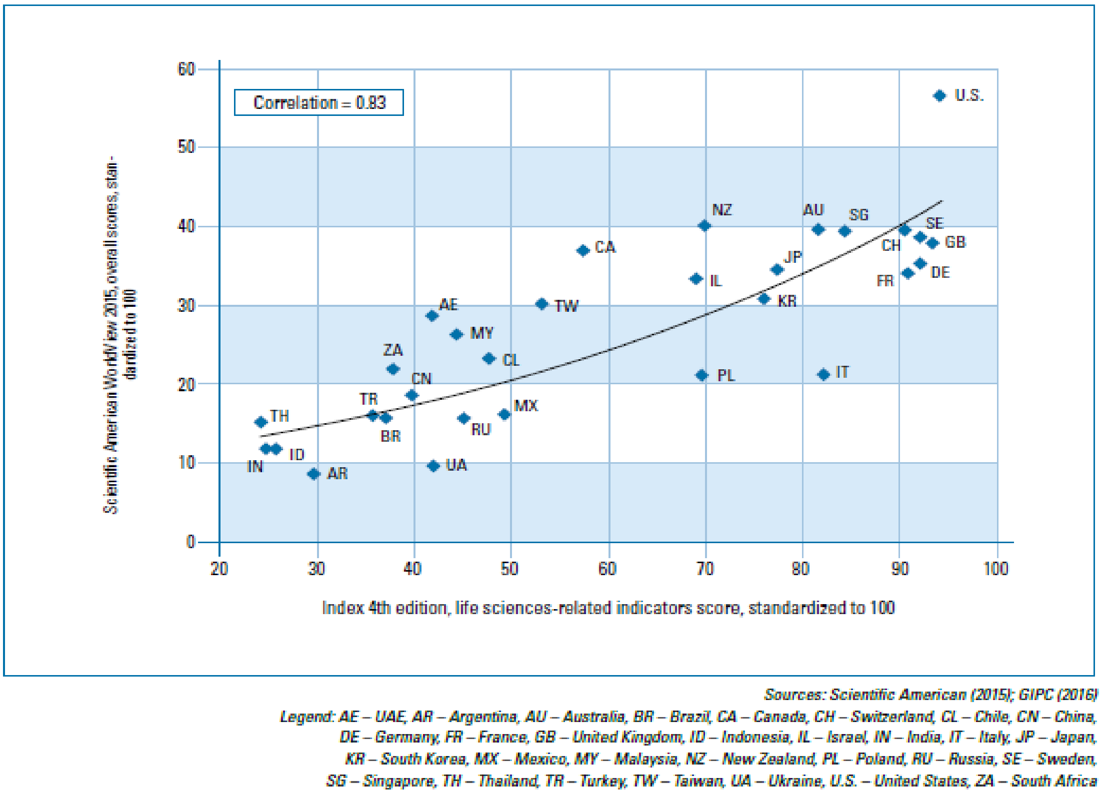


Figure 8.34: Association between the Index 4th Edition Scores on Life Sciences – Related Indicators and the Scientific American WorldView (2015) [Source: GIPC (2016)]

Given South Africa's growing Biotechnology patents portfolio, it is therefore important that any possible IP policy changes support rather than stunt the growth of Biotechnological innovations, which as we can see from **Figure 8.34** rely on IP protection for their successful commercialisation.

8.9 CONCLUSIONS

This chapter has dealt extensively with a rather complex matter of IP commercialisation to enable us to better contextualise the patenting data established in **Chapter 7**. There are a number of findings worth highlighting again in this section.

This study finds that there has been an exponential growth in publications by South Africans, over the period 1997-2015, almost tripling from 4 585 in 1997 to 14 996 in 2015. A critical look at the most prolific (top 10) publishing institutions reveals that they also tend to be the same top 10 patenting institutions (as established in **Chapter 7**). These very institutions also tend to be the ones with the most established TTOs. A critical review of commercialisation outcomes also reveals that, with the exception of a couple of outliers, in particular the University of the Witwatersrand, the same institutions are more successful than the others in respect of revenues earned, start-up formation and licences granted. The study thus concludes that there is a correlation between publications, patenting, TTO capacity and commercialisation. Institutions with high publication outputs also tended to exhibit higher patenting rates. The fact that commercialisation outcomes for the University of the Witwatersrand do not match up with its dominance in patenting and publications suggests that this correlation is a complex one and would need further separate investigation. The consistency of North-West University's commercialisation outcomes in light of its publication and patenting outcomes is quite impressive and would seem to suggest that they have a higher conversion rate from publications to patents and also to products, processes, licences, start-ups, and revenues, as has been illustrated in this chapter. This is echoed by Dudhia *et al.* (2017:18) who disclose that:

> *"The single university that stood out the most was North-West University which was not in the top five producers of research but was in the top five patent filers".*

This is also consistent with the findings in Sibanda (2009:127-134), which attributed North-West's performance to higher patent expenditure and a tradition of doing more applied research or product development and less basic research.

In **Chapter 7**, it was established that South Africa had a nascent Biopharmaceutical/Biotechnology sector based on its growing patent portfolio in this field. In this **Chapter 8**, this study has established that most publications have been in the same field. This is not very surprising, given that this field is represented in the top research fields by GERD. This field is dominated by institutions and there is a need to grow the level of private sector participation either through incentives to attract existing private sector or focused entrepreneurial activities to ensure intensified SMEs formation through start-up formation based on institutions' IP. The dominance of the institutions in this field could be linked to a concerted focus by the DST to promote this sector, as exemplified in the

Biotechnology Strategy (2001), the TYIP (2008) (Grand Challenges) and the Bioeconomy Strategy (RSA, 2013) and their implementation.

At present, private sector funding priorities, as represented by BERD in terms of SIC categories, show possible differences in focus between the private and public sectors. BERD is indicative of the current South African economy, which is becoming highly services sector oriented (>60% of GDP), as illustrated in **Chapter 3**. Of great concern is the decline in the private sector component of GERD, which as of 2014/15 stood at 40.8%, compared to 55.8% in 2001/02. The author is of the view that, in order for the South African economy to experience the levels of growth punted in the NDP (2012), this decline must be reversed.

The study notes the importance of appropriate human resources for both knowledge production as well as its commercialisation. More particularly, the growth in the number of R&D personnel (which have doubled and tripled if one considers head count and full-time equivalent (FTE), respectively) is an important development. Although this growth is welcome, this study is of the view that the rate of growth of R&D human resources must be accelerated in order to have sufficient capacity to absorb any anticipated increases in R&D expenditure; and also, capacity for technology transfer and adaptation, were South Africa to follow the example of South Korea in embracing in-bound technology transfer.

This study has also demonstrated that, in general, the institutions are progressively increasing their commercialisation outcomes, as represented by licences, start-up formation and revenue growth. Given the stagnation in domestic patenting and the growth in international patenting by South Africans, particularly the institutions, the progressive increases in commercialisation outcomes by the institutions, it would appear that there is untapped potential in the role of the institutions in transforming South Africa's economy. More particularly, the conversion rate of patents to products and processes, as represented by revenues earned and start-ups established, is reasonably high, given the paucity of private sector funding. Most of the commercialisation is government-funded. It is the author's view, supported by Lubango (2009:112) that involvement of more research personnel with industry experience would strengthen the institutions' commercialisation prospects.

South Africa has been improving its global standing, as measured by the various indices dealt with in this chapter, in particular the GCI and the GII, when benchmarked against the other members of the BRICS group. However, an uncertain IP policy standpoint could turn perception into reality in respect of these rankings, as is apparent from the concerns raised by the US Chamber IP Index (2017).

It is evident from the GEM that more efforts must be put into growing entrepreneurship. The importance of this for start-up formation and growth has also been highlighted by this study.

The issue of funding for commercialisation requires serious consideration if South Africa is to grow its economy through IP and innovation. IP protection is a business consideration and does cost money. Defending IP can also be costly. As seen from one of the case studies in this chapter, it is important to put in place mechanisms to support the costs associated with IP management, otherwise South Africa will not grow its IP portfolio.

Lastly, the role of government's policies and approaches in respect of IP and innovation issues would appear to have started to bear some fruits, albeit modest at this stage. More particularly, the role of the IPR-PFRD Act and NIPMO is underscored by the increases in IP protection and management by the institutions, as well as the commercialisation. As already indicated in **Chapter 5**, the object of the IPR-PFRD Act is the use and commercialisation of IP emanating from publicly financed R&D. Indeed, this study, through the case studies as well as by means of the quantitative information relating to commercialisation, has established that, 10 years since the IP Policy (2006), the ideals set out in the WPS&T (1996) and the NRDS (2002) in respect of IP are starting to be realised.

CHAPTER 9: CONCLUSIONS AND RECOMMENDATIONS TOWARDS AN IP-ENABLED INNOVATION ECOSYSTEM

"…we have to devote the necessary resources to scientific and technological research and development, including biotechnology. We must further encourage innovation among our people and ensure that we introduce new developments into our productive activities. Fourthly, while ensuring that we continue to develop a balanced economy, we must also identify and develop the lead sectors that will help us further to expand the base for creation of wealth and give us the possibility to compete successfully within the dynamic world economy." Thabo Mbeki[232]

9.1 INTRODUCTION

IP is an important tool for development that South Africa can effectively use to realise its envisaged socio-economic development and meet the goals set out in the NDP. This view is strongly supported by the GIPC (2017:7) which states that:

> *"IP is, in fact, a critical instrument for countries seeking to enhance access to innovation, grow domestic innovative output, and enjoy the dynamic growth benefits of an innovative economy."*

As detailed in **Chapter 4**, a number of international arrangements, such as the Paris Convention and the TRIPS Agreement, have negotiated positions in bilateral and multilateral international forums and associated agreements, which have greatly influenced the national IP policy environment and, in turn, the NSI. In aligning the South African IP system to these international arrangements, it is important also to take cognisance of the fact that some of these arrangements were negotiated and concluded several decades ago. For example, the TRIPS Agreement, which has become the global standard for IP protection, as we have seen in **Chapter 4**, was in the making since the end of the Uruguay round, spanning from 1986 to 1994, although it only came into force in 1995. Notwithstanding the fact that the TRIPS Agreement has been the global standard for more than 20 years, the core fundamentals of the patent system it provides remain in

232 Former President of the Republic of South Africa, Thabo Mbeki in the Preface to the NRDS (2002:3)

force, despite the introduction of new technologies in the advent of the 3rd and 4th industrial revolutions; the situation is aptly captured in GIPC (2017) as follows:

> *"The TRIPS Agreement largely predates globalization and the technological revolution that has allowed complex flows of information, capital, and talents to move virtually seamlessly around the globe."*

9.2 INTERNATIONAL ARRANGEMENTS AND DOMESTIC IP SYSTEM

Given that South Africa is a signatory of important international IP legal instruments, which have had a significant impact on innovation and trade globally (in particular, the Paris Convention, the TRIPS Agreement and the PCT), as discussed in **Chapter 4**, these instruments should be used to shape South Africa's IP system and in turn NSI. In this regard, it is submitted that South Africa must explore the full extent and spirit of the TRIPS Agreement to ensure that IP is used to promote technological innovation and the transfer and dissemination of technology. Recent proposals on the development of the National IP Policy discussed in **Chapter 7** would appear to be narrowly focussed, and to place significant emphasis on IP and public health. The protagonists of these proposed amendments have argued that this is not the case and that public health is an issue requiring urgent attention, owing to the burden of disease on the state and the impact of IP on access to health. Although this may be the case, the best approach would have been and should be a clear argument on the use of IP as an instrument for socio-economic development. This point is also made very clearly by the US Chamber IP International Index, in their explanation of why South Africa has a low score on the Index.

As the TRIPS Agreement has a broader reach, in particular with regard to the promotion of sectors of vital importance to their socio-economic and technological development, it is submitted that the emerging South African National IP Policy should unequivocally pronounce on this broader reach. In particular, it should advocate for a plan to ensure wider use of IP in all key sectors of potential growth for South Africa, as well as increased awareness of IP as an instrument for wealth creation.

In ensuring effective implementation of the TRIPS Agreement and related flexibilities, South Africa should strive for a balance in bilateral and multilateral engagements when called upon to adopt the so-called TRIPS-plus provisions, which would limit South Africa's ability to make full use of the TRIPS Agreement through implementation of the flexibilities. In this regard, the Max Planck Principles for Intellectual Property Provisions in Bilateral and Regional Agreements[233] directed at achieving "*better mutually advantageous and balanced regulation of international IP"* may be a useful guide. The author submits, however, that these Principles should not necessarily dictate how South Africa approaches multilateral arrangements. Paragraph 6 of the Max Planck principles states that:

> *"IP protection and enforcement rules in bilateral and regional agreements tend to erode the policy space inherent in the TRIPS Agreement. States bound by such rules are less able to tailor their IP laws to fit their domestic environment and to adapt them to changing circumstances. These trends also affect current and future multilateral initiatives in international IP law."*

In multilateral arrangements, there is always a balancing of negotiated positions and trade-offs to be considered, and there is a need for skilful negotiation, to balance the trade-offs that come with the TRIPS-plus provisions. As an example, in the case where a negotiated outcome in a bilateral arrangement has demonstrable potential to result in significant job creation or access to markets for South African manufactured goods, in return for South Africa adopting more stringent IP provisions (even bordering on TRIPS-plus), South Africa should take a balanced approach, considering its level of development. Naturally, any position that is adopted would not to be extended to other countries based on the Most-Favoured Nation principles under TRIPS. The following extracts of the Max Planck Principles, are instructive in this regard:

> *"Part Two – Recommendations*
> *I. Negotiation Mandate and Strategy*
> *13. Countries facing IP demands should aim to develop their own pro-active agenda on IP issues in a consultative and participatory domestic process. This may include identifying limits for additional IP protection and*

233 http://www.ip.mpg.de/fileadmin/ipmpg/content/forschung_aktuell/06_principles_for_intellectua/principles_for_ip_provisions_in_bilateral_and_regional_agreements_final1.pdf [last accessed 23 March 2017]

> *enforcement, especially limits motivated by the protection of public interests. …*
> *II. Negotiation Process*
> *16. Each negotiating country should evaluate, for example in the form of impact assessments, the IP demands they face in terms of their implications for public interests, the realization of human rights, and the financial burdens and implementation costs they entail. …*
> *III. Negotiated Outcome*
> *18. If parties agree on IP provisions containing stronger protection or enforcement obligations, these provisions should nevertheless be sufficiently flexible to take into account the socio-economic situation and needs of both parties.*
> *19. Countries should consider the long-term consequences for the public interest and their domestic IP system in case they accept IP demands in exchange for obtaining trade preferences or other benefits. They should also be aware that such benefits are progressively eroded whenever their trade partners offer equivalent or greater benefits to third countries."*

Whereas the focus of this study has been on the patent system as a proxy for the IP system, the approach to the National IP Policy should be more far reaching than just focussing on patents; it should ensure that South Africa's IP system incorporates the best principles from the various international arrangements. This is particularly important given the convergence of technologies and thus the fact that some of the innovations, particularly computer implementations or business models that are relevant for the services sector, may not lend themselves patentable but could be protected through, *inter alia,* copyright law.

9.3 SOUTH AFRICAN IP SYSTEM AND TRIPS FLEXIBILITIES

As we have seen in **Chapter 5**, not all TRIPS flexibilities are incorporated into the South African patent law. Given that South Africa is a middle-income country with a relatively sophisticated industrial sector, in comparison to its peers and indeed other African economies, this study advances the view that the focus with regard to the flexibilities should not be on the level of protection but rather on the efficiency of its IP system. A weaker IP system would not enable South Africa to accelerate its development; yet too strong an IP system that is substantially based on a TRIPS-plus regime may be detrimental, given the low level of participation in the IP system by South Africans, as this study has established. Accordingly, South Africa will be best placed to incorporate all TRIPS flexibilities and in particular, the following for the reasons already alluded to in **Chapter 5** and also given South Africa's desired macroeconomic environment, as detailed in **Chapter 3**, in order to increase the efficiency of its IP system:

(i) full extent of patentability criteria,
(ii) disclosure flexibilities,
(iii) research exception,
(iv) utility models, and
(v) aspects relating to substantive examination of patent applications.

Whereas the IP Policy Framework (2016) argues for significant amendments to South Africa's compulsory licensing provisions, after having analysed the current compulsory licencing provisions in South Africa and their actual use, this study finds that the law is both sufficient and enabling. More importantly, the current provisions would appear to provide an equitable balance and hence safeguard the interests of all affected parties, rights holders and public interest.

As detailed in **Chapter 4**, various compulsory licensing attempts have, in the end, been settled amicably through granting of voluntary licences and immunity from suit (as in the case of Aspen). It is thus submitted that the current requirements of granting compulsory licensing in South Africa's patent legislation are not at all inhibiting but rather represent the maturity of South Africa's IP system and also a separation of roles between the legislature, the administration and the judiciary.

This study has not identified any biased or controversial judiciary decision on the interpretation and/or implementation of the compulsory licence provisions in the South African Patents Act. Accordingly, it is submitted that the arguments advanced by both the Draft IP Policy (2013) and the IP Policy Framework (2016), viz. to have compulsory licences decided at administrative levels, lack a substantiated basis. This is particularly so, given that any prospective compulsory licensee, even in the area of public health, may approach the courts to make their case why they should be granted a compulsory licence. Given that compulsory licencing provisions already form part of South African patent law, any amendments in respect of easing the issuing of compulsory licence must consider a variety of circumstances. These include historical experiences in South Africa with compulsory licences, the extent of the mischief that proponents of this change believe must be addressed, the balancing of rights between rights holders and the general public, and the real benefits to be derived by the NSI and the country's socio-economic challenges, by such amendments.

It is thus submitted that, to date, the case made for the amendments is narrowly focussed and driven by access to health considerations in isolation from the actual state of the IP system in South Africa.

It is also submitted that these amendments would introduce yet another administrative burden on the state that should rather divert the resources towards increasing awareness and use of the existing IP system by residents (including an increased awareness of the compulsory licensing provisions and their actual use, to the general public). An amendment that this study does support within the ambit of compulsory licensing, however, is the domestication of the Doha Declaration on the TRIPS Agreement and Public Health Waiver Decision (TRIPS Article 31bis). Visser (2011:4) deals adequately with this Waiver Decision. At present, South Africa has not domesticated TRIPS Article 31bis that provides a basis for bulk imports into one country and re-exportation into the rest of the Southern African Development Community (SADC) region, for example. It is thus submitted that domesticating this waiver may stimulate domestic generic manufacturing capacity whilst also providing South Africa's trading partners in the region with no manufacturing capacity with the means to implement compulsory licenses, which they may grant, as South Africa can then export generic drugs to them under these provisions.

Similarly, whereas the regulatory exemption or Bolar provision already forms part of South African patent law, there must be deliberate awareness of this flexibility, with particular emphasis on the benefits that it provides, and how these relate to South Africa's future desired macroeconomic environment. This study advances the view that this flexibility is more important than the administrative compulsory licensing provisions punted, as it makes full use of the patent system and also talks to actual capacity building to enable South Africa to address the burden of disease through increased manufacturing capacity relating to local generic medicines, and the early market entry of generic drugs soon after patent expiry of relevant proprietary medicines. There is also potential to fully explore development of medicines based on indigenous knowledge systems, including appropriate protection mechanisms for IP in indigenous knowledge. Full use of the regulatory exception provisions is also supported by South Africa's increased R&D capability in the pharmaceutical sector, as indicated by patenting trends seen in **Chapter 7**.

An appropriate use of both the research exemption and the regulatory exception provisions have the potential to stimulate R&D and manufacturing capacity in the pharmaceutical sector (a sector in which South Africa imports many inputs, such as the Active Pharmaceutical Ingredient (APP)), given South Africa's disease burden. Stimulating R&D should occur within an ultimate vision of growing the local pharmaceutical industry. Given South Africa's membership of SADC, South Africa could find itself at the centre of implementation of the SADC Business Plan on Pharmaceuticals.[234] In order to stimulate the growth of the local industry, there would need to be an alignment between the R&D investment by both government and the private sector. More particularly, the growing life sciences capabilities of the institutions, as indicated by the institutions' patent portfolios (**Chapter 7**), must also be aligned to the disease areas of future opportunities, where diagnosis, prophylaxis and treatments would be required within SADC.

Progress has been made towards developing a SSE system, for substantive examination of patent applications across all technology sectors in the medium to long term. As discussed

234 http://www.sadc.int/themes/health/pharmaceuticals/ [last accessed 13 May 2017]

in **Chapter 7**, this study recommends the implementation of a hybrid system that comprises pre-grant opposition as well as well as SSE. Introduction of the requirement for disclosure of the patent prosecution history and records from foreign equivalent applications and patents would greatly assist in managing bottlenecks. In addition, use of pre-grant opposition procedures would also ensure public participation in quality assurance, thus providing a mechanism of ensuring that relevant prior art is brought before the examiners in sectors of importance. Notwithstanding the above, South Africa must find ways of ensuring that this transition to SSE does not further alienate local inventors and innovators, owing to further reduced access to the patent system because of the increased costs associated with a SSE system. A balance must be found whilst respecting the principle of national treatment.

9.4 BOOSTING USE OF THE IP SYSTEM AND PARTICIPATION BY SMES IN THE NSI

Global patenting has been on the rise, particularly since the new world order brought about by the WTO in 1994. Straus (2016:457) states that much of this has also been fuelled by the emergence of new technologies and an understanding, particularly by countries such as China, that *"the competition of the future world is a competition for intellectual property rights."*[235] If South Africa is to compete in this new world order, it has to increase its contribution to the global knowledge pool. In particular, it has to broaden the participation of the various players in the NSI. More particularly, there is a need to promote and support the utilisation of the IP system, in particular, the patent system by residents. This is particularly pertinent since domestic patent filings have remained stagnant over the 20-year period covered by this study, despite the emergence of new technologies and South Africa becoming part of the new world order, having joined the WTO in 1996. Of great concern is that the South African IP system does not show any signs of growth in patenting rates, other than in biopharmaceuticals/biotechnology (spearheaded by institutions) and

235 China Steps up IPR Protection to Promote Innovation', China Daily (3 October 2006), available at http://www.chinadaily.com.cn/china/2006-10/03/content_701281_3.htm (last accessed 3 June 2017), in (Straus, 2016)

in the financial services sector (dominated by mix of a couple of local and foreign assignees) (**Chapters 7** and **8**). Both of these are part of the new technology areas of importance referred to above.

The patent numbers at the South African patent office (**Figure 7.1**) have to all intents and purposes remained stagnant over the past 20 years. This suggests that the increase in the patent applications and patents by institutions is accompanied by an inverse decrease in patent applications and patents by corporates and individuals (that have traditionally utilised the IP system), otherwise there would be an increase in the overall domestic patenting levels. Indeed, the study has shown this to be the case. In **Chapter 7**, for example, some of the top assignees in the period 1996-2005 have either reduced their levels of patenting or are not featured at all in the top assignees for the 2006-2015 period. Some of the reasons this study advances for this finding include:

(i) changes in the structure of the economy from a fairly industrialised economy to more services-oriented industries (as seen in the macroeconomic environment analysis in **Chapter 4**). Services industries are less inclined to apply for patents than manufacturing industries;

(ii) decline in the size and maturity of the private sector, as we have seen with some of the companies, such as Element Six relocating most of their operations off-shore, and as such less patents being registered with South African priority and/or South Africa inventor addresses;

(iii) decreased R&D investment by business (**Figure 8.11**), presumably owing to insufficient incentives for the private sector to invest in R&D and to patent resultant knowledge. The revisions to the R&D tax incentive may alter this position;

(iv) changes to the structure and research activities by state owned entities such as Denel and Eskom that had patent applications filed or patents granted in the period 1996-2005, as this study has shown, but fewer to no patent applications or patents in the later period of 2006-2015;

(v) very little understanding and use of the patent system by individual inventors and innovators in South Africa. Indeed, though significant patenting activity at the

South African patent office has been from corporates and institutions, there has been very little growth in use of the patent system by local inventors and innovators. This could be because of a low capacity to invent and patent as well as an underdeveloped ability to use the patent system;

(vi) lack of financing mechanisms to fund patenting costs by SMEs in the face of an underdeveloped venture capital financing sector; and

(vii) not much appreciation of the value of the IP system and, in particular, of patents as an economic tool to building the competitiveness of firms and ensure wealth creation through start-up creation.

An analysis of the patenting trends by South African residents abroad (**Chapter 7**) shows that very few SMEs apply for patents. This is greatly concerning, given the reality aptly stated in (Erstling, 2010:465) that *"SMEs are often the backbone of economic development in emerging economies"*. This is affirmed in (NDP, 2012:117), which states that *"Small-and medium-sized firms will play an important role in employment creation."* The OECD (2011:71) further found a *"highly concentrated market structure … dominated by established businesses".*

This study therefore recommends a deliberate long-term focus on growing and strengthening the SME sector in order to have a vibrant NSI. In addition to increased R&D investment by the private sector, the study recommends that South Africa puts in place mechanisms to ensure increased use of the IP system by SMEs, such as, *inter alia*:

(i) increased awareness,

(ii) incentives to support international protection of their IP,

(iii) a deliberate programme to boost SMEs' competitiveness through in-licensing and technology transfer that supports development of local industries (particularly in manufacturing, labour absorbing and exports generating sectors), and

(iv) stronger linkages to the institutions for them to gain better access to technologies developed with public funding.

Such a deliberate focus will also contribute towards transforming the structure of the South African economy by reducing the dominance of large and established players, and realise the vision espoused in the (NDP, 2012:119):

> *"in [a] significant increase in the number of new firms that are established, decreased levels of economic concentration in most sectors, more diversified economic activity, deeper supply chains with more intermediate inputs sourced from local suppliers, and higher levels of innovation."*

In terms of (iii) above, specific interventions may encompass improving the understanding of the IP system, the principles of territoriality, assistance to SMEs to undertake patent searches relevant to their businesses to better understand the IP landscapes, assistance with identifying relevant patents (not in force in South Africa) that they can use without fear of infringement, assistance in negotiating licenses, where there are prospects of infringement, and financial support for concluding relevant technology transfers and acquisitions, as well as any accompanying skills or know-how transfer.

The anticipated significant costs associated with migration to a SSE patent system, necessitates that South Africa find ways of increasing the use of the IP system by South African residents, in particular individual innovators and SMEs. In this regard, South Africa should strongly consider introducing a petty patents or utility model system for the protection of incremental innovations, which may be affordable and more accessible than the patent system. At the same time, recognising the need to embrace the full extent of the IP system, this study recommends that concerted efforts be made to promote the value and use of the designs registration system, for the protection of aesthetic qualities of commercial embodiments of innovative products. The designs registration system is more accessible, more affordable and less costly to enforce than the patent system.

Cost and access to finance are some of the barriers to access to and effective use of the IP system, by residents, particularly individual innovators and SMEs. In this regard, on the basis of the lessons gleaned from the NSI, this study recommends that South Africa should explore mechanisms for giving financial assistance to local innovators to obtain and commercialise their patents, particularly where these have the potential to affect the priority sectors of the economy. Such assistance will expedite broader and more inclusive use of and access to the IP system by residents, and also ensure that the SSE does not become a disincentive to local innovators who are presently not fully utilising the patent system. As has been demonstrated by this study, financial assistance in the form of 50% of their patent costs, which are provided to institutions to cover the patenting activities of their researchers, has already demonstrated and led to an increased use of the patent system by institutions. In this regard, TIA together with NIPMO could establish a joint fund to facilitate the protection and commercialisation of locally developed innovations as well as in-licensing of foreign technologies, where there are demonstrable benefits; there is also potential for further local IP creation and development, which would enhance South Africa's global competitiveness. The erstwhile Innovation Fund used to operate such a fund, which benefited companies such as Altis Biologics (see **Section 8.7** supra). Innovation competitions could be a further source of such locally developed innovations. In this regard, the Gauteng Accelerator Programme Innovations Competition run by The Innovation Hub provides a good model on which other parties could collaborate and perhaps create specific themes of locally developed IP and licensed IP that addresses current challenges and/or creates industrialisation or manufacturing opportunities in South Africa.

This study advances the view that, for South Africa to beneficially extract value from the IP system, it cannot rely solely on IP developed by its residents, but has to strategically make use of foreign owned IP too, which can be either licensed in or adopted, based on reliance on the principle of territoriality. Although first mooted in the NRDS (2002), in explaining the *"innovation chasm"*, as illustrated in **Figure 8.1** supra, this approach has not received much attention. Suffice to say that, notwithstanding various efforts to enhance innovation finance, skills development, and engender an entrepreneurial culture, it is submitted that the *"innovation chasm"* has remained unchanged, largely owing to the disjuncture between industry priorities and R&D undertaken at institutions, as well as a lack of strategic use of foreign owned IP.

9.5 IP MANAGEMENT AT PUBLICLY FINANCED INSTITUTIONS

This study reveals that significant and fundamental advances have been made in IP management in institutions over the 20-year period, as a result of policies driven by the

DST, in particular, the implementation of the IPR-PFRD Act and associated support mechanisms arising from this legislation. Institutions, in general, have increased their patenting, some more so than others, as detailed in **Chapter 7**. Traditionally research intensive institutions, in particular HEIs such as the CSIR, ARC, the University of Cape Town, the University of Stellenbosch, the University of the Witwatersrand, the University of Pretoria, North-West University, as illustrated in Sibanda (2007), which had IP policies before the IPR-PFRD Act came into place, have benefitted greatly, as demonstrated by their patenting activities (see **Chapter 7**) and commercialisation outcomes (see **Chapter 8**). This success can be attributed, in part, to the early start they had in IP awareness and having put in place appropriate IP management systems.

From an analysis of the NSI detailed in **Chapter 6**, this study illustrates that, whereas the transformation of the NSI has been an on-going exercise since the WPS&T (1996), the period 2006-2015 is characterised by significant initiatives by the DST working with the institutions to transform the manner in which IP is managed. It would appear that the decision to establish a dedicated department responsible for science and technology was an important and insightful one. Although first suggested in the WPS&T (1996), and then more specifically recommended in the NRDS (2002), real systemic changes relating to management of IP emanating from publicly financed R&D were only initiated in 2006 with the Cabinet approval of the IP Policy (2006). This was followed by the promulgation of the IPR-PFRD Act in 2008 and its implementing regulations, making it effective from August 2010.

Table 9.1 captures the benefits, which institutions that responded to the Commercialisation Questionnaire, stated they have derived from the IPR-PFRD Act. The respondent institutions were grouped into two groups, based on whether or not they had some TTO Function (albeit limited) immediately prior to the promulgation of the IPR-PFRD Act in 2008. For institutions that had such a TTO function prior to 2008, there were three broad benefits, namely:

(i) contracting with third parties and commercialisation,

(ii) support from NIPMO for strengthening their TTO functions as well as funding their patent portfolio, and

(iii) increased awareness and appreciation particularly by senior management in these institutions of the importance of IP.

In the case of those institutions that had no TTO capacity in 2008, the three top benefits are:

(i) establishment of a TTO function,

(ii) increased IP awareness particularly amongst the researchers, and

(iii) IP protection because of increased awareness by the researchers, coupled with support from NIPMO.

Table 9.1: Top Benefits Derived by Institutions from the IPR-PFRD Act [Source: Author generated from respondents of commercialisation survey, 2017]

INSTITUTIONS WHO HAD SOME TTO FUNCTION per (Sibanda 2009:130)
1. Contracting with Third Parties and Commercialisation: • Levelled playing field in negotiations with prospective commercial partners • Leverage during licence negotiations • Increased IP awareness during contracting and clarity on ownership • Strengthened negotiating position when need to assert rights to IP ownership • Baseline position, based on law, to negotiate IP clauses • Consistent Full Cost funding model across the university
2. NIPMO (OTT Support and IP Fund): • Better IP Management Systems • Enhanced TTO operations (staff and activities) from NIPMO support • Finalised IP Policy • Finalised Full Cost Model
3. Increased IP Awareness by Senior Management and Researchers: • Greater IP awareness has led to need to appropriately resource TTO function • Recognition of importance of Technology Transfer Office by Senior Management • Benefit sharing incentives motivate researchers to invent • Better understanding of IP and Tech Transfer issues amongst certain stakeholders • Better understanding of role of TTO by management and need for societal benefits • Legislation to back up institutional IP policy • Ease of enforcement of IP Disclosures • Facilitated protection of IP emanating from theses before public disclosure • Greater awareness of IP Value
INSTITUTIONS WHO HAD NO TTO FUNCTION per (Sibanda 2009:130)
1. TTO Capacity: • Assistance in development and implementation of IP Policy from NIPMO • Establishment of TTO by the University • Access to relevant IP and tech transfer skills

• Access to funding for TTO functions and capacity • Additional services for staff and students • Establishment of TTO and strengthening of internal IP structures • Improved internal processes on IP, innovation and commercialisation pipeline
2. Increased IP Awareness: • Clarity on IP Ownership • Increased awareness of IP but still more to be done to embed understanding • Rethinking IP issues beyond Act and monetisation of university owned intellectual assets • IP Training • Increased IP awareness and its importance • Potential source of third stream income
3. IP Protection: • Access to patent filing support • Enabled IP protection • Act enabled more emphasis on innovation at universities

The difference in benefits derived by the two types of institutions is reflective of their maturity in respect of their IP management and innovation journey. The *more mature* institutions (in essence those that had prior TTO functions), which also to a large extent account for most of the R&D being undertaken in South Africa as well as the highest number of publications, are now starting to grapple with issues of commercialisation and technology transfer to third parties. In contrast, the *less mature* institutions are still establishing systems, capacity related matters and evolving in line with the R&D capacity of the institution.

The top challenges faced by these two groups of institutions in the implementation of the IP-PFRD Act are shown in **Table 9.2**. The *more mature* institutions' TTOs identified the top three challenges to be the following:

(i) some adverse impact on international collaboration owing to having to articulate the full cost model,

(ii) administrative and transactional burden caused by the reporting requirements,

(iii) contracting with third parties and commercialisation owing to the restrictive joint IP ownership provisions as well as what would appear to be frustrations regarding conversion of patents to revenues or value.

Table 9.2: Top Challenges Faced by Institutions in Implementation of the IPR-PFRD Act [Source: Author generated from respondents of commercialisation survey, 2017]

INSTITUTIONS WHO HAD SOME TTO FUNCTION per (Sibanda 2009:130)
1. International Collaborations: • Dealing with foreign funders and more difficult contract negotiations • Running philanthropic funded clinical trials at full cost decreased competitiveness of local institutions
2. Administrative and Transactional Burden: • Much longer contracting periods with non-SA owing to lack of understanding of IPR-PFRD Act • Enormous transactional costs in ensuring compliance with Act • Referral and reporting requirements onerous • Explaining IPR-PFRD Act intricacies (e.g. when making referrals to NIPMO) • Administrative and reporting requirements cumbersome and costly
3. Contracting with Third Parties and Commercialisation: • Difficulty in working with companies that want to own IP but don't want to pay full cost • Too restrictive in terms of IP ownership • Joint IP ownership requirements too restrictive • Loss of autonomy in negotiating contracts with both public and private sector • General prohibition on granting of royalty free licences • Low conversion rate of patents to income a massive financial risk
4. Others: Lack of clarity on undergraduate students IP
INSTITUTIONS WHO HAD NO TTO FUNCTION per (Sibanda 2009:130)
1. Commercialisation: • Benefit sharing a challenge particularly in royalty free plant breeder's rights and also to enablers not easy • Expectations that are not aligned to what tech transfer can deliver • Lack of skilled TTO staff who understand issues
2. Understanding of IPR-PFRD Act: • Industry misunderstanding of effect of IPR-PFRD Act on relationship with university • Reconciliation of IPR-PFRD Act with Nuclear Energy Act • Lack of understanding of rationale, drivers and potential outcomes and benefits of public technology transfer • Lack of understanding of the IPR-PFRD Act • Increased administration with low returns

Suffice to note that the third challenge is the opposite side of the coin to one of the three benefits identified by the same group of institutions in respect of contracting with third parties.

In the case of the *less mature* institutions, two main challenges were identified as being:

(i) commercialisation, with the specifics reflecting the growing pains of institutions, which have not had much prior exposure to commercialisation – but also bearing in mind that the IPR-PFRD Act focuses on commercialisation of IP, which often takes time and requires a strong IP portfolio, which these institutions lack, and

(ii) lack of understanding of the IPR-PFRD Act, coupled with potential conflict of laws (in case of Science Councils established in terms of their own laws), as well as misalignment within the institutions as to why they should be implementing the IPR-PFRD Act.

Lastly, the *more mature* institutions, in particular, raised the lack of clarity regarding ownership of students IP as being a particular challenge. This may be related to their being R&D intensive institutions and the fact that students are contributing to academic staff projects or contract R&D projects, as part of their studies.

This study finds that there is a correlation between the R&D intensiveness of the institutions as represented by publication output relating to their patenting activities. The most prolific (top 10) institutions by publications tend to be the same top 10 most prolific patenting institutions (see **Chapters 7** and **8**). These institutions also had the most established and capacitated TTOs. In addition, with the exception of a couple of outliers, in particular the University of the Witwatersrand, this study finds that there is a correlation between commercialisation outcomes (as indicated by revenues earned, number of start-ups created, and licenses granted), and patenting intensity of the institutions. A correlation has also been established between commercialisation outcomes and the capacity and experience of the TTOs at the institution. The leading institutions are the CSIR, ARC, NECSA, the University of Stellenbosch, the University of Cape Town, Nelson Mandel Metropolitan University, North-West University, and the University of Pretoria. North-West University appears to have the highest conversion rate of publications to patents, and conversion of its IP into commercialisation outcomes, as was seen in **Chapter 8**. The main reason advanced for this higher conversion relate to the inclination of most of its research activities to be more applied research than basis, thus having more practical outcomes in the form of new products / services, as compared to more publications where the focus is on basic research. Given the stagnation of the patenting levels in South Africa, the growth of patenting by the institutions is a very promising development that this study attributes in large part to the IPR-PFRD Act.

Notwithstanding the fact that most of the commercialisation outcomes may be modest, there is indeed a growing culture of commercialisation, and it is thus envisaged that such institutions will play a bigger role in the transformation of South Africa's macroeconomic landscape.

The main sectors, in which most patents and commercialisation activities by the institutions are found, include Biopharmaceutical/Biotechnology, ICT and electronics, nuclear/radioisotopes, and energy. There is a need for R&D undertaken at the institutions to align more closely with the priority R&D areas of industry and the private sector; this study, through comparing the BERD to the GERD, has established that these are often not aligned.

9.6 PATENTING IN TECHNOLOGY SECTORS AND THE NSI

This study finds that there are differences, firstly, in patenting between the institutions and business, particularly regarding the technology areas, as indicated by the IPCs (**Chapter 7**), secondly in areas of R&D investment or R&D activity, and lastly with regard to patenting propensity (**Chapters 7** and **8**).

Over the 20-year period (1996-2015), South Africa has had several technology clusters based on an analysis of the patent landscape: (i) Chemistry, catalysis and fuel (ii) Diamonds and Abrasives (iii) Financial Services (iv) Biopharmaceuticals/Biotechnology (v) Mineral Processing and Separation. The Mineral Processing and Separation cluster was very dominant in the period 1996-2005 but is absent from the patent landscape for the 2006-2015 period (see **Figure 7.19**).

An analysis of the institutions' patent landscape in **Chapter 7** has shown that most inventions were in life sciences related fields, mostly in the Biopharmaceutical/Biotechnology sector. Patenting in this sector occurred prominently by the institutions; this has been on the increase over the 20-year period, with most of the patenting happening in the period 2006-2015. This trend is consistent with the findings in Jordaan (2016:40). The prominence of patenting in this sector by institutions correlates with the fact that 50% of the invention disclosures at the institutions occur in this sector (see **Figure 8.28**). This study postulates that the patenting activity being seen in the period 2006-2015 is a result of the implementation of the Biotechnology Strategy (2001), which made significant funding available for R&D in this sector.

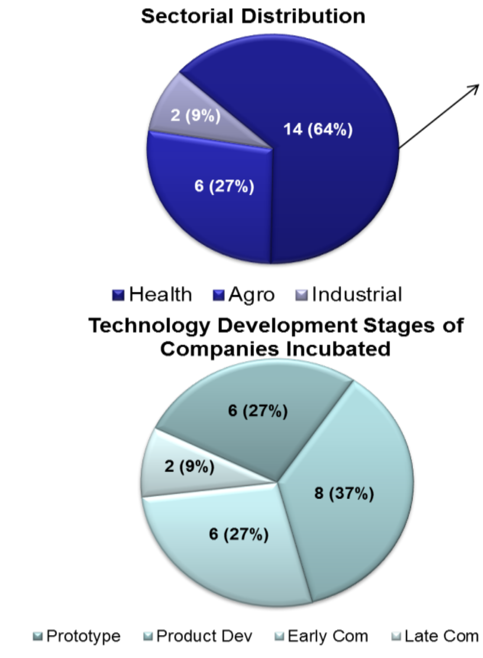
The growth of the patent portfolio in the Biopharmaceuticals/Biotechnology sector is of great importance, given the potential of South Africa's pharmaceutical sector, which presently accounts for only 1.6% of the GDP (**Chapter 3**), although it is the largest in Africa. The fact that the pharmaceutical sector has the second largest negative trade balance or BOP (**Table 3.3**) also makes it an important sector that IP can play a role in growing, thus increasing its contribution to reducing the BOPs. The Biopharmaceutical/Biotechnology sector also forms part of the largest BERD by SIC Manufacturing Category by industry, although its contribution to this SIC is modest, as can be seen from **Figure 8.10**, given also the finding by Jordaan (2016:37) that private funding for biotech in South Africa is virtually non-existent.

Noting that *"South Africa's private sector still lacks critical mass,"* Jordaan (2016:38) argues that, whilst there appears to be a growing, yet nascent local Biotechnology sector or cluster, this has been public sector driven, and primarily driven by HEIs, as Science Councils' contribution have declined over the period 2004-2008 to date. Jordaan (2016:41) advocates for a strong private sector driven Biotechnology sector that should be dominated by *"innovative SMEs in particular [as these] are key to the growth and dynamism of biotech."* This study supports this view by Jordaan (2016) and suggests that the commercialisation model for IP from institutions should be a hybrid of licensing to existing private sector biotechnology firms (to boost their competitiveness) and start-up formation with experienced founders in industry and the private sector. This would build a critical mass of successful dedicated Biotechnology firms. In this regard, the study advances the view that the well-established R&D capabilities at the HEIs can best serve the nascent Biopharmaceutical/Biotechnology private sector.

This study further advances the view that the introduction of the research exemption in terms of the TRIPS Agreement flexibility into South African patent law, coupled with an appropriate mix of increased late stage public and private R&D and Venture Capital (VC) investment in the Biopharmaceutical sector could be important stimuli to the growth of a robust South African Biopharmaceutical/Biotechnology sector. This would be ably anchored by the growing R&D and patenting activities in this sector, by the institutions. This would appear to be aligned to the Bioeconomy Strategy vision outlined in RSA (2013). Finally, for this sector to succeed, it is important to focus on establishing a supportive ecosystem, which links the institutions to supportive pre-commercial infrastructure, business support services including access to entrepreneurial training and/or entrepreneurs, developmental and VC funding, as well as access to markets. The author has been leading the development of such an ecosystem since 2012, in his role as Chief Executive Officer of The Innovation Hub, the innovation agency of the Gauteng Province, which has the development of a science and technology park in Tshwane (Pretoria) as its flagship project. In February 2012, the Gauteng Provincial Government approved the BioPark@Gauteng Business Plan, to establish a world-class African first life sciences enterprise development to provide a pre-commercial infrastructure and incubator. Opened in October 2014, Phase 1 of the BioPark@Gauteng in addition to subsidised office accommodation and pilot manufacturing was, as of June 2016, already providing a comprehensive business incubation programme (technical and business development support, business mentorship support, access to market research reports, market access opportunities, access to funding, and IP/legal advisory services). A summary of the start-up companies incubated in Phase 1 is shown in **Figure 9.1**.

Owing to increased demand for Good Manufacturing Practice (GMP) facilities by some of the Phase 1 incubated start-up companies (shown in **Figure 9.2**) as well as a pipeline of companies from the Gauteng Accelerator Programme (GAP) (GAP: Biosciences), an innovation competition in the Biotechnology related fields run by The Innovation Hub in collaboration with TIA and Emory University (Atlanta, Georgia, USA), the Gauteng

Government with *the dti* has provided support to the development of Phases 1b and 2, which should open its doors in August 2017.



Healthcare Sector BioPark Companies

Selected Phase 1 Companies:	Product / Innovation Focus	Stage of Development
Vx Pharma	Clinical trials	Commercial
Altis Biologics	Devices	Commercial / manufacturing
SmartSpot *(WITS University)*	Diagnostics	Commercial
S-Tip	Devices	Commercial
XS Health	Pharmaceutical	Commercial
UBA Biologix	Diagnostics	Commercial
MARTI TB diagnostics *(University of Pretoria)*	Diagnostics	Clinical Trials
Toothache solutions	Pharmaceutical	Clinical Trials
Ketlaphela	API	Early commercial
LookSeeDo	Smart Infrastructure	Early Commercial
Syringa BioScience	Pharmaceutical	Early Commercial
Touch prosthetics	Advanced upper prosthetics	Product Development
Mashudu medicals	Ear Prosthetics	Product Development

Figure 9.1: Status of BioPark@Gauteng biopharmaceutical cluster development by The Innovation Hub, as of June 2016 [Source: Sibanda, 2016]

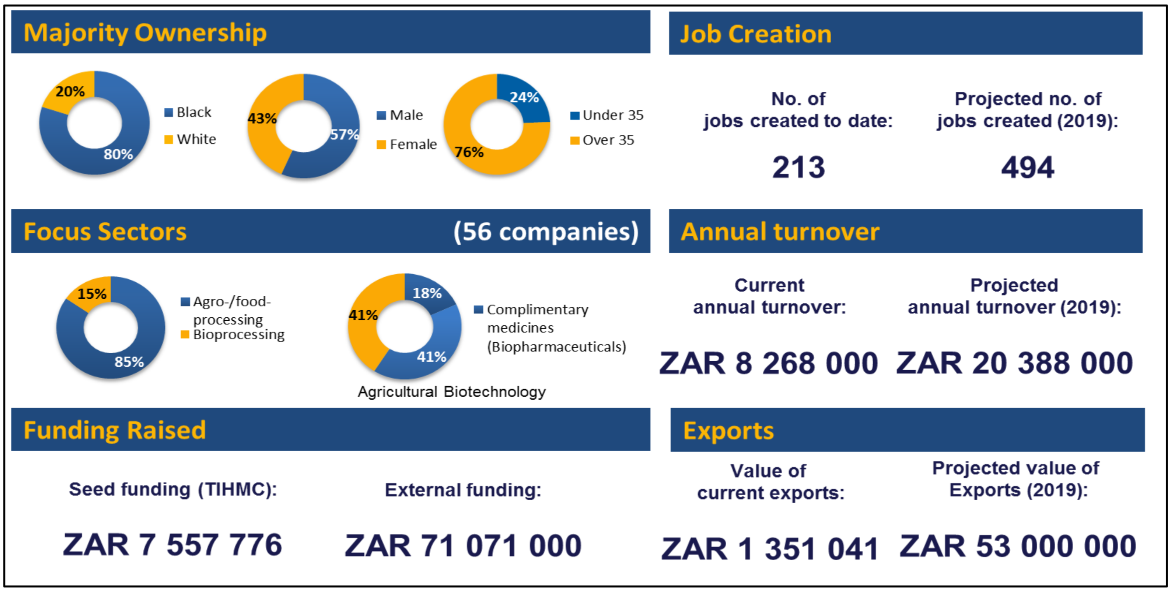


Figure 9.2: Status of BioPark@Gauteng biopharmaceutical cluster development by The Innovation Hub, as of January 2017 [Source: The Innovation Hub (2017)]

The potential of the BioPark@Gauteng as an ecosystem coordinator and catalyst for growth of a Biopharmaceutical/Biotechnology cluster in Gauteng is evident from the 56 companies already supported by The Innovation Hub, shown in **Figure 9.2**. A focus should be on scaling up these companies to become medium- to large-sized businesses that not only can anchor South Africa's embryonic Biopharmaceutical/Biotechnology cluster. The scaling up of these companies' businesses will also boost local manufacturing. There is also, potential for them to increase exports beyond those projected by 2019, as shown in **Figure 9.2**, increase R&D investments and patent outputs and ensure the global competitiveness of this sector. This example is provided to demonstrate just but one of the good foundations in place to support this nascent sector.

The largest negative balance of payments is in respect of the *"computers, electronics and opticals"* sector (**Table 3.3**). Patenting activities in the ICT related fields are largely in the services sector, and not so much associated with the hardware aspects of the ICT sector. Thus, unless there are deliberate efforts to grow the hardware and manufacturing aspects associated with this sector, there is little potential to stimulate the manufacturing industry (**Chapter 7**) that is based on the services industry. The prevalence of non-South African assignees with South African named inventors, particularly in ICT related patenting and mostly in financial transactions related fields, suggests possible competitiveness clusters or competencies in these areas in South Africa. This may not be surprising, given the shifts in South Africa's economy, which has become increasingly services oriented over the 20-year period of this study. Notwithstanding the services orientation of the South African economy, ICT related invention disclosures from institutions stand at 11% of all disclosures behind Advanced Manufacturing/Engineering, which is at 26% of all disclosures. It is suggested that there would be more benefit from increased ICT-electronics oriented innovations as well as more value for the institutions to increase their patenting activities in Advanced Manufacturing/Engineering, given the significant impact of such inventions for South Africa's top manufactured exports to the rest of the African continent (**Figure 3.11**). The activities at the University of Cape Town and the University of Stellenbosch, where ICT-electronics related patents have been successfully licenced to a number of start-ups initiated by their academics, demonstrate the potential of this sector. ICT implemented innovations should be encouraged and supported, given their importance in driving the growth of the manufacturing sector in the Fourth Industrial Revolution. In addition, emphasis should also be placed on strengthening the collaboration between industry and institutions, as the manufacturing sector accounts for industry's second largest BERD (**Figure 8.9**). It is important that this sector grows, given its relevance for addressing unemployment.

The study reveals that the significant and fundamental shifts in IP management in institutions over the 20-year period can be attributed to policies driven by the DST, in particular, the IPR-PFRD Act and the associated support mechanisms arising from this legislation, including the enabling role provided by NIPMO. Whilst there could be some hiccups and challenges (as alluded to by the institutions above) in the implementation of the IPR-PFRD Act, the institutions in general have found this piece of legislation to be more beneficial than a hindrance. In the period 2006-2015, as we have seen in **Chapters 7** and **8**, these benefits are reflected in increased patent activity, enhanced commercialisation activities, better capacity for IP management and commercialisation at institutions, largely because of the support provided by NIPMO, compared to the period 1996-2005.

9.7 IP ENABLED TECHNOLOGY TRANSFER AS MECHANISM FOR STRENGTHENING THE NSI

Technology transfer is relevant from two perspectives: in the first instance, the transfer of IP and technologies developed at the institutions to the private sector, and in the second instance, more developed and even commercially available foreign originating or owned IP and technologies into the NSI. Whereas the first aspect is dealt with in terms of commercialisation, with licensing being one of the modes of enabling such transfer, the second aspect is based on an assessment of external capabilities that could address some of the challenges in the NSI and/or supplement locally developed IP in addressing such challenges, as well as create new economic opportunities. The territoriality of patents and the exhaustion regime, which in the case of South Africa is international exhaustion, provide opportunities for South Africa to make use of in-bound technology transfer and diffusion strategies, first punted in the NRDS (2002) as far back as 2002. Similar strategies and approaches have been effectively implemented by countries such as China, Japan, and

South Korea in industrialising their economies, transitioning their innovation systems and building capabilities to generate endogenous IP and innovations. The exact approach that these countries took may not *per se* be appropriate today, given the extent of globalisation that has since taken place. However, the principles are the same; and the author thus advances the view that such approaches have become easier to implement because of technological developments, digital revolution and South Africa's current capabilities. Accordingly, this study argues that South Africa has to have a deliberate and concerted in-bound technology transfer strategy in a handful of important sectors (ideally three and at most five) in realising the vision in the NDP (2012). Having established those sectors, what will be required is to also establish the current capabilities and the potential impact of these sectors to South Africa's macroeconomic environment, and then to identify foreign capabilities to be targeted and facilitate engagements between both local players and those foreign capabilities. Ideally, South Africa has to start where it has capabilities, both from current IP generation by further unpacking the data in **Chapter 7**, as well as absorptive capabilities, which will allow it to absorb foreign originating IP and technologies effectively. This is an area of future research that this study proposes should be undertaken.

The study has also demonstrated the importance of a good patent portfolio for the success of commercialisation and technology transfer, when one considers the correlation already alluded to above between commercialisation outcomes and a good IP portfolio (mostly patented, save for the case of NECSA, which relies on a hybrid of patents and trade secrets in respect of manufacturing processes).

As already alluded to in **Section 9.6**, there is a disjuncture between the patent portfolio at institutions and the R&D investments made by industry in respect of the sectors. For effective technology transfer, institutions' R&D and patenting activities must be in the areas of interest to industry. Accordingly, institutions' R&D programmes must be aligned with industry priorities, not only for the institutions to have access to industry contract R&D funding but also to facilitate technology transfer. IP then becomes an enabler of technology transfer, through licensing and assignment. In the same way that Government made a conscious decision to invest in the creation of a chemicals and petrochemicals industry, and essentially, the birth of Sasol, it is important for South Africa to review its national policies and areas of public investments in R&D and innovation in general and to position these as future new anchor industries for the South African economy. This study suggests three specific sectors to be pursued by South Africa for similar large-scale and long-term investments, based on the patent analysis, commercialisation data, publication outputs as well as review of the macroeconomic landscape, namely

(i) Biopharmaceuticals/Biotechnology (as already comprehensively dealt with in **Chapters 7, 8** and in this chapter);

(ii) Energy, given that significant investments have been made in this sector (Pebble Bed Modular Reactor and Eskom), as the IP portfolio demonstrates in **Figures 7.13, 7.35, 7.52,** and **7.53**, as well as in Hydrogen Economy/Fuel Cells as per the HySA (2007) strategy. There are also capabilities that have been demonstrated by institutions such as the University of Johannesburg in solar technology. Regrettably, the decision by government in 2010 to divest from the Pebble Bed Modular Reactor technology without a clear exit strategy to the private sector has compromised the potential of the IP portfolio that had been established until then.

(iii) ICT/electronics, given that the second most patenting activity by institutions is in this area, based on the IPCs (G01N, G06F, G01B, G01R, H01M, H04M, H01L) (**Figures 7.23, 7.24, 7.25, 7.35, and 7.46; Table 7.3**). Some of the patents in this sector are in financial services or transactions, which appear to be assigned to foreign companies; this is based on the fact that these patents cite at least one South African resident inventor but do not reflect a South African priority data. Another reason for suggesting this sector is the commercialisation successes, to date, largely by the institutions, some of which form part of the case studies in **Chapter 8**.

In the area of Biopharmaceuticals/Biotechnology, reference was made in **Section 9.3** above to the SADC Business Plan which seeks at stimulating the pharmaceutical industry. This is echoed by Kahn (2017) who discloses that *Analysis by the Southern African Development Community concluded that the region could support up to two API manufacturing* *facilities,"* thus providing South Africa with an opportunity to be a significant player in API manufacturing, based on the existing capacities. In this regard, Kahn (2017) further discloses that:

> *"STATE-owned pharmaceutical manufacturer Ketlaphela, which has yet to begin production of active pharmaceutical ingredients (APIs), may soon face competition from a black-owned rival called Inicio, which has secured a licensing agreement with German firm Fluxpharm. The agreement is an important step towards possible local API production for HIV/AIDS drugs, which locally based pharmaceutical manufacturers import from China and India. APIs are the key biological components of medicine. Inicio is conducting a joint pre-feasibility study with the Industrial Development Corporation (IDC) into the viability of commercialising technology for local API production …. The government has been pushing for local manufacture of the APIs used for HIV/AIDS medicines to try and improve the security of supplies, reduce the pharmaceutical trade deficit, and make better use of SA's fluorspar resources. SA has the world's second-biggest reserves of fluorspar, which are largely exported as raw materials and beneficiated elsewhere …. The licensing deal with Fluxpharm covered APIs for HIV/AIDS medicines, and 22 other drugs."*

The examples cited by Kahn (2017) are aligned to the case this study makes for South Africa to make strategic large-scale investments in the Biopharmaceutical/Biotechnology sector. In addition, these examples are aligned to the recommendations this study makes of strategic use of in-bound technology transfer to create local industries and/or boost local manufacturing.

The three specific sectors this study advances for South Africa to pursue for large-scale and long-term investments, based on the patent analysis, commercialisation data and publication numbers, are similar to those suggested by Walwyn and Hagendijk (2012:4) in their critical Review of the Ministerial Review (2012); they strongly recommended:

- *"increase incentives (or uptake of existing incentives) for business innovation, especially for technology-intensive sectors such as telecommunications, advanced manufacturing and pharmaceuticals; and*

- *increase government R&D expenditure in the critical areas of health, telecommunications, energy and manufacturing outputs as well."*

Notwithstanding the key recommendations in NDP (2011) to grow the manufacturing/industrial sector, the present patent portfolio does not indicate that South Africa has any strength in this sector. A more concerning finding of this study, based on an analysis of the IPCs of the PCT applications, EPO and USPTO patents in **Chapter 7**, for the periods 1996-2005 and 2006-2015, is a general decline in the industrial sector. A review of the assignee details shows that this sector was previously dominated by companies such as African Explosives, AEL Mining, Anglo American, BHP Billiton, Detnet South Africa, Orica Explosives, De Beers Industrial Diamonds, Element Six, Sandvic (see **Figures 7.13, 7.14, 7.34, 7.35, 7.52,** and **7.53**), most of which do not feature in the list of top assignees for the period 2006-2015. The decline in patenting activity in the industrial sector over the period coincides with the fact that the South African economy has deindustrialised, as illustrated by the macroeconomic environment analysis detailed in **Chapter 3** above. This study therefore submits that, given the sluggish invention disclosures at the institutions in this sector (see **Figure 8.26**) coupled with stagnant patenting activity in general, the industrial sector could greatly benefit from a structured deliberate and concerted in-bound technology transfer programme directed at ensuring IP enabled revitalisation and reindustrialisation of the South African economy.

A reflection on the TYIP (2008) suggests that investments in two of the five grand challenges (Farmer to Pharma and Energy Security) have resulted in distinct patent portfolios, although the Energy Security cluster appears not to be as mature as the Biopharmaceutical/Biotechnology cluster. This is understandable given that investments in the Farmer to Pharma grand challenge were preceded by the National Biotechnology Strategy (2001) interventions, which predate those in Energy Security, enabled by the National Hydrogen and Fuel Cell Technologies Research, Development and Innovation Strategy (2007). It is thus recommended that Energy Security may be another area where in-bound technology transfer may indeed be beneficial in addition to the proposed large-scale investment proposed earlier in this section. Coupled with the emerging local IP portfolio from the institutions, in-bound technology transfers could accelerate the development of this sector, which may also boost the development of the industrials/manufacturing sector.

McKinsey (2015), as part of the five bold priorities, identifies the following priority sectors:

(i) Advanced manufacturing, with a focus on high-value added categories, such as automotive, industrial machinery and equipment, and chemicals;

(ii) Service exports, given South Africa’s highly developed service industries, particularly the financial services (wholesale and retail banking and insurance); and

(iii) raw and processed agricultural exports.

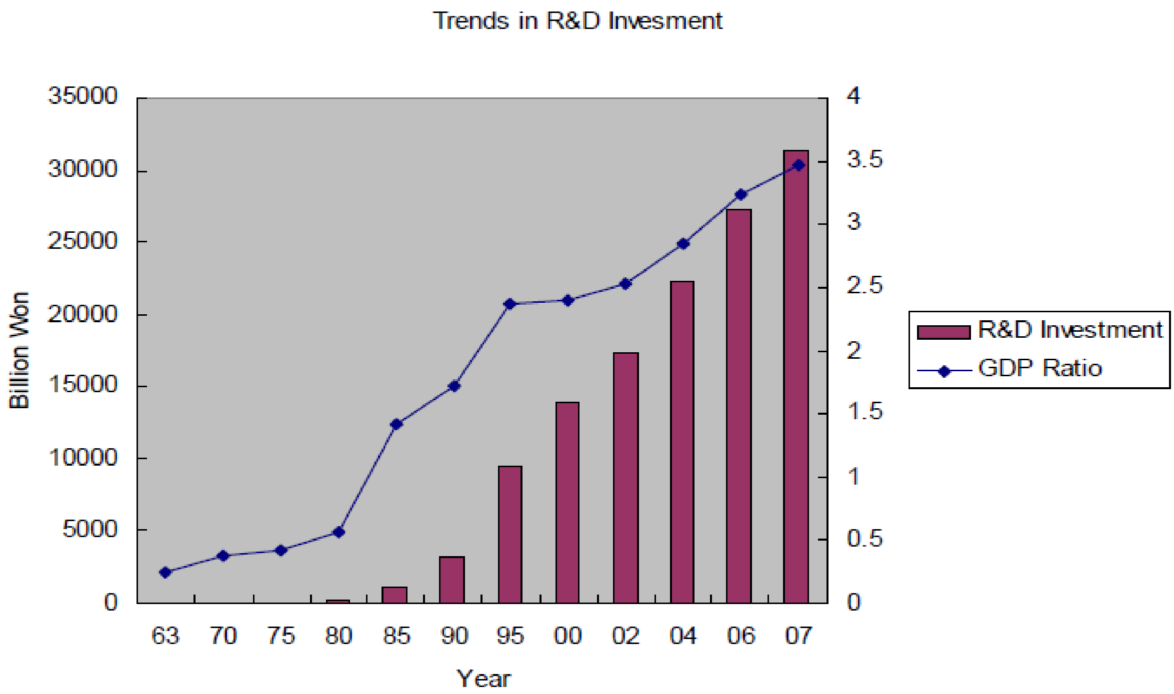
Other than the financial services, this study has not found any evidence in respect of existing IP capabilities that could anchor and/or stimulate growth, to support these priority sectors. A review of the eight (8) PCT applications filed by the ARC in the period 1996-2015 (see **Figure 7.26**) as well as the four (4) USPTO patents granted to the ARC in the period 2006-2015 (see **Figure 7.43**), shows that only one patent application, WO200060135301A1, which relates to the processing of rooibos extract is in agroprocessing. None of the other patent documents are in agroprocessing, but rather relate to primary agriculture, new species of fruit, animal vaccines, avian immunoglobulin genes, vaccines for animals, or control and treatment of disease in fruits and/or plants. It would thus be fair to conclude that, although revenues accruing to the ARC illustrated in **Figure 8.22** could suggest possible capacity and/or competencies in agroprocessing, given the ARC’s focus on agriculture, this study to the contrary points to commercialised IP being in primary agriculture (possibly through commercialisation of plant breeders rights) as well as in plant and animal health. In the case of the automotive sector, a review of the PCT patent applications and patents granted by the USPTO and EPO, which cite a South African inventor, reveals that the share of PCT applications with an IPC classification (B60 – Vehicles in general), is no more than 4% for the PCT applications, almost 3% of USPTO patents, and almost 4% of EPO patents. This is to be contrasted with the findings of this study that the share of Biopharmaceutical/Biotechnology related PCT patent applications, EPO and USPTO patents that cite an inventor with a South African residence, is at least 10%.

9.8 A FRAMEWORK MODEL BASED ON LESSONS FROM SOUTH KOREA FOR AN IP-ENABLED INNOVATION ECOSYSTEM FOR SOUTH AFRICA

This study supports the view that IP is an enabler and that South Africa needs to increase its propensity to use the IP system, and in particular, patents to stimulate its development. However, IP should not be seen in isolation, and as such, the study does not advocate a position of IP protection or patenting for the sake of patenting. Neither does the study advocate a practice of patent or perish, i.e. patenting merely for the sake of malicious compliance with institutional IP policies or the IPR-PFRD Act, but rather the country should focus on patenting for commercial and strategic reasons.

As already discussed in other parts of this study, IP is an economic construct, and it should be viewed in perspective. The discussion of commercialisation of IP is a pertinent one, because it focuses on the translation of IP into innovation that can benefit society in one form or another. For this translation process to yield meaningful outcomes, the quality of the IP portfolio is of great relevance. Quality relates both to its relevance to and its alignment with industry imperatives and/or future areas of growth of the country, as well as the strength as measured by protection criteria, in particular novelty and inventiveness in the case of patentable inventions.

In the preceding sections, there has also been acknowledgement of the important relationship between R&D investment and economic growth. Reference has also been made to the fact that countries that have high R&D investment (>1% of GDP) have experienced higher economic growth than those that made significantly less investment. It has also been established that the economic growth of such countries was accompanied by increased levels of IP generation and protection, as indicated by patents, as a proxy for IP. The example of South Korea is illustrated in **Figure 9.3** and discussed below.



	1981	1985	1990	1995	2000	2005	2007
Number of Patents	1,808	2,687	7,620	12,512	34,956	73,512	123,705

Source: KOITA

Figure 9.3: Increased R&D investment and corresponding growth in number of South Korean patents in the period 1981 – 2007 [Source: Chung, 2010]

In the meantime, as illustrated in **Figure 9.3** it is worth noting that in excess of 120 000 patents per year are granted to South Korean residents. According to WIPO (2015:36), South Korea has *"achieved virtually constant growth since 1990" with more than 13 138 PCT applications from Korea in 2014."* Increased R&D investment has the greatest potential to foster the development of high-tech industries, which in turn will unlock the industrialisation of the South African economy, as illustrated by Chung (2010:348). This study advances the notion that the structure of the R&D investment in South Africa will need to change if this is to happen. As illustrated in **Figure 8.11**, the industry R&D share of GERD is below that of government, at 40.8% and has been on the decline since 2001. This decline should be reversed and efforts should be made to increase the industry share of GERD, as was the case in Korea's transition, illustrated in **Figure 9.4**.

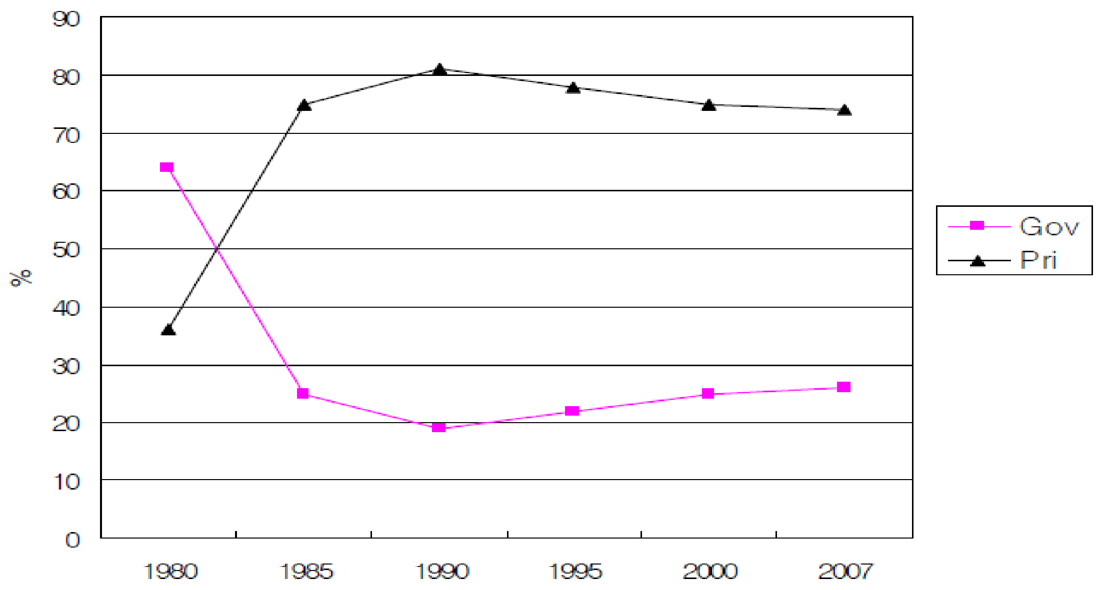


Figure 9.4: Changes in Government and Industry Contribution of Total R&D Expenditure in South Korea in the period 1981 – 2007 [Source: Chung, 2010]

One of the mechanisms to enable this could include a revamp of the R&D tax incentive that is in place with a view to providing further incentives to stimulate and grow the industry share of GERD. Another mechanism could include strategic funding instruments that encourage industry to increase its share of GERD owing to increased public matching or partnership funding for joint industry and institutions, where industry has first right of refusal to commercialisation of IP that may vest with the institutions. It is submitted that such a mechanism may even close the gap between industry R&D priorities and institutions' R&D agenda and thus facilitate alignment of R&D priorities to support industry as well as development of new industries.

One of the lessons from South Korea is that for increased investment in R&D to translate into a larger IP portfolio and higher levels of innovation, there should be an adequate supply of R&D capacity. This is articulated by Chung (2010:346) who notes that *"R&D investment is constrained more by a lack of human resources than by a lack of financing."* This view is also supported by Walwyn and Hagendijk (2012:3) who, in their critical Review of the Ministerial Review (2012), reflect that:

> *"Clearly, new and highly targeted funding is important. However, higher expenditure may not itself result in an increase of outputs of the NSI, as is assumed in several parts of the report. Increased expenditure in a system*

limited by human capital will increase the cost of full-time equivalent (FTE) researchers, thereby raising the cost of research whilst the actual size and outputs of the system may remain stagnant."

In the efforts to increase the human resources for R&D, it is important that the observations highlighted by Kahn (2007:11) in his discussion of South Africa's position on the internationalisation of R&D are taken into consideration and that mitigation factors are put in place to address the challenges identified:

> *"Growing the volume of R&D toward the 1% target assumes that additional funding and, most critically, that several thousand more skilled researchers will be available to do the work. But the science system experiences an internal brain drain to government and the business sector, and an exodus of brains to feed the appetite of industrialized countries."*

As already discussed, commercialisation of IP is just as important, if not more so than just protection of IP. Accordingly, the human resources required for an effective IP enabled NSI must comprise an appropriate mix of both IP generating skills (essentially R&D capacity) as well as innovation-enabling skills (with regard to commercialisation and entrepreneurship). It is therefore important that the growth in South Africa's R&D personnel experienced since 2012 cited by CeSTII (2017) (see **Figure 8.12**) is accelerated. It is thus hoped that the stagnation that was experienced in the period 2004-2011, was a lag period in respect of the significant investments that the country has been making in its education system. At the same time, it is important to grow the entrepreneurial and commercialisation skills, as discussed in **Chapter 8**.

At the same time that it was increasing its R&D investment, Korea also adopted a broad-based investment in education to address the critical human resources deficit. As detailed in Chung (2010:346), this included growing the number of school enrolments into the tertiary level. The long-term objective in the case of Korea was to grow full time researchers (from 39 000 in 1985 to 100 000 in 1995; and then 180 000 in 2005), with the ultimate objective of having 80% of high school graduates entering university. It is thus submitted that these concerted efforts in terms of increased R&D investment and increased focus on human resources development have effectively paved the way for South Korea's economy to grow and for its transition to comprising high-tech industries.

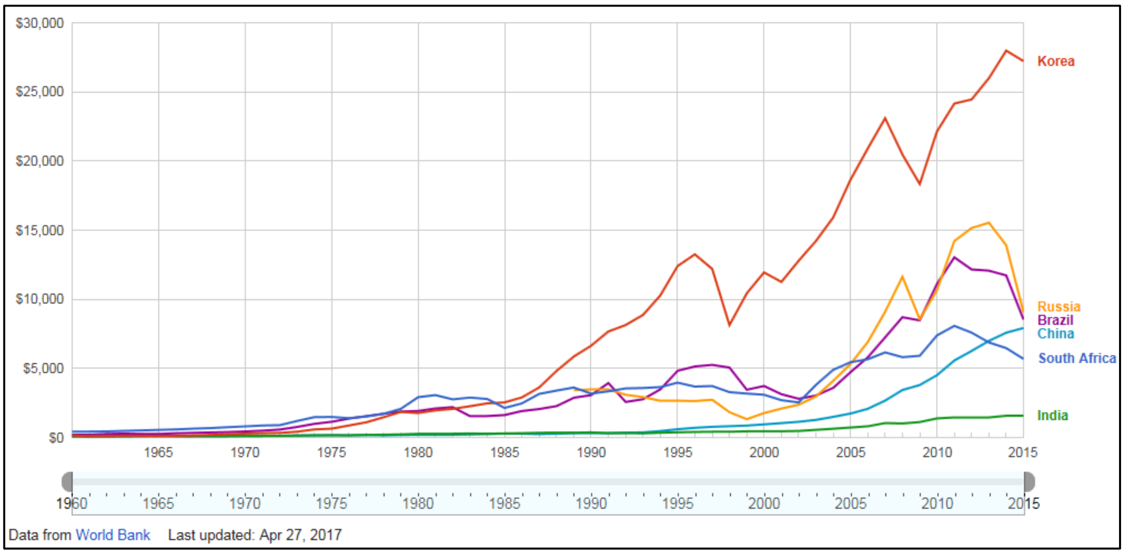


Figure 9.5: GDP per capita (US$) for BRICS countries compared to Korea for period 1960 – 2015 [Source: World Bank Data][236]

As can be seen in **Figure 9.5**, which compares Korea's GDP per capita with the BRICS countries, as of 1985 (when patenting drastically increased as illustrated in **Figure 9.3** and the private sector share of GERD overtook that of government as shown in **Figure 9.4**), Korea's GDP started to experience dramatic growth, contrary to that of the BRICS countries.

An analysis of the South African IP portfolio, as detailed in **Chapter 7**, would suggest that, other than the industry supported clusters of *"chemicals and petroleum"* and *"diamonds and abrasives"*, South Africa does not have other strong IP portfolios. The nascent biopharmaceutical/biotechnology and electronics/ICT/financial services IP portfolios need to be supported by other globally competitive IP portfolios that can be licensed in, in the form of "*in-bound technology transfer,"* if South Africa is to fast-track its development of high-tech industry clusters in these areas. This *"in-bound technology transfer"* comprises a process of technology adaptation to local conditions, which may also be the source of new

236http://www.google.co.za/publicdata/explore?ds=d5bncppjof8f9_&ctype=l&strail=false&bcs=d&nselm=h&met_y=ny_gdp_pcap_cd&scale_y=lin&ind_y=false&rdim=region&idim=country:KOR:ZAF:RUS:IND:BRA:CHN&ifdim=region&tstart=739058400000&tend=1433282400000&hl=en&dl=en&ind=false&icfg

IP, as alluded to by Murad Ali and Chevalier (2011:346). Essentially, this process comprises a transition from imitation to innovation, and an effective use of the patent system, as widely documented in the literature for a number of countries, including Japan, USA, China and Korea. Straus (2017) discusses a similar approach adopted by Padlock Therapeutics, founded in 2013 to translate R&D outcomes on autoimmunity therapies commercially; in order to do so, they licenced patents and assets from GSK to create new therapies. This study emphatically submits that, in today's globally connected world, South Africa must also embrace this approach, if the country is to leapfrog other more developed countries. Not heeding this will only result in South Africa stunting not only its own growth but also its relative global competitiveness.

9.9 IS THERE A POSSIBLE CASE FOR REPOSITIONING OF THE SCIENCE COUNCILS?

This study has shown that, in the period 2006-2015, the universities collectively filed more patent applications (**Figure 7.21** and **7.22**) and have a higher number of patents granted at the USPTO and EPO (**Figure 7.34** and **7.35**), than all the Science Councils combined (ARC, CSIR, Mintek, MRC, WRC). The opposite was the case in the period 1996-2005, when in essence the CSIR dominated the patenting but other Science Councils also featured prominently. It is also submitted that Science Councils such as the WRC and MRC, which have a dual mandate of funding R&D as well as undertaking R&D, were affected by the IPR-PFRD Act, which states that, where they act as a funder, they cannot own the IP, but rather that the recipients of the funding should own the IP. A review of the commercialisation by the institutions in **Chapter 8** shows more and growing commercialisation activities by the HEIs (**Figure 8.19, 8.24**, and **8.25**), more so than the Science Councils. Given the intended positioning of the Science Councils to be further down the innovation value chain, and closer to the market, it would thus be expected that they should be more involved in translational R&D activities in support of and/or complementary to the R&D outputs of the HEIs. This study therefore recommends a systemic review and repositioning of the Science Councils and greater clarity on their role within the NSI. Whereas knowledge generation, the filing of patent applications and the obtaining of patents are an important foundation for any successful economy, it is important that the knowledge covered by these patents is accelerated beyond proof of concept and commercialised into scaled-up sustainable businesses for IP to have real, meaningful and lasting impact. In this regard, this study suggests that Science Councils should drive the establishment of new industries through development oriented translational R&D that is essential for new commercial products and manufacturing processes. Sikrin *et al.* (2017), in their article on why China was overtaking the USA in respect of manufacturing and conversion of R&D investment, observe that *"accelerating product and process innovation in the US can boost annual manufacturing output by more than 5%, or around US$100 billion."*

Accordingly, this study suggests that, if South Africa is to achieve the levels of manufacturing envisioned in the NDP (2011), there should be significant emphasis on the translation of technological breakthroughs embodied in patent applications and patents into products and services that can boost domestic manufacturing. In this regard, it is important that the Science Councils have a better understanding of industry supply chains for them to become the bridge between HEIs and industry, to ensure effective technology transfer and commercialisation. For this to happen, a higher proportion of any increase in R&D investment or industry incentive for R&D investment should be targeted at the development and translational aspects of the R&D value chain as opposed to basic and applied research. The emphasis on the proximity of the Science Councils to the market essentially requires a combination of endogenous IP and licensed-in IP in order to fast-track time to market, but also of necessity would require development of translational or commercialisation-related human resources. The shift in the positioning and mandate of the Science Councils within the NSI that this study recommends are more radical and the percentage of translational research undertaken by Science Councils should be much higher than the 45% mooted in the recommendations of the Ministerial Report (2012:202).

9.10 COMPARATIVE POSITION OF SOUTH AFRICA AMONGST THE BRICS COUNTRIES

This study has illustrated that, in absolute numbers, South African international patenting activity is very modest compared to its peers among the BRICS countries. Whereas Brazil and Russia have almost tripled their patents at the USPTO over the period 2006-2015, South Africa has increased no more than a dismal 50%. A better comparison however, is to look at the number of patent applications/patents per million population for each of the BRICS countries, based on the population numbers provided in **Figure 7.65**. **Figures 9.6** and **9.7** illustrate such comparative analysis (with Figure 9.7 excluding China for ease of comparison). What is evident is that, whereas South Africa had the highest number of patent applications filed per million population (8.65) in 2006, this had dropped down to 6.39 in 2015, and South Africa had been overtaken by China between 2009 and 2010. Russia, which was ranked second behind South Africa in 2006, had overtaken South Africa in 2011 and was now ranked second, together with South Africa in 2015. India and Brazil, in contrast, have remained fairly constant over the period.

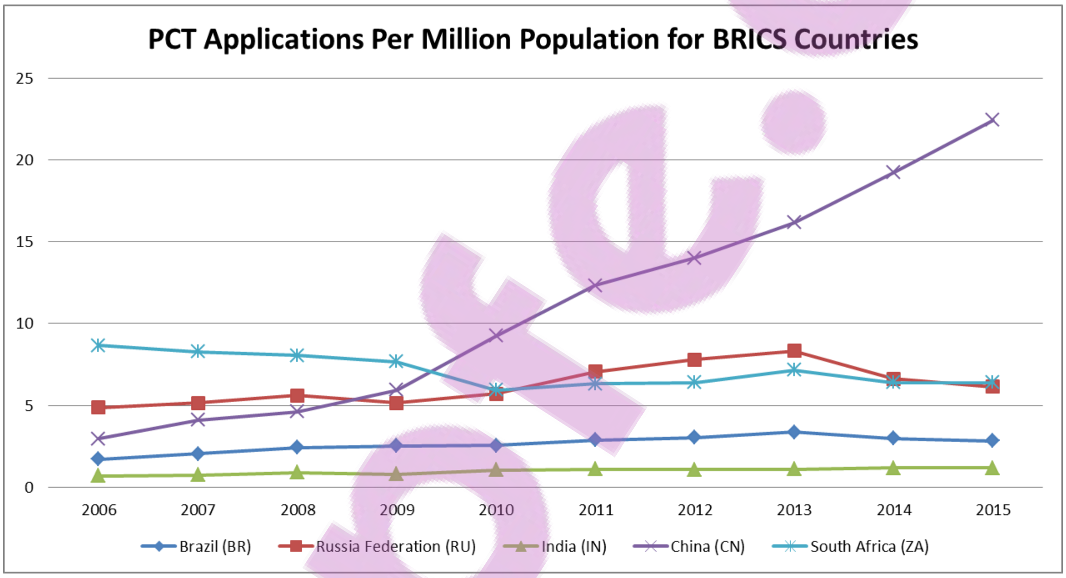


Figure 9.6: PCT applications per million population for BRICS countries [Source: adapted by author from WIPO Statistics Database]

A similar trend can be observed in **Figure 7.7** in terms of USPTO patents. Whereas in 2006 South Africa had the highest number of USPTO patents per million population at 2.22, it was overtaken by China in 2011, and by 2015, was ranked second with 3.39 behind China (6.11). India, in particular, has had a higher rate of increase of its USPTO patents over the period. Both India and Russia could surpass South Africa in the next couple of years.

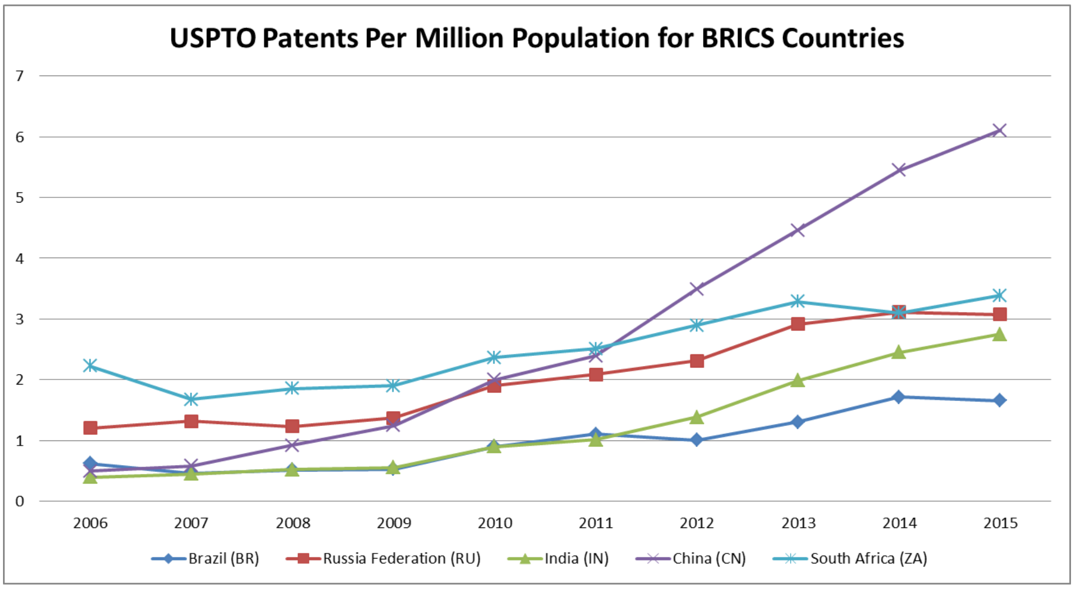


Figure 9.7: USPTO patents per million population for BRICS countries [Source: adapted by author from USPTO Database Statistics]

China, in particular, has made the biggest strides, having become more TRIPS compliant and deploying a range of patenting strategies that include in-licensing and acquisition of foreign developed technologies. China would also appear to have had a more long-term and focussed strategy on boosting its innovation output, which is set to continue, given the findings by Sikrin *et al.* (2017) that China was increasingly shifting its focus towards late stage translational R&D. This study thus finds that, whereas in absolute numbers, South Africa lags behind its peers in the BRICS countries, on a per capita basis, it has been slipping and was as of 2015 ranked second behind China, which had surpassed South Africa between 2010 and 2011.

9.11 AREAS FOR FURTHER RESEARCH

Further **research** in the form of one or more studies should be explored in a number of areas that formed the findings and recommendations of this study in order to supplement and strengthen them. In respect of the patent analysis, a more detailed study is needed of the private sector patenting trends, with emphasis perhaps being placed on the period of 2006 to date. Furthermore, a deeper understanding of what is being patented at the South African patent office is required, with a focus on the trends since 2006, in respect of applicants, their nationality, fields of inventions patented, and the relative proportion of residents to non-residents.

Another area of study is exploring the potential of in-bound technology transfer based on a systematic understanding of South Africa's competencies and IP generation capabilities, up to three sectors, with absorptive capacity to absorb foreign originating IP and technologies effectively, where in-bound technology transfer could meaningfully transform these sectors and the South African economy. Some suggestions have been provided in **Sections 9.6** and **9.7** above.

To some extent, this study has done a comparative analysis of South Africa as part of the BRICS group of countries; this is an area where further research is recommended. Particular emphasis should be on testing some of the observations and recommendations that this study has made.

9.12 CONCLUSIONS

This study has sought to address the four issues that Kaplan (2009:1) was of the view needed to understood better, namely: the characterisation of the IP regime and its impact on innovation; the performance of South Africa's IP and innovation systems with a particular emphasis on determinants and constraints; the impact of the IP regime on the performance of the NSI; and the possible impact of the proposed IP policy changes on innovation.

In so doing, the author has demonstrated, in respect of the IP and NSI, the assertions by Makgoba (2010:67) about a system that consists of different elements that must function coherently in a coordinated manner to achieve a common objective. The case study of South Korea provides an important illustration of such different elements of an IP system that have been effectively interwoven with an innovation system, with positive outcomes. The South African case studies set out in this **Chapter 9** do indeed prove that the IP system in South Africa has the elements to drive the NSI. The emergence of the institutions amongst performers to be reckoned with within the NSI has undoubtedly been a result of deliberate policy choices in respect of the management of IP that has emanated from publicly financed R&D and, in particular, from the implementation of the IPR-PFRD Act. This study has also demonstrated the need for more private sector involvement in IP management together with alignment of research priorities between the public and the private sector, with particular emphasis on growth and on the creation of new industries. Mangena (2015:247) aptly captures this imperative in stating that:

> *"The significant weakness of the South African IP law presently is that it does not sufficiently cover research, development and innovation in the private sector space. This is a serious shortcoming, considering the fact that it is the private sector that should be powering us into the knowledge-based economy, not the public sector."*

Given the performance of the South African IP system, this study has also advanced the need for strategic in-bound technology transfer and licensing of foreign originating IP in the growth of existing industries and the creation of new ones, for South Africa to address challenges in the macroeconomic environment and grow its global competitiveness. To achieve this, the study has also made specific recommendations regarding the structure of the funding between public and private sector, and the need to increase the use of IP by the private sector and, in particular, to focus on scalable high growth SMEs. A number of sectors, where such growth can easily be realised, based on the current IP capabilities, have been identified and include Biopharmaceuticals/Biotechnology, ICT/Electronics, and Energy. In all these areas, specific focus should be on driving local manufacturing capabilities to create new job opportunities and to address the challenges identified in the NDP (2012). The declining investment in formal R&D by South African companies, as identified in the OECD (2011:62) needs to be addressed, if the economy is to experience real growth.

The discourse regarding the IP system has clearly established its various elements and areas for improvement to ensure coherency and the achievement of the common goal of socio-economic development.

Lastly, whereas this study may have placed greater emphasis on high technology innovations and associated patenting, it is very important that South Africa adopt a broader approach to its IP system, with a focus on enabling more use and ensuring its inclusivity. Similarly, South Africa's development has to be inclusive, and that cannot be the case, if the NSI does not increase its appreciation and use of the IP system in its totality, beyond patents. In this regard, this study echoes the sentiments by Mammo (2016:29) who, in his discussion of an appropriate innovation system and integrated development, advances the view that:

> *"[Innovation and Development System] IDS should include both high-end R&D as well as low-end or bottom of the pyramid informal innovative activities that should be volarised [commercialised] and integrated along with different types of knowledge … this should include all knowledge sources including reverse innovation and engineering along with grassroots innovation."*

It would appear from the foregoing that South Africa has the foundations to be globally competitive, a view that is supported by the OECD (2012) that notes that *"… emerging developing countries have "islands of excellence" which are very innovative, world-leading businesses, sectors, regions and research institutions or universities."* In striving to do so, it must ensure that its IP regime is inclusive and that it is strategically used to drive long-term socio-economic objectives. Whether that is achieved or not will depend on the willingness of all stakeholders within the NSI to work together in a coherent and coordinated manner.

BIBLIOGRAPHY

Books

1. Adesida, O., Karuri-Sebina, G., and Resende-Santos, J. (2016). *Innovation Africa – Emerging hubs of excellence*, Emerald Group Publishing Limited, United Kingdom
2. Bansi, R (2016). *Commercialization of University Innovation in South Africa*, PhD Thesis, Durban University of Technology, South Africa
3. Berger, M., Murugi, J, Buch, E., IJsselmuiden, C., Moran, M., Guzman, J., Devlin, M. and Kubata, B. (2010). *Strengthening pharmaceutical innovation in Africa.* Council on Health Research for Development (COHRED); New Partnership for Africa's Development (NEPAD)
4. Burrell, T.D. (1999). *Burrell's South African patent and design law* 3rd ed., Durban, Butterworths
5. Chang, H-J. (2006). *The East Asian Development Experience: The Miracle, the Crisis and the Future*. London: Zed Books
6. De Carvalho, N.P. (2010). *The TRIPS regime of patent rights*, 3rd ed., Wolters Kluwer Law International, Alphen aan den Rijn
7. De Soto, H. (2000). *The mystery of capital: why capitalism triumphs in the West and fails everywhere else*. New York, Basic Books
8. Dickens, C. and Schama, S. (1990). *A tale of two cities*. New York, Vintage Books
9. GIPC (2016). *Infinite Possibilities – IP as a Development Tool: Supplementary Statistical Analysis to the US Chamber International IP Index*, Global Intellectual Property Center, US Chamber of Commerce, 2016, also available at http://www.theglobalipcenter.com/wp-content/themes/gipc/map-index/assets/pdf/2016/GIPC_IPIndex_Annex.pdf
10. GIPC (2017). *The Roots of Innovation,* US Chamber International IP Index, Fifth Edition, Global Intellectual Property Center, US Chamber of Commerce, February 2017
11. Klopper, H., Pistorius, T., Rutherford, B., Tong,L-A., Van der Spuy, P., and Van der Merwe, A. (2010). *Law of intellectual property in South Africa*, Durban, LexiNexis

12. Lings, K. (2014). *The missing piece - Solving South Africa's economic puzzle*, Pan Macmillan South Africa
13. Lubango L.M. (2009). *Industry specific know-how, inventiveness, and research performance of universities' entrepreneurs: A cross-national patent portfolio analysis.* PhD thesis, Pretoria, University of Pretoria
14. Maharajh, R. (2011). *Innovating beyond racial capitalism: A contribution towards the analysis of the political economy of post-apartheid South Africa* (Ph.D. dissertation Lund University)
15. Mangena, M (2015). *Triumphs and Heartaches*, Picador Africa, South Africa,
16. McKinsey Global Institute (2015). *South Africa's Big Five Bold Priorities for Inclusive Growth,* McKinsey & Company, September 2015
17. Nyatlo, M (2015). *Creating an implementation framework to improve the effectiveness of technology transfer offices at South African universities*, PhD Thesis, Da Vinci Institute, South Africa
18. Sexton, DL and Kasarda, J.D. (1992). *The State of The Art of Entrepreneurship*, PWS-KENT Publishing Company, Boston
19. Sibanda, M. (2007). *The State of Patenting in South Africa*. Special Report. Pretoria, South Africa: Innovation Fund
20. Taubman, A., Wager, H. and Watal, J. (2012), *A handbook on the WTO TRIPS Agreement*, (WTO Training Edition, World Trade Organisation, Cambridge University Press)

Articles

1. Alessandrini, M., Klose, K. & Pepper, M.S. (2013). "University Entrepreneurship in South Africa: Developments in Technology Transfer Practices", in *Innovation: Management, Policy & Practice*, 15(2), pp. 205-214. Also available at http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.848.8825&rep=rep1&type=pdf [Last accessed on 12 November 2016]
2. Amechi, E.P. (2015). "Using Patents to Protect Traditional Knowledge on the Medicinal Uses of Plants in South Africa," 11/1 Law, Environment and Development Journal, available at http://www.lead-journal.org [Last accessed on 10 August 2015]

3. Anja, B. and Neil, F. (2012). "Intellectual property rights, innovation and technology transfer: a survey", *Munich Personal RePEc Archive*, MPRA paper No. 36094, posted 20 January 2012 19:23 UTC; pp. 36

4. Baker BK, US PhRMA Bares its Fangs (2014). South Africa Patent Law reform and Access to Medicine at Risk Yet Again, blog posted 18 January 2014, http://www.fixthepatentlaws.org/?p=830 [Last accessed on 2 October 2014]

5. Bansi, R. and Reddy, K. (2015). "Intellectual property from publicly financed research and intellectual property registration by universities: A case study of a university in South Africa," in *Procedia – Social and behavioural Sciences* 181 (2015) 185-196

6. Bishnoi, B.R. and Goyal, P. (2011), "Intellectual Property Rights and the WTO," in *Journal of Arts, Science and Commerce*, vol. II, Issue 2, April 2011

7. Bhattacharya, S. Scientometrics (2004) 61: 361. doi:10.1023/B:SCIE.0000045115.23375.50

8. Braga. C and Fink. C. (1997), "The Relationship between Intellectual Property Rights and Foreign Direct Investment", in *Duke Journal of Comparative & International Law*, vol 9:163

9. Campbell, K. (2017), "South African R&D spending on the rise but government aims yet higher," *Engineering News*, 12 April 2017, available at http://www.engineeringnews.co.za/article/south-african-rd-spending-on-the-rise-but-government-aims-yet-higher-2017-04-12l [Last accessed on 28 November 2017]

10. Chesbrough, H. (2005). "Open Innovation: A New Paradigm for Understanding Industrial Innovation," 26 October 2005, available at https://myweb.rollins.edu/tlairson/ibtech/openinnovation.pdf [Last accessed on 30 April 2017]

11. Chetty, P. (2010)., "Review of IPR and Regulations: Intellectual Property Rights from Publicly Financed Research and Development Act, Act No 51 of 2008, Republic of South Africa," in *The African Journal of Information and Communications*, issue 10 2009/2010

12. Chung, S. (2010). "Innovation, Competitiveness and Growth: Korean Experiences," in *Annual World Bank Conference on development economics, 2010, Lessons from East Asia and the global financial crisis*, edited by Justin Yifu Lin and Boris Pleskovic, May

2011, pp.333-355, available at http://www.rrojasdatabank.info/wbdevecon10-22.pdf [Last accessed on 30 June 2017]

13. Correa, C.M. (2001). "Review of the TRIPS Agreement: Fostering the Transfer of Technology to Developing Countries," in *Third World Network Series* 13, Malaysia
14. Correa, C.M. (2004). "The International Dimension of the Research Exception," AAAS/SIPPI Paper, January 2004
15. Correa, C.M. (2005). "TRIPS agreement and access to drugs in developing countries," in *Sur International Journal on Human Rights*, v. 3, pp. 25-27; see also in *Emory International Law Review*, vol. 17, n. 2. Atlanta (Ga.), 2003
16. Could new BRICS bank rival IMF for top spot? 1 August 2014, available at http://likebulb.blogspot.co.za/2014/08/could-new-brics-bank-rival-imf-for-top.html [Last accessed on 10 March 2017]
17. Daniels, L. (2017), "South Africa Cabinet Considers Draft IP Policy" in *Intellectual Property Watch"*, 6 June 2017
18. Deere, C. (2009). "The Politics of Intellectual Property Reform in Developing Countries" in *Property And Sustainable Development: Development Agenda in A Changing World*, Pedro Roffe, ed., Edward Elgar Press: Oxford: Oxford University Press
19. Dominique Guellec, D and Van Pottelsberghe de la Potterie, B. (2001). "R&D and Productivity Growth: Panel Data Analysis of 16 OECD Countries," OECD Economic Studies No. 33, 2001/II, pp.104
20. Dreyfuss, R., (2004). "Protecting the Public Domain of Science: Has the time of an experimental use defense arrived?" 46 Arizona Law Review, pp. 457
21. Dudhia, Z., Zhukov, V., Kasianov, P. (2017). "A Focus on the Top 5 Innovative Universities in South Africa" Clarivate Analytics, May 2017
22. Eisenberg, R.S. (1989). "Patents and the Progress of Science: Exclusive rights and experimental use," Chicago Law Review(1989), Vol 56, p. 1017
23. Eliseev, A. (2012) Lights go off on SA electric car project, in Daily Maverick, 20 April 2012, available at https://www.dailymaverick.co.za/article/2012-04-20-lights-go-off-on-sa-electric-car-project/#.WTwEXssgrIU [Last accessed on 15 June 2017]

24. Erstling, J. (2010). "Korea's Patent Policy and Its Impact on Economic Development: A Model for Emerging Countries?" *Faculty Scholarship.* Paper 138. http://open.mitchellhamline.edu/facsch/138 [Last accessed on 15 October 2016]

25. Experimental Use as a Defence to a Claim of Patent Infringement, Association Internationale pour la Protection de la Propriété Industrielle Annuaire, 1992/III [AIPPI Ann.], at 282–83

26. Ferance, S.J. (2003). "The Experimental Use Defence To Patent Infringement", available at http://www.ipic.ca/reviews/20-1-01_ferance.pdf [Last accessed on 5 August 2013]

27. Freeman, Avi (2011). "Patentable Subject Matter: the View From Europe," International Free and Open Source Software Law Review, 3(1), pp 59 – 80

28. Garrison, C. (2006). "Exceptions to Patent Rights in Developing Countries", *UNCTAD-ICTSD Issue Paper* No. 17, Geneva, 2006

29. Gault, F. and Gang, Z. (2010). "The Role of Innovation in the Area of Development, in Innovation and the Development Agenda," *OECD Innovation Strategy*, edited by Erika Kraemer-Mbula and Watu Wamae (2010) – available at www.sourceoeced.org/development/9789264088917 [Last accessed on 27 December 2014]

30. Gibbons. L.J. (2011). "Do as I Say (Not as I Did): Putative Intellectual Property Lessons for Emerging Economies from the Not So Long Past of the Developed Nations" 64 *SMU Law Review* 923

31. Gregory, S. (2008). "Intellectual Property Rights and South Africa's Innovation Future," Trade Policy Report 23, 2008, pp. 7

32. Hammond, C. (2005). "The Wider Benefits of Adult Learning: An Illustration of the Advantages of Multi-method Research", in *International Journal of Social Research Methodology,* 8(3): 239-255

33. Hedley, N. (2015). "Manufacturing Down in the dumps" in the *Financial Mail*, April 9 – April 2015, pp. 20

34. Henninger, T. (2009). "Disclosure Requirements in Patent Law and Related Measures – a comparative overview of existing national and regional legislation on IP and

Biodiversity", available at http://ictsd.org/downloads/2009/11/henninger-biodiversity-ip-think-piece-final.pdf [Last accessed on 6 August 2013]

35. IDC (2013). "The South African economy: An overview of key trends since 1994" Industrial Development Corporation

36. Iles, K. (2005). "A Comparative Analysis of the Impact of Experimental Use Exemption in Patent Law on Incentives to Innovate", in *4 Nw. J. TECH. & INTELL. PROP.* 61 http://scholarlycommons.law.northwestern.edu/njtip/vol4/iss1/3 [Last accessed on 19 September 2013]

37. Johnson, J.H. (2005), "The Economics of Patent Policy: A Review of Recent Empirical Studies", in G. Leonard and LJ Stiroh, *Economic Approached to Intellectual Property Policy, Litigation and Management* (National Economic Research Association 2005) 13

38. Jordaan, D. (2016). "Biotech Innovation in South Africa: Twenty Years in Review", in 35 *Biotechnology Law Report 37* No. 1, 2016, pp. 37-42

39. Kahn, M. (2007). "Internationalization of R&D: where does South Africa stand?" in *South African Journal of Science* 103, January/February 2007

40. Kahn, T. (2017). "New player set to enter AIDS-drug production," in *Business Day*, 8 June 2017

41. Kameri-Mbote, P. (2005). "Intellectual property Protection in Africa: An assessment of the status of laws, research and policy analysis on intellectual property rights in South Africa," IELRC Working Paper 2005 – 3, International Environmental Law Research Centre, 2005; also available at http://www.ielrc.org/content/w0503.pdf [Last accessed on 8 August 2015]

42. Kaplan, D.E. (1999). "On the Literature of the Economics of Technological Change. Science and Technology Policy in South Africa", in *The South African Journal of Economics*, 67 (4), pp. 473-490

43. Kaplan, D. (2004). "South Africa's National Research and Development Strategy: A Review", in *Science, Technology and Society*, Vol. 9 (2), pp. 273-294

44. Kaplan, D. (2009). "Intellectual Property Rights and Innovation in South Africa: A framework" in *The economics of intellectual property in South Africa*, WIPO, 1-17

45. Kevin, I. (2005). "A Comparative Analysis of the Impact of Experimental Use Exemption in Patent Law on Incentives to Innovate, 4 Nw. J. TECH. & INTELL. PROP. 61 http://scholarlycommons.law.northwestern.edu/njtip/vol4/iss1/3 [Last accessed on 19 September 2013]

46. Kim, L. (1980). "Stages of Development of Industrial Technology in a Developing Country: A Model" in *Research Policy*, 9, 254-277

47. Kim, Youn-Suk, (1992). "Korea's Technology Policy for Industrialisation: Imported Technology for Economic Development," *Korea Journal of Population and Development*, vol. 21, No. 1, July 1992, pp. 1

48. Knowledge Ecology International (KEI) Statement on Thailand Compulsory licenses, http://www.cptech.org/ip/health/c/thailand/kei-thaicl-statement.html

49. Kraemer-Mbula, E., Pogue, T.E. and Khan, M. (2011). ERAWATCH COUNTRY REPORTS 2011: South Africa, ERAWATCH Network – Institute for Economic Research on Innovation (IERI) 2011 pp. 37

50. Kriel, H., Coates, M., Smit, E. (2015). "Enabling Breakthrough Technologies Using Nanofiber Expertise" in *International Fiber Journal*, 11 December 2015, available at http://fiberjournal.com/featured-articles/enabling-breakthrough-technologies-using-nanofiber-expertise/ [Last accessed on 19 March 2017]

51. Laik. K. (2005). "Role of Intellectual property in economic growth" in *Journal of Intellectual Property Rights* (10) 2005 pp. 465-473

52. Loon, L.W. (2009). "Exploring Flexibilities within the Global IP Standards" (2) I.P.Q. 162-164

53. Makgoba, M. (2010). "Living the True Meaning of the National System of Innovation", in *Focus* 59, November, Pages 67 – 73

54. Manzini, S.T. (2012). "The national system of innovation concept: An ontological review and critique" in *S Afr. J Sci.* 108(9/10), Art. #1038, 7 pages. http://dx.doi.org/10.4102/sajs. v108i9/10.1038, pp. 2 of 7

55. Maskus, K. (2003). "TRIPS, Drug Patents and Access to Medicines-Balancing Incentives for R&D with Public Health Concerns", in Knowledge Economy, Development Gateway, at

www.developmentgateway.org/download/206719Maskus_on_TRIPS,_Drug_Patents,_Medicines.pdf [Last accessed on 10 September 2016]

56. Mckay, J. (2005). "South Korea's Education and Skills Development Some Lessons From Africa," Global Best Practice Report No. 2, The South African Institute of International Affairs, 2005, ISBN: 1-919969-30-6, also available at http://www.saiia.org.za/research-reports/304-south-korea-s-education-and-skills-development/file [Last accessed on 13 November 2016]

57. Misati, E. and Adachi, K. (2010). "The Research and Experimentation Exceptions in Patent Law: Jurisdictional Variations and the WIPO Development Agenda, *Policy brief* Number 7. March 2010

58. Muchie, M. (2016). "Towards a Unified Theory of Pan-African Innovation Systems and Integrated Development", in *Innovation Africa – Emerging hubs of excellence*, edited by Adesida, O., Karuri-Sebina, G., and Resende-Santos, J., Emerald Group Publishing Limited, UK

59. Munyuki, E. and Machemedze, R. (2010). "Implementation of the TRIPS flexibilities by east and southern African countries: Status of patent law reforms by 2010," EQUINET Discussion Paper 80. EQUINET: Harare, pp 18

60. Murad Ali, K.P. and Chevalier, F. (2011). "Strengthening Indigenous Technological Innovation Capabilities in Developing Countries," *Journal of US-China Public Administration*, ISSN 1548-6591, Vol. 8. No. 3, 340-354

61. Nair, G.G. (2008). "Impact of TRIPS on Indian Pharmaceutical Industry," *Journal of Intellectual Property Rights* Vol 13, September 2008, pp. 440

62. Ncube, C., Abrahams, L. and Akinsanmi, T. (2014). "Effects of the South African IP Regime on Generating Value from Publicly Funded Research: An Exploratory Study of Two Universities," in *Innovation and Intellectual Property: Collaborative Dynamics in Africa,* UCT Press, pp. 292

63. Ncube, C.B. (2013). "Harnessing intellectual property for development : Some thoughts on an appropriate theoretical framework," PER / PELJ 2013(16)4, also available at http://www.ajol.info/index.php/pelj/article/view/99743/89021 - [Last accessed on 18 June 2014]

64. Patra, SK and Muchie, M (2015), "South African Competency in High Technology: An exploration of patents granted in USPTO to South African Inventors" available at http://www.sarchi-steid.org.za/index.php/working-papers/item/139-south-african-competency-in-high-technology-an-exploration-of-patents-granted-in-uspto-to-south-african-inventors

65. *"PBMR facing massive cuts". World Nuclear News. 18 February 2010.* Available at http://www.world-nuclear-news.org/C_PBMR_facing_massive_cuts_1802101.html [Last accessed on 4 December 2016]

66. Pechacek, J.T. (2012). "The Past, Present, and Future of South Africa's Patent System", *Cybaris®*: Vol. 3: Issue. 2, Article 3. Pp. 200 Available at: http://open.wmitchell.edu/cybaris/vol3/iss2/3

67. Pillay, P. (2010), "Chapter 5 - South Korea," in *Linking higher education and economic development Implications for Africa from three successful systems*, pp.71, also available at https://www.chet.org.za/books/linking-higher-education-and-economic-development [Last accessed on 1 June 2017]

68. Pouris, A. and Pouris, A. (2011). "Patents and economic development in South Africa: Managing intellectual property rights". *S Afr J Sci.* 2011; 107 (11/12, Art. #355, 10 pages, available at http://dx.doi.org/10.4102/sajs.v107i11/12.355 [Last accessed on 22 June 2014]

69. Ramazan, I.C.T.U. and Essop, H. (2012). "The Role of the South African Government in Developing the Biotechnology Industry – from Biotechnology Regional Innovation Centres to the Technology Innovation Agency," Stellenbosch Economic Working Papers: 19/12, November 2012

70. Ranjan, R. (2003). "PCT System and Its Impact on the Developing Countries," *Journal of Intellectual Property Rights*, vol 8, January 2003

71. Reiss, S.M. "Commentary on the Paris Convention for the protection of Industrial Property", *Lex-IP.com Commentary on the Paris Convention*, also available at http://www.lex-ip.com/Paris.pdf [Last accessed on 31 January 2017]

72. Savastano, D. (2012). "PST Sensors Makes Major Strides in Printed Silicon" in *Printed Electronics Now*, 1 April 2012, available at

http://www.printedelectronicsnow.com/contents/view_online-exclusives/2012-01-04/pst-sensors-makes-major-strides-in-printed-si/

73. Schacht, W.H. and Thomas, J.R. (2005). "Patent Law and Its Application to the Pharmaceutical Industry: An Examination of the Drug Price Competition and Patent Term Restoration Act of 1984 ("The Hatch-Waxman Act")", *CRS Report for Congress*, Updated January 10, 2005

74. Sibanda, M. (2009). "Intellectual Property, Commercialization and Institutional Arrangements at South African Publicly Financed Institutions". *The economics of intellectual property in South Africa,* Geneva, WIPO, 113 -145

75. Sibanda, M. (2012). "Intellectual Property and Patenting – Guard It!" *EE Publishers* http://eepublishers.co.za/article/inovationhub-02-intellectual-property-and-patenting-guard-it.html [Last accessed on 4 April 2013]

76. Sibisi, S. (2014). "Preface" in *The Missing Piece, Solving South Africa's Economic Puzzle*, by Lings, K (2014), McMillan, South Africa

77. Singh, S.P. and Dube, M. (2014). "BRICS and the World Order: A Beginner's Guide" (May 30, 2014), available at http://dx.doi.org/10.2139/ssrn.2443652 [Last accessed on 9 July 2015]

78. Sinha, D. (2008) "Patents, Innovation and Economic Growth in Japan and South Korea: Evidence from Individual Country and Panel Data," *Applied Econometrics and International Development* Vol. 8-1

79. Simkins, C. (2014). "South Africa**:** Innovation and Democracy," Democracy Works. Conference Paper, 2014, available at http://www.cde.org.za/wp-content/uploads/2014/04/democracy-works---south-africa-conference-paper---innovation-democracy---by-charles-simkins-pdf-.pdf [Last accessed on 12 November 2016], pp. 27

80. Sirkin, H., Rose, J. and Choraria, R. (2017). "An Innovation-led Bood for US Manufacturing," April 2017, available at https://www.bcg.com/publications/2017/lean-innovation-led-boost-us-manufacturing.aspx [Last accessed on 1 June 2017]

81. Sparks, C. (2014). "Deconstructing the BRICS" *International Journal of Communication* 8 (2014) 392-418

82. Straus, J. (2008). "How to Break the Deadlock Preventing a Fair and Rational Use of Biodiversity," *Journal of World Intellectual Property*, Vol. 11, no. 4, pp. 229 - 295

83. Straus, J. (2012). "A marriage of Convenience: World Economy and Intellectual property from 1990 to 2012" *American Intellectual Property Law Association Quarterly Journal* 639 Fall 2012 (40) no 4

84. Straus, J. (2014). "The Bolar exemption and the supply of patented active pharmaceutical ingredients and generic drug producers: an attempt to interpret Article 10(6) of Directive 2004/27," pp. 895 – 908, *Journal of Intellectual Property Law & Practice*, 2014, Vol. 9. No. 11

85. Straus, J. (2016). "How much patenting is needed for sustainable global competitiveness? The case of the Italian mechanical engineering industry", *Journal of Intellectual Property Law & Practice*, 2016, Vol. 11. No. 6, 450-459

86. Straus, J. (2017). "Intellectual Property Rights and Bioeconomy," *Journal of Intellectual Property Law and Practice*, 2017, Vol. 12, No.7, 576

87. Teljeur, E. (2003). "Intellectual property rights in South Africa: An Economic Review of Policy and Impact", *The Edge Institute*, South Africa

88. Thackeray, M. (2011). "Twenty Golden Years of Battery R&D at CSIR,1974–1994" *S. Afr. J. Chem*., 2011, 64, 61 –66

89. The Innovation Hub (2017), internal communication presentation entitled "BioPark Infrastructure Projects Phase 1, 1b, 2 and 3", February 2017

90. Thorpe, P. (2002). "Study on the Implementation of the TRIPS Agreement by Developing Countries, *Commission on Intellectual Property Rights study papers, Volume 7 of Study paper / Commission on Intellectual Property Rights*, Great Britain, pp. 23 available at http://www.iprcommission.org/papers/pdfs/study_papers/sp7_thorpe_study.pdf [Last accessed on 24 August 2015]

91. Timm, S. (2017). "Are these the 10 all-time biggest exit deals for SA start-ups" in *Ventureburn*, 5 June 2017, available at http://ventureburn.com/2017/06/biggest-sa-exit-deals-digital-all-stars/ [Last accessed on 24 June 2017]

92. Tomlinson, C. and L Rutter, L. (2014). "The Economic & Social Case for Patent Law Reform in South Africa," Research Paper, Treatment Action Campaign, South Africa,

February 2014 – available at http://www.health-e.org.za/wp-content/uploads/2014/02/The-Economic-and-Social-Case-for-Patent-Law-Reform-in-South-Africa.pdf [Last accessed on 23 August 2015]

93. Vandoren, P. (1999). "The implementation of the TRIPS Agreement" (2) *Journal of World IP* 1999, 27

94. Venter, I. (2016)."A-developed solar panels beat European intellectual property challenge" in *Engineering News*, 4th March 2016, available in http://www.engineeringnews.co.za/article/sa-developed-solar-panels-beat-european-intellectual-property-challenge-2016-03-04/rep_id:4136 [Last accessed on 24 June 2017]

95. Visser, C. (2011). *"Patent Exceptions and Limitations in the Health Context"* Annex V to WIPO Standing Committee on the Law of Patents Document SCP/15/3, available at http://www.wipo.int/edocs/mdocs/scp/en/scp_15/scp_15_3-annex5.pdf [Last accessed on 24 May 2017]

96. Walwyn, D. and Hagendijk, R. (2012). "Too many actions, too few priorities: Commentary on the ministerial review of the STI landscape." *S Afr J Sci*. 2012; 108(9/10), Art. #1436, http://dx.doi.org/10.4102/sajs. v108i9/10.1436 [Last accessed on 24 April 2017]

97. Wang, C. (2013). "The Long-run Effect of Innovation on Economic Growth," May 15, 2013, available at https://www.murdoch.edu.au/School-of-Business-and-Governance/_document/Australian-Conference-of-Economists/The-long-run-effect-of-innovation-on-economic-growth.pdf [Last accessed on 23 May 2016]

98. Wangwe Wangwe S.M. (2003). "African systems of innovation: Towards an interpretation of the development experience." In: Muchie M, Gammeltoft P, Lundvall B, editors. *Putting Africa first: The making of African innovation systems*. Aalborg: Aalborg University Press, 2003; p. 75–91

99. Winnink, J. (2016). "Scientific Breakthroughs produced in South Africa," International Conference on Scientometrics, STI Policy and Science Communication, 31 October – 3 November, Stellenbosch, South Africa, available at http://www0.sun.ac.za/scistip/wp-content/uploads/2012/10/Winnink_J.pdf [Last accessed on 30 April 2017]

100. Wolrad Prinz zu Waldeck und Pyrmont, (2008). "Research Tool Patents After Integra v. Merck— Have they reached a Safe Harbor?" 14 Mich. Telecomm. Tech. L. Rev.367, available at http://www.mttlr.org/volfourteen/waldeck.pdf [Last accessed on 21 September 2015]

101. Wolson, R.A. (2005). "The Role of Technology Transfer Offices in Building the South African Biotechnology Sector: An Assessment of Policies, Practices and Impact" paper presented for the Bringing Sciences to Life Conference, University of Toronto, April 29 to May 1, 2005

102. Wolson, R. (2007). "Technology Transfer in South African Public Research Institutions" in *Intellectual property management in health and agricultural innovation: A handbook of best practices* 9eds. A Krattiger, RT Mahoney, L Nelsen, et al) Davies: Public Intellectual Property Resource for Agriculture (PIPRA) available at http://www.ipHandbook.org [Last accessed on 10 August 2015]

103. Zhang, J., Du, D., & Park, W. G. (2015). "How Private Property Protection Influences the Impact of Intellectual Property Rights on Economic Growth?" *Global Economic Review*, 44(1), 1-30

Others

1. Cochrane, D, (2014). "DTI's Intellectual Property Draft Policy: facts, uncertainties and implications - What are the consequences for South Africa's pharmaceutical and other industries and the chronic lack of skilled scientists and engineers?" Media Briefing - Free Market Foundation, 26 November 2014, available at http://www.freemarketfoundation.com/issues/media-release-dtis-ip-draft-policy-is-incoherent-and-contains-unsubstantiated-and-incorrect-statements-on-the-law [Last accessed on 24 December 2014]

2. Du Plessis, E. (2015). "Summary of the Roundtable: Substantive Search and Examination," 25 February 2015, Adams and Adams, available at: http://www.adamsadams.com/index.php/media_centre/news/roundtable_discussion_substantive_search_and_examination/ [Last accessed on 30 September 2015]

3. Faul, K. (2015). "NIPMO 5 year report", unpublished (2015)

4. Mjwara, P. (2015). Presentation at the Tshwane University of Technology Innovation Indaba, slide entitled "A High-Technology Manufacturing Trade Deficit Trend" Tshwane University of Technology Innovation Indaba, 27th October 2014

5. Mphahlele, B. (2017), Private communications / emails between McLean Sibanda and Brian Mphahlele, March 2017, Executive Manager: Business Development, brian.mphahlele@necsa.co.za

6. Sibanda, M. (2016). "Proposal for the Expansion of the BioPark Life Sciences Pre-commercial and Incubation Facility at The Innovation Hub, Pretoria, South Africa – Prepared for the BIO Partners," BIO Convention, San Francisco, June 2016

7. SiMODiSA: Accelerating growth of small and medium enterprises in South Africa: Policy recommendations for enhancing the start-up / SME ecosystem in South Africa, October 2014, South Africa

8. Straus, J. (2012b). "National Substantive Patent Examination in the Changed Global IP Landscape: An Academic Perspective", Presentation at the Roundtable Discussion on Substantive Patent Examination, Companies and intellectual Property Commission (CIPC), Pretoria, 30 August 2012

Official Reports

International

1. BMI (2015). *BMI South Africa Pharmaceuticals & Healthcare Report Q2 2015*

2. CIPR (2002). *Integrating Intellectual Property Rights and Development Policy,* Commission on Intellectual Property Rights, London 2002)

3. Cornell University, INSEAD, and WIPO (2013): *The Global Innovation Index 2013: The Local Dynamics of Innovation,* Geneva, Ithaca and Fontainebleau. ISSN 2263 3693 /ISBN 978-2-9522210-3-0

4. Cornell University, INSEAD, and WIPO (2014). *The Global Innovation Index 2014: The Human Factor In innovation,* Fontainebleau, Ithaca, and Geneva, pp. 12 available at http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2014-15.pdf –[Last accessed on 8 June 2015]

5. Cornell University, INSEAD, and WIPO (2016): The Global Innovation Index 2016: Winning with Global Innovation, Ithaca, Fontainebleau, and Geneva – available at

http://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2016.pdf [Last accessed on 13 November 2016]

6. EY (2014). *Ernst and Young* **(***EY) Africa Attractiveness Survey, 2014* – available at http://www.ey.com/Publication/vwLUAssets/EY-attractiveness-africa-2014/$FILE/EY-attractiveness-africa-2014.pdf [Last accessed on 3 May 2015]

7. OECD (2004). *Patents and Innovation: Trends and Policy Challenges*, OECD Publications, Paris Cedex 16, France, available at https://www.oecd.org/sti/sci-tech/24508541.pdf [Last accessed on 15 July 2017]

8. OECD (2007). *Reviews of innovation Policy: South Africa* – ISBN-978-92-64-03823-3 OECD Publications, France

9. OECD (2010) *Innovation and the Development Agenda* OECD Publishing. ISBN 978-92-64-08891-7, OECD Publications, France

10. OECD (2011). *The Gauteng City-Region, South Africa*, OECD Territorial Reviews, OECD Publishing, France, also available at . http://dx.doi.org/10.1787/9789264122840-en [Last accessed on 16 July 2017]

11. OECD (2011b), "Eco-innovation policies in South Africa ", Free Document, Environment Directorate, OECD, available at https://www.oecd.org/env/consumption-innovation/50452349.pdf [Last accessed on 16 July 2017]

12. OECD (2012) *Innovation and Inclusive Development* Conference Discussion Report Cape Town South Africa; Accessible at http://www.iadb.org/intal/intalcdi/PE/2012/10975.pdf [Last accessed on 12 January 2014]

13. OECD Patent Databases Identifying Technology Areas for Patents, available at https://www.oecd.org/sti/inno/40807441.pdf [Last accessed on 9 November 2016]

14. STISA-2024. African Union Science Technology and Innovation Strategy for Africa 2024 - On the Wings of Innovation – STISA-2024 – available at https://caast-net-plus.org/object/document/1228 [Last accessed on 17 April 2017]

15. UNCTAD (1996). United Nations Conference on Trade and Development, The TRIPS Agreement and Developing Countries, , UNCTAD/ITE/1, United Nations, New York and Geneva, 1996

16. UNCTAD (2011). Using *Intellectual Property Rights To Stimulate Pharmaceutical Production In Developing Countries*: A Reference Guide, United Nations Conference on Trade and Development, United Nations, New York and Geneva, 2011

17. WEF (2014). *The Global Competitiveness Report 2014–2015*, World Economic Forum, Geneva available at http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2014-15.pdf [Last accessed on 8 June 2015]

18. WEF (2016). *The Global Competitiveness Report 2016–2017*, World Economic Forum, Geneva, available at http://www3.weforum.org/docs/GCR2016-2017/05FullReport/TheGlobalCompetitivenessReport2016-2017_FINAL.pdf [Last accessed on 16 July 2017]

19. WIPO (2010) - Committee on Development and Intellectual Property ("CDIP") *Report CDIP/5/4; CDIP/5/4 Rev; CDIP/6/10* http://www.wipo.int/meetings/en/doc_details.jsp?doc_id=142068; and CDIP/7/3 - http://www.wipo.int/meetings/en/doc_details.jsp?doc_id=203320 [Last accessed on 4 January 2014]

20. WIPO (2011). Study on Patents and the Public Domain (April 27, 2011), World Intellectual Property Organisation, available at http://www.wipo.int/edocs/mdocs/mdocs/en/cdip_4/cdip_4_3_rev_study_inf_2.pdf [Last accessed on 10 August 2015]

21. WIPO (2015). Patent Cooperation Treaty Yearly Review 2015, World Intellectual Property Organisation, , available at http://www.wipo.int/edocs/pubdocs/en/wipo_pub_901_2015.pdf [Last accessed on 18 July 2017]

South Africa

1. Baseline Study (2008-2014). *Inaugural Baseline Study: 2008-2014 of the South African National Survey of Intellectual Property and Technology Transfer at Publicly Funded Research Institutions,* Department of Science and Technology, Southern African Research and Innovation Management Association (SARIMA), the National Intellectual Property Management Office (NIPMO) and the Centre for Science,

Technology and Innovation Indicators (CeSTII), 2017, available at http://www.dst.gov.za/images/2017/2017_pdfs/SA-IPTT_BASELINE-SURVEY-REPORT-2017.pdf [Last accessed on 23 April 2017]

2. CeSTII (2017). *Main Analysis Report: South African National Survey of Research and Experimental Development 2014/15*. Centre for Science, Technology, and Innovation Indicators, Human Sciences Research Council, Tshwane, Department of Science and Technology, available at http://www.dst.gov.za/images/2017/2017_pdfs/SA-RD-SURVEY-MAIN-ANALYSIS-REPORT-201415-WEB.pdf [Last accessed on 23 April 2017]

3. CIPC (2014). *Companies and Intellectual Property Commission Annual Report 2014/15*, available at http://pmg-assets.s3-website-eu-west-1.amazonaws.com/151014CIPC_AR.pdf [Last accessed on 17 April 2017]

4. CIPC (2015). *Companies and Intellectual Property Commission Annual Performance Plan 2015/16*; 27 July 2016, available at www.cipc.co.za [Last accessed on2 August 2015]

5. Draft IP Policy (2013). *Draft National Policy on Intellectual Property (IP) of South Africa, A Policy Framework,* Department of Trade and Industry, Government Gazette No. 36816, 4 September 2013 Pretoria South Africa www.gov.za/documents/download.php?f=198116 [Last accessed on 18 September 2013]

6. GIKES (2012). *Gauteng Innovation and Knowledge Economy Strategy*, Gauteng Provincial Government, April 2012, available at http://www.foresightfordevelopment.org/library/55/1371-gauteng-innovation-and-knowledge-economy-strategy [Last accessed on 8 October 2016]

7. IPAP (2015). *Industrial Action Policy Plan 2015*, Department of Trade and Industry

8. IPR Policy (2006). *Framework for Intellectual Property from Publicly Financed Research, 2006*, Department of Science and Technology, available at http://www.pmg.org.za/policy-documents/2006/07/07/intellectual-property-rights-ipr-from-publicly-financed [Last accessed on 20 May 2014]

9. Ministerial Review (2012). *Ministerial Review of the Science, Technology and Innovation Landscape in South Africa*, Department of Science and Technology, published March 2012; Government Gazette No.35392, Notice 425 of 2012, 31

March 2012, available at http://www.dst.gov.za/images/Final Ministerial Report MAY 16 4 .pdf [Last accessed on 4 October 2016]

10. NACI (2014). *South African Science , Technology and Innovation Indicators*, 2014, National Advisory Council on Innovation, Department of Science and Technology
11. NACI (2015). *South African Science, Technology and Innovation Indicators, 2015*, National Advisory Council on Innovation, Department of Science and Technology available at http://www.naci.org.za/wp-content/uploads/pdf/SA-STI-Indicators-2015.pdf [Last accessed on 6 November 2016]
12. National Survey of Research and Experimental Development – Main Analysis Report 2012/13, Department of Science and Technology, March 2015; available at http://www.dst.gov.za/index.php/resource-center/rad-reports/1290-rad-survey-results-2012-2013 [Last accessed on 12 July 2015]
13. National Treasury, 2013 Budget review – available at http://www.treasury.gov.za/documents/national%20budget/2013/review/chapter%202.pdf [Last accessed on 4 May 2015]
14. National Treasury, 2015 Budget Review – available at http://www.treasury.gov.za/documents/national%20budget/2015/review/FullReview.pdf [Last accessed on 4 May 2015]
15. NDP (2012). *The National Development Plan: Vision 2030*, National Planning Commission, The Presidency, Republic of South Africa, Government Printer, Pretoria
16. NRDS (2002). *South Africa's National Research and Development Strategy,* Department of Arts, Culture, Science and Technology, 2002, Government Printer, Pretoria/ Tshwane, also available at http://www.esastap.org [Last accessed on 2 August 2015]
17. RSA (1994). *White Paper on Reconstruction and Development, Government's Strategy for Fundamental Transformation*, Government Printer, Pretoria
18. RSA (1996). Growth, Employment and Redistribution Strategy, Department of Finance, Government of the Republic of South Africa, Government Printer, Pretoria
19. DST. (2001). A National Biotechnology Strategy for South Africa. Available at http://www.dst.gov.za/publications-

policies/strategiesreports/reports/dst_biotechnology_strategy.PDF [Last accessed on 21 September 2015]

20. RSA (2010) New Growth Path: The Framework, Department of Economic Development, Government Printer, Pretoria
21. RSA (2013) *Bioeconomy Strategy*, Department of Science and Technology, available at http://www.gov.za/sites/www.gov.za/files/ [Last accessed on 21 September 2015]
22. SPII Report (2014). *Impact Evaluation of Support programme for Industrial Development*, Final Report submitted to DPME, Genesis Analytics, 24 April 2014
23. Statistics South Africa quarterly labour force survey (QLFS), http://www.statssa.gov.za [Last accessed on 15 May 2015]
24. TIA Review (2013). *Technology Innovation Agency Institutional Report*: briefing by Department of Science and Technology, September 2013 available at https://pmg.org.za/committee-meeting/16400/ [Last accessed on 13 November 2016] and http://www.pmg.org.za/report/20130918-technology-innovation-agency-institutional-report-briefing-department-science-and-technology-shortlisting [Last accessed on 27 December 2014]
25. THRIP Review (2015). *Implementation and Impact Evaluation of the Technology and Human Resources for Industry programme (THRIP)*, Business Enterprises at University of Pretoria, 8 April 2015
26. WPS&T (1996). *Preparing for the Twenty First Century: White Paper on Science and Technology*, Department of Arts, Culture, Science and Technology, Government Printer, Pretoria

Legislation

International

1. European Patent Convention - available at https://www.epo.org/law-practice/legal-texts/html/epc/2016/e/ar52.html [Last accessed on 14 August 2016]
2. Patentgesetz [PatG] [German Patent Act], Dec. 16, 1980, section 11(2)
3. Australia (1990) Australia Patent Act 1990 as amended
4. Canada (1985) Patent Act (R.S.C., 1985, c. P-4)Patents Act

5. United States 35 USC 271(e)(1)
6. The Bayh-Dole Act of 1980 (Patent Rights in Inventions Made with Federal Assistance) - 35 U.S.C. § 200-212; 37 C.F.R. Part 401

South Africa

1. IPR-PFRD Act. Intellectual Property Rights from Publicly Financed Research and Development Act (2008), GG No. 31745 of Dec. 22, 2008, Republic of South Africa, Government Printer, Pretoria; (IPR-PFRD Act)– available at http://www.wipo.int/wipolex/en/details.jsp?id=6663 [Last accessed on 15 June 2014]
2. Patents Act. Patents Act, No 57 of 1978 as amended, Republic of South Africa
3. RSA (1965). Medicines and Related Substances Act, 1965, as amended, Government Gazette No. 1171, Notice No. 1002, 7 July 1965, as amended by Act 90 of 1997: Medicines and Related Substances Control Amendment Act, 1997 (Government Gazette Notice No. 18505, 12 December 1997)
4. RSA (1993a). Trade Marks Act (1993), Republic of South Africa, Government Printer, Pretoria – also available at http://www.wipo.int/wipolex/en/details.jsp?id=4074 (Last accessed on 14 May 2014)
5. RSA (1993b). Designs Act (1993), Republic of South Africa, Government Printer, Pretoria; also available at http://www.wipo.int/wipolex/en/details.jsp?id=13086 [Last accessed on 2 August 2015]
6. RSA (1997). Copyright Act (1997), Republic of South Africa, Government Printer, Pretoria; also available at http://www.wipo.int/wipolex/en/details.jsp?id=4067 [Last accessed on 2 August 2015]
7. RSA (1998). Employment Equity Act, Republic of South Africa, Government Printer, Pretoria, Government Gazette 19412, Notice No. 1392 of 1998, 30 October 1998
8. RSA (2002). Patents Amendment Act (2002), Republic of South Africa, Government Printer, Pretoria – also available at http://www.wipo.int/wipolex/en/details.jsp?id=6256 (Last accessed on 14 May 2014)

9. RSA (2003). Broad Based Black Economic Empowerment Act 2003, Republic of South Africa, Government Printer, Pretoria

10. RSA (2004). National Environmental Management: Biodiversity Act, 2004: Regulations on Bio-Prospecting, Access and Benefit Sharing, No. R. 138, 8 February 2008, (BABS Regulations)

11. RSA (2008a). Technology Innovation Agency Act 2008, Department of Science and Technology, Republic of South Africa, Government Printer, Pretoria, (TIA Act)

International and Regional Instruments

1. Agreement on a Unified Patent Court of 19 February 2013, signed by 25 EU Member States (Official Journal of the European Union No. C 175/1 of 20.6.2013)

2. Berne Convention for the Protection of Literary and Artistic Works (as amended on September 28, 1979)

3. Convention for the European Patent for the common market signed at Luxembourg on December 15, 1975, commonly referred to as the Community Patent Convention (CPC 1975)

4. DOHA Declaration. *Declaration on the TRIPS Agreement and Public Health*, adopted on 14 November 2001 by the Fourth WTO Ministerial Conference, Doha, Qatar; available at http://www.wto.org/english/thewto_e/minist_e/min01_e/mindecl_trips_e.htm [Last accessed on 15 October 2016]

5. TRIPS Agreement. *Agreement on Trade-related Aspects of Intellectual Property Rights*, April 15, 1994, Marrakesh Agreement Establishing the World Trade Organisation, Annex 1C, 1869 U.N.T.S. 299, 33 I.L.M. 1197

6. Paragraph 6 Decision. *Decision of the General Council, Implementation of Paragraph 6 of the Doha Declaration on the TRIPS Agreement and Public Health*, WT/L/540 (Aug. 30, 2003) [hereinafter Decision of 30 Aug. 2003]

7. Paris Convention. *Paris Convention for the Protection of Industrial Property*, March 20, 1883 21 U.S.T 1583, 828 U.N T.S 305, Last revised at Stockholm, July 14, 1967

8. WTO (1994) - Marrakesh Agreement Establishing the World Trade Organisation ("the WTO Agreement")

Case Law

International

1. Applied Research Sys. Holding N.V. v. Organon et al., Gerechtshof [Hof] [Court of Appeals], 3 Feb. 1994, NJ 463 (Neth.), 28 IIC558 (1997)
2. Association for Molecular Pathology v. Myriad Genetics, Inc, 569 U. S. ____ (2013); also available at http://www.supremecourt.gov/opinions/12pdf/12-398_1b7d.pdf [Last accessed on 21 September 2015]
3. Astellas Pharma Inc v Polpharma SA, Supreme Court of Poland, Docket No IV CSK 92/13, 23 October 2013
4. Bundesgerichtshof [BGH] [Federal Court of Justice], July 11, 1995—Clinical Trials I, 28 IIC 838 (1997); [1997] R.P.C. 623, 640 (F.R.G.) [hereinafter Clinical Trials I], at pp. 639
5. Farbenfabriken Bayer AG (Zirngibl and Others) Application 1973 RPC 698 704
6. German Federal Supreme Court [1998] R.P.C. 423 (435) – Confirmed by the German Federal Constitutional Court in 2000
7. Lloyd-Jacob J in Glaxo Group Ltd's Application 1968 RPC 473 at 480
8. Madey v. Duke Univ., 2002 U.S. Dist. LEXIS 19500 (M.D.N.C., Apr. 29, 2002, available at http://cyber.law.harvard.edu/cyberlaw2005/sites/cyberlaw2005/images/Madey_v._Duke_%28trial%29.pdf [Last accessed on 18 September 2015]
9. Merck KGaA v. Integra Lifesciences I, Ltd., 545 U.S. ___ (2005); 125 S. Ct. 2372 (2005)
10. Merck KGaA v Integra Lifesciences I, Ltd.,125 S. Ct. 2372, No. 03-1237 (2005)
11. Roche Products v Bolar Pharmaceuticals, 733 F.2d. 858 (Fed. Cir. 1984)

South Africa

1. AECI Explosives Ltd v Ensign-Bickford (South Africa) and Others 1994 BP 42 (60A)
2. Ensign Bickford (South Africa) (Pty) Ltd. and Others v AECI Explosives and Chemicals Ltd. (4/95) [1998] ZASCA 73; 1999 (1) SA 70 (SCA); [1998] 4 All SA 453 (A)
3. Gentiruco AG v Firestone South Africa (Pty) Ltd 1971 BP 58 (A)
4. Gentiruco AG v Firestone SA (Pty) Ltd 1972 (1) SA 589 (A)

5. Hazel Tau & others v. GlaxoSmithKline & Boehringer Ingelheim ("Hazel Tau Case") – Competition Commission South Africa (2003)
6. Pharmaceutical Manufacturers' Association of South Africa v President of the Republic of South Africa. Case No 4183/98, filed Feb 18, 1998
7. Rotaque (Pty) Ltd v General Mining and Finance Corp and Another 1986 BP 534 (A)
8. WA ScholtensChemischeFabrieken NV v Hoechst SA (Pty) Ltd and Another 1966 BP 371 (CP)

ANNEXURE A: Commercialisation Questionnaire

Commercialisation of Intellectual Property Emanating from Publicly Financed Research and Development in South Africa.

This questionnaire is intended to establish the extent of commercialisation of IP by publicly financed institutions in South Africa, and help establish the impact of the Intellectual Property Rights from Publicly Financed Research and Development Act, 2008 ("IPR Act).

Request is made for the institutions to provide as much information as possible, so as to enable to collective findings and recommendations to help strengthen the South African innovation eco-system. The survey forms part of Mr McLean Sibanda's PhD studies which cover a period year period of 1996-2015. Data may not be available from the institutions prior to 2010 when the IPR Act became effective. In this regard, institutions are requested to provide whatever data is available. The specifics of the information provided, such as names of licensees, assignees, etc., will not be published contrary to the terms of said agreements with third parties, unless institutions have provided their consent in this regard.

DUE DATE: 8th February 2017

`

SECTION A: Background and Qualitative Information

1. NAME OF INSTITUTION:	
2. WHAT YEARYOU'RE YOUR INSTITUTION'S TECHNOLOGY TRANSFER OFFICE (TTO) ESTABLISHED?	
3. HOW MANY PEOPLE ARE IN THE TTO:	
4. QUALIFICATIONS OF TTO STAFF AND THEIR BACKGROUND:	1. 2. 3. 4.

SECTION B: Commercialisation Quantitative Information

5. How many licenses did your institution grant in the periods?

	Total	**Exclusive/ Non-exclusive**
2006		
2007		
2008		
2009		
2010		
2011		
2012		
2013		
2014		
2015		

6. How many of these were granted to:

Foreign Parties	
Local Large Companies	
Local SME's / University spin-outs / Start-up companies	

7. How many start-up companies did your institution establish in:

	Total	**Based on one or more patents?**	**Based on copyright (e.g. software, computer programme, etc)**	**Based on trade secrets / Other**
2006				
2007				
2008				
2009				
2010				
2011				
2012				
2013				
2014				
2015				

8. How many patents/ IP has your institution assigned to third parties, in the period 2010-2015?	
	Number
Foreign Parties	
Local Large Parties	
Local SME's / University spin-outs / Start-up companies	

9. How much revenue has your institution generated from the commercialization of its IP?	
	Rands
2006	
2007	
2008	
2009	
2010	
2011	
2012	
2013	
2014	
2015	

10. What is the preferred commercialization form for your institution? *(mark in order of preference, with 1 being most preferable and 3 least)*	
Licensing	
Start-up	
Assignment / Sell the IP	

11. What would you consider to be the biggest hurdles to commercialization? (select a maximum of 5) *(mark in order of importance, with 1 being biggest and 5 being the least hurdle of the five selected)*		
a.	Access to financing	
b.	Access to market	
c.	Skills/ human capacity	
d.	Regulatory environment	
e.	Weak IP position	
f.	No Incentive to participate in commercial activity	

g.	Lack of local industry receptors	
h.	IP too early stage	
i.	Lack of market traction	
j.	Other (please name up to 3, if any)	

12. Which technology sector do most of your invention disclosures belong to?	
Biotechnology (including medical devices, diagnostics, therapeutics)	
ICT/ Electronics / Computer implemented inventions	
Advanced Manufacturing	
Mining	
Other (Please specify)	

13. PLEASE NAME 3-5 BENEFITS THAT YOUR INSTITUTION HAS DERIVED FROM THE IPR ACT *(list in order of importance, with 1 being the biggest benefit and 5 being the least important of the benefits derived of the ones that you have identified)*	
1.	
2.	
3.	
4.	
5.	

14. PLEASE NAME UP TO 3 CHALLENGES YOUR INSTITUTION HAS FACED IN THE IMPLEMENTATION OF THE IPR ACT IN ORDER OF IMPORTANCE *(list in order of importance, with 1 being the biggest challenge and 3 being the least important challenge of the three that you have identified)*	
1.	
2.	
3.	

15. PLEASE PROVIDE UP TO 5 RECOMMENDATIONS IN TERMS OF WHAT CAN BE DONE WITHIN THE INNOVATION ECOSYSTEM TO INCREASE THE COMMERCIALISATION OF IP EMANATING FROM PUBLICLY FINANCED R&D *(list in order of importance, with 1 being most important recommendation that would result in greatest impact and 5 being the least important of the five recommendations by impact)*	
1.	

2.	
3.	
4.	
5.	

16. PLEASE PROVIDE DETAILS OF ANY LESSONS LEARNT IN IMPLEMENTING THE IPR ACT TO DATE	
1.	
2.	
3.	
4.	
5.	

://the end

Thank you for your assistance in completing this questionnaire before the due date of 8th February 2017.