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MODELLING SOUTH AFRICA'S INCENTIVES UNDER THE MOTOR INDUSTRY DEVELOPMENT PROGRAMME

by

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Summary

Modelling South Africa's Incentives under the Motor Industry Development Programme

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Despite it being a global phenomenon, there is no formal process to guide governments' offer of incentives to industry. Specific to South Africa, the offer of incentives to the automotive industry to support its competitiveness has had mixed results. Industry trade deficit has consistently increased and investment in R&D has remained minimal. The purpose of the study was to develop a formal model to determine the effect of changes in the value and basis of the Productive Asset Allowance (PAA) incentive on industry competitiveness and on industry trade balance.

An overview of the South African automotive industry, automotive policy and industry performance under the country's Motor Industry Development Programme (MIDP) was done. This was followed by literature review on investment, investment incentives, R&D and competitiveness. Quantitative and qualitative data was collected through observer participation in the study situation and expert opinion interviews. A formal modelling process of the PAA based on the system dynamics modelling protocol followed. The PAA model had to be extended to incorporate the Import-Export Complementation (IEC)

incentive structure because of the intertwined nature of the effect of PAA and IEC on industry dynamics.

The study findings as per the specific study objectives were as follows:

- The prospect of the PAA to support the competitiveness objective was dependent on the extent to which the incentive would motivate technological innovation in the automotive industry.
- The often-assumed positive relationship between investment and investment incentives was not universal. Each case of industry incentive offer has to be judged on its own merit.
- The PAA had a significant and positive effect on industry investment, but limited ability to support long-term industry competitiveness though R&D and innovative activities.
- The IEC rather than the PAA incentive was the major contributor to the industry trade balance trend.
- The PAA-IEC incentive model exhibited time-bound constraints. The model demonstrated saturation as benefits awarded to industry tended towards the domestic market size over time.
- The PAA-IEC incentive model had no specific policy lever to direct investment into R&D and innovative activities. By this measure the model was not a strong policy framework for supporting long-term industry competitiveness.

For the South African automotive industry, the study introduced and showed the usefulness of applying system dynamics modelling in understanding causes of unintended consequences of government incentives to the industry. For countries in which offer of incentives is part of the national industrial policy, the study provided scientific means through which the question of how to structure incentives can be objectively investigated as a means of improving policy decisions on such industry intervention.

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Samevatting

Modellering van Suid Afrika se Aansporingsmaatreëls onder die Motornywerheid-ontwikkelingsprogram

deur

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Ekonomiese aansporingsmaatreëls van regerings kom wêreldwyd voor, maar daar is geen formele riglyne daarvoor nie. Met spesifieke verwysing na Suid Afrika, het aansporingsmaatreëls om die motorvervaardigingsbedryf meer mededingend te maak in die wêreldmark, gemengde resultate gehad. Handelstekorte van die motorvervaardigingsektor het skerp toegeneem, en investering in navorsing en produkontwikkeling het skraps gebly. Die doel van hierdie studie was om 'n formele model te ontwikkel om te bepaal wat die invloed is van verandering in die waarde en basis van een van die aansporingsmaatreëls, die Produktiewe Batetoelaag (Engels: Productive Asset Allowance – PAA), op die motorvervaardigingsektor se mededingendheid en handelsbalans.

'n Oorsigstudie is uitgevoer van die Suid Afrikaanse motorvervaardigingsbedryf, toepaslike beleid, en prestasie van die motorvervaardigingsbedryf onder die Motornywerheids-ontwikkelingsprogram (Engels: Motor Industry Development

Programme – MIDP). Dit is gevolg deur 'n literatuurstudie oor nywerheidsbelegging, aansporingsmaatreëls vir nywerheidsbelegging en die invloed van navorsing en ontwikkeling op mededingendheid. Besyferde en kwalitatiewe data is versamel by wyse van waarnemerdeelname in die studiesituasie, asook deur onderhoude met deskundiges. 'n Formele modelleringsproses van die produktiewe batetoelaag is gevolg, gebaseer op 'n stelseldinamika-modelleringsprotokol. Die produktiewe batetoelaagmodel moes uitgebrei word om die regering se aansporingsmaatreëls vir Invoer-Uitvoerkomplementering (Engels: Import Export Complementation – IEC) in te sluit vanweë die twee aansporingsmaatreëls se verweefde invloed op die dinamika van die nywerheid.

Die bevindings van die studie, in ooreenstemming met die studiedoelwitte, was soos volg:

- Die verwagting dat die produktiewe batetoelaag die motorvervaardigingsbedryf meer mededingend sou maak, was afhanklik van die mate waartoe dit tegnologiese innovasie in die motornywerheid kon aanspoor.
- Die algemeen aanvaarde positiewe verwantskap tussen belegging en aansporingsmaatreëls vir belegging was nie algemeen geldig nie. Elke geval van 'n aansporingsmaatreël moet op eie meriete beoordeel word.
- Die produktiewe batetoelaag het wel 'n beduidende en positiewe invloed op belegging deur die motorvervaardigingsbedryf gehad, maar het 'n beperkte vermoë getoon om langtermynmededingendheid te bevorder deur navorsing en ontwikkeling en deur innovasie.
- Die invoer-uitvoerkomplementeringsmaatreëls was die hoofbydraer tot die handelsbalanstendense in die motorvervaardigingsbedryf, en nie die produktiewe batetoelaag nie.
- Die gekombineerde model van die produktiewe batetoelaag en die invoer-uitvoerkomplementeringmaatreëls het tydsgebonde beperkings vertoon. Die model het versadiging aangetoon namate voordeelwaardes toegeken aan die bedryf oor tyd geneig het na die waarde van die plaaslike mark.
- Die produktiewe batetoelaag en die invoer-uitvoerkomplementeringmaatreëls het geen spesifieke beleidshefboom om belegging in navorsing en ontwikkeling en

innoverende aktiwiteite te bevorder nie. Gemeet aan hierdie maatstaf was dit nie 'n kragtige beleidsraamwerk om oor die langtermyn nywerheidsmededingendheid te bevorder nie.

Vir die Suid Afrikaanse motorvervaardigingsbedryf het die studie die voordele van stelseldinamika-modellering aangedui as 'n hulpmiddel om die oorsake te verstaan van onbedoelde gevolge van die aansporingsmaatreëls wat die regering aan die bedryf bied. Vir ander lande wat aansporingsmaatreëls as deel van 'n nasionale nywerheidsbeleid aanbied, bied hierdie studie 'n wetenskaplike werkwyse waardeur aansporingsmaatreëls objektief ondersoek en gestruktureer kan word ten einde beter beleidsbesluite te kan neem oor sulke ingrepe in die nywerheid.

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"*The Gods did not reveal, from the beginning, all things to us; but in the course of time, through seeking, men find that which is better*"
Bell & Bell, 1980, p.4.

"*But as for certain truth, no man has known it, nor will know it; neither of the gods, nor yet of all things of which I speak. And even if by chance he were to utter the final truth, he would himself not know it; for all is but a woven web of guesses*" Popper, 1963, p.26, quoting Xenophanes, *Verses*, (570-475 B.C).

ACKNOWLEDGEMENT

This project has been a journey. Like any journey, it was impossible to be adequately prepared for all adventures and eventualities. Hence, as I reach the end of the journey, I feel highly indebted to the following people that trustfully held my hand in one way or another and enabled complete the sometimes-lonely expedition:

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- AIDC staff, for becoming my second family.

Above all, thanks to God almighty that decides what should and should not be.

DEDICATION

This thesis is dedicated to the following very special people in my life:

- My dear wife Edith and our ‘little’ ones, Fina, Tina, Bob and Tim, for their love, trust and always being on my side as I struggled along.
- My mother, for her love and inspiration. Mum, you epitomise the challenges of an African woman and her resilience to move on against all odds; a great lesson to me.
- My entire family for always reminding who I am.

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DECLARATION

I declare that the thesis *'Modelling South Africa's incentives under the Motor Industry Development programme'* is my own work and that all sources that I have used or quoted have been indicated and acknowledged by means of complete references

Martin Kaggwa | Date

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1.1 Overview of the South African automotive industry

1.1.1 The South African economy

South Africa is a developing country at the Southern tip of the African continent with a recorded population of 44.8 million people in 2005. It is a dominant economy on the African continent, with GDP of $576.4 billion, accounting for some 25% of the entire continent's GDP and producing around 40% of the continent’s industrial output (South Africa Economy Overview, 2007). Its major strengths include its physical and economic infrastructure, natural mineral and metal resources, a growing manufacturing sector, and strong growth potential in the tourism, higher value-added manufacturing and service industries. Since transition to democracy in 1994, South Africa has enjoyed improved economic performance, significant capital inflow, a growing export sector, and improved business. The 2006 growth figures from Statistics South Africa showed that real GDP rose by an annual rate 5.6% in the fourth quarter of 2006, far exceeding market expectations (Statistics South Africa, 2006). By the end of 2006, the country had recorded the longest period of economic expansion in its history. There is a strong expectation that the country will continue on an upward growth path in the foreseeable future. Despite the economic progress made, the country still struggles with high unemployment levels that can be attributed, in part, to the “unemployable” population created by its past legacy. Sustained industrial growth is seen as one of the ways through which the country can create jobs for its population.

From a global perspective, the country is ranked 94 in terms of gross national income per capital (3,630 US dollars per annum) above a country like Brazil but below Turkey. The growth competitive ranking of 2005 ranked South Africa as 28 in business and 46 in technology (Global Competitiveness Ranking, 2005). However, the country investment in R&D as a percentage of national GDP remains quite low (0.8%) compared to that of developed countries like the USA and Japan (Table 1).

Economy	**Competitiveness index rank 2005**			**R&D/GDP 2003**
	Growth	**Business**	**Technology**	**%**
USA	2	1	1	2.6
Japan	12	8	8	3.1
UK	13	6	17	1.9
Poland	51	42	39	0.5
Turkey	66	51	53	0.6
South Africa	***42***	***28***	***46***	***0.8***
Brazil	65	49	50	1.13
Mozambique	91	98	83	-

Table 1: Growth competitiveness index ranking 2005
(OECD, 2006)

In a separate Competitiveness Report of 2006, compiled by the Swiss-based Institute for Management Development (IMD), South Africa was ranked number 44. This was an improvement of three places from the rating of 2005 (IMD, 2006). Only 61 countries were rated in 2006 by the IMD. South Africa was the only African country to be rated.

Fostering sustainable industrial development in areas where poverty and unemployment are at their highest through industry support remains the key industry policy objective of South Africa. The automotive industry is seen as an important contributor to this national objective.

1.1.2 South African automotive industry

The automotive industry is the leading manufacturing sector in the South African economy. It is the third largest contributor to national GDP after the mining and financial sectors. In 2005, the sector accounted for 7% of the country's GDP and 87% of Africa's vehicle output (Galbraith, 2007, p.15). The sector comprised of 8 passenger car assemblers (all of them subsidiaries of multinational corporations), 12 medium and heavy commercial vehicle assemblers, 8 independent importers and over 270 first tier suppliers. Total employment in the sector amounted to 112,470 in 2002.

In the early 1990s, the majority of locally-based vehicle assembly (OEMs) companies were South African, owned under license to multinational vehicle manufacturers and manufacturing exclusively for the domestic and the small Sub-Saharan African market. By early 2004, all of the OEMs were either fully or majority owned by parent companies. This has had a direct impact on the composition of the automotive components industry, with global component manufacturers establishing greenfield operations in South Africa.

Most of the global major motor vehicle brand manufacturers are represented in South Africa. These include Toyota, BMW, Volkswagen, DaimlerChrysler, Nissan, General Motors, Ford (incorporating Mazda, Land Rover and Volvo) and Fiat. Major platforms in the country include the Toyota IMV Hilux, BMW E90 – 3 series, and Mercedes Benz – W203 C Class (Table 2). Many of these models are produced for both the domestic and export markets. For three models, IMV Hilux, Mercedes W203 and BMW E90, the export proportion exceeds domestic sales.

OEM	**Platforms**	
Fiat	Palio 178	
BMW	E90 - 3 Series	
DaimlerChrysler	W203 - 'C' Class	
Volkswagen	A5 - Golf	PQ24 - Polo
Nissan	QW - Hardbody	HS02 - Almera
Toyota	IMV 692N - Hilux	558N - Corolla
Ford	Ranger/Mazda Drifter	Ford Focus/Mazda3/Volvo S40
General Motors	Isuzu	Opel Corsa

Table 2: South African automotive industry: OEMs and major platforms in 2006
(NAAMSA, 2006)

Despite its significant role on the continent, the South African automotive industry accounts for only 0.71% of the world's vehicle production (Table 3). The industry still has a long way to go before it becomes a significant player in the global automotive business. The expectation, however, is that the country can explore its location advantage to penetrate the African market and use trade agreements as a lever to export into developed countries' markets.

Rank	Country	Production	% World Production
1	USA	11,989,387	18.69
2	Japan	10,511,518	16.38
9	Brazil	2,210,062	3.44
10	UK	1,856,049	2.89
12	India	1,511,157	2.36
15	Thailand	927,981	1.45
18	Poland	593,779	0.93
19	***South Africa***	***455,052***	***0.71***
20	Czech Republic	448,360	0.70
21	Taiwan	430,814	0.67

Table 3: Global automotive manufacturing 2004 (World total was 64.2 million units)
(Galbraith, 2007, p.14)

1.1.3 South Africa's automotive industry policy

Automotive production in South Africa started in the 1920s. Government used tariff regulation and local content requirements to guide industry growth (Black, 2001, p.779). The initial phase that lasted until 1961 was a classical import substitution, favouring simple assembly in the domestic market. Very high protective tariffs on imports created space for development of an industry of small plants, producing many models in small volumes at a high cost (Department of Trade and Industry South Africa, 2004, p.8). By the early 1990s, it was evident that the hitherto adopted inward-looking policy stance was not sustainable in the long run. The industry had to comply with the General Agreement on Tariffs and Trade (GATT) and World Trade Organisation (WTO) trade regulations (Damoense & Simon, 2004, p.252). Domestic market constraint meant that exports had to play a big role in industry growth. Government realised that industry needed encouragement with a number of "sticks and carrots" to change and improve its competitiveness (Coyne, 2000, p.11). Of major importance to Government was finding ways by which to maintain and grow the industry in a less protected trade environment. Table 4 summarises development stages of automotive policy in South Africa.

Policy Measure	Period
1. High tariffs	1920 to 1995
2. Local content requirements by mass	1961 to 1987
3. Local content requirements by Value	1989 to 1995
4. Import-export complementation (MIDP)	1995 to date
5. Productive asset allowance (MIDP)	2000 to date

Table 4: Development of automotive policy in South Africa
(Damoense & Simon, 2004, p.252)

In 1995, the South African government launched a Motor Industry Development Programme (MIDP) aimed at establishing a competitive industry, both locally and globally. The MIDP replaced a series of protection and local content requirements that had previously characterised the industry (Black, 2001, p.780). The main objectives of the MIDP were to increase competitiveness of the industry, encourage industry growth through export, stabilise employment levels, improve the industry's trade balance and make vehicles more affordable in the domestic market (Barnes and Black, 2003, p.5). The MIDP strategy was to rationalise the industry by reducing the number of models produced locally. It was envisaged that rationalisation would lead to reduced average costs by creating economies of scale and subsequently lead to industry competitiveness. To compensate for the discontinued models, an Import-Export Complementation (IEC) arrangement was instituted. Under this arrangement, firms would earn import rebates based on the value of local content exported. The earned rebates could be used to offset import duties payable on Complete Built Units (CBUs) and components imported by OEMs (Flatters, 2002, p.3).

The Import-Export Complementation arrangement has been the driving force behind the high increase in automotive exports from South Africa. Total automotive-related exports have grown by 30% per annum on an average basis, and for component exports by 31% per annum since 1995 when the MIDP was introduced.

In 2000, the government introduced another incentive for the industry, to be based on the level of investment - the Productive Asset Allowance (PAA). The PAA allows firms undertaking qualifying investment in the automotive industry to claim back 20% of the value of invested assets in rebates. PAA benefit is spread over a period of five years. Productive assets qualifying for the PAA were defined to include capitalised Research and Development (R&D). The objective of the PAA was to enhance the motor industry's contribution to economic growth of the country through increased international competitiveness, productivity, employment in the industry, and economies of scale; also to compensate for the reduced protection due to the lowering of import duty on CBUs.

Though it is premature to judge the impact of the PAA as an MIDP incentive (Barnes and Black, 2003, p.29), there is growing interest in the PAA as the only supply-side incentive for the industry under the MIDP dispensation. South Africa is under pressure to ensure that the industry incentives do not contravene WTO trade protocol following concern on a potential challenge by the Australian government on South African leather exports benefiting from the rebate system (Olivier, 2007).

There is also a recognised gap in supporting industry Research and Development (R&D) up to commercialisation stage. It was envisaged that the PAA could potentially help fill the R&D support gap.

1.2 Challenges facing South African automotive industry

1.2.1 Benefits vis-à-vis costs of the MIDP

The offer of investment incentives to the automotive industry is a global phenomenon. Because many countries perceive the industry to have economic importance and significance to a host region, the industry is often a recipient of state aid to cushion or offset the effect of market forces (Rhys, 2000, p.22). Though the success of the MIDP in increasing automotive exports is not disputable, some analysts have reservations on describing the programme as a complete success (Bell and Madula, 2003, p. iii-viii). Key areas of concern that have emerged in the past 10 years of the MIDP program relate to the cost of the program to Government, limited job creation realised thus far, deteriorating industry trade balance, vehicle affordability, and skewed benefits of the programme in favour of OEMs.

Benefit passed on to the industry by way of import rebate credit certificates generated via the Import-Export Complementation arrangement and the PAA facilities is explicit and quantifiable, but the cost of the MIDP has never been scientifically documented or quantified. As such, whether the programme is meeting its objectives at acceptable cost levels to the national treasury remains unresolved among major stakeholders. This has become a source of tension in efforts to take forward government support of the automotive industry. Flatters (2002, p.1), one of the main critics of the MIDP, argues that the MIDP makes vehicles expensive in the domestic market because the only way rebate recipients can benefit from the MIDP is by charging a price higher than that which is commensurate with duty free imports. He further points out that the direct cost per job created in the industry appears to be too high and the export expansion has not filtered through to local component manufacturers. According to Barnes and Black (2003, p.26) the major effect of the MIDP thus far, has been to increase automotive exports from South Africa without necessarily increasing local content used and with minimum integration and benefit to local component producers.

1.2.2 Deteriorating industry trade balance

The South Africa automotive industry has remained a net foreign exchange user since the inception of the MIDP, contrary to one of its objectives. Industry trade deficit had reduced from R14.1 billion in 1996 to R9.1 billion in 2003, but the deficit increased to R 27.7 billion in 2005, up from R18.8 billion in 2004 (Figure 1).

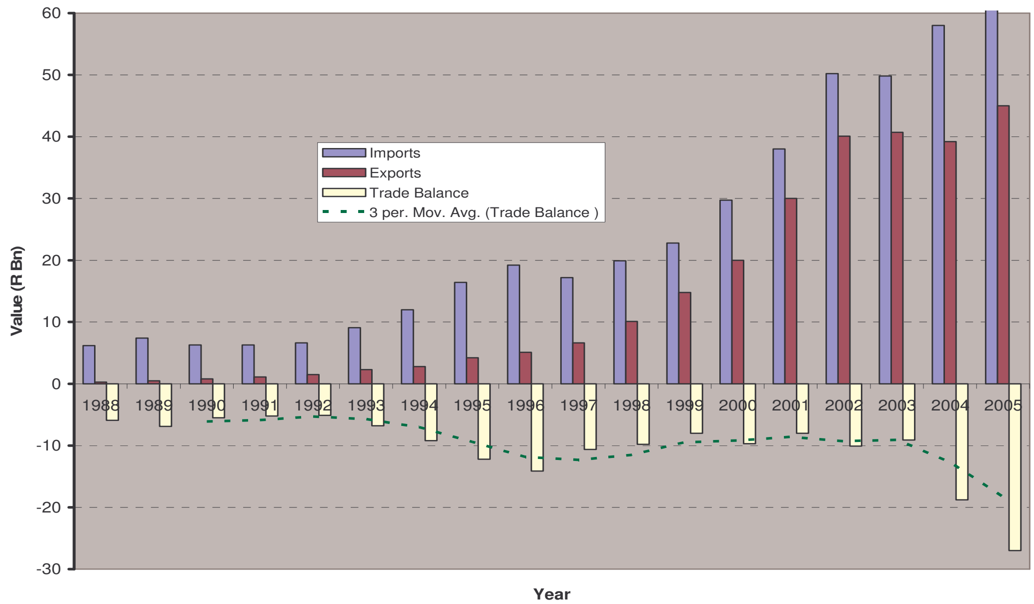

Figure 1: Automotive industry trade balance: South Africa
(NAAMSA, 2006, p.14)

The number of vehicle imports accounted for more than 50% of the domestic market in 2006 (Figure 2). There is a possibility that the deficit will narrow down as new vehicle exports gains momentum, but if the existing deficit trend is to continue, a need may arise for government take proactive steps to limit imports. The deteriorating trade balance has a potential to crowd out domestic production and its subsequent benefits in the long term. In this debate on the widening industry trade deficit, what is not well articulated by stakeholders is whether the MIDP structure could be the cause of the status quo and if so how to revisit the structuring of the MIDP.

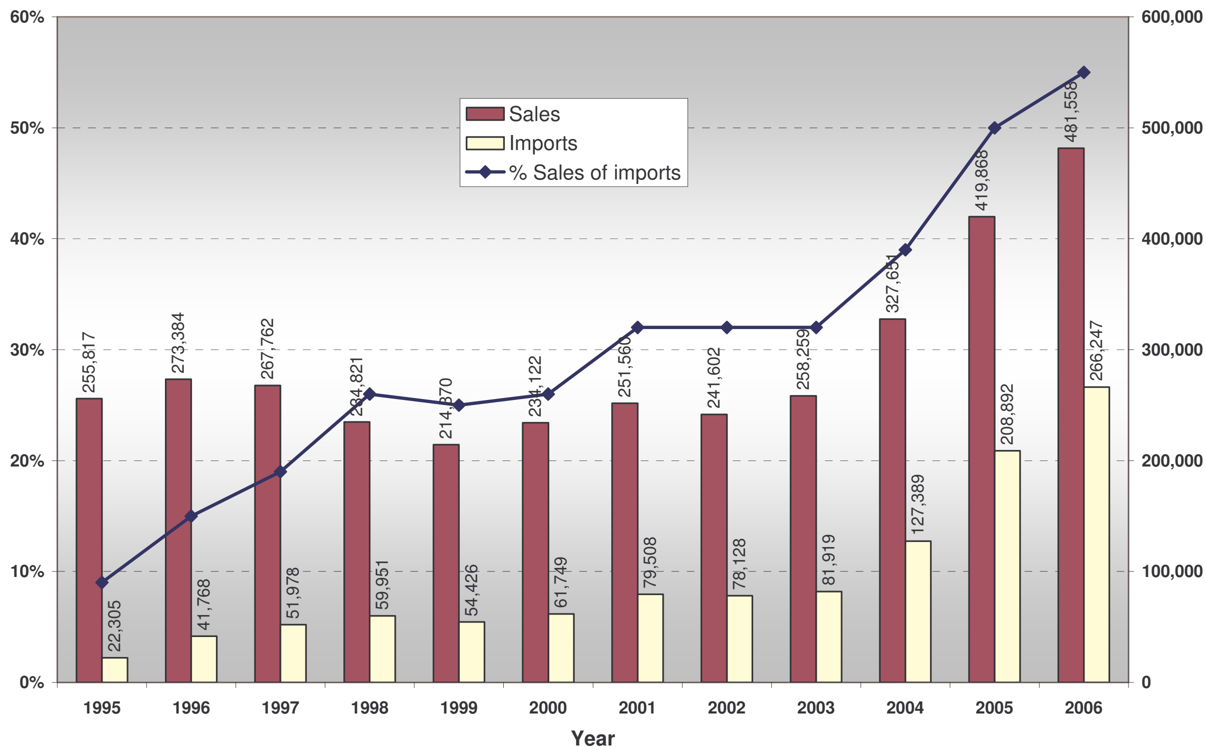

Figure 2: Imports as a percentage of total passenger vehicle sales in South Africa (KPMG, 2007))

1.2.3 New requirement on automotive component supply

South Africa has no vehicle brands hence it is through the supply of automotive components to global brands that the local industry is enabled to participate into the global automotive business. Supply of components to global brands is highly dependent on the global structure of the automotive industry and the strategic goals of vehicle assemblers vis-à-vis component suppliers. The global automotive industry is structured in such a way that at the top of the hierarchy are vehicle assemblers (OEMs), followed by the Original Equipment Suppliers (OESs). The OESs manufacture automotive parts and accessories directly to the OEMs. They must have technology capabilities to meet performance and interface requirements set by assemblers. At the lower level of the hierarchy are the second and third tiers suppliers (Figure 3).

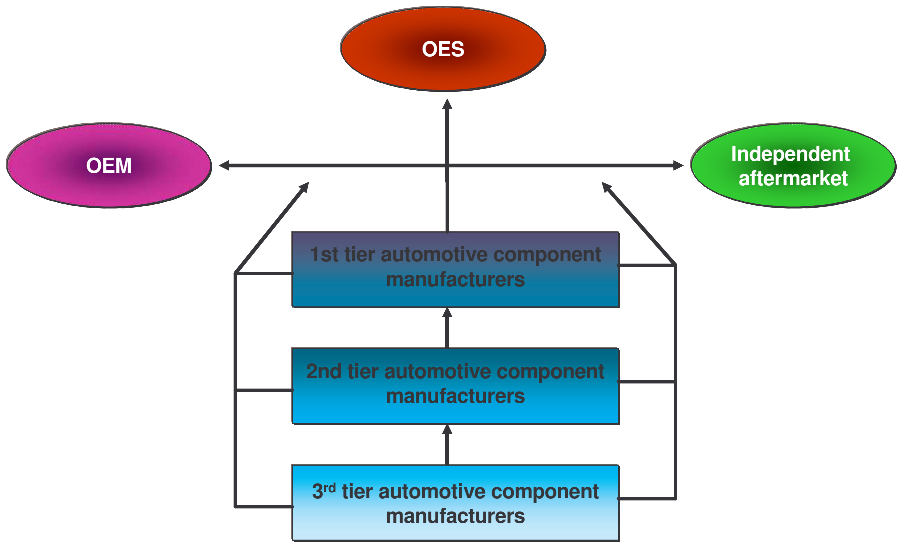

Figure 3: Global automotive industry structure
(UNIDO 2003, p.x)

Automotive component manufacturers in South Africa fall in the category of the lower tier component manufacturers who supply manufactured parts and accessories to OEM's, OESs and the independent aftermarket. Up the early 1990, the design and innovation capabilities dictated to the lower tier component manufacturers were within the competency of the South African local component sector. Since mid 1990s, however, OEMs have been delegating more design activities to component manufacturers. For such components, OEMs supply the overall performance specifications and information about the interface with the rest of the car and the supplier is required to design a solution using its own technology. There has also been a shift towards the supply of complete functions rather than individual components. First-tier suppliers have become responsible not only for the assembly of parts into complete units, but also for the management of second-tier suppliers. The new component supply requirements necessitates that the local component sector acquires high levels of technological competencies. Many of the South Africa component manufacturers are struggling to keep pace with these new technological requirements to supply OEMs. The situation is exacerbated by the follow-design and follow-sourcing strategies in the automotive components supply under which preference is given to the use the same suppliers in many difference locations. These strategies have been a logical consequence of the supplier taking more responsibility for design and for the increasing commonality of models between markets. There is a possibility that South Africa's automotive industry participation in the global automotive value chain will decline over time unless the MIDP empowers the local component sector to acquire technological competencies in line with OEM new supply requirements. The increase in South African supplier competitiveness has an added advantage of encouraging long-term business relationship with OEMs (Moos et al, 2006).

1.2.4 WTO compatibility of MIDP incentives

The Import-Export Complementation arrangement, under which the industry was enabled to break into international markets, is a demand-side incentive. It enables local exporters in the automotive industry to become more competitive in the international market based on the indirect subsidy they receive from Government. Export subsidies are, however, vulnerable to challenge under the WTO trade protocol on free trade as they are considered trade distorting. Under the WTO Agreement on Subsidies and Countervailing Measures (SCM Agreement), subsidies based on export performance are not prohibited but are actionable for developing countries. That is, if export subsidies are found to be causing injury to the domestic industry of the importing member country, the importing country can impose countervailing duties (Ahuja, 2005, p.4). It is likely that the South African government will restructure the incentive in the way that makes it less vulnerable to countervailing duties or come up with an alternative incentive model that will offer the same benefits as the IEC benefits to the industry.

The need to address the limited benefit of the IEC arrangement to component manufacturers, the creation of sustainable employment, improvement of the industry trade balance account and the risk that the IEC arrangement could be challenged by South Africa's trading partners under WTO regulations, create a case for examining the use of supply-side incentives, as alternatives, under the MIDP. Supply-side incentives focus on supporting production, though they may also indirectly influence the demand side and lead to competitiveness by bidding down factory prices through cost reductions. Because supply-side incentives have no direct influence on trade, they are not at risk of challenge with WTO regulations relating to eliminating barriers to trade in goods and services.

1.3 Research logic and broad issues for investigation

1.3.1 Research problem statement

Offer of investment incentives under the MIDP to support industry competitiveness has:

- Increased the industry trade deficit from R 12.2 billion in 1995 to R 27 billion in 2005, an increase of 121%.
- Not led to investment in R&D as a necessary process towards long term competitiveness. Investment in R&D has remained below 10% of total industry investment in the period 1995 to 2005.

1.3.2 Research question(s)

What is the effect of change in the PAA structure on the trade balance of the South African automotive industry? How should the incentive be structured if it is to contribute significantly to the industry competitiveness and subsequent production growth?

1.3.3 Purpose of study

The purpose of the study was to determine the effect of changes in the value and basis of the PAA on industry competitiveness in general, and on industry trade balance in particular. Simulated scenarios are used as a basis for recommendations on how the incentive should be structured to benefit all stakeholders in the motor industry, without compromising on the already achieved gains.

1.3.4 Objectives of the study

Specific objectives of the research project were as follows:

1. To analyse performance of South Africa's automotive industry under the MIDP and the prospects of the PAA in supporting the industry competitiveness objective.
2. To explore the body of theoretical literature underpinning the offer of industry investment incentives in general, and assess how it informs the case of the South African automotive industry.
3. To review the structure and performance of the Productive Asset Allowance as a competitiveness supporting incentive.
4. To develop a system dynamic model of the PAA and use it to simulate effects of changing the incentive policy rules on industry trade balance and competitiveness.
5. To recommend from the simulations results how the PAA could be structured in order to mitigate against continued deterioration in industry trade deficit and to contribute towards industry competitive objective.

1.3.5 Hypothesis

The offer of MIDP incentives, specifically the PAA, is a significant contributor to the deterioration of the automotive industry trade balance in South Africa. By changing policy rules relating to the incentive, industry competitiveness can be enhanced via increased R&D investment, and the industry trade deficit trend can be reversed.

1.3.6 Study rationale

Governments all over the world give incentives or some form of support to the local automotive industry. The expectation, therefore, is that the South African government will continue supporting the automotive sector. Limitations in achieving objectives set out at the inception of the MIDP, coupled with the potential of challenge to the current incentives under the WTO free trade regulations, call forth creative ways by Government to support the industry. The PAA as the only supply-side incentive of the MIDP could be the most appropriate alternative; however, there is limited understanding of the overall impact of the PAA in the short and long run. Further still, the inclusion of capitalised research and development expenditure under productive assets qualifying for the incentive has created another important dimension to the incentive, which is yet to be investigated. There is an opportunity to contribute to the current and future reviews of South Africa's Motor Industry Development Programme by modelling the effects of possible policy interventions relating to the PAA.

Can the PAA be structured in a way that provides the same benefit to industry yet without exacerbating industry trade balance? Can the incentive substitute the current demand-side IEC incentives in the industry? If so, to what extent? The study attempts to answer these questions, among others.

1.3.7 Research approach

A system dynamics (SD) approach was used in this study. Developed in the 1950s at the Massachusetts Institute of Technology (MIT) by Forrester (1961), SD is a computer-based methodology for building quantitative and qualitative models of complex situations so that they can be better understood and managed (Caulfield & Maj, 2001, p.26). SD allows experimenting with and studying of behaviour of the models over time. The approach facilitates understanding of the relationship between the behaviour of a system and its underlying policy decision rules through four distinguishable stages: a) identifying the problem; b) exploring existing information on the problem; c) using feedback control concepts to organise available information into computer simulation models and; d) revealing behavioural implications of the described model (Sterman, 2000, p85-87).

1.4 Synthesis

The study formalises an intuitive incentive into a simulation model, thus coming up with a policy tool that can test industry reaction to policy decisions on the PAA and the IEC within an acceptable confidence interval and which can be improved upon. It further provides an interface between an economic and system dynamics approach to policy work.

In so doing, the study contributes towards enriching economic policy analysis with system dynamics theory. Study outcomes should to be of interest to policy-oriented academicians in terms of approaching a policy problem from two different theoretical perspectives. Policy makers involved with industry incentives will find it useful in providing a formal framework to guide their policy decisions.

In its answers to the research question, the study is particularly useful in informing future decisions on the PAA and MIDP incentives in general. Most importantly, the study was intended to bring a new perspective to understanding the offer of sectoral investment incentives in South Africa.

2 The Advent and Prospects of Investment Incentives in the South African Automotive Industry with Reference to Comparable Economies

2.1 Introduction

After almost seven decades of protection through high tariffs and stringent local content requirements, South Africa opted for a gradual liberalisation process of its automotive industry in 1995 (Barnes, 2000, p.9; Barnes and Black, 2003, p.5). The Motor Industry Development Programme (MIDP) provided the framework for the industry liberalisation process. In lifting the protection curtain, Government exposed the industry to global competitive pressures, together with international trade obligations as stipulated and enforced under the World Trade Organisation (WTO) protocol (Barnes, 2000, p.9). The MIDP was to be reviewed periodically to ascertain that the industry was on course to ensure international competitiveness. Based on the industry performance of the first five years of the MIDP, the then Board of Tariffs and Trade (BTT), now the International Trade Administration Commission (ITAC) recommended the introduction of an investment incentive for the industry – the Productive Asset Allowance (ITAC, 2000).

Investment incentives can be broadly defined as financial or fiscal inducement provided by national or regional governments to induce investors to establish presence, to expand an existing business, or not to relocate anywhere else (UNCTAD, 2003a, p.18). Investment incentives can be broadly categorised as:

- Financial incentives, such as cash grants to an investor
- Fiscal incentives, such as tax holidays and tax rebates based on specified criteria
- Other incentives that could take the form of subsidised infrastructure or services, market preferences and regulatory concessions.

Globally, incentives are one of the policy tools used to attract inward investment by national governments. According to the United Nations Conference on Trade and Development (UNCTAD, 1996, p.3-4; UNCTAD, 2003b, p.24), the number of countries granting investment incentives and the range of possible incentive measures has been on the rise since the 1990s. The choice of which incentives to offer is often dependent on the fiscal vibrancy of a particular country, expected effectiveness and appropriateness, and more recently, compliance with the WTO regulations. Many developing countries opt to offer fiscal incentives because they cannot afford outright financial grants. Though the South African automotive industry has been a beneficiary of all three categories of incentives, fiscal incentives have been by far the most significant (UNCTAD, 2003b, p.24).

Introduced in 2000, the PAA is a fiscal incentive intended to support investment in state-of-the-art productive assets. As such, it contributes to national efforts in making the local industry globally competitive. In order to further the competitiveness objective, vehicle manufacturers that wanted to benefit from the PAA had to reduce the number of models manufactured domestically – rationalisation of production. It was envisaged that rationalisation would reduce average production costs and enhance global competitiveness of the industry, especially that of the component-manufacturing sector, which had been limited by small order volumes. Starting as a relatively small incentive, the PAA has attracted interest as a possible and sustainable means by government to support the automotive industry in the light of global trade obligations and innovative industrial policy that emerged in the 1990s. This chapter takes a historical review of the PAA and provides a foundation for policy action pertaining to the incentive in light of its elevated importance to the industry. The chapter ends with a comparative analysis of international experience on automotive industry development policy in Australia, Thailand and Argentina

2.2 The Motor Industry Development Programme (MIDP) of the South African Automotive Industry

2.2.1 Historical perspective

In 1992, the South African government decided to appoint a special task team – the Motor Industry Task Group (MITG), comprising industry experts to advise government on long and short-term strategies for the future of the industry. The appointment of the MITG was necessitated by challenges and limitations of using local content requirements[1] as a policy tool to sustain the growth of the industry in light of domestic and global development in the automotive industry.

MITG submitted its report in 1994, which included specific recommendations for the light motor vehicle and heavy vehicle categories. MITG recommendations were published in the Government Gazette of 29 April 1994. The National Association of Automobile Manufacturing of South Africa (NAAMSA), the National Association of Automotive Component and Allied Manufacturers (NAACAM) and the National Union of Metal Workers of South Africa (NUMSA), the major stakeholders in the industry, did not support MITG recommendations, specifically those on affordability of vehicles, duties, rationalisation and Import-Export complementation facility.

The Board of Tariffs and Trade was then tasked to formulate a Revised Customs Dispensation Programme for the industry for both light and heavy vehicles based on recommendations by MITG, taking into consideration feedback received on the initial report. The Board's first proposals were published for comment in the Government Gazette of 9 December 1994. A final draft of the revised dispensation was adopted and implemented as from 1 September 1995 (ITAC, 1994). The BTT Revised Customs Dispensation for the Motor Industry of September 1995 came to be formally known as the Motor Industry Development Programme (MIDP).

2.2.2 Initial recommendations of the MIDP

The overarching objective of the MIDP for light vehicles was improvement of the industry's competitiveness to such an extent that it would survive in the long term under less protection. For heavy motor vehicles, the objective was to reduce their costs, with a

[1] As a means of developing the local industry, the South African government had legislated local content requirements for the industry. Domestic CBU manufacturers would offset part of the excise duties, based on the level of local content use. By 1994, the industry was implementing phase VI of Local Content Programme which had commenced in 1989. In phase VI, local content was measured based on value rather than weight. Phase IV had been preceded by various phases of local content requirements as far back as 1960, during which local content was measured in terms of mass.

commensurate reduction in the costs of input used to manufacture heavy vehicles (SA, 1995:2). Under the revised dispensation for light motor vehicles, customs duty on Completely Built Units (CBUs) was reduced from 70% in 1994 to 65% ad valorem in 1995. The duty was to be gradually phased down to 25% ad valorem by 2002. Duty on OEs (Original equipment for use in CBU manufacturer) was reduced to 49% and was to be brought down finally to 30% in 2002. Duties for medium and heavy commercial vehicles were to be phased down too, to reach a 20% for CBUs and 25% for OEs by 2000 (Table 5).

	Light Vehicle Segment		Medium and Heavy Vehicle Segment	
Effective Date	**CBUs (%)**	**Components (%)**	**CBUs (%)**	**Components (%)**
January 1, 1995	65.0	49.0	40.0	50.0
January 1, 1996	61.0	46.0	37.5	45.0
January 1, 1997	57.5	43.0	35.0	40.0
January 1, 1998	54.0	40.0	30.0	35.0
January 1, 1999	50.5	37.5	25.0	30.0
January 1, 2000	47.0	35.0	20.0	25.0
January 1, 2001	43.5	32.5	-	-
January 1, 2002	40.0	30.0	-	-

Table 5: MIDP phase down of import duties
(ITAC, 1994, p.66)

The phased approach in reducing import duties was to allow industry time to adjust to increase in competition. Economic theory predicts that a reduction in tariffs has an equalising effect of domestic to world market prices. Protected industries tend to produce less efficiently and charge higher prices due to lack of competition. Opening up of the industry can lead to replacement of domestically produced products with cheap imports. If the situation were to be left to market forces, a domestic industry can collapse. It was, therefore, critical to implement a phased approach in opening up the industry.

The MIDP included additional recommendations for the light vehicle category:

i. Introduction of an International Trade Duty Rebates facility under which the following rebates were applicable:
   - Light vehicle manufacturers were entitled to a 35% International Duty Free Allowance (ITDFA). Both Completely Built Units (CBUs) and Original Components (OEs) imported in the country would qualify for the rebate. The ITDFA was to be calculated based on total value of sales.

- Import-Export Trade Balance: The rebate allowed locally based OEMs to use foreign exchange earned from exports to offset duty payable on imported CBUs and OEs net of the duty free allowance. Component manufacturers could also benefit from the facility.
- Export Facilitation Scheme: Any exporter could earn export credits under the scheme. The credits could be used by local vehicle manufacturers to reduce duties payable on imported CBUs and OEs. If earned by a component manufacturer or any other importer, they could be used to import replacement or after-market components or ceded to an OEM.

ii. Local content requirement on CBUs was abolished. Component local content was to be based on a component being wholly or partly manufactured in South Africa. Not less than 25 percent of the factory or component cost had to be incurred within the Southern Africa Customs Union (SACU). A component would not be considered for the rebate unless the final process of manufacturing was carried out in the SACU area.

iii. A small vehicle incentive in the form of an additional duty free allowance was to be granted to OEMs in respect of motor vehicles below a net ex-factory selling price of R40,000. The incentive was to be phased out over a period of three years (ITAC, 1994, p.68).

The MIDP adopted a separate development programme for the medium and heavy commercial vehicle category. The main reason for a separate dispensation for this category was the fact that commercial vehicles were considered capital equipment – input to the country's production processes (ITAC, 1994, p.70). Under the revised dispensation,

i. On duties payable:
   - Excise duties on the vehicle category were discontinued.
   - An initial rate of customs duty of 40% on commercial CBUs was to apply. The duty was to be scaled down to 20% over a period of six years. Duty of 50% was to be levied on imported OEs (Table 5).
   - Vehicles imported in a condition other than completely knocked down (CKD) would be subject to 40% customs duty.

- Imported OEs for the manufacture of medium and heavy vehicles would be exempt from the payment of surcharges.
- Provision was made for a rebate of duty on subcomponents for the manufacture of OEs.

ii. Local content requirements were abolished.

iii. An import-export trade balance rebate facility, as in case of light vehicles, was introduced.

These recommendations constituted the first MIDP. The programme has been periodically reviewed to fine-tune policy levers to meet the stipulated objectives based on observed performance and changing market dynamics. Though there have been changes on the levels of duties payable, calculation of rebates and introduction of new incentives, increasing industry competitiveness remains the overarching objective to achieve.

2.3 Trend of key industry variables in the first five years of the MIDP

The MIDP was to support and facilitate the continued growth of the industry in the light of domestic market conditions and global influences. The emerging trends of key industry variables after five years of a gradual liberalisation process were to inform the Board of Tariffs and Trade on how to take forward the industry incentive dispensation, given the objectives that it set out to achieve. This section examines industry performance trends and changes in the industry profile in the first five years of the MIDP.

2.3.1 Investment

Increased and sustained investment in the automotive industry, though not an explicit objective of the MIDP was critical in the realisation of the programme's success. Economic theory is unfortunately ambiguous on the relationship between liberalisation and investment. Depending on market conditions, the opening up of a previously protected market may or may not increase investment. The theory of 'jumping' the tariff barrier is, however, well documented in international economics; firms that face significant barriers to enter a particular market opt to create subsidiaries to produce within the protected market as a way of avoiding the barriers. In accordance with the tariff-jumping argument, trade liberalization measures decrease the cost of trade and could therefore reduce inward investment (UNCTAD, 2003b, p.13). At the commencement of the MIDP in 1995, despite the protected regime under which the industry had been operating, seven global OEMs – BMW, Daimler Chrysler, Volkswagen, Toyota, Fiat, Ford and Nissan had invested and were operating in the country. General Motors and Peugeot had previously withdrawn. The highly protected South African automotive industry had been successful in attracting major global OEMs prior to 1995. It was important that the liberalisation of the industry should not lead to less investment. OEMs could potentially fall back to producing at cheaper locations overseas and simply import products into South Africa under the relaxed trade regime. Investment in the industry was, therefore, an important variable to keep track of as the industry opened up. Table 6 presents trend in investment by the domestically based OEMs for five years before and after the introduction of the MIDP. It is noticeable that from 1990 to 1995, investment by OEMs was on a downward trend, reaching a record low of only R400 million in 1993. By the end of 1994, industry investment had decreased by more than 25 per cent compared to the investment in 1990. At the inception of the MIDP in 1995, there was an urgent need to come up with a policy to rejuvenate investment in the industry.

The MIDP seemed to reverse the falling investment levels. OEM investment jumped from R492 million in 1994 to R1,171 million in 1996, an increase of 138%. By 1999, investment by OEMs had reached R1,511 million but seemed to level off at this point. Between 1996 and 2000, the average annual growth rate of investment by OEMs was 7.5%. At the end of the first five years of the programme, the MIDP seemed to have been effective in stimulating industry investment.

Year	Investment (Rm)
1990	660.00
1991	697.00
1992	858.00
1993	400.00
1994	492.00
1995	847.00
1996	1,171.00
1997	1,265.00
1998	1,342.00
1999	1,511.00
2000	1,562.00

Table 6: Investment expenditure by South African vehicle assemblers
(NAAMSA, 2001, p.5)

2.3.2 Employment

Employment is an important factor in judging the performance of an industry, particularly in developing countries. Despite the rather contradictory objective of production efficiency through the acquisition of state-of-the-art technology on one hand and sustaining jobs on the other, the success of the South African automotive industry could not be adjudicated without considering employment created. Global evidence shows that an automotive industry on a growth path is not always a significant employer, particularly the vehicle-manufacturing segment. Using the case of the Argentine automotive industry, Miozzo (2000, p.659) shows that growth of the automotive industry could be accompanied by job losses. Nevertheless, there are exceptions to the view that the automotive industry is not a job creator. McAlinden et al (2003, p.7), using the case of the United States, assert that the automotive industry is and can be a significant employer and an important contributor to the economy. Applying the concept of employment multiplier to quantify indirect employment created, McAlinden concludes that for each direct job created in the US automotive industry, 2.9 more jobs were generated, down and upstream, in the economy.

Unlike McAlinden, the analysis of employment trends in this study takes a conservative approach to industry job creation – only direct employment in the industry is considered. Conclusions reached might understate industry impact on job creation, and potentially overlook some policy levers that could grow industry proxy employment, but the approach is less blurred by uncertainty and subjectivity from calculations and estimations.

In stating MIDP objectives, a compromise to tone down on the employment objective was reached between Government and the industry. It was stated that the programme intended to stabilise rather than create employment. However, the level at which employment was to be stabilised was not stated. It was against this background that Barnes and Black (2003) in the MIDP Review Report indicated that the employment stabilisation object had been achieved despite head count decrease from 38,600 to 32,300 between 1995 and 2000 in assembly plants, and from 47,000 to 38,500 in the component sector. Overall, direct employment in the industry had dropped by 1.7% from 1996 to 2000 (Table 7).

Year	Assembly Industry	Component Industry	Tyre Industry
1995	38,600	47,000	11,000
1996	38,600	45,000	10,000
1997	37,100	44,000	9,500
1998	33,700	40,000	9,100
1999	32,000	39,000	9,000
2000	32,300	38,500	8,600

Table 7: Employment in the South African automotive industry - 1995 to 2000
(NAAMSA, 2001, p. 5)

Based on the less than expected job loss, the Board on Tariffs and Trade considered the employment trend as acceptable after five years of the MIDP. It should, however, be noted that employment statistics did not distinguish between permanent and casual employment. Inability to distinguish between the nature and structure of employment created can potentially bias conclusions on industry employment.

2.3.3 Production, import and export, and domestic sales

2.3.4 Production

Although investment was to be the driving factor for the industry's growth, it had to do so through increased production levels. The logic here was that investment would increase production capacity and subsequently industry output. Increased production would lower average costs through the realisation of economies of scale. Low average costs would contribute towards industry competitiveness and consequently a larger market share in both domestic and international markets – the industry would be put on a high growth trajectory. Demand for factor inputs would increase, more people would be employed and sourcing of local components would rise.

Unlike investment, which increased drastically after the inception of the MIDP, the level of production moved in the opposite direction. On average, production (units of vehicles produced) decreased by 1.4% per year between 1995 and 2000. Production reached a record low of 310,333 units in 1998, 78,109 units lower than production level of 1995. Units produced in 2000 were 8.4% lower than at the inception of the MIDP (Table 8). It was clear that the MIDP was not meeting its goal in stimulating domestic production. This was an irony that the policy makers of the MIDP had to contend with; the programme was delivering on investment but the effects of increased investment were not being realised in terms of increased production levels. If productivity was not decreasing, which was less likely because increased investment is associated with improved technology, the production trend presented an anomaly that required further investigation.

2.3.5 Imports and exports

Trade liberalisation permits equalisation of global prices for commodities and services. Consumers in high cost producing locations are afforded the opportunity to get goods and services at lower global price levels in the absence of trade barriers. Prior to 1995, the automotive industry in South Africa had been producing too many models at low and inefficient scale. The opening up of the industry led to competition between domestically produced and imported automotive products. Against the background of low economies of scale, vehicle imports increased drastically in the first four years of the MIDP. By 1997, vehicle imports to South Africa had increased to 74,666 units from 22,305 units in 1995. Within the same period, vehicle exports were increasing but at a lesser rate than imports. The trend changed in 2000 when for the first time export levels surpassed vehicle imports; 66, 413 units were imported compared to 68,038 units exported. Viewed independently, vehicle export increased from 25,896 units in 1998 to 59,716 units in 1999 reaching 68,031 units in 2000, an almost threefold increase (Table 8).

Improving industry trade balance was one of the MIDP objectives on which the success of the programme was to be adjudicated. Though exports recorded a significant increase in the first five years of the programme, their positive contribution to the industry trade balance was offset by increasing level of imports. The increase in imports was attributable to relatively lower global prices of automotive products and implicitly on the design of the MIDP import-export complementation arrangement. Under the import-export complementation arrangement, OEMs are awarded import rebate credits based on the level of exports. OEMs can only benefit from the arrangement by importing vehicles or components and offset duties payable using the received credits. The import-export complementation arrangement created an additional incentive to import. After five years of the MIDP, industry trade balance had not improved.

2.3.6 Domestic sales and market

Market potential or the existence of effective demand – the desire for a product accompanied by the means to buy it, is an important factor considered by investors when deciding where and how to invest. According to Rhys (2000, p.1), the three conditions necessary for the survival of a modern automotive industry are best use of available resources at any level of production (lean production), economies of scale, and the existence of an effective market. Investment incentives are only marginally important when making investment decisions. Investment by major OEMs in South Africa under the protected market regime was mainly due to the existence of a small but effective automotive market in the country. Limited competition meant that OEMs could price vehicles high enough to make profits despite producing at low levels. With the opening up of the industry to global competition, market share for individual OEMs had to shrink as imports entered the local market unless mitigated by domestic market growth. For new OEMs and those that had already made investment in the country, domestic market growth and the process of industry liberalisation had to be considered when making decisions on long-term investment.

Between 1995 and 2000, the size of the domestic market as reflected by the level of local sales declined by an average 2% per annum. Vehicle sales did pick up in 1997 increasing to 421,076 units from 399,967 units in 1996, but thereafter domestic sales declined. Total domestic vehicle sales in 2000 were 11% lower than sales in 1995 (Table 8). Decline in sales was mainly in the car category. By 2000, it was evident that the domestic market could not support rapid industry growth and the subsequent realisation of economies of scale by the locally based OEMs. If the industry was to continue on a growth path, stakeholders had to come up with creative means of penetrating markets outside the country. The move towards an export-oriented policy was motivated partly by the domestic market constraint. For long-term survival, industry growth had to be de-linked from domestic market expansion (Bell and Madula, 2003, p.iv).

Year		Production	Imports	Exports	Domestic Sales
1995	Cars	242,488	22,305	8,976	255,817
	LCVs	133,719	4,034	6,356	131,397
	MHCVs	12,235	950	432	12,753
	Total	**388,442**	**27,289**	**15,764**	**399,967**
1996	Cars	235,359	41,768	3,743	273,384
	LCVs	135,641	4,559	7,125	133,075
	MHCVs	14,252	1,050	685	14,617
	Total	**385,252**	**74,666**	**11,553**	**421,076**
1997	Cars	226,242	51,978	10,458	267,762
	LCVs	121,204	4,550	8,000	117,754
	MHCVs	13,870	1,000	1,111	13,759
	Total	**361,316**	**57,528**	**19,569**	**399,275**
1998	Cars	193,212	59,951	18,342	234,821
	LCVs	104,862	5,122	6,806	103,178
	MHCVs	12,259	1,300	748	13,511
	Total	**310,333**	**66,373**	**25,896**	**351,510**
1999	Cars	212,291	54,426	52,347	99,669
	LCVs	101,907	4,343	6,581	103,178
	MHCVs	11,024	1,500	788	122,928
	Total	**325,222**	**60,269**	**59,716**	**325,775**
2000	Cars	230,577	61,749	58,204	234,122
	LCVs	113,269	4,114	9,148	108,235
	MHCVs	12,404	550	679	12,275
	Total	**356,250**	**66,413**	**68,031**	**354,632**

Table 8: South Africa vehicle production, import, exports and domestic market size - 1995 to 2000

(NAAMSA, 2006, p.19)

Notes: a: LCVs - Light commercial vehicles
b: MHCVs - Medium and heavy commercial vehicles.
Domestically produced cars and LCVs total represent a proxy for aggregate local production.
Information based on data collected by NAAMSA and estimates of non-NAAMSA sales. GDP growth rate represents GDP annual changes at market prices in real terms.

2.3.7 Supplier development

The MIDP had to facilitate the integration of domestic component manufacturers into the global automotive value chain. It was envisaged that through the support of OEMs to supply to international markets, taking advantage of supply contracts negotiated and facilitated by parent OEMs, domestic suppliers would be afforded an opportunity to participate in the global automotive business. Interactions between domestic suppliers and domestic subsidiaries of global OEMs would also have positive spin-offs in terms of technology transfer and ex-efficiency. The pre-1995 low production levels by local OEMs could not support a vibrant, locally based automotive component sector. In the automotive industry, the component sector often has a bigger potential to create jobs and to stimulate domestic technological capabilities through spill over effects (Humphrey & Memedovic, 2003, p.19). Supplier development, therefore, had to be part of the overall industry development strategy.

The extent to which supplier development had taken place within the first five years of the MIDP was an elusive aspect. No explicit data is kept by industry or government on this aspect. Assessment of local supplier development could only be done using proxies, such as local content use and component exports. Although supplier development could also be evaluated using other proxies, like the level of training that component manufacturers had received and the level of other positive externalities emanating from component manufacturer's interaction with the OEMs, relevant data was not obtainable and where available, it was unreliable. Local content use and domestic component sourcing remained the most feasible parameter to judge the extent to which domestic suppliers were enabled to participate in the global value chain of the automotive industry. The extent to which multinational OEM subsidiaries sourced from domestic suppliers and local content utilisation in domestically produced CBUs was taken to be indicative of local supplier development.

The share of locally sourced components used in domestic OEM assembly was on the decline from 1992 to 1994. It remained low but stable between 1994 and 1995 (Bell and Madula, 2003, p.28). There was substantial reduction in the share of locally sourced components as a proportion of total component usage from 40.1% in 1996 to 33.8% in 2000 (Table 9). By implication, local component manufacturers were proportionally benefiting less from vehicle production by the OEMs. If the proportion of local components per each manufactured CBU were to continue on the same declining trend of 1996, it would mean the MIDP would become less and less effective in supporting local component manufacturers despite of industry growth that had started to pick up in 2000 (Table 9).

Year	Imported OE/Total OE	Local OE/Total OE	Imported OE/WVT[a]	Local OE/WVT	Total Local Content/WVT
1996	59.9	40.1	41.9	28.1	58.1
1997	61.2	38.8	42.8	27.2	57.2
1998	58.3	41.7	40.8	29.3	59.2
1999	60.0	40.0	42.0	28.0	58.0
2000	66.2	33.8	46.3	23.7	53.7

Table 9: South Africa's automotive component sourcing - 1996 to 2000
(Derived from data from the Trade and Investment South Africa (TISA) presented in Bell and Madula (2003, p.26)

Notes: a- WVT - Wholesale vehicle sale turnover

1) Total OE component usage relate to CBUs assembled for the domestic and export market.
2) The last three columns were derived on assumption that the non-material portion of local content (labour, cost, overheads, etc. was 30% of wholesale turnover. See previous note

Total local content – both material and non-material was on a down-swing between 1996 and 2000, but at lower rate than material local content viewed in isolation. Total local content (material and non-material) declined at an average annual rate of 1.9% between 1996 and 2000, while the material local content decline rate was 3.8% per annum. The trend in local content use seemed to indicate that local OEMs were systematically reducing components sourced from local manufacturers. Other production costs like labour costs and overheads were also declining. Bell and Madula (2003, p.31) contend that even after accounting for foreign exchange bias on the valuation of imported OE, the decline in local content and sourcing of domestic OE was evident across the board.

The declining trend of local content use and domestic OE sourcing by OEMs was expected to worsen as duties on imports decreased. Cheaper imports could find their way to the domestic market and would put more pressure on domestically produced components. Supplier development was yet another deliverable on which the MIDP had not succeeded five years after the inception of the programme.

2.3.8 Vehicle prices

From 1995 to 1998, new vehicle price increases remained well below the domestic inflation rate measured in terms of the consumer price index. The years in question were characterised by relative exchange rate stability, significant reductions in levels of protection and increased competition through the advent of new importers and distributors in the local automotive industry (NAAMSA, 2006, p.7). The trend could not be sustained; as from 1999, cars prices in the country were above domestic inflation according to the national inflation rate and vehicle price indexes (Table 10). The failure of the MIDP to make cars affordable for domestic consumers has since become a point of contention between the trade unions and industry. The trade unions contend that the MIDP has skewed benefits in favour of locally-based vehicle manufacturing subsidiaries, with little benefit to workers and the general public. Their position gets support from some researchers that argue that MIDP incentives have been costly policy errors and that the attention given to the sector exceeds its contribution to output, export and employment (Flatters, 2002, p.2).

Year	Inflation (% change in consumer price index for metropolitan areas)	% in vehicle price index for metropolitan areas
1995	8.7	8.2
1996	7.3	2.7
1997	8.8	6.3
1998	6.7	4.3
1999	5.2	6.0
2000	5.4	7.2

Table 10: South Africa's consumer and vehicle prices indexes
(NAAMSA, 2006, p.7)

A major limitation in adjudicating whether the MIDP was successful in reducing domestic prices of vehicles was the realisation that vehicle prices in the country were a function of a number of factors, namely interest rates, financing options and packages, insurance premiums, and disposable incomes. Vehicle financing institutions, vehicle dealers and the insurance industry had an impact on the pricing of vehicles in the country. Hence, vehicle prices could not be adequately addressed within the confines of the MIDP policy framework only. Apart from the factory price to which MIDP had a direct bearing, insurance charges, interest rates and dealership costs were key determinants of market prices for vehicles in South Africa.

It is a fact, however, that MIDP incentives create a business case for local manufacture/assembly of vehicles to supply to global markets. By implication, the MIDP incentives are significant enough to reduce factory prices of locally assembled vehicles to the extent that they can be competitively marketed in the global automotive market. The incentives in general have significant effect on the cost assembly of vehicles in South Africa. However, the vehicle price effect of the downward cost pressure of MIDP incentives is dependent on a number of factors some of which are outside MIDP policy framework. MIDP incentives provide “a bottom line cushion” to local car assemblers and hence mitigate against drastic vehicle price increases in the country.

To make vehicles affordable to domestic consumer’s required collaborative efforts from industry, government departments – the department of Trade and Industry, South Africa Revenue Services, National Treasury and other vehicle service providers, specifically, banks and insurance companies.

In this respect, making vehicle affordability an explicit objective of the programme, without further qualification, might have been an unrealistic expectation on the part of the MIDP policy formulators.

Another important dimension on vehicle pricing emanated from the import-export complementation incentive of the MIDP. The incentive acted as an indirect export subsidy, by way of its calculations being based on local content value exported. Exporting vehicle manufacturers were benefiting over and above the actual price paid for each vehicle bought in the international market. The extra benefit on each vehicle exported disadvantaged domestic consumers in that the exporting company would be less willing to accept a lesser benefit than that obtainable from a global market sale. Economic theory postulates that export subsidies raise domestic prices, reducing consumption but raising output and export levels. Goods would be exported for less than society’s marginal production cost and for less than the marginal benefit of domestic consumers (Begg et al, 2003, p. 447). This seems to be case for South Africa's automotive industry.

The MIDP was a well- intentioned programme intended to usher a previously protected industry into a competitive global environment, in order to take advantage of its benefits without losing achievements made thus far. On the whole, at the end of the first five years of implementation, an unqualified statement about the programme's success could not be made. Of all the stipulated objectives on which the programme was supposed to deliver, it was only on the exports expansion and investment increase that the success of the programme was undisputable. Improvement of the industry trade balance, stabilisation of employment, domestic supplier development and affordability of vehicles in the domestic market had to a large extent not been achieved. Further still, the increase in exports was based on 'improvised' competitiveness of an indirect export subsidy. Among the many challenges that confronted policy-makers after five years of the MIDP were the explicit achievement of industry competitiveness, ensuring linkages between success of one objective with others and a clear understanding of cause and effects of policy action on major industry variables were. The potential for the programme to lead to unintended and undesirable consequences was a significant risk at the time.

2.4 The Productive Asset Allowance (PAA)

The PAA is an import rebate earned by manufacturers of specified light motor vehicles, registered with the South African Department of Trade under the MIDP, and by component manufacturers contracted to supply components to such manufacturers, on investment in productive assets. The rebate is non-tradable between companies and may be used only by approved motor vehicle manufacturers to import specified light motor vehicles. The PAA was intended to further support the achievement of global competitiveness of the industry through domestic production rationalisation. The main motivation for this support instrument was to encourage manufacturers of specified light motor vehicles to reduce the proliferation of light motor vehicle models produced, through the importation of low volume niche products rather than attempting to produce these models domestically, and for localisation of original equipment components for fitment to these rationalised models and for export (ITAC, 2005, p.5).

The PAA provides OEMs in the Southern Africa Custom Union (SACU) with 20% of the value of investment in new productive assets. The benefit is spread over a period of five years. For component manufacturers undertaking investing in the SACU region, the instrument provides for an effective 16 per cent of the value of capitalised productive investment via consenting OEM(s).

2.4.1 Criteria for benefiting from the PAA

According to the PAA Guidelines (ITAC, 2005), in order to qualify for the support instrument, qualifying OEMs have to meet the following conditions:

- Investment in new productive assets; these could be land and buildings, or/and plant and machinery. Capitalised expenditure on research and development would also qualify.
- Rationalisation of models domestically produced.

PAA applications are holistically assessed based on:

- Substantial increase in production levels per platform per annum for existing OEMs. For new OEMs, a production volume of 20,000 units have to be reached within two years after the commencement of production
- Support for local manufacturing through sourcing and development of domestic OE manufacturers
- Contribution towards reduction in net foreign exchange use in the industry
- Support of consumer interest, for example, by making quality vehicles available at affordable prices
- Contribution towards employment and technology enhancement.

Qualifying component manufacturers have to meet related, but not completely the same, conditions as OEMs. For a component manufacturer to qualify for the PAA it has to meet these conditions:

- Supply components to an already qualifying OEM under the programme, supported by contract or a letter of intent to supply
- Investment should be made for the manufacture of original equipment components for fitment to a rationalised range of specified light motor vehicles manufactured for both the domestic and the global market. The investment has to relate to new plants or approved plant expansions.

The PAA applications for component manufacturers are assessed on the same criteria used on OEMs.

2.4.2 Exclusion and non-qualification for the PAA

The PAA is mutually exclusive of any other investment incentive provided in the SACU region. Manufacturers from the region obtaining investment incentives from respective governments would be excluded from the PAA for the investment in question. The exclusivity condition of the PAA means that investors tend to opt for the incentive only when it provides superior benefits compared to any other available investment incentive obtainable in the region, or where it is the only incentive available.

The following assets do not to qualify for the PAA, but exclusions may not be limited to these assets:

- Commercial vehicles
- Passenger cars, including station wagons and minibuses
- Loose implements like hand tools classifiable under Chapter 82 of the Customs and Excise Act, 1964.

Adjudication on other assets is based on whether an asset is seen as productive, new and related to an approved project.

2.4.3 Qualifying value of productive assets

The qualifying value of productive assets means the value of the productive assets as capitalised in the balance sheet according to generally accepted accounting practices. Rented and leased assets are valued at the capitalised official interest rate as published by the South African Revenue Service for the year of application. Where the actual value of asset capitalised exceeds or is projected to exceed the approved amount, the applicant is required to make a supplementary application to the Department of Trade and Industry.

2.4.4 Application and claiming process for the PAA

To access the benefits of the PAA, qualifying OEMs and component manufacturers have to submit an application to the International Trade Administration Commission (ITAC). Completed applications must reach the Department not later than 180 days prior to commencement of production.

Applications should include a business plan outlining marketing and sales plan, a production plan, budget, income statements and balance sheets for a period of 5 years as from the start date of production. ITAC assesses whether the planned investment contributes towards the realisation of MIDP objectives based on the business plan and the other documentation submitted with the application. Project approval is adjudicated in a holistic manner; an application cannot be turned down based on one factor. Information submitted at the application stage forms the basis for future decisions on release of subsequent year certificates as the project is implemented. The application process is presented in Figure 4 below.

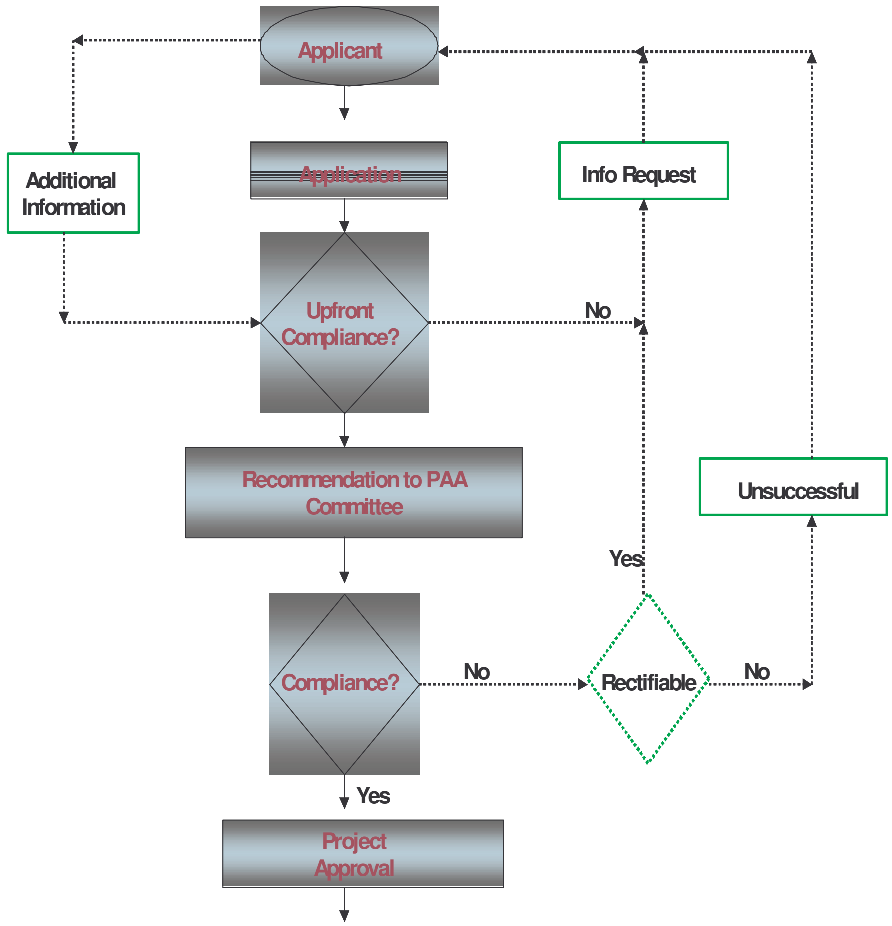

Figure 4: The Productive Asset Allowance application process
(Steyn, 2002)

Claims for the PAA can only be submitted after the approval of the project by ITAC. The approval of the project provides certainty that rebates will be received on investment undertaken under the approved project and within the maximum capitalisation value allowed for the project. Assets included in a claim for a particular year of capitalisation have to be audited by an external auditor. An unqualified auditor's report on the claimed assets must accompany a claim. In addition, a claim has to be accompanied by a detailed factory layout, showing the productive assets to be installed, presented in a way that can allow technical assessment by a qualified engineer. ITAC appoints engineers to visit the site to certify that the claimed investment qualifies for PAA. Based on the information provided in the claim, plus the unqualified external auditor and consulting engineer's report, a decision to issue certificates is made. Figure 5 summarises the claiming process. For each year of capitalisation, a separate claim has to be submitted.

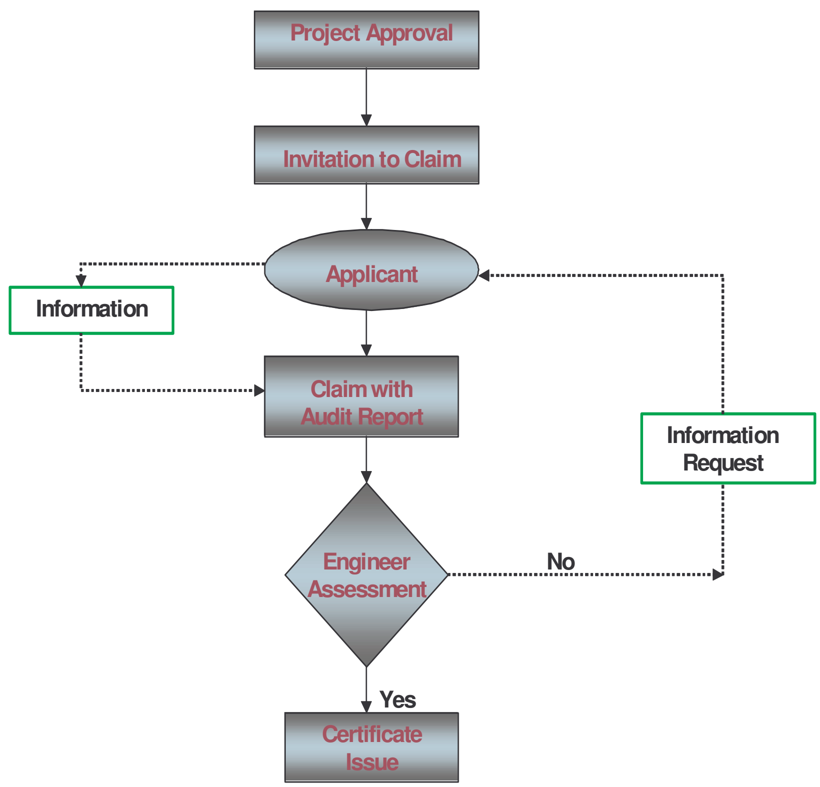

Figure 5: Productive Asset Allowance claiming process
(Steyn, 2002)

To get their subsequent certificates, claimants have to provide updated information on their business plan, company ownership, most recent financial statements and a tax clearance certificate. The issuing of follow-on certificates could be terminated if there are significant performance deviations from the business plan submitted at application stage. Claimants are obliged to motivate performance deviations of more than 10 per cent on the business plan upon which the adjudication of the project approval was based (ITAC, 2005).

2.4.5 Industry benefit from the PAA

With the industry investment increasing at an annual compound rate of some 14%, the expectation is that the value of PAA qualifying investment and hence the value of PAA certificates generated will continue increasing at an almost similar annual growth rate. The number of vehicles that OEMs will be able to import annually using PAA certificates to offset duty payable will increase at an even faster rate given that the imports duties are decreasing over time. To the extent that such imports will be the low volume niche models that support local OEM rationalisation strategy, the PAA's role in support of the industry competitive objective of encouraging domestic production of fewer models at large scale could be achieved.

It is not easy to make an unqualified statement on the effect of the PAA on industry investment in isolation; however, even if the realised investment would have taken place, companies had an additional motivation to invest in the most efficient means of production, since such expenditure was subsidised. The possibility to claim for R&D expenditure, under the PAA dispensation has a potential to motivate component manufacturers to engage more in R&D as a means to meet the ever-increasing technological expectations of OEMs. On the margin, the incentive could also motivate some OEMs to consider locating part of their R&D in the country, a process that is conspicuously missing, yet critical to industry growth.

What is not disputable is that the PAA has directly contributed towards the monitoring of the industry rationalisation process. Applicants for the incentive have to present business plans in which they have to state a planned rationalisation process. Subsequent issue of follow-on certificates is dependent on limited deviation from information provided at the application stage. Effectively thus, the PAA provides a mechanism through which Government keeps track of the performance of OEMs and components towards achieving MIDP objectives.

The rationalisation process as motivated and monitored through the PAA administrative process could also have had positive spin-offs to component manufacturers, though supportive quantitative data on this is not readily available. The move towards specialisation in few models could have created a bigger market for locally produced OE components. Local content accountability imposed on the OEMs further motivated increase in demand for locally produced components. Component manufacturers have also benefited from the "subsidy" on productive investment used in the production of components to fit rationalised models. OEMs have to pay a qualifying component manufacturer a fixed price of 80% of the value of the certificate issued by ITAC. PAA incentivised tooling purchased by OEMs but stationed at OE component manufacturers premises could have provided another positive spin-off for some OE component manufacturers.

2.5 Comparative international experience on automotive industry development policy

2.5.1 Australia

2.5.1.1 Background of Australian government assistance to the Australian automotive industry

Australia started the process of liberalisation of its automotive industry in 1985. The opening up of the Australian automotive industry increased competitive pressure in the domestic market. Locally based OEMs and OE component manufacturers were compelled to match world prices. Competitive pressure encouraged rationalisation of the industry as a way to reduce production costs. By 1997, the number of OEMs in Australia had fallen from 5 producing 13 models to 4 assemblers producing 5 models in 4 plants (Australian Productivity Commission, 2002; Clarke et al, 1998, p.5). Industry rationalisation was accompanied by job losses; between 1990 and 2001 employment declined by 30%. On the positive side, the reduction of tariffs and the subsequent competition pressure in the domestic market benefited local consumers by bidding down prices and creating greater choices.

Despite the reduction in tariffs from 30% in 1994 to 15% in 2001, the country sustained domestic production. Imports did, however, increase from 25% in 1985 to 60% in 2001.

Faced with the increasing market share of imports, the industry had to focus on the export markets as a source of growth.

2.5.1.2 The Australian Automotive Competitiveness and Investment Scheme (ACIS)

The ACIS of Australia is the industry-support programme most comparable to the PAA. The ACIS commenced in 2001, replacing the Export Facilitation Scheme (EFS) that had previously provided duty free imports on CBUs and OE based on the value of exports. One motivation for the termination of the EFS was that it was potentially challengeable under WTO rules (Clarke et al, 1998, p.19).

The ACIS was intended to be a temporary measure to support the Australian automotive industry in the transition period to lower tariff levels. The scheme provides eligible participants with tradable import duty credits based on production, R&D, and investment activities.

Under the ACIS, motor vehicle producers are eligible for the following duty credits:

i. 25% of total production of motor vehicles, engine and engine components, multiplied by the automotive tariff rate
ii. 10% of investment value of approved plant and equipment used in the production of motor vehicles, engines and engine parts

Component producers, automotive machine tool and automotive tooling producers, and automotive service providers were eligible for duty credits based on:

i. 25% of the value of investment in approved plant and equipment
ii. 45% of the value of investment in approved R&D

Automotive component producers for other components, other than engine and engine parts and automotive services for third parties could also qualify for 25% rebate on investment in plant and equipment and 45% on R&D expenditure (Australia, 2002).

The ACIS was designed to deliver the same support to the industry as the previous arrangements in a manner that conformed to the WTO trade protocol. The programme removed the link between exports and industry assistance, to a general production subsidy, not tied to any particular end use. The incentive extended support to R&D, which is not contentious under the WTO. Australia had gone through the experience of their support to the industry being challenged in the WTO and the ACIS was designed to avoid the same challenges in future (Australian Productivity Commission, 2002).

As with the PAA, the assessment of the impact of the ACIS is difficult because it has been operational for a short period of time and its effects are mixed up with a range of other factors and incentives that impact on industry performance. One of the major benefits of the scheme cited by OEMs and component suppliers, however, was its support to R&D. The programme has so far proved useful in attracting R&D to the country, which would have otherwise been based at the parent company or in other countries (Australian Productivity Commission, 2002). The incentive is also indicative of Australia's commitment to continue supporting the industry, creating certainty to potential investors in the country.

On the whole, under the ACIS Australia has managed to attract reasonable investment for the automotive industry through the offer of investment incentives both on national and regional levels. Coupled with other favourable factors that characterise the Australian passenger motor vehicle industry, such as highly skilled human capital, well-developed design capabilities and relatively low labour costs (Clarke et al, 1998, p.1), Australia has managed to maintain a vibrant and competitive domestic automotive industry with all major world producers being represented. By designing vehicles for specific consumer tastes, Australia has so far been able to occupy particular niche markets (Clarke et al, 1998, p.2). Though the industry is still under pressure to compete globally with minimum incentives, the government in Australia has a clear role in supporting the automotive industry particularly through the provision of research infrastructure and support of quality OE development and production (Riemens, 2002, p.2). The country is still re-adjusting its competition strategy to consolidate its production for niche markets by taking advantage of its competitive factors.

South Africa is more likely to take the Australian ACIS approach of industrial policy in mapping out the future roles of the MIDP against the background of recent questioning of its import-export complementation arranged initiated, not surprisingly, by the Australians.

2.5.2 Thailand

2.5.2.1 Thailand's automotive policy under a protected regime

The early success of Thailand in attracting global automotive makers to the country is attributable to its Industrial Investment Promotion Act of 1962 (Higashi, 1995). The Promotion Act provided a privilege package, which included 50 per cent reduction of import duty on CKD for five years, corporate tax exemption for 5 years, free foreign exchange repatriation, and a liberal immigration policy that facilitated easy acquisition of foreign expertise.

Though Thailand was successful in attracting investment in the automotive industry, the investment was not effective in meeting the intended objective of developing the domestic industry. In fact, the combined effect of the investment promotion package was the crowding out of local production. CBU imports increased, there were too many small assembly plants that could not realise economies of scale and OEMs could manipulate the local content formula by inflating prices of locally purchased components. The government was forced to implement a rationalisation and localisation process through legislation. In 1978, Thailand announced the prohibition of the establishment of new car assembly plants. An import ban was also imposed on CBUs. As a result of the new legislation, approved car passenger models were reduced from 84 to 42 series in 1984 (Higashi, 1995).

The period 1987 to 1990 was characterised by rapid growth of the Thai economy. Local demand for vehicles increased due to increased purchasing power. Automotive sales grew by 23% in 1987, reaching 38% in 1990. The growth in domestic production to meet domestic demand created demand for domestically produced components. By 2003, total automotive production had reached 750,512 units with domestic sales mounting to 533,176 units (Chiasakul, 2004, p.16). Large automakers found it more profitable to have their subcontractors set up production lines in Thailand to take advantage of cost effective labour, shorter time delivery, and closer access to suppliers. Thailand again realised an investment boom in OE manufacturing within the period.

2.5.2.2 Liberalisation of Thai Auto Industry

The automotive liberalisation process in Thailand came in 1991. The change of policy stance was a strategic step toward the long-term survival of the country's automotive industry by forcing local manufacturers to improve efficiency, technology and product quality so as to compete with the rest of the world. The government lifted the ban on CBU imports and in 1998; all local content requirements on the industry were abolished.

Government established a Board of Investment (BOI) to be the principal agency to provide incentives to stimulate investment. The BOI designed investment incentive packages to attract foreign automakers, while at the same time promoting the country's industrial competitiveness under the liberalised industry regime. Thailand has maintained leadership in the South Asian countries in both automotive production and sales. It is important to note that Thailand chose to target its production of pick-up trucks for a niche market. In 2004, the country was the second largest pick-up truck market in the world after the United States. Through positioning itself as a niche high quality automotive producer, especially with the pick-ups, Thailand has enhanced its competitiveness, enabling the country to compete with China in attracting investment. To complement this strategy, the country maintains a coherent industrial development policy and quality workforce (Wiriyapong, 2004, p.1; Chiasakul, 2004, p.33).

Thailand presents a success story of using investment incentives in a less protected automotive industry, but not in isolation of a supportive regulatory policy framework like duties allowable and strategic decisions such as production for a niche market.

The fundamental difference between the Thai automotive industry development trend and that of South Africa is the stage of industry growth when the liberalisation process commenced. Thailand had already achieved a high level of localisation of its automotive industry compared to South Africa before embarking on the liberalisation process. In Thailand, global OEMs established joint ventures with domestic companies as a means to further the localisation process. In the case of South Africa, global OEMs producing in the country have maintained their autonomy even buying out the minority shares that had been previously owned by local companies. The investment incentive offer in South Africa is therefore subject to different dynamics, particularly the low linkages between global and local manufacturers in the country.

2.5.3 Argentina

2.5.3.1 Argentine automotive policy

The automotive industry in Argentina is a significant contributor to the national economy, as in the case of South Africa. Argentine's industry support approach was two-phased: first the stimulation of local demand and at a later stage the industry was re-oriented toward exports. The major move toward export promotion was embarked on in 1988. Two main initiatives were responsible for the success of the Argentine automotive industry in the 1990s under a liberalised trade regime, namely, an industry-government-labour agreement and the implementation of a commercial partnership with Brazil (Miozzo, 2000, p.661; Humphrey & Memedovic, 2003, p.13). Argentine did not have an explicit investment incentive.

The Argentine automotive policy approach combined income, industrial and trade policy tools in opening up the industry while still protecting the domestic industry and encouraging modernisation efforts.

The income policy as part of an industry-government-labour agreement involved the stimulation of local demand by cutting down vehicle prices through tax reduction on vehicle producers, setting long-term wages for the industry, and reduction of commissions payable to vehicle producers, component suppliers and dealers. Further still, there was a 30% reduction in employer contribution to social security.

The industrial and trade policy involved an undertaking and motivation of vehicle producers to embark on long-term investment, rationalisation and the endeavour to produce for the export market.

The objective of government was to make automotive production in Argentine very profitable to vehicle producers and thus motivate more investment. This multifaceted policy was initially successful; national vehicle production in Argentine increased more than five-fold from 100,000 to 450,000 units between 1990 and 1997. Employment was the only area of interest that did not respond positively to the policy. Industry headcount reduced, which was partly attributed to an increase in average industry productivity (Miozzo, 2000, p.659).

The commercial partnership of Argentine with the Mercosur region in general and Brazil in particular played another important role in the development of their automotive industry (Chudnovsky et al, 2003, p.2). The agreement sought to manage bilateral trade and the progressive liberalisation process. Markets of the two countries were to be integrated through a system of compensated exchange and gradual increase in imports. The formation of the Mercosur region was of strategic interest to global OEMs against the background of circulated markets in developed countries. Mercosur provided the largest market outside Europe without the stiff Japanese competition.

Direct policy intervention by the Argentine government and partnership with Brazil under the Mercosur framework created a conducive environment for automotive industrial growth. The initiatives led to rationalisation of production through OEM mergers (in 1987, Ford and Volkswagen merged to form Autolatina; the Argentine Antelo Group bought Renault subsidiary to form Ciadea) and elimination of duplicate investment. The agreement was also accompanied by new investments and acquisition of state-of-the-art technology for OE production. Miozzo (2000, p.652) contends that export expansion in Argentine was not due to liberalisation per se, but to the Mercosur region influence and the compensated trade agreement with Brazil. These policy measures were made in the context of internationalisation and transnational integration based on geographic specialisation and global sourcing.

Another factor responsible for the success of the Argentine automotive industry in the 1990s was the national policy related to acquisition of domestic technology and organisational capabilities. The integration of local suppliers in the OEM production process was, however, limited. This was attributable to the lack of capacity by locally based OE manufacturers to develop technological competence to design OEs. As a result, whenever a new model was to be launched, use of local content decreased while imported components increased drastically. Miozzo (2000, p.675) reports on an unfavourable and skewed relationship between OEMs and component suppliers in Argentine, which benefits the OEMs without developing OE suppliers. Lack of integration of local OE component manufacturers was exacerbated by the phenomenon of 'importing' of suppliers that had a strategic historical and capability relationship with the OEMs at the cost of domestic component manufacturers. This led to the weakening of domestic technological and organisational capabilities (Miozzo, 2000, p.676; Novick et al, 2003, p.16; Albornoz and Yoguel, 2004, p.634). The liberalisation process seemed to have moved too fast to allow OE suppliers to acquire the technological capabilities required in the global automotive business (Lall, 1993, p.720).

Despite the initial success in attracting investment in the 1990s by addressing the economic fundamentals, the Argentine automotive industry has since slowed down. Local OE manufacturers are struggling to participate in the international automotive value chain because global OEMs have not sufficiently facilitated the process. Costs and benefits of the industry liberalisation process have been uneven, with component suppliers bearing much of the cost and vehicle producers getting much of the benefits. At the heart of the slowdown is failure by the country to build local expertise and to acquire the relevant skills and technology to facilitate business links between global OEMs and domestic producers.

2.6 Prospects of the PAA for the South African Automotive Industry

On the surface, the PAA seems to be contributing towards its underlying goal, achievement of MIDP objectives. However, there are critical issues to be addressed before an unqualified statement on the effectiveness of the incentive to the industry can be made.

In attracting investment, investment incentives do not operate in isolation, they play only a marginal role (Rhys, 2000, p.1). The reasonable investment in the South African automotive industry by global OEMs, despite comparatively low levels of investment incentives, points to the fact that some other fundamentals necessary for attracting investment were in place. According to Bezuidenhout (2005), the major contributing factors for above average growth of the South African automotive industry in 2005 were low inflation and interest rates, strong consumer sentiments and business confidence, low vehicle price inflation and attractive sales and marketing packages. The PAA is not operating in isolation of other MIDP incentives and general policy framework. The theoretical underpinnings of the MIDP are complex, and the dynamic relationship between various incentives and industry performance indicators are unclear. It is quite difficult to identify the cause and effect of the various industry variables of the MIDP policy framework (Flatters, 2002; Barnes and Black, 2003; Bell and Maduna, 2003). The PAA adds to this complexity. How to structure the incentive to become more efficient in achieving the desired goal requires untangling the complexity of all factors at play in the industry as a starting point.

Another dimension to this debate is that authors on the subject have tended to overlook whether all productive assets are equally productive. Is machinery as productive as embedded new technology? Whether all "productive assets" should be considered the same across the board is an issue that could bring new perspective in understanding the potential role of the PAA to the industry. Industry stakeholders have reservations that the incentive in its current form can significantly influence decisions in the industry. According to the NAACAM Directory 2004, there were other government incentives, not industry specific, which could offer benefits superior to those of the PAA. For investment of less than some R60 million, the Small and Medium Enterprise Development Programme (SMEDP) offered better benefits than the PAA. The discretionary nature and time constraints imposed on benefiting from the incentive tend to make the PAA a less dependable basis of long-term investment decisions.

2.7 Synthesis

Overall, the success of using the PAA as an investment incentive for sustained growth of the South African automotive industry through enhanced competitiveness is dependent on supportive domestic measures that augment the expansion of the domestic market. It will also depend on the export potential of South Africa, geographical economies of scale and the extent to which the incentive is aligned to strategic interests of global OEMs and mega OE suppliers. Increased investment in the industry should be accompanied by deliberate efforts to integrate local OE suppliers into the global automotive value chain. The integration of the local industry into the global value chain will significantly depend on the acquisition of skills and technological capacity required to meet ‘new’ supply requirements that are being placed on OE manufacturers. In general, international experience of countries like Argentine, Thailand and Australia seem to indicate that success of the PAA in contributing to the competitiveness objective will depend on the extent to which the incentive will effectively motivate technological innovation in the country’s automotive industry.

In mapping out the way forward for the use of the PAA, policy makers need to have a fair understanding of the possible effects of structuring the incentive. This process could benefit from a structured understanding of the dynamics that underpin interaction of Government with private OEMs through the offer of investment incentives. The process should be cognisant of the role of technology in taking the automotive industry to the next stage of development. It should be guided by a formal model capturing industry performance as a system, in which dynamics, feedback systems and delays jointly influence realised outcomes. Otherwise, the incentive may not be useful in achieving its intended objectives and this would, in the long run, come at a high cost to the National Treasury and the economy as a whole.

3 To Give or Not to Give Incentives to South Africa's Automotive Industry: A Literature Review

3.1 Introduction

This chapter explores economic theory and empirical work that form the basis for the offer of investment incentives to South Africa's automotive industry.

The offer of incentives for investment is based on the assumption that there is a positive relationship between investment and investment incentives. On the other hand, countries or regions do not want investment for its own sake, but rather for benefits derived from it. Economic theory on the relationship between investment and investment incentive is often based on a neo-classical economic model of a profit maximising firm (Brunker et al, 1986, p.4). It is held that a firm will invest up to point where its marginal product revenue of capital equates the cost of additional capital. Investment incentives reduce the cost of capital acquisition, hence motivating more investment, holding other factors constant. In answering the question whether South Africa should offer investment incentives to the automotive industry, literature on investment and investment incentives and on how investment benefits host regions is relevant.

In the first section, the theoretical framework that links investment and investment incentives is examined. Thereafter, the empirical work on benefits to an offering location or entity that emanate from investment is explored. Further, literature on South Africa's automotive investment under the country's Automotive Industry Development Programme (MIDP) is reviewed before making policy recommendations are made.

3.2 Investment and investment incentives: theoretical underpinnings

3.2.1 Flexible Accelerator Model

From the profit maximising neo-classical assumptions on the behaviour of a profit maximising firm, Hall and Jorgenson (1967, p.391) derived a function for investment with user-cost of capital as one of the determining factors. They incorporate postulations on a production function i.e. constant returns to scale, exogenously determined output and an adjustment mechanism of capital stock to derive a model that captures most of the relevant explanatory variables relating to an investment incentive and actual investment.

The model specifies desired capital stock (K^d_t) as a function of output (Y_t):

$$K^d_t = \alpha(Y_t) \qquad \alpha > 0 \qquad (1)$$

Investment (I_t) is defined as the difference between desired capital stock and capital stock from the previous capital stock:

$$I_t = K^d_t - K_{t-1} \qquad (2)$$

From equation (1) the stock of capital in the previous period will be a function of output from the previous period:

$$K^d_{t-1} = \alpha(Y_{t-1}) \qquad (3)$$

Rearranging equation (2):

$$(I_t) = K^d_t - K_{t-1} = \alpha(Y_t) - \alpha(Y_{t-1}) = \alpha\,(Y_t - Y_{t-1}) \qquad (4)$$

Equation (4) expresses investment as a function of the rate of change in output. With the introduction of adjustment lag, equation (2) is modified as follows:

$$I_t = \lambda(K^d_t - K_{t-1}) \qquad 0 < \lambda < 1 \qquad (5)$$

Using equation (1) we get:

$$I_t = \lambda(\alpha Y_t - K_{t-1}) \qquad (6)$$

Equation (6) captures a partial adjustment mechanism where a fraction λ of the gap between desired and actual capital stock is filled within each period by investment.

Because different levels of output can be produced by varying capital-labour ratio, α cannot be a constant. It is assumed that decision on capital-labour mix will depend on the relative cost of labour and capital discounted over the investment life span. The desired capital-labour ratio and therefore capital output ratio (α) will depend on the cost of capital. The investment function, as a result, takes the form:

$$I_t = I(Y_{t,} CC_t, K_{t-1}), \quad \text{where } CC_t \text{ is the cost of capital} \qquad (7)$$

The cost of capital variable in the accelerator model opens the way for the introduction of important economic variables and policy tools, including investment subsidies and incentives, in the investment equation. Theoretically, the cost of capital (CC_t) will depend on real interest rates (r_t), capital depreciation (a_t), expected inflation (p_e), and level of government subsidy on investment (g_i). A more comprehensive and realistic investment function could therefore be specified as:

$$I_t = I(Y_t, r_{t,} a_t, p_{e,} g_i, K_{t-1}) \qquad (8)$$

Equation (8) provides a framework for capturing relationships between of investment incentives, investment and production.

Jorgenson's model is criticised for not being consistent with perfect competition market conditions. The theory fails to determine explicitly the rate of investment but relies on an ad hoc stock adjustments mechanism (Howell et al, 2002, p.1498; Gould, 1968, p.48; Treadway, 1969, p.227).

3.2.2 Tobin's q theory

The alternative neo-classical theoretical approach linking investment incentives and actual investment as proposed by Jorgenson's model is Tobin's 1969 q theory. In the theory, q is defined as the ratio of market value of capital to its replacement cost. The q value determines incentive to invest (Hayashi, 1982, p.214). In other words, a profit maximising firm will always look at two factors when making an investment decision: how much value will the firm derive from investing an additional unit of capital and how much does it cost the firm to acquire that unit of capital. The theory introduces the cost of installing new investment in the firm's optimisation decisions, thus, capturing the role of tax rules, investment tax credit and depreciation formulas, as these have a direct effect on cost of acquiring capital for investment vis-à-vis value to the firm derivable therefrom.

Formulation of the q theory model starts with an optimisation function of a firm's present value of future after-tax receipts:

$$V(0) = \int_0^\infty R(t)^{\exp}\left[-\int_0^t r(s)ds\right]dt \qquad (1)$$

where R(t) is net receipts and r(s) is the nominal discount.

R(t), is then defined as profits after tax, plus depreciation tax deductions, minus purchase of investment goods plus investment credits i.e.

$$R(t) = [1-u(t)]\pi(t) + u(t)\int_0^\infty D(x,t-x)p_1(t-x)I(t-x)dx - [1-k(t)]p_1(t)I(t) \qquad (2)$$

where π(t) is profit before tax at time t

u(t) is corporate tax rate

D(t) is depreciation allowance per dollar of investment at the time t

x(t) is age of an asset

$p_1(t)$ is price of investment good

I(t) investment

k(t) the rate of investment tax credit

Through specifying fiscal-investment incentive parameters in equation (2) and substituting accordingly in equation (1) the optimal investment level of a profit maximising firm can be influenced. For detailed derivation and specific solution(s), see Hayashi (1982, p.214-218).

Both the Jorgensons' and Tobin's models come to the conclusion that the cost of capital has an influence on investment, and investment incentives are one of the factors that decrease the cost of capital. By offsetting the cost of capital investment, incentives can potentially increase investment, holding other factors constant. The fundamental difference between Jorgenson's model and Tobin's q theory model is that Jorgenson uses the capital-labour substitutability to introduce capital cost considerations. Tobin's argument centres on firm benefit from invested capital. He introduces the cost of capital as being relevant to the investment decision, only to the extent that it influences the point where the marginal value of capital equates the marginal cost of capital.

Both the Jorgenson and Tobin's q theory model are important in providing a theoretical foundation for the relationship between investment and investment incentives; however, the models do not specify conditions under which the relationship would take a particular form. All they say is that based on neo-classical economic assumptions, one can derive expressions linking investment and investment incentives, among many other factors. The models, however, set a foundation for empirical work of establishing how investment incentives (more so fiscal incentives) influence actual investment.

3.3 Fiscal investment incentives and investment: empirical studies

Investment incentives have been widely used as a tool to address industrial development in both developed and developing countries (Hall and Jorgenson, 1967, p.392; Bernstein, 1994, p.56; Bronzini & Blasio, 2006, p.237; Davies, 2005, p.500). Investment incentives often take the form of fiscal concessions hence the common interchangeable use of 'investment incentives' and 'tax incentives' phrases in the literature on the subject. The target for the incentives is often the attraction of foreign direct investment, the rationale being that many of the host countries or regions lack adequate capital to support their development agendas. Investment incentives lure mobile capital to a particular location by providing a signal to potential investors for favourable investment conditions (Raff and Srinvasan, 1998, p.168). Today, virtually all developing countries are using some form of incentives to attract direct investment (Hadari, 1990, p.121). The wide use of tax incentives to attract investment has led to a number of studies on merits of this offer and its impact on investment. Findings so far are mixed and inconclusive but nonetheless informative (Howell et al, 2002, p.1498; Tung & Cho, 2000, p.105).

3.3.1 Incentives as an effective tool for stimulating investment

Fumagalli (2003, p.964) argues that an offer of incentives facilitates efficient investment location decisions that would not otherwise have taken place without incentives in a particular place. His argument is supported by a number of empirical studies that concluded that the offer of investment incentives did influence investment (Bronzini & Blasio, 2006; Hall & Van Reenen, 2000; Tung & Cho, 2000; Head et al, 1999).

Bronzini & Blasio (2006, p.328) used a descriptive statistical analysis to assess whether the offer of investment incentives to areas of the Italian manufacturing industry which lagged behind had a positive effect on investment. They found evidence that investment incentives did indeed bring forward investment projects in order to take advantage of available incentives. Such investment would not have taken place or could have potentially taken place at a later stage.

With a similar intention of establishing a relation between offer of incentives and investment in a particular location, Tung and Cho (2000, p.105) used Chinese data to test the assertion that creation of special tax incentive zones was effective in inducing foreign investment into such areas. China provided an excellent opportunity to test incentive-investment relationships, as by 1993 the country had become the largest recipient of foreign investment despite its previous non-capitalistic economic strategy. Their regression analysis results showed that tax incentives were effective in attracting investment to China, and did influence the selection of a particular form of investment.

Head et al (1999, p.197) studied Japanese investment in the USA between 1980 and 1992 to assess the effectiveness of investment promotion efforts of US states, using incentives. After controlling for agglomeration and fixed region effects, they found that incentives in the form of tax revenue and job-creation subsidies affected the location of investment. Unilateral withdrawal of investment incentives caused individual states to lose a substantial amount of Japanese investment. Still in the USA, Hall & Van Reenen (2000, p.449) found that the offer of tax incentives for R&D had a positive effect on actual R&D taking place, but not on investment in general, pointing to the fact it might be useful to disaggregate investment in assessing how incentives affect investment.

The fact that incentives do not homogeneously influence all categories of capital was also observed by Feltenstein & Shah (1995, p.253). They examined the relative efficacy of using a tax instrument to promote private capital formation in Mexico. They found that corporate tax reduction had the most stimulative impact on investment. They however pointed out that if the intention of the incentive offering country is to encourage acquisition of state of the art technology, fiscal incentives may be ineffective as generic fiscal incentives increase the demand for both new and old capital.

Proponents of incentives for investment cite the above and many more such studies to make their case. However, there are as many if not more empirical studies that conclude otherwise, as will be reviewed below.

3.3.2 Ineffectiveness of investment incentives

Many other authors, supported by empirical work, argue against the use of investment incentives. They make a point that the offer of investment incentives, whether fiscal or other special subsidies, plays an insignificant role in influencing investment (Hasset and Hubbard,1998, p.103; Sethi et al, 2002, p.686; Lim, 1983, p.207; Moore & Swenson, 1987, p.671; Beyer, 2002, p.192; Dunning, 1980, p.14; Globerman & Shapiro, 1999, p.513).

In justifying their case, a number of anti-investment incentive authors have approached the debate on industry incentives by interrogating factors that influence a firm's decision to investment in a particular location. From this perspective, Caves (1971) and Dunning (1980) postulate that investment, specifically foreign investment, is a strategic decision by a particular firm that allows it to exploit resource ownership advantage and has nothing to do with incentives. Dunning (1980) further suggests that a decision to invest in a particular location is often motivated by the existence of resources, both material and human, that the firm wants to take advantage of, rather than investment incentives.

The position by Dunning (1980) is supported by a number of studies that argue that the offer of an investment incentive is a wasteful exercise. Investment is driven by economic fundamentals such as market potential, economic growth, political stability and dependable legal systems, among others (Ozawa, 1995; Narula, 1996; Dunning and Narula, 1996; Lall, 1995). Investment is a firm level decision that involves strategic considerations. It cannot therefore be explained by one single factor (Sethi et al, 2002, p.691).

Sethi et al (2002) introduced the "push" dimension in terms of factors determining investment location decision, an aspect that is often omitted by many authors on the determinants of investment. He presents a generic model that integrates institutional and strategic factors into investment theory and argues that the two aspects need to be considered in tandem, when considering factors that influence investment and investment location. Incentives are just one of the many investment-determining factors (Table 11).

Push Factors (Strategic Factors)		Pull Factors (Institutional Factors)
Competitive intensity from rivals, both local players as well as other MNEs Finite absorptive capacity for investment in the host country Reducing profit margins Oligopolistic rivalry	→ **Decisions to migrate investment** →	Political and economic stability Independent judiciary – rule of law Sound technological base and infrastructure Technically skilled labour Low wages Large and lucrative market Policy liberalisation Investment incentives Minimum restrictions

Table 11: Pull and push factors explaining investment location decisions
(Sethi, 2002, p.691)

Sethi et al (2002)'s proposition is supported by empirical work of Bevan & Estrin (2000, p.26) who also found that country risk, unit labour cost, market and gravity factors were the key determinants for attracting investment to Central and Eastern Europe in the period of transition from socialism to capitalism.

The trivialness of investment incentives was also pointed out by Hasset and Hubbard (1998, p.103). Using US data on investment in 10 developing countries, they found that the effect of investment incentives on the price of capital goods was very small. They claimed that this was due, in part, to price increases by the suppliers of capital goods in the presence of investment incentives. Hasset and Hubbard (1998)'s finding suggests that even if the user cost of capital goods were to be a significant determinant for investment, as proposed by Jorgenson and Tobin's model, the offer of investment incentives may not increase investment.

Beyer (2002, p.191), in a comparative analysis of how successful fiscal incentives were in attracting investment in transition economies found that incentives had little or no value at all. In a correlation analysis of 15 transition European countries between 1993 to 1998, in which all country/time points were combined, Beyer found an insignificant negative correlation coefficient of r = -0.116 between fiscal investment incentives and actual investment. He argues that it was the privatisation process, and the subsequent change in economic and political conditions that had the biggest influence on investment in the transition countries. Investors are always looking for investment opportunities and they do not need incentives to find them. (Beyer, 2002, p.193) further points out that host countries or regions face a set of potential investors motivated by different reasons. Since incentives target non-homogeneous potential investors, their effects will always differ. The choice of which incentives to offer has to take into account not only the costs vis-à-vis benefits of intervention but also the overall strategic orientation of the targeted companies (Melin, 1992, p.99).

Empirical work on the effects of investment incentives on investment in developing countries is still limited, though there is a general belief that a country's overall economic character is more important for investment to take place (Howell et al, 2002, p.1500; Tanzi and Shome, 1992, p.31; p.15; Jenkins & Thomas, 2002, p.44). Tanzi and Shome (1992, p.31-65) contrasted the use of tax incentives in South East Asian economies and came to a conclusion that the positive effect on industrialisation in Taiwan, Korea, and Singapore when compared to a less positive effect in Malaysia, Indonesia and Thailand, was due to economic fundamentals, despite the offer of comparable tax incentives. Specific for Southern Africa, Jenkins & Thomas (2002) conducted a survey, with predominantly European parent countries operating in SADC, to determine the main factors influencing investment in the region. According to their findings, the most important motivation for investment in Southern Africa was the size of local market; more important than cost considerations. Hence, South Africa with the largest domestic market in the region hosted most of foreign subsidiaries' investment in the region. They further claimed that though market size was critical, economic openness, the quality of institutions and physical infrastructure of the host economy, economic growth and stability were correlated with investment inflow in Africa. They did not consider incentives as an important determining factor for investment. Jenkins & Thomas (2002) conclusions are supported by Dupasquier & Osakwe (2005, p.255) who posit that to attract investment, African countries need to image build in terms of political, macro-economic and legal framework stability. Countries should be seen to be supportive and responsive to the needs of their current investors, should aggressively market investment opportunities and open up their economies, rather than simply give selective industry investment incentives.

There seems to be a consensus among anti-incentive authors that the role played by investment incentives in influencing investment decisions is minimal and only relevant when competing locations have almost similar macro-economic and institutional fundamentals. Investment-targeting incentives simply improve bottom lines for the investor since the decision to invest would have been made already based on the region fundamentals.

From both theoretical and empirical work it is clear that whether investment incentives influence investment and how, is still a question that begs to be answered. It calls for further research before a generalised position can be taken.

3.4 Benefits of investment

As previously noted, host countries or regions, do not want investment for its own sake but for benefits that emanate from increased production activity enabled by the investment. Therefore, a further question of interest for an investment host region is whether the enabled investment benefits the host. A few studies have claimed that investment, specifically foreign investment, has positive spin-offs in terms of stabilising economies of recipient countries (Laski, 1998, p.1), increase in trading activities (Brenton et al, 1999, p.96; Deichmann, 2001, p.142), and integration of the domestic market into the global value chain (Lankes and Venable, 1996, p.331). However, the question of whether investment always benefits a host location is far from being answered. A direct relationship between foreign investment and domestic economic growth is not automatic (Kogut, 1996, p.293; Reis, 2001, p.412).

3.4.1 Externalities and investment

The theory of externalities and investment posits that investment will always have benefits that accrue to its location area that the investor will not be rewarded for. Investors, being profit maximisers, will underestimate optimal investment because of the unrealised benefit. In order to avoid this under-investment, potential investors need to be compensated, as a way of correcting this market failure. Incentives act as a tool to fill the gap between social and private returns of investment, thus correcting the market failure and leading to efficient investment decisions (Brewer and Young, 1997, p.177). Further still, countries opt to offer incentives for investment because such investment, particularly foreign investment, is seen as an effective conduit of technology transfer to domestic firms and it is associated with positive spillovers to its new location. By providing additional capital to a host country, foreign investment can create new employment, fill the resource gap between domestic savings and optimal investment, enhance international trade and increased domestic productivity in general (Dupasquier & Osakwe, 2005, p.244). The underlying premise is that multinational corporations possess superior intangible assets including technology, managerial skills, export contacts, reputation and goodwill (Bwalya, 2006, p.514-515).

In line with economic theory, a number of studies claim to have found a positive relationship between foreign investment and positive externalities. Increase in productivity of domestic firms is the commonly cited externality (Kokko, 1994, p.279; Barrell and Pain, 1997, p.1776; Blomström and Kokko, 1998, p.247; Driffield, 2001, p.105). Such studies claim that due to the technology that comes with the foreign investors, domestic firms benefit from business relationships with foreign firms.

On the other extreme end are a few studies that have come up with evidence that foreign capital is detrimental to host economies. Haddad and Harrison (1993, p.55), and Aitken and Harrison (1999, p.605) caution on "market stealing" by foreign firms; a situation where domestic firms do not realize economies of scale and the subsequent reduction in their average sales because output demanded from them would be "stolen away" as foreign firms take over large parts of the market. FDI might also constrain the deepening of domestic R&D capabilities, a situation referred to as "crisis construction" (Lall, 2001, p.192).

Most literature on foreign investment and spillovers, however, seems to indicate that foreign investment will be accompanied by positive spin-offs but under strict conditions in the host economy. The level of foreign ownership, for example, is considered as being critical in determining the nature and level of externalities to host economies (Chhibber and Majumdar, 1999, p.222; and Blomström and Sjöholm, 1999, p.915). Foreign ownership in a domestic firm has to reach a particular threshold to realise positive externalities. Spillovers tend to be stronger in sectors where local competition is higher and technology less advanced. Blomström and Kokko (1998, p.248) maintain that the higher the level of competence and the more the competition in the market, the greater the absorptive capacity of and the positive benefits for the host country. Blomström et al (2001, p.124) report that FDI spillovers will depend on trade regimes and export orientation of the recipient firms.

Investment incentives indeed affect the cost of capital and the cost of capital is a significant determinant of investment. However, without clear evidence that investment will always have positive effects on the host economy and that investment incentives will indeed influence investment, economic analysis is required on the effect of the offering of investment incentives to the South African Automotive industry to achieve MIDP objectives.

3.5 Incentives in the South African Automotive Industry

Two extreme views have so far emerged in the debate on incentives in the South African Automotive industry. On one hand are authors who claim that the incentive arrangement cannot be considered as a success because its costs exceed the benefits. Flatters (2002, p.13) asserts that such incentives, specifically the import-export complementation incentives under the MIDP, have been costly policy errors and that the attention given to the sector exceeds its contribution to output, export and employment. Given the fact that there are some sectors of South African economy that have realized success without government support, Flatters argues that incentives to the automotive industry may only be increasing the bottom lines of local vehicle manufacturers without necessarily influencing their investment decisions.

On the opposite extreme are authors who claim that the MIDP is an example of a well-designed, successful industrial policy. Barnes, Kaplinsky and Morris (2003, p.20) present the South African automotive sector as a success against the Washington consensus that the role of government, in enabling industrial development through industrial policy, should be minimal. They claim that properly administered incentives can be an effective tool among developing countries to kick-start domestic industrialisation. Their position is supported by Black (2001). He postulates that the offer of investment incentive to the automotive industry played a key role in influencing major foreign firms in the automotive industry to draw their South African operations into their international networks (Black, 2001, p.780). This allowed integration of the local industry into the global automotive value chain without destabilising gains made by the industry under the protected trade regime. He further claims that performance of South African automotive manufacturing industry under the MIDP incentive dispensation is evidence to the fact that clear and stable incentives can positively influence firm behaviour (Black, 2002, p.18).

An observable commonality among authors on the MIDP incentives is the admission that the policy framework of MIDP as driven by the import-export complementation is hard to evaluate. “The extraordinary complexity of the MIDP makes it difficult to determine the effects of changes in the key MIDP policy variables”, say Bell and Madula (2003, p. viii). According to Flatters (2002, p.5), the effectiveness of the system is very hard to evaluate since the MIDP incentives are tied to export promotion, which in turn stimulates importation through earned export credits. The multiple and at times apparent conflicting objectives of the MIDP makes the overall evaluation problematic.

3.6 Synthesis

Economic theory on the offer of investment incentives and the empirical work on the relationship between investment and benefit to host locations are inconclusive on whether and how to offer investment incentives to an industry like the South Africa automotive industry. The situation is further complicated by domestic diverse views on the cost and benefit of the industry incentives.

Notwithstanding the ambiguous relationship between investment incentives and investment as proposed by Jorgenson and Tobin, the theoretical literature rationalises the offer of investment incentives as a means of correcting market imperfections created by investment externalities (Brewer and Young, 1997; Bwalya, 2006, Blomström and Kokko, 1998; Driffield, 2001). In other words, the intention of investment incentives is to remove market distortions created by investment externalities and facilitate investment by potential investors so as not to under invest (Dupasquier & Osakwe, 2005, p.244).

The basic assumption of this conventional literature, that the rationale for offer of investment incentives is the existence of investment externalities and hence taking the offer of investment incentives as market correction mechanism, is not entirely correct. Many countries or entities offer investment incentives, not because there are externalities attributable to investment, but rather to influence investment externalities. Investment incentives are intended to influence investment decisions to the extent that investment serves particular objectives. More often than not, the intention is not to correct market imperfection but rather to make markets imperfect. In the case of South Africa, one of the national objectives is to ensure that investment in the automotive industry is maintained at levels that sustains employment. This level of investment might not be at a production level that would allow the most effective and efficient way of production.

The question of how to offer investment incentives to the South Africa automotive industry could have been best served by economic literature that addresses how investment incentives influence investment externalities, which literature perspective is unfortunately limited or missing. The same question can however benefit from literature that addresses how investment incentives influence factors known to influence investment externalities. This is a proxy approach to the understanding how incentives may influence investment externalities, specifically positive externalities. In as far a manufacturing is concerned, positive externalities relates to wider societal benefit that accrue to the local productive activities. In this regard, industry competitiveness is a key factor in ensuring sustained benefit from investment made to a particular location. The extent to which competitiveness is enabled by investment incentives is a fair proxy as to how such incentives are influencing investment externalities. For completeness, we extend the literature review to cover theoretical and empirical aspects of investment, investment incentives and competitiveness in the next chapter.

4 The Productive Asset Allowance and South African automotive industry competitiveness

4.1 Introduction

South Africa's adoption of an outward-looking industrial development policy strategy after 1994 was motivated, in part, by the desire to detach domestic industry performance from national economic growth (Black, 2001, p. 779). It was acknowledged that the domestic market was not able to support high production volumes that could allow efficient and competitive domestic production. Given the emphasis put on exports and foreign investment to drive national growth, international competitiveness became an important component of overall national development strategy. South African policy makers hoped to emulate the successful experience of some East Asian countries that had succeeded in achieving high economic rates through exporting (Edwards & Golub, 2004, p.1323). In line with national development strategy, the South African government introduced an investment incentive for the automotive industry, the Productive Asset Allowance (PAA) in 2000. The incentive was intended to support efforts to make the domestic industry competitive in the long term under the country's Motor Industry Development Programme (MIDP). Against the background of reducing import duties, the industry needed additional motivation to encourage domestic investment. Achieving comparative competitiveness was critical for the local vehicle and component manufacturing subsidiaries, as the global structure of the automotive industry dictates that subsidiaries located all over the world compete for business from their parent company.

The chapter explores literature on R&D activities and industry competitiveness. This is followed by an empirical assessment of the prospects of the PAA to support South Africa's automotive industry competitiveness through R&D effort using industry performance data for the period 1998 to 2004. A strong assumption is made that R&D and subsequent innovation are prerequisites for long-term industry competitiveness. Cognisance is taken of the fact that R&D may not always lead to competitiveness (Papadakis, 1995, p.569); however, it is widely accepted that R&D is the most common way through which national industries can acquire independent and unconditional intellectual property rights.

4.2 R&D investment and industry competitiveness

4.2.1 Definitions

R&D can be defined as a formal improvement-driven undertaking to discover new knowledge about products, processes and services. It comprises of the bulk of creative systematic activities undertaken to increase a stock of knowledge and the subsequent use of this knowledge to devise new application (Frankema & Lindblad, 2006, p.304). According to Zhouying (2005, p.38), R&D entails developing of technologies that can be commercialised under independent intellectual property rights. It enables firms to create new technologies and/or to build on existing technologies obtained through technology transfer. R&D is seen as the foundation of technology progress and sustainable competitiveness in the modern era (Solow, 1957, p.320; Lengnick-Hall, 1992, p.399; Lim, 1994, p.834; Wint, 1998, p.281; Frankema & Lindblad, 2006, p.316).

Competitiveness on the other hand refers to the ability of a firm or industry to increase in size, market share and profitability. Quoting the US Presidential Commission on Industrial Competitiveness, Clark and Guy (2000, p.364) define competitiveness as "the degree to which it (a nation) can, under free and fair market conditions, produce goods and services that meet the test of international markets while simultaneously maintaining and expanding the real income of citizens". The later definition takes cognisance of the welfare effects of increased productive activities as a country captures bigger market shares. Some other authors have linked the definition of competitiveness with an increase in per capita income and employment (Oughton, 1997, p.1486). They claim that competitiveness is a product of increased productivity. To achieve competitiveness, output per each factor of production, including labour has to increase, if all other factors are constant. Assuming perfect market conditions or at least market conditions that support a positive correlation between reward for factor inputs and productivity, wage rates payable will increase with productivity. Competitiveness will therefore lead to an increase in GDP per capita and overall improvement in national welfare.

The definition of competitiveness as it applies to nations is sometimes contested. In the words of Krugerman (1994, p.44), "competitiveness is a meaningless word when applied to national economies. And the obsession with competitiveness is both wrong and dangerous". Despite the divergent views on whether one should attempt to define competitiveness at national level and on the scope of the definition, the meaning of competitiveness when applied to a particular industry producing goods and services for a contested global market is less blurred by controversy. Industrial competitiveness encompasses increase in market share and profitability achieved through provision of goods and services of higher quality at a lower price, compared to that of competitors. It is important to note that for sustainability, the industry need not be subsidised in any way. In the subsequent analysis, the definition of competitiveness is limited to an increase in the South African automotive industry's share of a free global market.

4.3 Economic theory on R&D and competitiveness

From a macroeconomic perspective, the link between R&D and competitiveness is via technology growth. This theory can be traced in the early work of Solow (1957, pp.312). Using an econometric model based on a neoclassical production function [$Y = F(K, L)$ - where Y is output, K is capital and L labour], Solow calculated the growth in output attributable to change in capital and labour respectively. By totally differentiating the production function, he derived the elasticity of output with respect to capital and labour. Applying a competitive pricing condition ($\partial Y / \partial K$ = price of capital; $\partial Y / \partial L$ = the price of labour) the share of both capital and labour were calculated. Solow's results showed that growth rates in capital and labour could not account for the overall output growth. He attributed "the uncounted for" growth in output to "residual" factors associated with technological change, including R&D (Solow, 1957, p.320).

Solow's theoretical conclusions on the role of residual factors, particularly technological progress, are consistent with a more recent large-scale World Bank study of 1991 that showed that labour and capital alone could not account for output growth in both developing and developed countries. According to the study, the most important source of output growth for developing countries was capital, but for developed countries, it was technical progress. For the developing countries, as a group, capital's contribution to output growth was 65% and that of technical progress was 23%. Developing country results contrasted sharply with those of developed countries where technical progress contribution to output growth was more important than that of capital and labour combined (Table 12). By implication, the growth in output in developed countries was largely a result of growing efficiency in the use of factor inputs (Lim, 1994, p.834). The contribution of technology progress to output growth was greater than that of labour across the board, for all developed countries. An interesting dimension of the study, as quoted by Lim, is that for most of the developed countries, the contribution of labour was negative. Essentially, reduction in employment would increase output growth for these countries. Although this assertion can be contested, it has serious policy implications for developing countries; for such countries to progress towards the "developed country" status labour contribution to national output is likely to decline and at one point it may become negative. So, if high employment levels are to be achieved or maintained, the contribution of technical progress will have to be enhanced significantly, to counteract the negative effect of labour; otherwise, competitiveness will be lost.

Region	Capital	Labour	Technical Progress
Developing Countries, 1960-87	65	23	14
Africa	73	28	0
East Asia	57	16	28
Europe, Middle East & North Africa	58	14	28
Latin America	67	30	0
South Asia	67	20	14
Selected developed countries, 1960-85			
France	27	5	78
West Germany	23	-10	87
Japan	36	5	59
United Kingdom	27	-5	78
United States	23	27	50

Table 12: Contribution of capital, labour and technical progress to output growth (%)
(Lim, 1994, p.835)

The realisation that productivity was not entirely a function of factor inputs triggered efforts by policy makers to focus on the postulated effect of R&D and technological progress on productivity in their quest to guide national competitiveness strategies.

Experiences of countries like Japan and Thailand played a key role in further elevating the importance of R&D and technological capability as national competitiveness-determining factors.

The current conventional thinking is that the link between R&D and competitiveness is via its effect on technological development and subsequent innovation. Innovation, technological advances and country competitive advantage happen to be connected by complex multidimensional relationships (Lengnick-Hall, 1992, p.399). The logic applied here is that competitiveness depends on average production costs. Production costs are a function of price and non-price factors, some of which are R&D capabilities and the ability to adopt and use new technologies. Sustainable competitiveness depends on the ability of a country or industry to offer comparative products to its competitors at lower prices on an open market. It requires that a country or industry is able to lower its production costs without sacrificing quality. Technology innovation offers one of the most practical ways to reduce production costs while at the same time maintaining or even increasing product quality. R&D happens to be perhaps the most widely used innovation approach. R&D investment has a powerful positive correlation with industrial profitability, product quality, return to investment, hence overall competitiveness (Merrifield, 1989, p.72). R&D activities generate knowledge, which is a factor of production, as such an indirect input in the neo-classical production function (Özçelik & Taymaz, 2004, p.410). Stumpf & Vermaak (1996, p.7) also pointed out that technology that results from R&D activities determines the actual value of the physical resource endowment of a country. Through its value adding, technology augments the value of a country resource base and enhances its competitiveness, holding other factors constant. Therefore, there is general agreement that countries seeking to enhance their international competitiveness, have to engage in domestic R&D and subsequent innovative activities (Wint, 1998, p.281).

It must be noted, however, that there are alternative means to acquire technological capacity other than undertaking R&D investment. An industry may opt for external license agreements, strategic alliances or partnerships (Lengnick-Hall, 1992, p.407). Such acquired technological potential, however, cannot be considered a national resource, and is less likely to serve the national interest for a country like South Africa. Based on the Chinese experience, Fan (2006, p.359) contends that development of innovative capability and self-developed technology are the key factors leading to domestic firms catching up with multinational corporations. She emphasises that domestic firms need to prioritise building innovative capabilities from the beginning in order to withstand competitive pressure from multinational companies as well as other domestic companies. Externally sourced technology puts pressure on the local human resource capabilities of a country, often requiring that the local labour force adapt to new production techniques in a very short time. Often, external experts are brought in to implement the new processes, with little technical knowledge being passed to the local labour force. Further still, external technologies tend to disempower local management in steering industry in a direction that serves national interests. It is, therefore, important that there is clarity on the part of policy makers as to what they want to achieve. If the intention is simply to participate in international business without a strong need for developing national capabilities, then efforts could be directed toward acquiring already available technology through licence and partnership agreements. However, if the intention is to develop a fairly independent and sustainable national competitiveness, domestic R&D efforts and intra-firm innovation among domestic firms are inevitable.

The link between R&D effort, innovation, technical progress and competitiveness has to be qualified; it is not straightforward and is characterised by time lags. For competitiveness to be realised, R&D generated knowledge has to be adopted and commercialised by industry; otherwise, the knowledge remains valueless. R&D is an input in the long process of achieving competitiveness. Like any other input in a chain of interrelated activities of a system, the relationship between input and output may be hard to establish. One has to consider time lags and control for other "competitiveness-determining" factors that simultaneously change with R&D efforts over time. Another challenge in the R&D and competitiveness analysis relates to measuring the effectiveness of R&D. Frankema and Lindblad (2006, p.316) point out that "Figures on R&D activities and numbers of people employed in R&D activities, the commonly used indicators of R&D activity, merely inform us about the scope of efforts and financial commitments but do not offer insight into the effectiveness of R&D efforts". The R&D success rate is dependent on a range of intermediary factors like knowledge management, technology absorptive capacity of the environment, and other soft technological variables. Zhouying (2005, p.36) claims that soft technological factors that relate to the emergence of new business technologies and cultures, such as modern management techniques, venture capital, virtual technology, incubators, etc. constitute soft technology that provides an environment for innovation and effective application of technologies, hence attainment of competitiveness. This explains why the United States with the highest expenditure on R&D and new technology in the world was less competitive than Japan on a number of product global markets (Zhouying, 2005, p.39). Institutional structures that support absorption and commercialisation of R&D output play a critical role in ensuring that R&D efforts lead to competitiveness attainment. Many developing countries rarely benefit from technology transfer because of the low efficiency they exhibit in absorbing the technologies required. The low absorption capacity is a direct result of incompleteness of the soft technology environment in these countries (Zhouying, 2005, p.40).

Notwithstanding the above concern on R&D and competitiveness, there is no doubt that new knowledge drives innovation and new knowledge is rooted in R&D activities. Innovation and technological capability are important assets for any country or industry in getting a competitive edge over its rivals in free contestable markets.

4.4 Need for local R&D and technological progress for the South African automotive industry

The new democratic government of South Africa inherited a considerable technology base from the past that could be improved upon to support the country's general competitiveness (Stumpf & Vermaak, 1996, p.3). The country as a whole boasted of a good physical infrastructure network and pool of local engineers and research institutions. Economic isolation had motivated development of reasonable local research capabilities in order to withstand effects of external trade embargoes.

The automotive industry was one of the many local industries that had to adapt to efficient means of production and doing business in order to hold out on external competition following the country's re-integration into the global economy in 1994. Apart from the historical industry inefficiencies perpetuated by many decades of protectionism, the South African automotive industry has a location disadvantage in terms of major global markets. Located at the Southern tip of the African continent, it is further away from both European and American markets than most of its global competitors, such as the former socialist Eastern European countries and Brazil. Yet exports are supposed to be drivers of the automotive industry growth. To effectively compete on the global scene, the local industry has to find a way to compensate for the distance disadvantage. The implementation of the "Just-In-Time" (JIT) supply concept under which components have to reach the assembly plants just in time to be used on the assembly line, has further exacerbated the location disadvantage for component supply. Component manufacturers have to be within easy reach of assembly plants; otherwise, they have to be supported by extremely efficient and robust logistical systems. The local component-manufacturing sector has to contend with this challenge.

Again, the nature of global automotive business configuration is such that subsidiaries of the major global vehicle manufacturers compete for business based on their respective business case. Without the previous market protection that had sustained inefficient domestic production, as a way to "jump the tariff wall", future business for domestic subsidiaries is very vulnerable. Local subsidiaries of global vehicle manufacturers have to achieve efficiency levels comparable to their counterparts all over the world that have been operating under competitive market conditions while the local industry was under protection. The local industry has to come up with creative means to catch up with its competitors.

Finally, as South Africa has no international vehicle brand there is a general realisation that component supply to international vehicle brands provides a crucial means for the country to participate in the global automotive value chain. However, the global automotive industry configuration is such that vehicle manufacturers are delegating more of the design responsibilities to component manufacturers. The tendency is for the vehicle manufacturers to provide the overall performance specifications and information about the interface with the rest of the car. The component manufacturer then designs a solution using its own technology. The new supply dynamics put enormous pressure on the component sector to acquire world-class technological competencies in order to participate competitively in the global automotive business. Profitable and long-term survival of the domestic automotive industry is highly dependent on acquiring technological competencies. This requires R&D efforts, not only to come up with new technology but also to create an environment that can absorb new technologies.

According to Stumpf & Vermaak (1996, p.8), countries like South Africa could mitigate against production location disadvantages by increasing their productivity through technology upgrade given its high percentage contribution towards production productivity (Table 13). It is not impossible for a country like South Africa that has some advantage in terms of resource endowment, to offset historical production inefficiencies by increasing the contribution of technology to its overall industry productivity.

Factor	**% Contribution**
Technology	38.1
Capital	25.4
Labour quality	14.3
Economies of scale	12.7
Resource allocation	9.5

Table 13: Factors contributing to productivity increase
(Stumpf & Vermaak, 1996, p.8)

Quoting Porter (1990) Stumpf & Vermaak, (1996, p.15) emphasised that: "National productivity is created not inherited. It does not grow out of a country's natural endowment, its labour pool, its interest rates or currency value as classical economists often insist. A nation's competitiveness depends on the capacity of its industry to innovate and upgrade".

Technology plays a bigger role in the creation of national wealth than physical resources and it assumes a self-multiplier effect. It is important that decision makers, including politicians, educationists, industrialists, organised labour etc. fully grasp and understand the interaction between the elements of economic growth, resource utilisation, and technology and that national policies are tailored towards this end (Stumpf & Vermaak, 1996, p.6).

Achieving competitiveness is closely related to and intertwined with technology progress. Global competitiveness is inseparably linked to productivity improvement and technology upgrade (Stumpf & Vermaak, 1996, p.7). Carayannis & Roy (2000, p.287) postulate that a firm's long-term competitiveness is directly proportional to its speed and acceleration of innovation. Global technology improvement has led to a decrease in product life cycles. Facilities, equipments and worker skills are rendered obsolete long before their useful lives have been realised (Merrifield, 1989:p.71). In order to remain competitive, firms have to innovate continuously and need to ensure that they realise a positive return to innovation-related investment over shorter periods. Innovation, however, requires substantial R&D layouts, which small firms may not be able to afford or rationalise. As such, innovation is more feasible with big firms (Özçelik & Taymaz, 2004, p.410). Frankema & Lindblad (2006, p.316) point out that because R&D often requires substantial investment with a high risk on its returns, governments have to play a key role in encouraging and facilitating R&D.

Specific to the automotive industry, there is a general tendency for R&D and innovative activities to be centralised at the headquarters of the parent company for both strategic and economic reasons. This tendency is a major constraint to national government efforts to kick-start R&D activities and innovation in the domestic industry. Innovation is a long-term, high-risk form of investment, but one which is necessary for industrial survival and profitable growth (Merrifield, 1989, p.73; Papadakis, 1995, p.571). Innovation is a necessary activity that late developing countries, including South Africa, have to undertake in their quest to become competitive. It was against this background that the South African government introduced the PAA as a separate incentive based on the value of investment related to state-of-art asset investment, R&D and technical expertise capitalised expenditure. The assumption was that the incentive would encourage the above forms of investment and hence contribute towards efforts to make the domestic automotive industry competitive in the long term.

4.5 Investment under the PAA

The PAA was introduced in 2000 but investment as far back as 1996 was eligible for the incentive. A wide range of investments, including advanced production equipment and world-standard water-based paint plants, have benefited from the PAA.

The nature of investment undertaken has a bearing on the process towards achieving competitiveness by an industry. According to Waddock & Graves (1994, p.11), R&D investment as opposed to capital investment is associated with improved industry competitiveness. Investment in plant, machinery and tooling is important in the realisation of short to medium term profitability of firms, but in the long run it is the R&D investment and the subsequent potential to innovate that is likely to determine industry competitiveness (Fan, 2006, p.367; Özçelik & Taymaz, 2004, p.410; Koschatzky et al, 2001, p.312; Lee, 2000, p.493). From both the perspectives of developing technological capabilities or facilitating assimilation of new external technology, R&D is a critical determinant of industry competitiveness in the long term (Gustavsson et al, 1999, p.1501). R&D investment intensity can also be indicative of the willingness of firms to commit themselves to new products and improved processes within a particular location (Waddock & Graves, 1994, p.4). By deciding to undertake R&D and innovation activities, enterprises signal the importance they attach to a location in terms of future competitive strategy.

Investment in R&D is one of the main determinants of innovative capacity. According to Gustavsson et al (1999, p.1501), cumulative R&D expenditure is a proxy for knowledge capital stock, an important determinant for new technology diffusion, an aspect critically important in the automotive business. For a domestic automotive industry to continue supplying automotive products competitively, it has to keep pace with the ever-improving technological specifications of global automotive vehicle manufacturers. Innovation is a critical element in achieving both production processes and resultant products that meet global standards (Koschatzky et al, 2001, p.312). Hence, for any industry that is focussed on the achievement of global competitiveness, there should be some indication that R&D and innovative activities are taking place or at least that there are efforts to facilitate easy diffusion of new external technologies.

In the realisation of the role that R&D and innovative activity can play in the domestic production of competitive automotive products, the South African government widened the scope of investment that could benefit from the PAA incentive dispensation to include R&D and related expenditures such as technical assistance and external expertise expenditures. The generic nature of the PAA, in terms of the investment that could qualify for the incentive, meant that the decision on the form of investment to be undertaken was left to the local industry. The industry could opt to invest more in plant, machinery and equipment or could decide to dedicate a reasonable budget to R&D activities. Since the offer of a generic industry investment incentive and an increase in investment does not guarantee increase in R&D investment, Government had to simply watch and see what type of investment would be enabled by the incentive. The PAA being a non-targeted investment incentive could, contrary to its objective, potentially lead to enterprises switching to less costly technological investment that yields quicker returns on investment in the short term at the cost of long-term competitiveness (Zhu et al, 2006, p.51). In this regard, the nature of investment that has taken place under the PAA dispensation can provide insights on the extent to which the PAA is supporting the process of realisation of the competitiveness objective of the South African automotive industry.

Since the inception of the PAA, investment in the industry has accelerated. Between 2000 and 2004, total investment increased more than twofold. However, corresponding investment in R&D activities has been minimal. Investment in plant, machinery and tooling constituted more than 80% of the total annual investment of vehicle manufacturers. Investment in support infrastructure that included R&D was less than 10% of total expenditure (Table 14). Land and buildings accounted for the rest of the investment.

Year	Total Investment (Rm)[1]	Investment in support infrastructure (incl. R&D) as a % of total OEM investment	Investment in plant, machinery and tooling - as a % of total OEM investment
1995	847	9.2	86.6
1996	1,171	11.1	85.0
1997	1,265	8.8	81.0
1998	1,342	10.4	85.2
1999	1,511	7.6	87.0
2000	1,562	9.0	83.9
2001	2,078	11.8	86.6
2002	2,726	9.6	84.8
2003	2,325	8.3	85.5
2004	3,577	10.1	86.9

Table 14: Investment expenditure by South African vehicle manufacturers - 1995 to 2004

(Department of Trade and Industry South Africa, 2004 and NAAMSA Annual Report 2001/2006, p.15)

The low level of R&D in the automotive industry is in line with the findings of the South African Innovation Survey of 2001, which showed that 51% of firms in the country were not engaged in R&D in terms of persons working on R&D activities (Table 15). On average firms in South Africa allocated less than 2% of their annual turnover to R&D innovation activities (Oerlemans et al, 2003, p.60). The percentage of gross domestic expenditure on R&D has remained below 1% of the country's gross domestic product, lower than most developed countries (Department of Science and Technology, 2005). On average, developed countries spend 2% of their GNP on R&D.

R&D Intensity*	Percentage of firms	Cumulative percentage
0%	51.2	51.2
0.01 to 1.50%	14.9	66.1
1.50 to 3.00%	16.9	83.0
3.00 to 4.50%	8.9	91.9
4.50 to 6.00%	1.4	93.3
6.00% or more	6.7	100

*R&D intensity refers to the percentage of workers in the total workforce of an organisation performing R&D activities

Table 15: South Africa's R&D intensity in 2000

(Oerlemans et al, 2003, p.60)

Considering the type of investments that have benefited from the incentive thus far, as well as the national effort towards R&D, the potential of the PAA to support the industry's progress towards sustainable global competitiveness appears to be weak.

In terms of actual industry competitiveness, industry performance indicators show mixed results. According to the European Competitiveness Report (2004), industry competitiveness can be adjudicated based on the extent to which an industry has defended, and/or gained market share in open markets relying on price and/or quality of its goods. Hence, common indicators for assessing industry competitiveness include the growth rate or increase in domestic market share of locally produced vehicles and export growth rates (Narayanan, 1998, p.219). The weak support of the competitiveness process by the PAA seems to be compounded by diminished ability of the domestic industry to defend its share of the domestic automotive market. The domestic market share of locally produced vehicles decreased from 93.2% in 1995 to 71.6% by 2004 (Table 16). According to the 2005 sale figures released by NAAMSA, the sale of locally-produced vehicles increased by 19.6% only, while the sale of imported cars increased by 155% from 2004 to 2005.

Year	**Domestic market share of locally produced vehicles (%)**	**Vehicle export – Annual growth rate**
1995	93.2	-
1996	88.7	-26.7
1997	85.6	69.4
1998	81.1	32.3
1999	81.5	130.6
2000	81.3	13.9
2001	77.9	59.2
2002	75.8	15.7
2003	77.0	1.1
2004	71.6	-12.8

Table 16: Domestic market share of locally produced vehicles and vehicle export growth rate in South Africa
(Calculations based on data from NAAMSA Annual Report 2006)

On the other hand, industry realised reasonably high growth rates in vehicle exports between 1997 and 2001 (Table 5), indicating that more automotive products from South Africa were being put on the global market. In the context of the automotive industry in

South Africa, however, export growth rates can be a weak proxy for international competitiveness. The offer of export-based import rebate credit certificates, as an incentive under the MIDP, cushions domestic vehicle manufacturers from competitive pressure. Although increase in exports is a desirable effect of the MIDP, one has to take into account government support received on exports before a statement on industry competitiveness based on an increase in exports can be made.

Still, if one is to consider the industry trade balance, as another proxy of industry competitiveness, it is unambiguous that the industry still has a long way to go before it can be considered competitive. Oughton (1997, p.1486) recognises that deterioration of trade balance and reducing world export are indicative of declining competitiveness, citing the case of the UK between 1985 and 1995 as a period characterised by the UK becoming less competitive. "In short, the malaise of the UK economy was poor competitiveness" (Oughton, 1997, p.1486). South Africa's automotive industry trade balance has been deteriorating since the inception of the MIDP and the status quo was not helped by the introduction of the PAA. Continued deterioration in the industry trade balance puts into question sustainability of industry growth and achievement of the competitiveness objective.

It should, however, be noted that the PAA has played a role in supporting the industry rationalisation process. To the extent that rationalisation of production can contribute towards industry competitiveness through reduction of average costs, the PAA might have had an indirect impact on supporting industry competitiveness. Applicants for the incentive have to present a business plan in which they have to state their planned rationalisation process. Issuing of subsequent certificates is dependent on performance not deviating excessively from or showing an improvement on the initial projection. Effectively, the PAA provided a mechanism through which Government could observe some details associated with the performance of vehicle and component manufacturers towards achieving MIDP objectives. Nevertheless, despite the increase in domestic vehicle production, market penetration of imported vehicles brings into question the extent to which realisation of higher production volumes through the rationalisation process can translate into industry competitiveness.

4.6 Impact of the PAA on an industry performance

Industrial policies like the PAA dispensation that support technological progress work in tandem with other factors, including but not limited to macroeconomic, education, science and technology policies (Figure 6). It is therefore important to note that how the PAA affects industry performance, in terms of competitiveness-oriented investment, is influenced by a number of other national policy stances that are not industry specific.

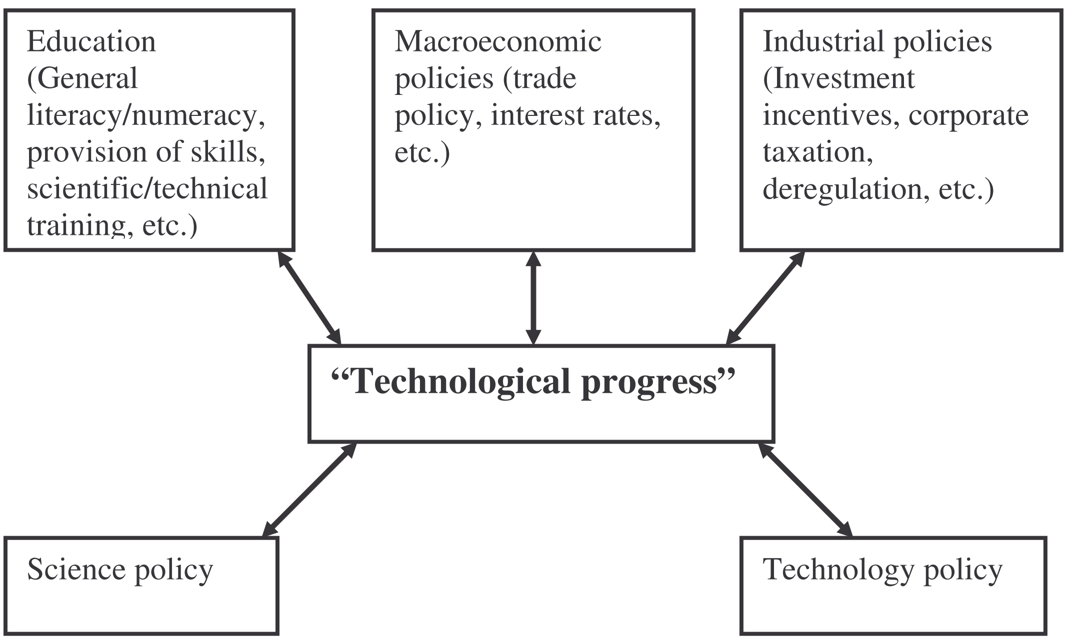

Figure 6: Policy and technological progress
(Clark & Guy, 2000, p.381)

From an industry perspective, the PAA does not operate in isolation of other MIDP incentives and the general automotive policy framework in South Africa. The theoretical underpinnings of the MIDP are complex. The dynamic relationship between various incentives and industry performance indicators is unclear. It is quite difficult to identify the cause and effect of the various industry variables of the MIDP policy framework (Flatters, 2002, p.2; Bell & Madula, 2003, p.vii). The PAA adds to this complexity. To make an unqualified statement on the effectiveness of the incentive requires untangling the complexity of all factors at play in the industry as a starting point. The immediate industry variable that the PAA impacts on is the level of industry investment, yet the offer of investment incentives alone is not a significant determinant in the local investment decision in the automotive industry (Rhys, 2000, p.3). The reasonable investment by global OEMs in the South African automotive industry, despite comparatively low levels of investment incentives, attests to the fact that some other fundamentals necessary for attracting investment could be in place. Again, the increase in investment does not guarantee industry competitiveness.

Another important dimension relevant to our analysis is the recognition that the South African automotive manufacturing industry cannot be viewed in isolation of global automotive dynamics. With the automotive industry being highly integrated globally, national sovereignty is almost inapplicable. One can no longer talk of a South African automotive industry but rather of the automotive industry in South Africa (Rhys, 2000, p.1). The structure and trends in the global automotive industry reveal that continued participation in and benefit from the global value chain will be dependent on the extent to which entities at each level of the industry hierarchy enhance their productive capabilities to meet increasing demands placed on them by the market dynamics. Local vehicle manufacturers will operate according to strategies set by their parent companies in the developed world. Component manufacturers will carry the biggest share of investment activities. In South Africa vehicle manufacturers make most industry investments. This may have to change if the industry is to align itself to global trends. Strategic access to vital core competencies will play a major role in survival in the future global automotive business. Building lasting relationships with the right partners in the global automotive business will also play a critical role. The success of the PAA is dependent, in part, on how the incentive will fit in and affect global automotive dynamics at play in the domestic industry.

Our analysis is based on a ceteris paribus principle, but points to the complexity of supporting automotive competitiveness and that some industry competitiveness-determining factors are outside the MIDP framework. It is important that policy makers acknowledge the limitation to support industry competitiveness via the MIDP in general and the PAA in particular. The existence of other competitiveness-determining factors and other industrial policies does not refute the observation that industry performance under the PAA shows no concrete evidence of progress towards sustainable competitiveness. According to Clark and Guy (1998, p.364), industry profitability and survival remain the ultimate indicators of competitiveness. Without evidence that the South African automotive industry can remain profitable and survive without Government support, one cannot conclude that the industry is on the global competitiveness graduation path.

4.7 Synthesis

Sustainable industry competitiveness is achieved by advanced technology, and developing such technology is costly in terms of time and financial resources (Zhu et al, 2006, p.66). The offer of an investment incentive may not be influential enough to motivate a profit-oriented industry to invest in R&D and innovation activities. This seems to be the case with the PAA for the South African automotive industry. The industry has increased its investment in production equipment and tools to produce vehicles and components to meet international standards, but with no visible effort to improve competitiveness in the long term. The offer of a generic investment incentive like the PAA, seems to have a significant and positive effect on industry investment, but has revealed limited ability to support the process of long-term industry competitiveness through R&D and innovation activities. The success of the PAA in supporting the competitiveness objective of the South African automotive industry will ultimately depend on the extent to which the incentive will facilitate the integration of the local industry into the global value chain. Trends in the global automotive business reveal that acquisition of technological capabilities to meet 'new' supply and market requirements will be a decisive factor in this regard. Government needs to have a formal means to assess the extent to which its policy intervention is indeed supporting the industry's competitive objective. This requires having formal models in place that links government interventions and competitiveness indicator variables.

5 Methodology and Research Design

In this chapter the methodological approach used in the study is justified and explained in section one and two. The research protocol, including data collection and analysis, is presented in section three. The chapter ends with a conceptualisation of the MIDP incentive mental model.

5.1 Methodological choice

5.1.1 MIDP incentives as a complex system problem

The choice of methodology for a research project depends, in part, on the research question(s) to be answered, the nature and extent of data availability and implicitly on how familiar the researcher is with this particular methodology. One of the problems confronting policy-makers in South Africa's automotive industry is lack of a formal policy model upon which new policy initiatives can be based. Policy intervention in the sector is often based on intuition and consensus building. Specific to the country's automotive industry, policy changes under the MIDP dispensation are often based on a comparison between industry performance and the conceived desired situation. If Government perceives the gaps between the desired and actual industry performance, it undertakes remedial measures to bridge these gaps. Sterman (2000, p.10) refers to this policy intervention approach as the event-oriented worldview (Figure 7). The approach does not acknowledge that actions often have reactions and that reactions change the policy environment in which policy decisions are being exercised. It focuses on the symptoms of the undesired outcome rather than trying to understand what could be generating the unwanted outcome.

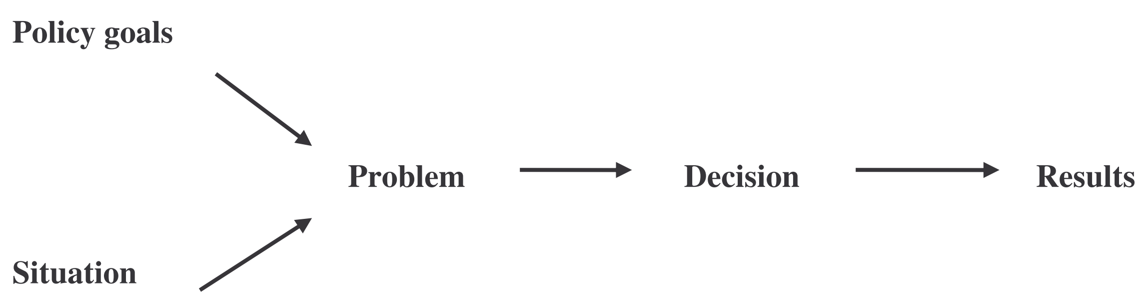

Figure 7: Event view of the world
(Sterman, 2000, p.10)

Though such an event-oriented view of the world can work in the short term, without understanding the cause of the undesirable performance behaviour, corrective policy intervention is almost impossible to devise. The approach increases the risk that some policy interventions may end up exacerbating the problem at hand without the knowledge of the intervener (Thomas, 1974, p.90).

It should be noted that for the MIDP, there are mechanisms in place to monitor the performance of the programme; however, it is exceedingly difficult to understand causes of unwanted outcomes under multiple and non-linear cause-effect relationships including feedbacks. Hence focus of policy discussion is often on industry outcomes. By focusing on industry outcomes, South Africa's automotive industry support model overlooks systemic interdependencies and feedback effects within the industry that have a bearing on industry behaviour. Yet, such factors have a bearing on industry performance in general. Sterman (2002, p.504) contends that the narrow event-oriented worldview is the root cause of well-intentioned efforts to solve pressing problems creating unanticipated outcomes – a phenomenon also referred to as policy resistance. Policy resistance is a central issue of concern in systems dynamics methodology and widely referred to in policy work. According to Meadows (1982, p.99) policy resistance occurs when policy intervention leads to delay, dilution, or defeat of the intended purpose. It is a tendency for intervention to be defeated by the response of the system to the intervention itself (Sterman 2000, p.3). Policy resistance often leads to the opposite of the intended results (Forrester, 1969). System dynamics singles out policy resistance as the main reason behind ineffective policy intervention. Forrester (1991) argues that as high as 98% of policies in a system have little effect on the intended systemic behaviour because of the ability of the system to compensate for changes in most policies.

The workings of the MIDP incentives demonstrate interrelationships between the automotive industry sectors and industry performance variables without explicit cause and effect. For example, vehicle assembly is linked to the domestic component sector through its supply of components to locally assembled vehicles. Increase in component manufacturing costs affect the overall cost of manufacturing of vehicles in South Africa. In terms of government incentive to the industry, import rebates to OEMs may reduce their production costs, through a downward pressure on the cost of imported OEs. On the other hand, the reduction in overall production costs of vehicles in the country may increase industry competitiveness, leading to industry growth. Some of the benefits of vehicle manufacturing may accrue to the local component sector by way of bigger markets for its products. These industry relationships are not static and independent, but are changing over time and are often non-linear and interdependent on each other. Such forward and backward relationships, changing with time, constitute a complex system. Policy design and intervention in complex situations necessitate use of special analysis tools that can capture feedback effects, non-linearities and time lags. Sterman (2000, p.5) suggests that policy interventions in complex systems require:

- Tools to elicit and represent mental models about the problem of interest
- Formal models and simulation methods to test and improve the mental model, design new policies and practise new skills
- Methods to sharpen scientific reasoning skills, improve group processes, and overcome defensive routines.

This approach is advisable due to the complexity of policy work as it cannot often be reduced to definite natural science laws and econometric models. Economic policies pursued by different countries are unique and are a function of a set of circumstances peculiar to a country and are intended to meet sets of objectives that cannot easily be reduced into functions to be optimised. Furthermore, world circumstances are always changing. Therefore, replication and generalisation of particular research findings, the two strongest arguments for most dynamic optimisation and pure econometric approaches, become less important (Sterman, 1991, p.6). Highly structured research design limits flexibility required for policy analysis and may serve only academic purposes, but not practical ones. The topic of incentives in the South African automotive industry is generating much debate; the objectives to be achieved are clear to stakeholders, but no party is sure whether the policy action being undertaken or to be implemented will achieve these objectives. If the issue was to be reduced to a dynamic optimisation function, it is likely that it will be practically impossible to get a mathematical solution for the function. Most importantly, it is likely that stakeholders will disagree on which variables must be included in the function or set of functions due to their diverse interests.

In essence, the offer of investment incentives to the South African automotive industry exhibits three distinct characteristics: Firstly, it is a feedback problem. An incentive is put in place by government; industry performance is observed and subsequently evaluated against the initial objectives. Policy action on incentives is adjusted or maintained depending on the deviation between results and initial objectives. This process constitutes a closed loop as illustrated in Figure 8 below:

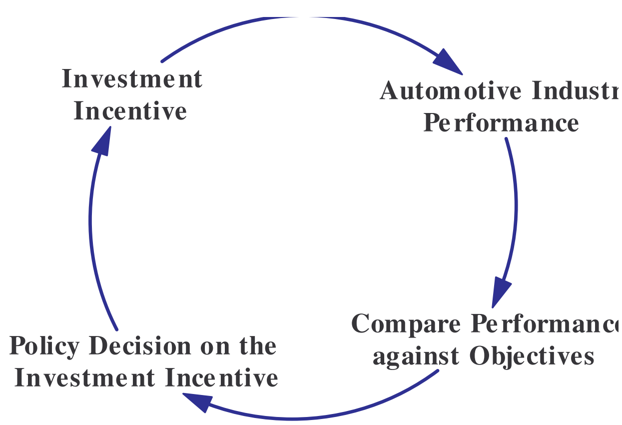

Figure 8: Closed investment incentive loop
(Adopted from Coyle, 1996, p.4)

Secondly, the results of the incentive are a function of systematic interactions between variables in the industry structure. There is a systematic way in which variables like investment, employment, local content use, size of domestic and international market affect each other to determine the overall performance of the industry. Thirdly, there are some broad rules that govern policy decisions within the industry that can be identified. These relate to the positive relationship between investment incentive and investment, for example. The above characteristics of the automotive investment incentive dispensation constitute a classical system dynamics problem; hence, it creates a strong basis for the use of system dynamics as a preferred methodology in answering the research question. System dynamics methodology is useful and applicable to policy problems where the dynamics have to do with the internal structure of the system (Barlas, 2002, p.1141).

The formulation of the MIDP, despite being a consultative process, put less emphasis on how incentives were to lead to industry competitiveness in the long term. As a result, processes, systemic factors and feedback effects within the industry have received little attention in the management and implementation of the programme. These factors, however, are critical in understanding industry performance. The future of the MIDP requires a re-examination of the initial thinking of the programme and a search for potential causes of unexpected industry outcomes, including systemic factors. It is critical to come up with a formal MIDP model that is cognisant of interrelationships between, and feedback effects among, industry variables and to reflect on how these systemic and process factors enrich the MIDP policy framework. System dynamics modelling often increases understanding of the problem at hand and is a basis for devising better policies (Vennix, 1996, p.3). The need to understand how industry structure is influencing the effectiveness or otherwise of incentives further reinforces the adoption of a system dynamics methodology for the research project.

5.2 System dynamics and system dynamics methodology

5.2.1 System dynamics

The system dynamics school of modelling has its own set of strict rules on what constitutes a proper professional procedure of the modelling process. The approach probably consists of a more internally consistent system of guidelines and standards than in other comparable schools of modelling (Randers, 1980a, p. xvi). Although models, in general should have a number of desirable attributes, each modelling approach tends to emphasise some, but not all. System dynamics as a unique modelling methodology is strong in increasing understanding of the observed phenomenon, and in establishing consequences of different options available at a decision point (Randers, 1980a, p.xvii). The system dynamics approach is inclined towards refutationism. Refutationism as a way of thinking in the knowledge acquisition debate holds that scientific knowledge consists of conjectures that are refutable, vulnerable to empirical error and that knowledge advancement is achieved through the process of adjusting, or change of mistaken conjectures to overcome refutations (Bell & Bell, 1980, p.4). The refutationism approach puts more weight on the thinking process than on data per se. In line with refutationism, the system dynamics field suggests that the first stage of generating knowledge is to think about the issue at hand. The refutation method requires the search for causal explanations, which in turn opens up the opportunity for objective interrogation of the presupposed causal relationships, and in the process new knowledge is created.

Although sometimes interchangeably used, system dynamics (SD) as a field of study and as a methodology are two different things. The system dynamics field deals with the study of and the managing of complex feedback systems, such as one finds in business and other social systems. In the SD field, system has a specific meaning related to the feedback effect:

> *"While the word system has been applied to all sorts of situations, feedback is the differentiating descriptor here. Feedback refers to the situation of X affecting Y and Y in turn affecting X perhaps through a chain of causes and effects. One cannot study the link between X and Y and, independently, the link between Y and X and predict how the system will behave",* (System Dynamics Society web page, www.systemdynamics .org).

System dynamics as a methodology is grounded in control theory and modern theory of nonlinear dynamics. System dynamics is also a practical tool that policy makers can use to help solve important problems (Sterman, 2002, p.503). System dynamics provides a means by which to capture complex relationships and feedback effects within a set of interrelated activities and processes (Vennix, 1996, p.21). Its presentation has a user-friendly interface that encourages non-academics to internalise the logic behind the model. In addition, the approach allows the use of quantitative and qualitative data; hence, it is not limited in its use when quantitative data is unavailable. Specialised software in system dynamics modelling allows scenario simulations, in fairly easy and understandable steps, an aspect critically important in applied research.

5.2.2 Principles of system dynamics methodology

The purpose of SD study is to understand causes of dynamic problems and search for high leverage policy interventions to alleviate them. According to Barlas (2002, p.1134), the SD approach is based on the following principles:

1. The existence of causal relations rather than mere statistical correlation: SD aims at understanding the underlying cause of dynamics behaviour rather than correlation or forecasting.
2. The adopted causal relationships are based on a “ceteris paribus” assumption despite the notion of causality being a debatable notion.
3. The time element should always be acknowledged. Over time, circular causality takes place, creating feedback effects. Without factoring in the time element some feedback effects will be suppressed. The relationship between population and birth rate, for example can be taken to be one-way and static. Over time, however, it changes to a dynamic feedback problem as birth rate begins to affect population. Often, there are intervening factors between the two variables under consideration for a feedback loop to form.
4. Dynamics behaviour pattern orientation: The problems of focus for SD modelling should be characterised by undesirable performance patterns rather than isolated events. It is recognised that events cannot be understood in isolation from their past dynamics. The goal of an SD project is therefore to construct a hypothesis that explains why and how the dynamic pattern of concern is generated.
5. Endogenous perspective: The internal structure should be the main cause of dynamic behaviour of concern.

6. Systems perspective: The dynamics of the variables must be closely associated with the operation of the internal structure of a system. The term 'system' is used holistically to refer to a collection of interrelated elements that constitute a meaningful whole. Elements within a system should be able to interact in a meaningful way to serve a purpose or to play a particular recognisable role. Coyle (1996, p.4) refers to a system as a collection of parts organised for a purpose. It follows that the model boundary should be wide enough to have an internal structure rich enough to provide an endogenous account of the dynamics of concern. The underlying philosophy of the endogenous approach is that even if there could be some external influence, the problematic behaviour arises because the internal structure of the system cannot appropriately cope with the external influence.

5.2.3 System dynamics modelling methodology and tools

System dynamics methodology is a method by which one can model process structures and analyse their behaviour through the investigation of how resources flow, accumulate and interact in a system over time in dynamic interdependent feedback loops (Vanderminden, 2006, p.17). A system dynamics approach deals with problems that are dynamic in nature i.e. changing over time and are associated with the internal structure of an identifiable system. The endogenous characterisation of problems under the system dynamics approach points to the fact that policy makers can influence systems to behave in desirable ways. As a means of investigating systemic dynamic feedback problems, system dynamic methodology builds models of selected aspects of a system to study specific behaviour.

SD methodology takes cognisance that the fact that most of the information needed to understand and later on devise solutions to a problematic situation lies in knowledge and assumptions embedded in the minds of those who are active participants in the problematic situation. The specific set of information and assumptions in people's minds about an aspect of interest is referred to as a mental model. Caulfield and Maj (2002, p.26) define a mental model as an enduring and accessible, but limited, internal conceptual representation of an external system whose structure maintains the perceived structure of that system; it is a filter through which we interpret experiences, evaluate plans, and choose among possible courses of action (Sterman, 2000, p.16). A mental model contains ideas, opinions, assumptions, generalisations, with respect to a policy problem and related issues (Vennix, 1990, p.16). It describes facts and concepts that constitute one's understanding of a particular phenomenon (Sterman, 1991, p.210). Mental models are the starting point of formal system dynamics modelling and the modelling process brings to the surface mental models driving a particular system (Caulfield & Maj, 2002, p.26)

System dynamics uses two main tools in the modelling process, causal loop diagrams and stocks and flow.

5.2.3.1 Causal loop diagrams

Causal loop diagrams are a pictorial depiction of the relationships of a systemic situation of concern. The diagrams are referred to as 'causal' because their first objective is to capture the causal relationships between variables and 'loops' because they also capture feedback effects among the variables under study. Feedback is one of the core concepts of system dynamics, yet a mental model seldom takes into cognisance feedbacks while determining dynamics of a system (Sterman, 2000, p.137). Casual diagrams provide an important means of capturing feedbacks in a system and make such effects explicit.

A standard form of presenting causal relationship is by using arrows and signs at the end of the arrows. The arrow presents a cause-effect relationship between the two variables connected. The interpretation is that the variable at the tail of the arrow has a causal effect on the variable at the arrowhead. The sign at the arrowhead specifies the nature of the causal effect, holding other factors constant. The '+' shows that the two variables move in the same direction when the causing variable changes. The '-' shows that the two related variables will move in opposite directions when the causing variable changes (Richardson, 1997, p.249). For example, the causal relationship between the price of a product and its demand will be depicted by an arrow from the price of the product to the demand of the product with a negative sign at the arrow end. This causal relationship, interpreted as the increase in the price of product, will cause the demand of the product to decrease, holding other factors constant.

Although loops often consist of a number of causal relationships, they take a unique sign - either positive (self-reinforcing) or negative (self-correction). The sign of the loops is also referred to a loop polarity or identifier. It is indicative of the overall effect of the feedback process. Reinforcing loops tend to amplify whatever is happening in the system, while self-correction loops tend to counteract and oppose change (Sterman, 2000, p.12; Richardson, 1997, p.248). Caution should, however, be taken in interpreting the polarity of a loop vis-à-vis what happens in reality. Polarity of casual loops describes what happens if there was to be a change in one of the related variables under consideration, holding other factors constant. Polarity may not necessarily describe what actually happens in reality. Sterman (2000, p.139) cautions that what actually happens is a function of the combined effect of other affecting factors that are held constant in deciding on the loop polarity. Also if the variables under consideration happen to be flows and stocks, without the explicit information on the rates of change, one cannot be sure that a positive change in the flow will indeed cause the stock to move in the same direction. Again, one has to keep in mind that correlation does not constitute causality. However high the R^2 value between variables and however significant the coefficients of a regression could be, due care should be taken before interpreting a relationship as causal (Sterman, 2000, p.142). A good example to illustrate this point is related to the frequency of car accidents during the rainy season due to slippery roads and the purchase of warm clothes. The incidence of road accident data is likely to have a high positive correlation with warm clothes purchases. If one was to interpret this relationship as causal, it may lead to an erroneous recommendation to reduce the purchase of warm clothes during the rainy season in order to reduce accidents. A summary of notes on causal loop symbols are presented in Figure 9.

Notes on the causal loop diagrams:

- → The arrows denote a cause-effect relationship between the connected variables
- "+" at the head of the arrow denotes that the connected variables change in the same direction, i.e., when one variable increases, the other variable will also increase and vice versa.
- "-" at the head of the arrow denotes that the connected variables change in opposite directions. When one variable increases, the other will decrease and vice versa.
- (+) denotes an overall reinforcing effect
- (−) denotes an overall tendency towards an equilibrium

Figure 9: Description of causal loop symbols

5.2.3.2 Stocks and flows

Another important tool in system dynamics modelling critical in quantitative modelling is the presentation of variables in the form of stocks and flows. This requires that the two types of variables be correctly distinguished. Stocks refer to accumulations over time. Stocks represent conditions within a system at any particular time of reference. Flows, on the other hand, represent the rate of change of stocks in the system. They are a set of activities that cause conditions to change (Barlas, 2002, p.1144; Richmond, 2004, p.15). Whereas stock tells you the state of affairs in a system, flow informs on how things are going (Richmond, 2004, p.35). Flows do not have an impact on stocks but rather fill or drain the stock. When you freeze time, stocks remain while the flows cease to exist. Hence, population is a stock but death and birth are flows.

In diagrammatic form, stocks are presented as a rectangle while flows are presented as arrows with a 'tap' to signify that the flow can be regulated. Flows can be uni- or bi-flows. Uni flows flow in one direction while in the latter the flow can be either way. Clouds represent the sources and sinks for the flow (Figure 10). "A source represents the stock from which a flow originating outside the model boundary arises, sinks represent the stocks into which flows leaving the model boundary drain" Sterman (2000, p.192).

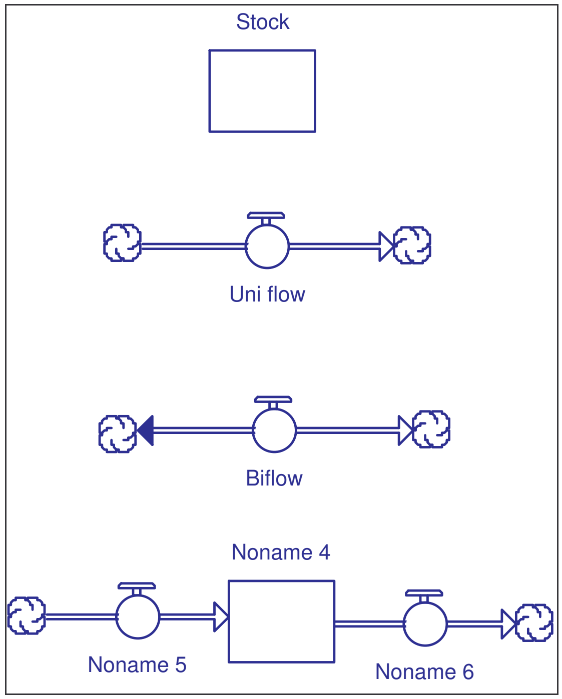

Figure 10: Generic presentation of stocks and flow diagrams

> *"Stocks play a central role in dynamics feedback management problems. Their control is often the primary responsibility of managers … Yet controlling stocks is subtle and dynamically complex by their nature"* Barlas, 2002, p.1146.

Using causal loop diagrams to capture systemic relationship, system dynamicists are able to develop qualitative models that provide insight on how the internal working of a particular system is influencing performance. Although some authors claim that qualitative modelling, using causal loops, should be treated just as the first step of the modelling process, its value in terms of making explicit the logic of intervention in complex problematic situations is not contestable.

Stocks and flow allows quantification of SD models and subsequent scenario simulations. Whereas qualitative modelling is informative on the general logic of intervention, the "what if" questions of complex situations can only be answered through quantitative modelling, using stocks and flows.

5.2.4 Steps in system dynamics modelling

There is a consensus on system dynamics modelling stages. The few differences noticeable among authors are more on the demarcation of the stages. A comprehensive comparison of how different authors present the modelling process was presented by Luna-Reyes & Anderson (2003, p.275). They point out that "although the ways of grouping the activities vary among the different authors, the activities considered along the different stages remain fairly constant across them, allowing the building of a comparison". The comparison table of states of SD modelling among major authors on the subject is presented in Table 17.

<table>
<tr><th>Randers (1980b)</th><th>Richardson and Pugh (1981)</th><th>Roberts et al (1983)</th><th>Wolstenholme (1990)</th><th>Sterman (2000)</th></tr>
<tr><td rowspan="2">Conceptualisation</td><td>Problem definition</td><td>Problem definition</td><td rowspan="2">Diagram construction and analysis</td><td>Problem articulation</td></tr>
<tr><td>System conceptualisation</td><td>System conceptualisation</td><td>Dynamic hypothesis</td></tr>
<tr><td>Formulation</td><td>Model formulation</td><td>Model presentation</td><td rowspan="3">Simulation (stage 1)</td><td>Formulation</td></tr>
<tr><td rowspan="2">Testing</td><td>Analysis of model behaviour</td><td>Model behaviour</td><td rowspan="2">Testing</td></tr>
<tr><td>Model evaluation</td><td>Model evaluation</td></tr>
<tr><td rowspan="2">Implementation</td><td>Policy analysis</td><td rowspan="2">Policy analysis and model use</td><td rowspan="2">Simulation (stage 2)</td><td rowspan="2">Policy formulation and evaluation</td></tr>
<tr><td>Model use</td></tr>
</table>

Table 17: System dynamics modelling process in classic literature
(Luna-Reyes & Anderson, 2003, p.275)

The modelling process in this study was tailored along the steps described by Barlas (2002). According to Barlas (2002, p.1147) the modelling process in system dynamics follows five distinctive steps:

1. Problem articulation (boundary selection): This involves clarifying the problem to be solved and ascertaining what important variables should be included in the model. Emphasis should be put on coming up with a simple model that captures the most important systemic factors. The usefulness of any model often lies in simplifying reality to a level comprehensible to the mind. Other issues to be considered at this level are the reference mode – sets of graphs and data showing the development of the problem over time and proper selection of time horizons.

2. Dynamic hypothesis: The hypothesis is dynamic because it must provide an explanation of the problem in terms of time (how it has developed over time and probably how it is likely to unfold in future). A dynamic systems hypothesis is a working theory of how the problem arose.
3. Formal formulation of a simulation model: Once the problem has been well articulated, an initial dynamic hypothesis formulated, model boundary defined, and a conceptual framework is in place, the next stage is to formulate a simulation - formal model.
4. Testing the model: This involves comparing simulated behaviour with the real world. Testing models using extreme conditions provides an easy way to find out whether the model makes sense.
5. Policy formulation and evaluation: Policy evaluation will involve the changing of parameters, strategies, structures, and decision rules to come up with a more desirable system arrangement.

5.3 Data collection

The system dynamics modelling process makes use of quantitative and qualitative data. Three data types are needed to develop the structure and decision rules of SD models: numerical, written and mental data (Forrester, 1980, p.555)**.** Numeric data takes the form of time series and cross section databases; written data ranges from organisation operation documents and archive documents to minutes of meetings; mental data includes all the information embedded in people's minds i.e. their understanding of how a system of interest works and how decisions are actually made.

5.3.1 Research location

The research was located within the Government Programmes Department of the Automotive Industry Development Centre (AIDC). The AIDC is a government established but autonomous company that was mandated to assist the South African automotive industry attain global competitiveness. The AIDC works in partnership with business, government departments and other organisations to invigorate economic growth via the automotive industry. At the time of data gathering, the AIDC Government Programmes Department supported government administration of the PAA and was the secretariat for the Motor Industry Development Council. The Government Programmes Department provided a centre for data collection on information pertaining to the performance of the automotive industry as it related to the MIDP. As far as PAA administration was concerned, the Government Programmes Department was responsible for receiving PAA applications from vehicle assemblers and component manufacturers. The department evaluated the applications and thereafter recommended to the International Trade Administrative Commission (ITAC) division of the Department of Trade and Industry (thedti) for the release of rebate certificates. The department received progress reports and business plan deviations on PAA benefiting projects, before it recommended the release of subsequent rebate certificates. The AIDC in general and the Government Programmes Department in particular provided an ideal location for relevant data collection, subject to confidentiality restrictions.

5.3.2 Secondary data

The research population of the study consisted of all vehicle and component manufacturing companies that constituted the South African automotive industry. In 2005, there were eight vehicle manufacturers and some 278 first-tier component manufacturers in the country.

Quantitative historical data was collected from thedti and the National Association of Automotive Manufacturers of South Africa (NAAMSA).

Thedti carries out annual surveys to capture industry performance data as part of its monitoring mandate. Although part of this data is confidential, data relating to general trends in industry performance is published in the department's annual publication "Current developments in the automotive industry" and is available in the public domain. Thedti data is triangulated with other internal but confidential data sources, thereby increasing its reliability. Since the researcher was not directly involved in the drafting of the questionnaire sent to industry, an independent assessment of the questionnaire was done to establish the extent to which the elicited data was appropriate to the research question. As the data sought was on industry performance, there was little ambiguity on interpretation of the questionnaire. As such, even if the researcher had prepared the questionnaire, it would not have been significantly different on questions relating to industry performance. One issue of concern on thedti data is its representativeness of the industry. Response to the industry survey questionnaire is voluntary; therefore, the sample size is self-selected. Depending on the number of companies that respond to the survey, thedti data may not be representative of the industry. A review of the 2006 annual survey, however, revealed that the sample size, for vehicle manufacturing, from which data was captured, was indeed representative of the industry. Questionnaires were sent to all eight local vehicle manufacturers in the country; all of them responded. Forty questionnaires were sent to the component sector of some 278 first-tier suppliers, and half of the companies responded.

NAAMSA is the national association of all domestically based light, medium and heavy commercial vehicle manufacturers. NAAMSA is also the representative organisation for franchise holders marketing vehicles in South Africa. NAAMSA membership stood at 25 companies at the beginning of 2006. The association collects performance data from all its members. The data is published in the organisation’s annual reports and is periodically disseminated to the public through press briefings. NAAMSA data was compared with thedti data and in cases of significant deviation between the two data sets, thedti data was preferred.

Industry performance data for estimation of model parameters and rates of change was compiled using thedti and NAAMSA data sets. A summary of industry performance data for South Africa is presented in Table 18.

Year	OEM Investment (R mil)[1]	Production (R mil)	Domestic vehicle market (R mil)	Exports (R mil)	Imports (R mil)	Rebatable Imports (IRCC and PAA) R mil
1990	660	13,636	19,584	800	6,300	
1991	697	12,800	19,379	1,100	6,300	
1992	858	12,238	19,206	1,500	6,600	
1993	400	14,409	21,677	2,300	9,100	
1994	492	15,638	23,705	2,800	12,000	
1995	847	22,236	33,633	4,200	16,400	4,800
1996	1,171	25,079	39,896	5,100	19,200	5200
1997	1,265	29,606	38,852	6,600	17,200	5,851
1998	1,342	25,306	36,359	10,100	19,900	7,415
1999	1,511	27,847	35,146	14,800	22,800	12,445
2000	1,562	38,872	40,593	20,000	29,700	17,761
2001	2,078	42,815	46,895	30,000	38,000	21,622
2002	2,726	55,602	46,928	40,100	50,200	27,307
2003	2,325	64,744	52,236	40,700	49,800	30,416
2004	2,220	71,833	66,353	39,200	58,000	28,938
2005	3,576	82,595	84,982	45,000	72,000	28,968

Table 18: South's automotive industry performance 1990 - 2005

Note: Value of rebatable imports calculated based on estimated PAA qualifying investment and the value of export performance

(NAAMSA, 2001/2006)

Literature on system dynamics modelling does not provide foolproof methods of determining which variables are important in understanding a problematic situation and the nature of causal effect among them. Some SD practitioners have adopted statistical means in ascertaining which variables should be included in particular models and to establish possible cause and effects. The statistical approach is criticised for being too mechanical and abstract to capture complex relationships often dealt with in systems dynamics modelling. There seems to be a general agreement that qualitative data, expert opinion and informed judgment are the best tools for determining variables for inclusion in the model.

> *"During the mid-1970s and early 1980s several system dynamicists undertook studies aimed at determining whether or not econometric techniques could be used to accurately estimate the parameters of a system dynamics model……Results of these studies showed overwhelmingly that under almost all but perfect circumstances, the econometric techniques were unable to accurately recover the model's parameter values",* Radzicki, 2004, p.6.

What is not well explored is the way in which statistical techniques can complement intuition and expert opinion and vice versa in the choice of model variables. For example, whereas SD modelling deals with causal relationships and not correlation, establishing correlation could be the first step towards the qualification of a causal relationship. In other words, correlation is a necessary but not a sufficient condition for a causal relationship. As such, correlation analysis can be used as an elimination method for hypothesised relationships and thereafter qualitative analysis and intuition can be used to confirm or refute causal relationships among those variables that are correlated. In this respect, a correlation analysis of quantitative data was done to ascertain that there was a potential causal effect among the identified key industry performance variables. Table 19 shows the correlation we intended to establish before applying qualitative data and expert opinion to assume causal relationships.

Independent variable	**Dependent variable**
Value of rebatable imports (IRCC)	Investment
Value of rebatable imports (IRCC)	Imports
Value of rebatable imports (IRCC)	Production
Market size	Investment
Market size	Imports
Market size	Production
Market size and Value of rebatable imports (IRCC)	Investment
Market size and Value of rebatable imports (IRCC)	Imports
Market size and Value of rebatable imports (IRCC)	Production
Production	Exports
Production	Employment
Market size	Production

Table 19: Hypothesised relation among industry performance variables

Apart from the relationship between rebatable imports and domestic market, the Pearson correlation coefficients for the above-hypothesised relationships were above 0.5 at a 95% confidence interval. A matrix of correlation coefficients of industry variables relevant to the MIDP incentive model is presented in Table 20.

Independent variable	Dependent variable	Pearson correlation coefficient	Significance level
Value of rebatable imports	Investment	0.87837	0.0004
Value of rebatable imports	Imports	0.93429	0.0001
Value of rebatable imports	Production	0.92862	0.0001
Value of rebatable imports	Market size	0.85359	0.0008
Market size	Investment	0.93365	0.0001
Market size	Imports	0.98056	0.0001
Market size	Production	0.98934	0.0001
Production	Exports	0.96688	0.0001

Table 20: Correlation between automotive industry variables

By implication, since there is a strong correlation between market size and rebatable imports, and each of these variables is individually correlated to investment, it can be deduced that there is a correlation between market size and rebatable imports taken together with investment. The same logic can be extended to the joint correlation between market size and rebatable imports vis-à-vis imports and production. The industry wide correlation and regression analysis of industry performance is included as Appendix 1. Meeting the correlation criteria meant that one could then subject the relationship to qualitative and intuitive rigour to establish causal effect before inclusion in the formal model.

5.3.3 Primary qualitative data

Although numerical and written data could be accessed from thedti databases and ITAC archive documents, subject to confidentiality, the biggest challenge was to access the qualitative mental data. Developing an MIDP incentive model required specific understanding of the intentions of the programme promoters and the assumptions underlying the dispensation. Such data was not explicit in the numerical and written data sources. The research had to come up with creative means to tap into information in stakeholders' minds.

It is widely acknowledged by a number of leading authors on the subject that the most important data required to build a system dynamics model is often qualitative (Luna-Reyes & Anderson, 2003, p.274). Articulation of problematic situations from a system dynamics perspective requires the use of qualitative data. Specific to policy work, subsequent formulation of a dynamics hypothesis and formulation of a qualitative model requires insight into the mental models of role players (Sterman, 2000, p.16; Luna-Reyes & Anderson, p.275). Key variables underlying behaviour of interest resides in the mental database of some of the actors (Richardson and Pugh, 1981, p.19). More often, mental data cannot be accessed directly but must be elicited through interviews, observation and other methods (Sterman, 2000, p.853). The researcher usually needs to interact with people involved in the problematic situation over and above the use of archival research, data collection, interviews and direct observation or participation (Sterman, 2000, p.90). Qualitative data is also useful at the model formalisation stage. It assists in the choice of which variables and structures are important in influencing the reference models and subsequently crucial in answering the research question. Sterman (2000, p.854) cautions that “omitting structures or variables known to be important because of numerical data are unavailable is actually less scientific and less accurate than using your best judgment to estimate their values”.

Quantitative data to support the model building process was collected using two collection techniques: participant observation and discourse analysis. In participant observation, the researcher interacts with the study situation. Standard collection instruments are a notebook and a collection of documents being discussed by the group. Data collected through participant observation can be paired with interview collection in order to unearth individual motivations or behaviour that may not be obvious (Luna-Reyes & Anderson, 2003, p.283).

Discourse analysis, on the other hand, is a qualitative data collection technique whereby one studies interaction of people in the context they occur naturally. The technique often goes hand in hand with and supplements participant observation. From data gathered from participant observation, the researcher selects the pieces of the text related to the problem under scrutiny, followed by a commentary that is a reflection of the wisdom and understanding that the specific text adds to the research effort (Bernard, 1999, p.442). In system dynamics modelling, the text should be describing behaviour over time for a specific variable or a causal structure inside the group's mental model. Qualitative data collection and analysis, when done properly, always bring formality and rigour into the modelling process (Luna-Reyes & Anderson, 2003, p.284).

The uncertainty and complexity of policies can overwhelm a single mind, as policy making is often a group exercise. The researcher had to be aware of the difference in perceptions and expertise of group members. Identifying positions on which there is consensus is one way to control for perception and expertise bias. It is consensus, not compromise, that is a vital element of policy formulation (Vennix 1996, p.5; Hines and House, 2001, p.14), but consensus has to be reached in an objective way. Post-meeting unstructured interviews were also held with contributing representatives to clarify positions upon which there was no consensus at the meeting. The intention was to ascertain that the meeting understood what the participant was trying to convey. This was another means to control communication gaps. It was recognised that there was a risk that members would be emotionally involved with a particular aspect of discussion and hence not reveal objectively what they thought (Collins & Bloom, 1991, p.28-29). The post-meeting interviews were aimed at further mitigating this bias.

In all, the researcher attended 17 MIDC meetings stretching over a period of 30 months (Appendix 2). A digital voice recorder was used to record these meetings. Information was later transcribed according to the following themes relating to the key steps of SD modelling:

1. Research problem identification/ establishment of the reference mode: The intention here was to confirm the problematic situation on which the research problem was based.
2. Working of the PAA: This related to incentive performance in a dynamic environment.
3. Causal effects within the industry: Although not explicitly expressed, special care was taken to capture the causal relationships within the industry, in particular those related to the reference mode. These had to be agreed upon by all stakeholders.

4. Systemic aspects: Under this theme, the researcher was looking for information to validate feedback effects within the industry under the MIDP incentive dispensation.
5. Data issues: Since quantitative data was often available for analysis, under this theme information regarding its completeness, relevancy and shortfalls in relation to the research question was captured.

The qualitative data emanating from the interactions and participation at the MIDC meeting was confidential as such could not be included as part of the study report. It should be noted, however, that in capturing the qualitative data, care was taken to ensure that the views captured were those on which all stakeholders agreed. Given the diversity of interests at the MIDC forums, special care was taken to avoid sector bias and non-agreed upon positions. Consensus is an important issue when it comes to soliciting information from people holding different views (Vennix, 1996, p.2). It is acknowledged that the sample used was self-selected as per the composition of the MIDC and as such its representativeness could be questioned. The nature of MIDC composition, however, ensured that all key stakeholders were represented for it to have a quorum. To a large extent, the MIDC constituted a representative stratified industry sample.

5.3.3 Expert opinion

Apart from the qualitative information that was accessed through the attendance of MIDC meetings, expert opinion was sought from three experts on MIDP incentives. The choice of the experts was a subjective exercise guided by the roles they played in the initial formulation and implementation of the programme, and expertise in system dynamics modelling.

Of all government officials that were involved in the formulation of the MIDP, only two were still employed by thedti. These specifically were selected for interviewing. Unstructured interviews were arranged with them to provide an insight into what motivated the start of the programme and its expectations. Details of the interviewees and dates of the interviews are provided in Appendix 3. Due to the good working relationships created and as the researcher became more familiar with the working of the incentives, the officials offered ongoing clarification on their initial insights. These insights from the people who were involved in the formulation of the MIDP were particularly important in the establishment of a mental model of industry incentives.

The implementation of the PAA had been outsourced to the Automotive Industry Development Centre (AIDC) Governments Department. The researcher was positioned in the same department as part of the PhD Internship. This allowed him to have in depth understanding into the practical administration of the incentive. It also exposed him to data pertaining to the actual performance of the incentive although much of which was confidential and could only be referred to for comparative purposes. Ongoing involvement with the administration of the PAA and interaction with other staff in the department enabled the researcher put into context, issues pertaining to the PAA incentive and how it related to the rest of the MIDP incentives and helped him to identify linkages within the industry, an aspect that had not been explicitly expressed by the governmental officials.

The modelling process also benefited from the input of a system dynamics modelling expert. An expert in system dynamics modelling was approached to advise on the formal model from a technical point of view. In the process, the model structure was validated to a reasonable extent.

5.4 Qualitative conceptualisation of MIDP Incentives model

5.4.1 Establishment of the reference mode

Using both qualitative and quantitative historical data, a reference mode for the research problem was established. The reference mode is the time development of an aspect of interest (Randers, 1980b, p.121). In this study, it was the trend in the industry trade balance after the commencement of the MIDP. The industry trade deficit had been increasing at a significant rate since the inception of the MIDP (Figure 11). The trade deficit trend simulated by the model did not fit actual trade balance well in the first 4 years of the MIDP.

This exception was acceptable; given the time frame for the simulation and that on the whole the simulated trend matched actual trade balance trend.

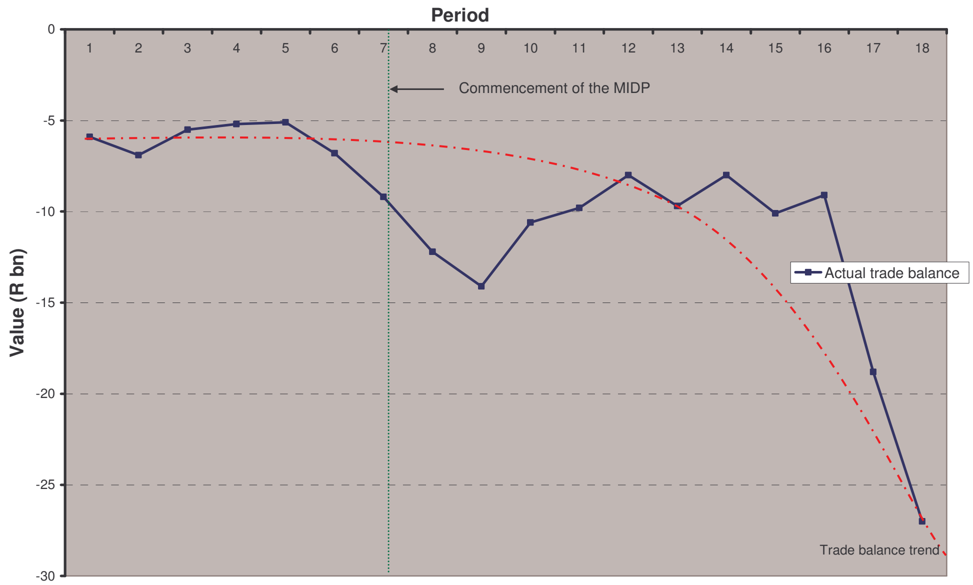

Figure 11: Reference mode for the study of the increasing trade deficit of the South's automotive industry (Period in years)

After establishment of the reference mode, the next step was to develop a model that was capable of reproducing the behaviour of the reference mode. The reference mode helped to keep the model simple and transparent by guiding the discerning process of variables that may not be so useful in explaining the mode. Hence, the focus of the study became oriented towards answering the question of what were the basic causes of the reference mode behaviour (Randers, 1980b, p.123).

5.4.2 Dynamic hypothesis

Since the only way the industry could benefit from the MIDP incentives was to offset duties payable on imports, MIDP incentives encouraged industry imports. This occurred without a commensurate increase in exports. The incentives were, thus responsible, in part, for the increasing industry trade deficit. By implication, industry success in the long term would be jeopardised by the increasing industry trade deficit potential to crowd out domestic production. The reference mode and the basic mechanism of the study constituted the dynamics hypothesis of the study (Randers, 1980b, p.126).

The formalisation process of the MIDP incentive model took advantage of the knowledge of MIDC constituent members, forum policy documents to which the researcher was exposed to when attending MIDC meetings, as well as archive data. As noted by Randers (1980b, p.129):

> *"Most human knowledge takes a descriptive non-quantitative form, and is contained in the experience of those familiar with the system, in documentation of the current conditions, in descriptions of historical performance, and in artefacts of the system"*

5.4.3 Model conceptualisation

The goal of the conceptualisation stage is to arrive at a rough model capable of addressing the relevant problem and for the formulation stage; it is to check that the basic mechanism is included in the conceptual model and that this conceptual model can reproduce the reference mode (Randers, 1980b, p.130). From an SD perspective, the automotive industry in South Africa can be seen as a system; that is, a group of independent but interrelated elements comprising a unified whole. The conceptualization of the PAA SD model started with capturing the static mental model of the MIDP incentives in general.

5.4.3.1 Motor Industry Development Programme mental model

The MIDP policy framework is guided by a uni-directional, static and non-interactive mental model. The model presupposes that providing the automotive industry with export and investment allowances to import automotive products in the country free of duty can influence industry competitiveness and the general economy positively. Companies use rebates to offset import duty payable on vehicles and automotive components in excess of the duty-free allowance. Figure 12 captures the interpretation of the thinking behind the MIDP design.

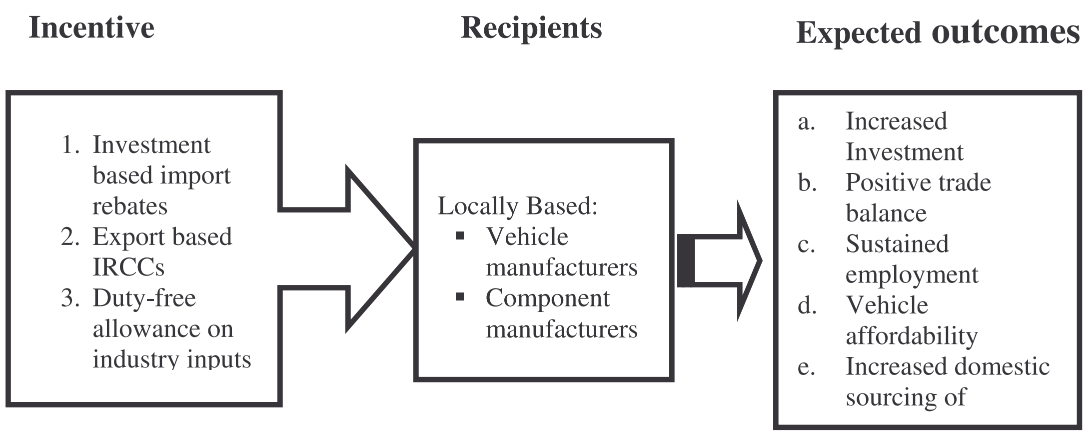

Figure 12: Static uni-directional MIDP incentive model

The MIDP mental model presented in Figure 12 reveals two conspicuous shortcomings from a systems dynamics perspective:

- It does not capture feedback effects between the model variables. The model assumes, for example, a positive relationship between the value of rebates earned and industry production levels, without taking into account that production levels may in turn affect the value of IRCCs through the export variable. Increase in production has a positive effect on export levels through low average cost realisation, and subsequently on the value of export-based IRCCs.
- The model assumes that MIDP objectives as captured by the expected outcomes matrix have no effect on each other. Possible trade-offs and complementations between programme outcomes seem to be acknowledged but not understood because of the complexity pertaining to the overall incentives offer.

The thinking behind the MIDP reveals gaps in capturing systemic relationships, processes and feedback effects active within the industry. Ignoring such feedback and variable interrelationships in the model leads to inaccurate and incomplete perceptions of factors underlying a particular policy and leads to ineffective policy intervention. In order to get a better insight into the effects of government support to the motor industry, these aspects have to be incorporated in the MIDP mental model.

5.5 Synthesis

The MIDP may appear to be a simple concept, but its ramifications on industry dynamics are vast. The working of the MIDP shows interrelationships between sectors and industry variables without explicit cause and effect characteristic of a complex system. Under the programme, Government uses two policy tools to influence industry performance – the stock of import rebates and the level of duty-free imports allowable. After specifying rules governing the policy tools, what transpires within the industry and the subsequent performance are largely dependent on triggered industry dynamics, which in turn depend on industry structure. To have an insight into the likely outcomes of government intervention, one has to understand the structure of the dynamics at play within the industry. A qualitative system dynamics model provides a useful starting point in this regard.

In the next chapter, a formalisation of the PAA and the IEC arrangement into a qualitative system dynamics model using high-level Casual Loop Diagrams (CLDs) is done. The CLDs capture some of the systemic factors that are omitted by presenting the MIDP as a uni-directional, static and non-interactive model. This is followed by quantitative formalisation of the incentive model using stock and flow diagrams. The model boundary was set to include those industry variables that have a direct relationship with investment and exports, on one hand, and also have a bearing on the industry trade balance as the reference mode.

6 Formalisation of the Productive Asset Allowance of the South African automotive industry using a system dynamics approach

6.1 Introduction

For many late-developing countries wishing to build up domestic manufacturing capacity, the question is no longer whether to give or not to give industry incentives, but of how to structure such incentives to serve national interests. The automotive industry is a key industry in South Africa and has been a recipient of government incentives in various forms for many decades. The intention of the latest version of the Motor Industry Development Programme (MIDP) was to support the industry to become globally competitive in the long-term. Ten years after commencement of the MIDP, the effectiveness of the programme in supporting industry competitiveness is being reviewed. The MIDP policy framework was based on intuition and consensus among stakeholders. Model assumptions on the program remain embedded in the mental models of its historical promoters, making it hard to discern internal inconsistencies. The problem with intuitive models is that they cannot be scientifically assessed to allow objective analysis and improvement. Formalising of intuitive mental models enhances their quality and increases the reliability of their simulations, an aspect critically important for policy intervention improvement (Richmond, 2004, p.6). This chapter presents a formalisation of the Productive Asset Allowance (PAA) and, by extension, the Import-Export Complementation (IEC) incentives of the MIDP, using a system dynamics approach. The first section recasts the static uni-directional MIDP incentive model into qualitative causal loop diagrams, capturing the main feedback effects within the industry relevant to the offer of government incentives. The second section presents quantification of the incentive model by way of capturing equations underlying its structure. Parameter estimation and issues pertaining to model validity are addressed in the last section.

6.2 Causal loop diagrams of the MIDP incentives

6.2.1 The PAA

From a system dynamics and conceptual perspective, the level of investment incentives receivable under the PAA increases with aggregate industry investment. With all other factors constant, an increase in investment will increase investment incentives obtainable. The increased value of investment incentives received will motivate further investment, which will in turn increase the value of investment incentives receivable. A reinforcing investment process is created. This is captured by an investment reinforcing causal loop named 'investment multiplier' in Figure 13. The reinforcing investment-investment incentive loop in Figure 13 is valid to the extent there are no intermediary factors that constrain increase in domestic investment. Since this is a less likely scenario, investment was modelled to be constrained by domestic market potential as explained below.

Rebates generated through investment directly increase the value of import rebates awarded to the industry and consequently increase the value of rebatable imports. The value of rebatable imports crowds out part of the domestic production, hence negatively affecting domestic production potential – the basis on which domestic production decisions are based, holding other factors constant. If domestic production potential is low, investment rates will be adjusted accordingly, leading to a subsequent downward revision of planned investment. With reduced investment, fewer rebates are generated, counteracting the already noted negative impact of rebatable imports on the production potential. The process constitutes a counter-balancing loop denoted as C in Figure 13. It should also be noted that the domestic production potential is also a function of other factors; the most important and most relevant ones to the research question being the size of the domestic market and exports. Both factors have a positive effect on the domestic production potential.

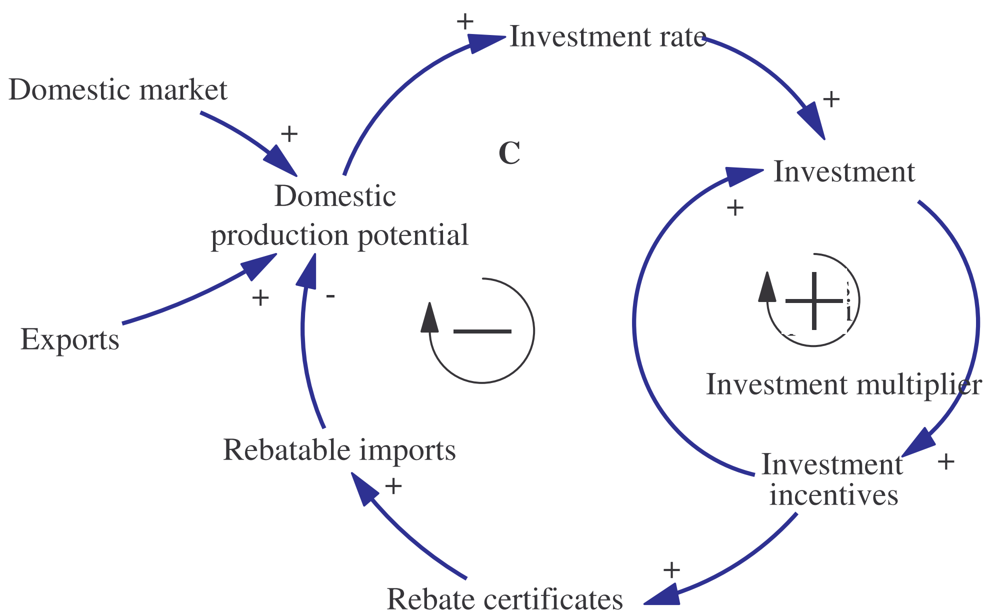

Figure 13: MIDP investment-investment incentive causal loop diagram

6.2.2 Import-export complementation arrangement

Analysing the effect of the PAA on industry performance dynamics cannot be done in isolation of the Import-Export Complementation (IEC) incentive dispensation. The PAA augments the stock of industry rebatable imports generated under the IEC dispensation; therefore, it is a major source of industry dynamics and feedback effects. Under the arrangement, companies exporting automotive products receive IRCCs based on the local content value exported. The arrangement is based on the assumption that increase in exports will drive domestic industry growth. For domestic companies to be able to export, they must produce world-class automotive products at globally competitive prices. Indirectly the incentive motivates the domestic industry to attain economies of scale and efficient production means. Achievement of efficient production levels is directly related to investment in productive assets and R&D efforts within the industry; as such the PAA and IEC effects are interrelated in supporting the industry competitive objective.

In terms of systemic relationships, increase in exports will increase the value of IRCCs receivable by the industry. Since companies can only benefit from the IRCCs received through offsetting duties payable on imports, the value of available IRCCs increases industry propensity to import. Duty free import, whose value depends on domestic wholesale value of vehicles, further augments the propensity to import since IRCCs are used to pay import duty net of the duty-free allowance.

By default, therefore, the import-export complementation arrangement has a delayed feedback effect on domestic production through the import propensity effect. If the domestic market growth happens to be less than the industry import growth rate, the effective market available for locally manufactured automotive products will decrease. Unless the increase in export is significant enough to offset reduction in the domestic market share of locally produced automotive products, domestic production will drop in the long run. Decrease in domestic production will decrease the value of IRCCs receivable via the export variable; mitigating against the continued decrease in local production. The import-export complementation loop is, therefore, counterbalancing.

In acknowledgment of the process towards long-term competitiveness, the delayed but positive effect of domestic R&D is introduced in the import-export complementation Causal Loop Diagram (CLD). Figure 14 below presents the functioning of import-export complementation in a high-level casual loop diagram.

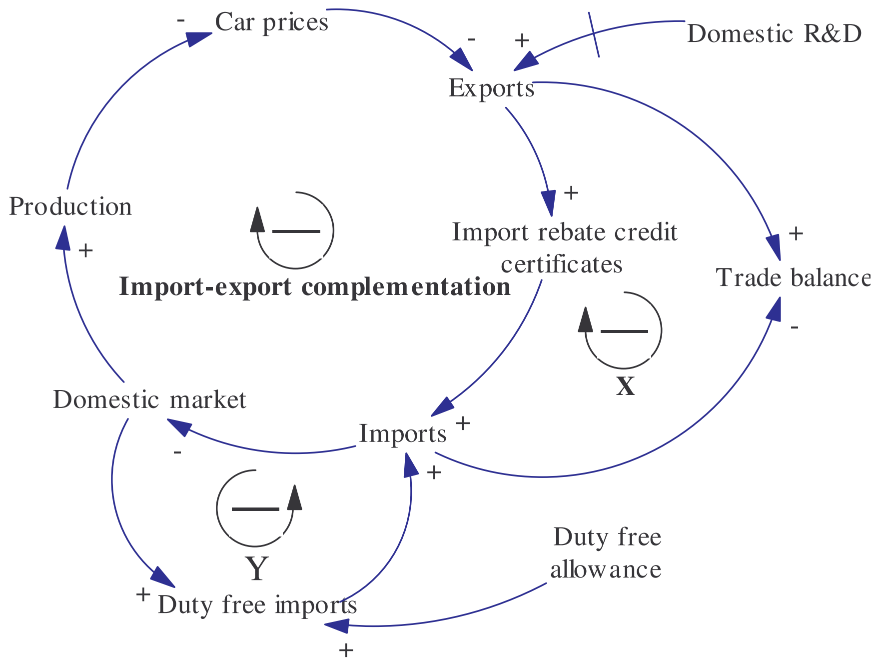

Figure 14: Import-export complementation causal loop diagram

Of much recent interest to stakeholders and the motivation behind this study, is the impact of the import-export complementation arrangement on industry trade balance. Exports improve industry trade balance; yet, on the other hand, exports increase propensity to import via export-based IRCCs. The resultant effect is another counter-balancing, but incomplete trade balance loop X shown in Figure 14.

Another counterbalancing loop pertaining to the IEC dispensation relates to the generation process of duty free imports. By definition, the value of duty free imports depends on the prescribed duty free allowance (percentage) and sale value of locally manufactured vehicles in the domestic market. As such, both the domestic market and duty free allowance have a positive influence on duty free imports. Duty free imports add to the stock of industry imports. As explained previously, imports in general, have a negative affect on the effective domestic market. This relationship between the domestic market, duty free allowance, duty free imports and industry imports is captured in the counterbalancing loop Y in Figure 14.

Although Figures 13 and 14 are separately presented, they are part of a single industry system. Due to the complexity of cause and effect involved between different variables, the human mind may not fully comprehend and anticipate outcomes of the combined interrelationships presented. Indications of likely outcomes are only possible through quantification of the model and simulation of scenarios. The qualitative articulation of the MIDP model, from a system dynamics perspective and using CLD above, provides a necessary foundation for quantification and simulation of the effects of South Africa's automotive incentives to industry performance. The quantitative modelling of the PAA and IEC is presented in the following section.

6.3 The MIDP Incentive Model

6.3.1 PAA model structure

Under the PAA dispensation, only investment in new and unused productive assets qualifies for benefit. Modified or refurbished assets may qualify for the PAA at the discretion of the International Trade Administration Commission (ITAC) workgroup, but in any case, such assets have to be declared and motivated at a project application stage. The value of assets qualifying for the PAA is therefore a proportion of total industry investment that can be captured by the equation:

$$\mathrm{P_{AA}I_t} = \alpha \mathrm{I_t} \tag{1}$$

where $P_{AA}I_t$ is the PAA qualifying investment in the year t, α is the PAA qualifying investment fraction and I_t is total annual industry investment.

Benefit from the qualifying investment takes the form of import rebates and is set at 20% of the qualifying investment. The value of rebates that can be generated from a particular value of qualifying investment can be presented as:

$$P_{AA}RG = 0.2 * P_{AA}I_t \tag{2}$$

where $P_{AA}RG$ is the PAA rebates generated per annum and the 0.2 is the existing PAA benefit fraction.

Since the benefit from the PAA is spread over a five-year period, the value of annual rebate certificates that can be generated is according to the equation:

$$RCR = P_{AA}RG/5 \qquad (3)$$

where RCR represents the value of rebate certificate release per year and the 5 represents the five-year period over which the PAA benefit is spread.

The value of imports that can be brought into the country using PAA rebates depends on prevailing import duty and the value of rebates issued in a particular year according to the equation:

$$P_{AA}RI = RCR/IMPORTDUTY \qquad (4)$$

where $P_{AA}RI_t$ is the value of imports that can be brought in the country, using the PAA rebates and *IMPORTDUTY* is the prevailing import duty in the year under consideration.

Figure 15 presents the PAA stock-flow diagram capturing relationships defined in equation (1) up (4). Stella software 'array' modelling capabilities were used to capture delays in the issue certificates generated in each year of investment.

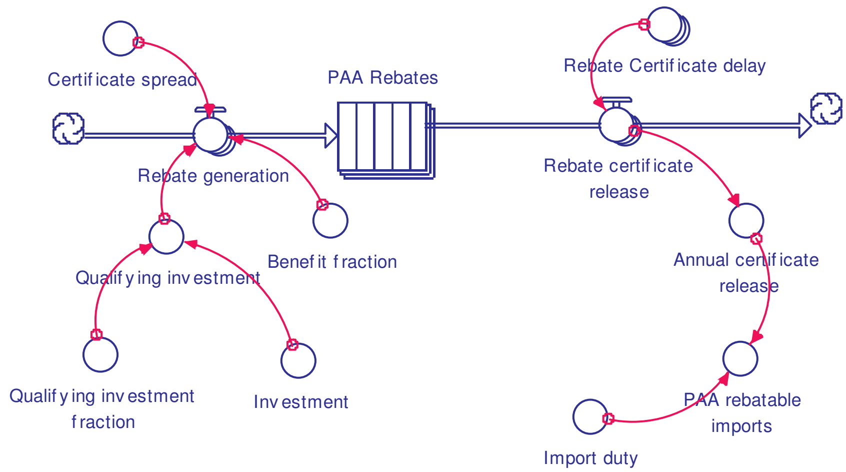

Figure 15: PAA stock-flow diagram

Next, the feedback effect of PAA rebates was incorporated. The first step was to make industry investment endogenous. This was done by introducing the investment rate variable. Industry Investment per year was set to depend on annual investment rate i.e.

$$I_t = I_{t-1}(1 + I_{rate}) \qquad (5)$$

where I_{rate} is the annual investment growth rate.

The investment-investment rate feedback effect was captured in a simple stock and flow diagram in Figure 16 depicting a potential exponential increase in industry investment over time. It is acknowledged that the use of growth rates lead to exponential growth in stock values and this may bias model extrapolation results over long periods. The timeframe for the MIDP is up 2020, which cannot be considered an excessively long period. Historical data should strongly support this exponential growth; otherwise, the rates may need to be adjusted as more recent data become available.

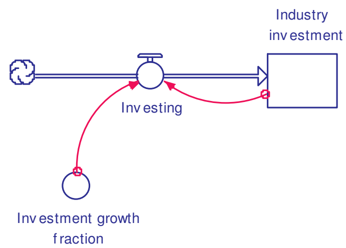

Figure 16: Industry investment feedback loop

One of the most import aspects of system dynamics modelling and a source of insights into system performance is the identification of feedback effects that often constitute closed loops. In order to close the PAA incentive model and against the background of the fact that investment depended on planned production, two local production potential explanatory factors other than rebatable imports: domestic market and exports were introduced. It is widely acknowledged that local market size is a major factor in investment location decision particularly in the automotive industry. Jenkins & Thomas (2002, p. 44) mentions that the size of the local market is believed to the most important motivation for European subsidiary companies in Southern Africa. European subsidiary companies happen to be strongly represented in South Africa's automotive industry. Exports augment the domestic market size while imports, whether rebated or otherwise, reduce the effective domestic market.

PAA rebatable imports add to the stock of industry imports into the country on which the industry did not pay duties. Given that the only way industry could benefit from the PAA incentive was through importing and offsetting duties payable using earned rebate certificates, firms would tend to import until they have exhausted import rebates received.

To account for the effects of domestic market size, exports and PAA rebatable imports on investment, the normal-investment-growth fraction variable was introduced. At this stage of model construction, both domestic industry and exports were taken to be static. To the extent that the above three variables affect investment, actual investment growth fraction would differ from the normal growth fraction. The difference would be the effect emanating from production potential factor (the basis of domestic production plans), which was postulated to be proportional to: *(domestic market + exports –PAA rebatable imports)/ (domestic market + exports)*. The logic of the equation was that as long as there are no rebatable imports, investment would grow at a normal rate dictated by the size of the domestic market and export potential.

The effect of PAA rebatable imports on production potential factor, which in turn affected the actual investment growth fraction, constituted a closed loop of the PAA incentive model presented in Figure 17. The feedback loop is implicitly non-linear based on the value of rebatable imports and exports. Increase in the value of rebatable imports relative to the export value mitigates against high increases in investment through its effect on actual investment growth fraction and vice-versa.

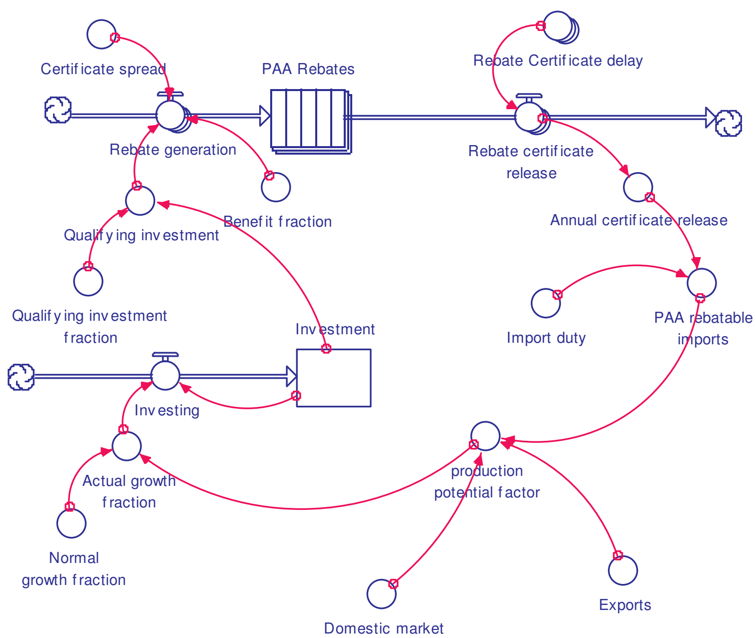

Figure 17: Closed loop stock-flow diagram for the PAA

By specifying initial model values and providing input values, the PAA model presented in Figure 17 enables simulation of the value of rebatable imports under different scenarios pertaining to the PAA benefit policy rule.

As highlighted previously, the effect of rebatable imports on production planned was underestimated in the PAA model above, as it did not take into account additional rebatable imports generated through the import-export complementation dispensation. In the following section, the model was therefore extended to include the import-export complementation dispensation, which contributed also to the value of rebatable imports in the industry.

6.3.2 Import-export complementation incentive model

Under the import-export complementation dispensation, firms earned Import Rebate Credit Certificates (IRCCs), based on a proportion of exported local content. Exports were specified as being determined by export growth rate, which rate was assumed exogenously determined - OEM exports are largely dependent on parent decisions but may be influenced by incentive offer. As such, the equation for industry exports per year could be presented as:

$$E_t = E_{t-1}(1+\beta) \tag{6}$$

where E_t is total industry exports per annum in the year t, and β is the export growth rate fraction.

It followed that the exported value of local content is captured by the equation:

$$ELC = ELCF * E_t \tag{7}$$

where *ELC* is the exported value of local content and *ELCF* is the exported local content fraction.

In terms of calculating the IRCC value to be awarded to an exporting entity, the exported value of local content was discounted at a rate determined by Government. The IRCC value generated, therefore, was a function of exported local content and the exported local content beneficiation fraction as determined for a particular year. Equation (8) below captures this relationship:

$$IRCCVALUE = ELC * LCBF \quad (8)$$

where *IRCCVALUE* is the value of IRCC generated per year, and *LCBF* the export local content beneficiation fraction.

By definition, the value of rebatable imports was equivalent to the value of IRCCs issued and is independent of the import duty rate. Figure 18 presents the import-export complementation model for generating IRCCs and subsequently rebatable imports.

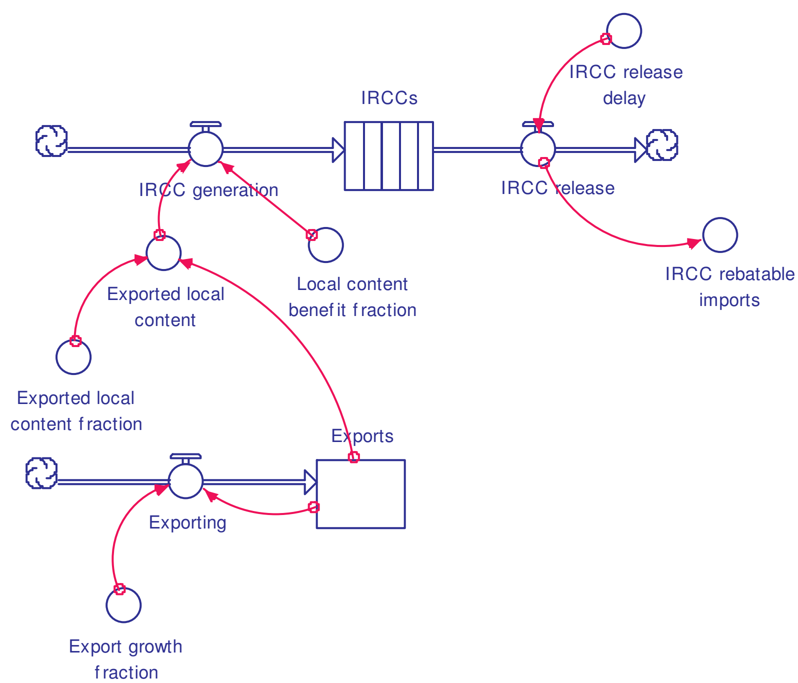

Figure 18: Import-export complementation stock-flow diagram

IRCCs generated under the IEC dispensation added to the overall stock of industry rebatable imports. To estimate the overall effect of rebatable imports on production plans, the PAA model and the IEC model were combined. A new variable, namely industry rebatable imports, which was a summation of PAA rebatable imports and IRCC rebatable imports was introduced. The direct link between PAA rebatable imports and production plans was removed and instead a link between PAA rebatable imports and industry rebatable imports on one hand, and IRCCs rebatable imports and industry rebatable imports on the other, was created. Thereafter, industry rebatable imports were linked to production potential factor. An important aspect to take note of under the combined PAA-IEC model was the fact that exports and the domestic market were allowed to vary over time through introduction of respective growth rates. The combined PAA-IEC model structure is presented in Figure 19.

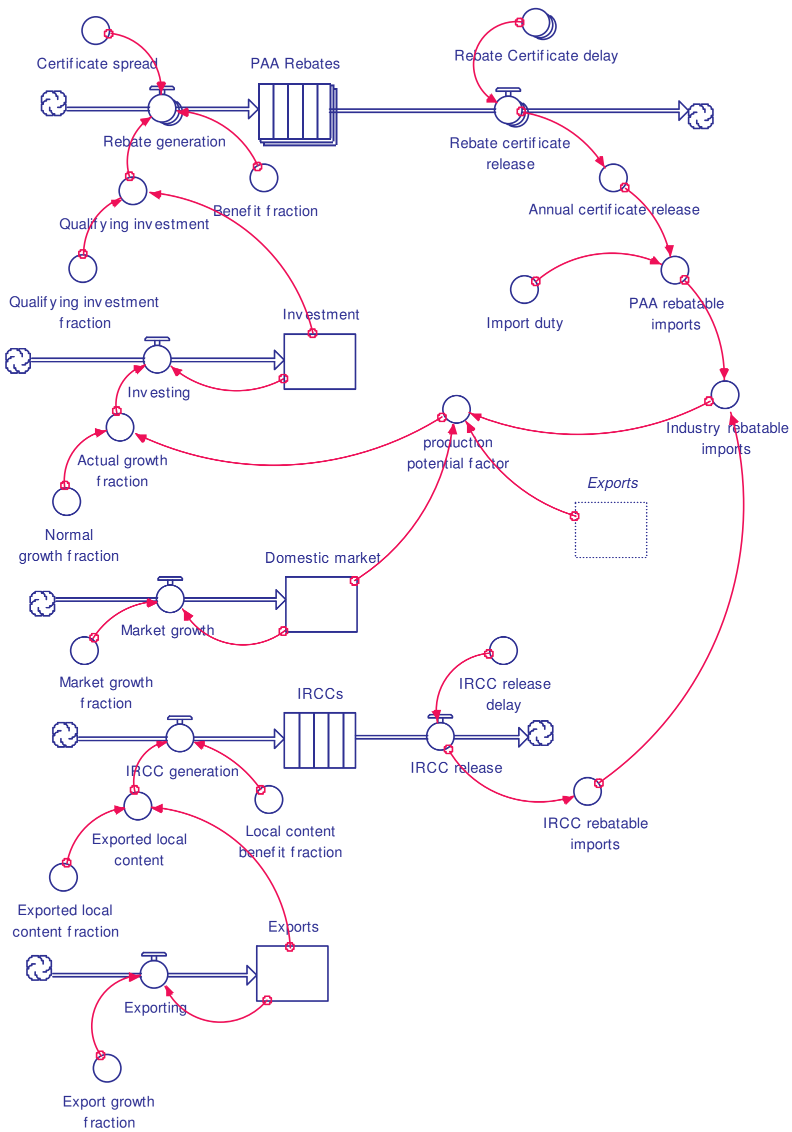

Figure 19: Combined PAA-IEC model structure

As in the case of causal loop diagrams, the PAA-IEC model was extended to include the industry trade balance variable. Introducing the trade balance variable allows sensitivity analysis of the industry trade balance account in response to a policy decision on the PAA and IEC incentive dispensations of the MIDP.

Industry imports were specified as an endogenous variable that depended on the import decision. The domestic market and the value of rebatable imports at industry level influenced the import decision. Before a firm within the industry could import, it had to have some insight into how much imports the domestic market could absorb. After establishing the import absorption capacity of the domestic market, the firm will have to consider the almost mandatory import it has to undertake in order to make use of import rebates earned. Hence, the postulation that the domestic market and rebatable imports were determining factors of the import decision. If there was no commensurate increase in the domestic market, there was a high likelihood that as rebatable imports increased, industry imports would also increase.

In the quantification of the model and behind the import decision, the impact of domestic market and rebatable imports on imports growth fraction was specified as being dependent on the ratio of industry rebatable imports and the domestic market. This impact declined as the value of rebatable imports tended toward the domestic market size. Figure 20 presents the extended PAA-IEC-Trade Balance model structure. The PAA-IEC-Trade model in Figure 20 could be quantified and used to simulate effects of the PAA and IEC policy variable on industry trade balance.

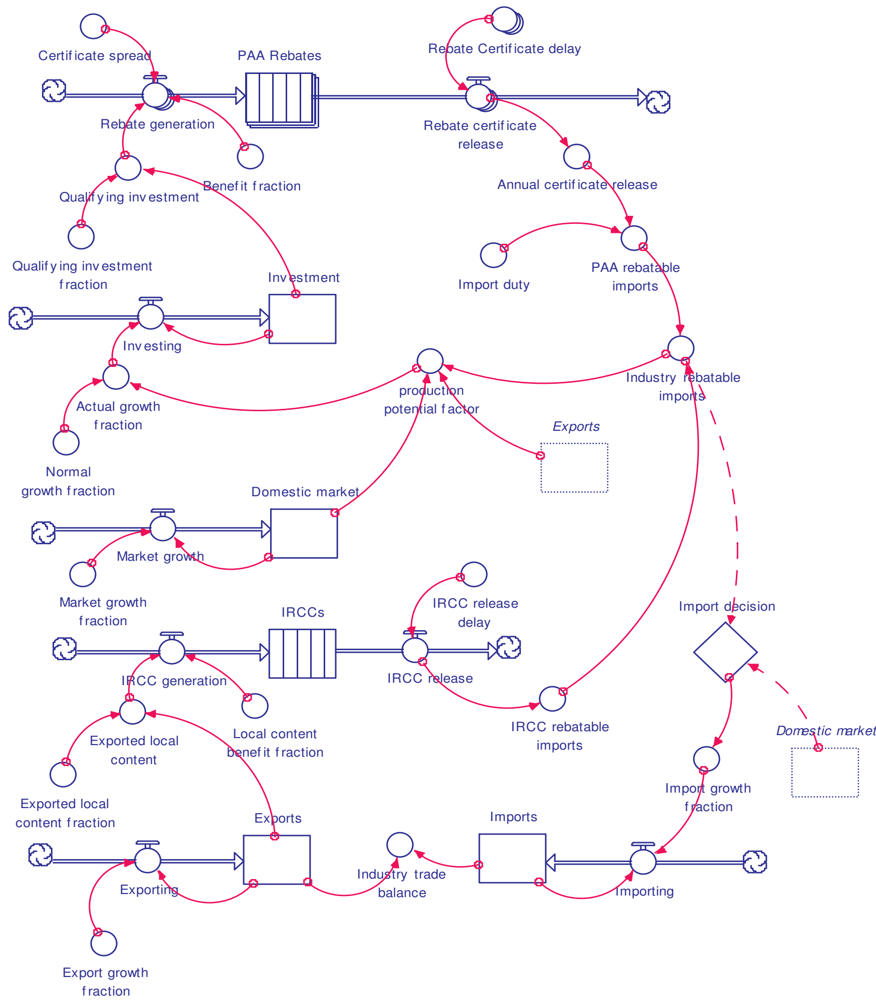

Figure 20: PAA-IEC-Trade Balance model structure

6.4 Model validation and testing

After formalisation of the PAA-IEC-International Trade model, the next step was to validate the model. Despite the wide use of the word 'validation' in modelling literature, models cannot be validated – if validation is taken to mean establishing truthfulness of the model. This is so because all models are a simple representation of reality developed with a mindset biased towards what the model intends to do and for whom it is intended to serve. What can be validated, however, are the analytical statements and propositions derived from the axioms of closed logical systems (Sterman, 2000, p.846). The issue is not about the validity of the model but its usefulness. When system dynamists talk about model validation, they are often referring to ways to make the model useful and acceptable to the intended clientele, a process that is more subjective than scientific. Referring to model validation Forrester (1961, p.123) wrote:

> *Objective model-validation procedure rests eventually at some lower level of judgement or faith that either the procedure or its goals are acceptable without objective proof.*

According to Richardson and Pugh (1981, p.310), model validation is not about establishment of the truthfulness of a model under consideration but rather a process that lead to people placing confidence in a particular model. They add that despite the well-documented steps in system dynamics modelling, there is little agreement about what good model validation is or ought to be. As a guide to ascertaining model validity Richardson and Pugh (1981, p.312) suggest that the modeller should instead answer two fundamental questions:

1. Is the model suitable for its purposes and the problem it addresses?
2. Is the model consistent with the slice of reality it tries to capture?

In practical terms, therefore, model validation takes the form of tests carried out on the model to increase its acceptance to the intended audience. The tests should check both structural and behavioural dimensions of the model (Richardson and Pugh 1981, p.314; Sterman, 2000, p.859). Sterman (2000, p.859-891) lists and explains 11 tests for assessing dynamics models that were adopted and extended from Forrester and Senge (1980):

- Boundary adequacy
- Structural assessment
- Dimensional consistency
- Parameter assessment
- Extreme conditions
- Integration error
- Behaviour anomaly
- Family member
- Surprise behaviour
- Sensitivity analysis
- System improvement

Sterman cautions that no one of these tests is adequate but a wide range of tests helps in understanding robustness and limitations of a model. Likewise, Richardson and Pugh (1981, p.314), created a summary of model tests in the form of a matrix mapping testing of suitability, consistency, utility and effectiveness to structural and behavioural aspects of the model (Table 21).

	Focusing on STRUCTURE	Focusing on BEHAVIOUR
Testing SUITABILITY for purpose (tests focusing inward on the model)	Dimensional consistency Extreme conditions in equation Boundary adequacy important variables policy levers	Parameter (in)sensitivity behaviour characteristics policy conclusions Structural (in)sensitivity behaviour characteristics policy conclusions
Testing CONSISTENCY with reality (tests comparing the model with information about real system)	Face validity rates and levels information feedback delays Parameter values concept fit numerical fit	Replication of the reference modes (boundary adequacy for behaviour) problem behaviour past policies anticipated behaviour Surprise behaviour Extreme condition simulations Statistical tests time series analyses correlation & regression
Contributing to the UTILITY and EFFECTIVENESS of a suitable, consistent model	Appropriateness of model characteristics for audience size simplicity/complexity aggregation/detail	Counter-intuitive behaviour exhibited by model made intuitive by model based analyses Generation of insights

Table 21: Summary table of tests for building confidence in system dynamics models (Richardson and Pugh, 1981, p.314).

> *Any of these tests by itself is certainly inadequate as an indicator of model validity. Taken together, they form a formidable filter, capable of trapping and weeding out*

*models and allowing passage only to those most likely to reflect something close to the truth***.** Richardson and Pugh, 1981, p.314

There is no rule of thumb as to the number of tests that should be carried out in order to establish validity of a particular model. The onus is on the modeller to decide on the set of tests that would adequately create reasonable confidence in a model developed for a particular purpose. Given the applied nature of this research project, explicit model structural tests were not carried out but rather an exploration of issues pertaining to model structure validity and thereafter model behaviour tests were conducted. As pointed out previously, the structure of the incentives model was not hypothetical. The PAA and the IEC were already in place and operational. Qualitative information by way of incentive offer guidelines provided the qualitative structure of the model. Hence, it was felt that structural tests would not be value adding in this regard.

6.4.1 Model structure tests

The ultimate objective of structural validity and hence of model structure testing is to ascertain that a model under consideration is a fair meaningful description of real relationships underlying the dynamic behaviour under study. Structural validity has to be established before one can proceed to behavioural validity, otherwise the latter will be pointless. Establishing model structural validity was not contentious because the qualitative and intuitive MIDP incentive framework was already in place and well documented. The researcher's role in this respect was to formalise the intuitive policy framework into a SD model by capturing the major source of dynamics relevant to the research problem and question. In formalisation of an policy frameworks already in existence, structural tests are continuously carried out in the sequential model building process. By the time the researcher comes up with a complete model on which behavioural tests can be done, the structural tests and validity would have been accomplished to a large extent. Structural validity is carried out through careful documentation of qualitative information on the policy framework and verifying the structure with stakeholders and experts at each stage of the model building process. In this regard, the PAA Guidelines and ITAC-Stakeholders documents pertaining to MIDP incentives provided well-documented reference notes on the structure of the PAA and IEC. On the IEC for example, the NAACAM Directory (2007, p.8) explains:

> *The import-export complementation scheme allows for reductions of import duties on cars and light commercial vehicles according to the value of local content exported. For every Rand of CBU exported, a percentage determined by Value of Export Performance (VEP) of CBUs may be imported free of duty. For every Rand of components exported, a percentage determined by the VEP of components may be imported free of duty. Value of Export Performance equals to the local value added of FOB price multiplied by a discount factor. The scheme is controlled by the issue of Import Rebate Credit Certificates (IRCCs) to registered importers once the foreign funds have been repatriated and all documentation completed.*

The PAA Guidelines (ITAC, 2005, p.5&9) on the other hand describes the working of the PAA incentive as follows:

> *The PAA provides for a rebate of the duty on imported completely built- up light motor vehicles to the extent of 20 per cent of the value of the investment in productive assets approved by the International Trade Administration Commission (ITAC). The rebate of 20 per cent will be spread equally over a period of 5 years at 4 per cent per annum, is non-tradable between companies and may only be used by the approved light motor vehicle manufacturer to import specified light motor vehicles. Only new or unused plant, machinery and tooling used for the sole purpose of manufacturing the rationalised range of light motor vehicles or automotive components for such light motor vehicles will qualify for purposes of the PAA.*

Due to the well-defined qualitative information of the PAA and IEC incentive functioning, expert opinion on the model structure was carried more as a re-affirmation of the model structure rather than bringing new insights to the model structure.

The choice of important variables to be included in the model was dictated by the reference mode – industry trade balance and industry variables upon which the incentives are based and on which the incentives have a direct effect. In this regard, the key variables on the development of the incentive model were imports, exports, investment, PAA rebates, IRCCs stock and the domestic market.

Given the steps taken in developing the formal model above, the testing of model consistency with reality and dimensional consistency was largely redundant. Since the modelling task was a formalisation of an already existing incentive framework that has been operation for a while, there was no fundamental difference between the incentive dispensation in reality and the formal model developed. Stocks were identifiable from the qualitative data while rates of changes could be computed from historical data and verified via expert opinion. Likewise, the sequential model building process accomplished conceptual fit. Stocks were captured as values in billion rand while rates and ratios were unitless.

In summary, structural validity testing was carried out from the model conceptualisation until the model simulation stage. The model was simulated only after ascertaining structural validity for each of small model sections, which finally constituted the aggregated model. As previously noted, three independent experts on the MIDP incentives portfolio assisted to validate the model structure as explained in the preceding section.

6.4.2 Behaviour tests

Establishing behaviour validity and hence model behaviour testing deals with ascertaining that the dynamic pattern generated by the model is close enough to the real dynamic pattern of interest. The behaviour dimension of the model has much to do with parameters used in simulating a model. Most parameters in system dynamics studies are estimated based on descriptive information obtained from participants in the system being modelled (Graham, 1980, p.144). For this research project, three aspects eased the process of parameter estimation:

1. Existence of a comprehensive set of guidelines relating to policy rules on industry incentives. Many of the parameters are specified in these guidelines. For example, the nature of investment and the fraction of that investment that translates into PAA rebates is specified in the guidelines.
2. Existence of time series data from which rates of change over time could be computed. The rates of change were used as reference variables that would make sense to both the researcher and stakeholders. Using historical rates of change, it was possible to use the phrase 'if the status quo was to hold in future' in communicating model results.
3. Most of MIDC representatives were professionals in their own right. They motivated their point of view using quantitative data, giving some indication of relevant parameter values.

A summary of parameter and rates of change used in the model, and their base of estimation is presented in Table 22. Comparisons between the actual values of investment, domestic market and exports as per the historical data, and the respective values per the growth fractions used to simulate the model are presented in appendix 4. The duty rate schedule for Built-up light vehicles and Original equipment components for the period 1999 to 2012 is also included.

Parameter	Value	Comment
Normal investment growth fraction	15%	Based on quantitative historical data
Domestic market growth fraction	9%	Based on quantitative historical data
Export growth fraction	27%	Based on quantitative historical data
Import growth fraction	Varying	Based on domestic market and rebatable imports
PAA benefit fraction	0.2	Factual
PAA certificate spread	5 (years)	Factual
Import duty	0.3	Factual but can changing over time
Export local content fraction	0.9	Based on historical data
Exported local content benefit fraction	0.7	Factual but can changing over time. Figure was adjusted to capture impact precious metal group special dispensation.
Impact of domestic market and rebatable imports on production plan	Varying	Based on qualitative and quantitative historical data
Impact of domestic market, exports and rebatable imports on import decision	Varying	Based on qualitative and quantitative historical data

Table 22: Model parameters for the PAA-IEC-Trade balance model

Even after defining model validation as a set of steps to undertaken to build confidence in a particular model it has to be done in context of the model purpose. In this respect, the first model behavioural test is often the establishment of whether the model can replicate the reference mode.

6.4.2.1 Model behaviour vis-à-vis the reference mode

Although it is widely acknowledged that the objective of system dynamics modelling is not point prediction of a system performance but rather to probe dynamics underlying a particular behaviour, it is important that an SD model can endogenously reproduce the reference mode of interest. Without replication of the reference mode, the model becomes irrelevant in providing insight into the problematic situation and as such cannot be useful. Richardson and Pugh (1980, p.317) claim that if a model cannot reproduce its reference behaviour mode, it is invalid. The first behavioural test undertaken was to assess whether and to what extent the model reproduced the reference mode behaviour – the exponentially increasing industry trade deficit. The base run showed that the model could endogenously replicate the reference mode behaviour (Figure 21). Replication of the reference behaviour and from an indigenous perspective indicated that the model could be valuable in highlighting leverage variables or points of action that could influence the deteriorating industry trade balance.

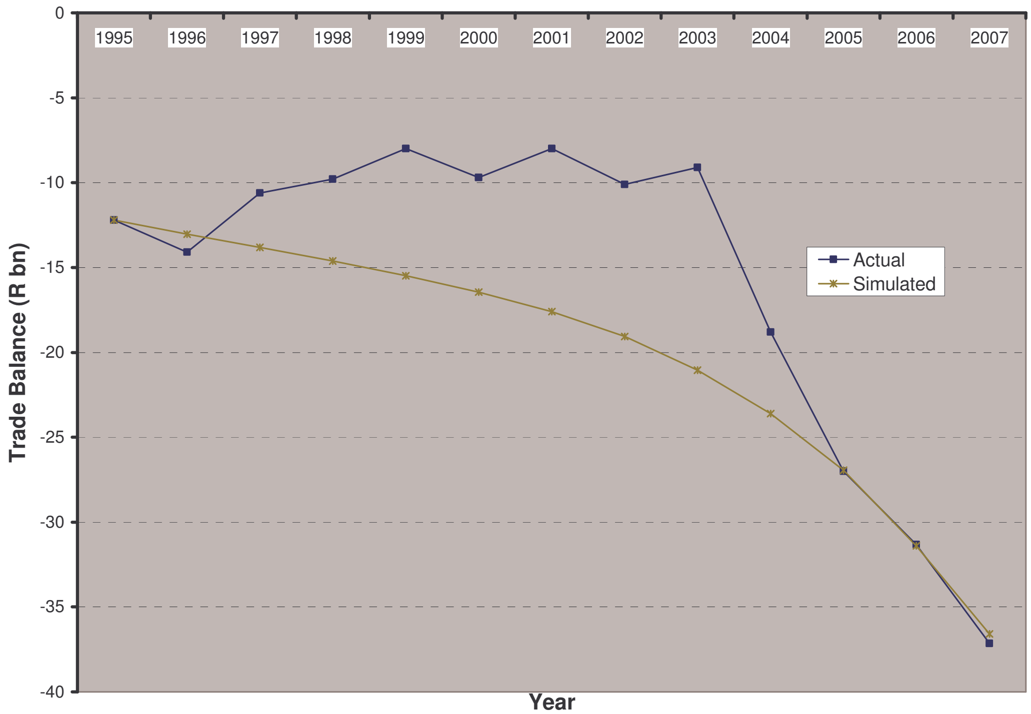

Figure 21: Model replication of the reference mode behaviour

The base model run showed weakness in predicting improvement in industry trade balance in the first five years of the MIDP, though it rightfully captured the deteriorating industry trade balance thereafter. The deficiency was not considered critical as model simulation over a longer period confirmed that the model could reproduce the general trend of the problematic behaviour. Again, the ultimate aim of policy-oriented system dynamics modelling is to reveal behaviour pattern rather point forecast. The complete set of Stella model equations for the base run reproducing the reference mode are presented in Appendix 5.

6.4.2.2 Model behaviour under extreme conditions

An important test of model validity is the check on how the model behaves under extreme conditions.

> *"Models should be robust under extreme conditions. Robustness under extreme conditions means that the model should behave in a realistic fashion no matter how extreme the inputs or policies imposed on it may be",* Sterman (2000, p.869).

In terms of extreme condition tests and relative to the industry incentives, model behaviour was tested under the following situations:

1. All investment qualifying for the PAA translates into rebate certificates i.e. setting PAA benefit fraction as 1.
2. None of the PAA qualifying investment translates into rebates i.e. setting PAA benefit fraction as 0.
3. There is no discounting of exported local content in calculating IRCC value awarded to industry exporters i.e. setting export local content benefit at 1.
4. None of the exported local content qualifies for rebate under IEC dispensations i.e. setting export local content benefit fraction at 0.

Figure 22 shows the extreme condition run in terms of PAA rebatable imports and industry trade balance when all investment qualifying for the PAA translates into rebate certificates. For the period 1995 to 2001, the PAA rebatable imports equal to 0 as the first certificates were only issued in 2002. After 2002, the value of rebatable imports starts to increase gradually but is insignificant in terms of the overall reference mode behaviour. The simulated behaviour was in line with reality, regarding the low value of PAA rebatable imports relative to the overall industry trade account. At this point it was also recognised that the industry trade balance starts to improve after some time.

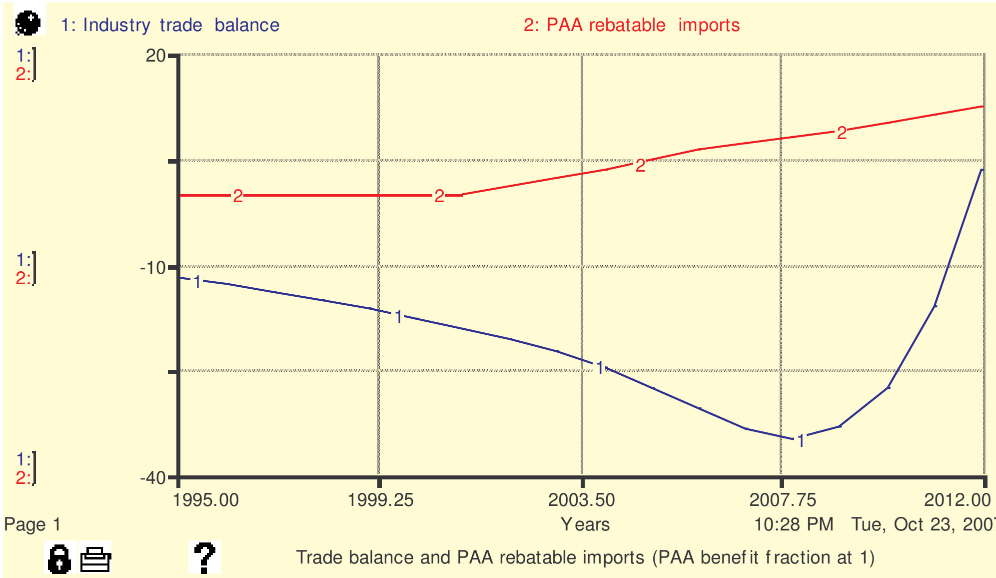

Figure 22: Trade balance and rebatable imports - PAA benefit fraction of 1

The opposite extreme run in which the PAA benefit fraction is set at 0, that is, none of the qualifying PAA investment translates into PAA benefit was examined. It was expected that the PAA rebatable imports would remain 0 throughout the simulation period and the reference mode would still remain unchanged given the small proportion of PAA rebatable imports relative to size of industry trade deficit. This was confirmed by the extreme condition run in Figure 23.

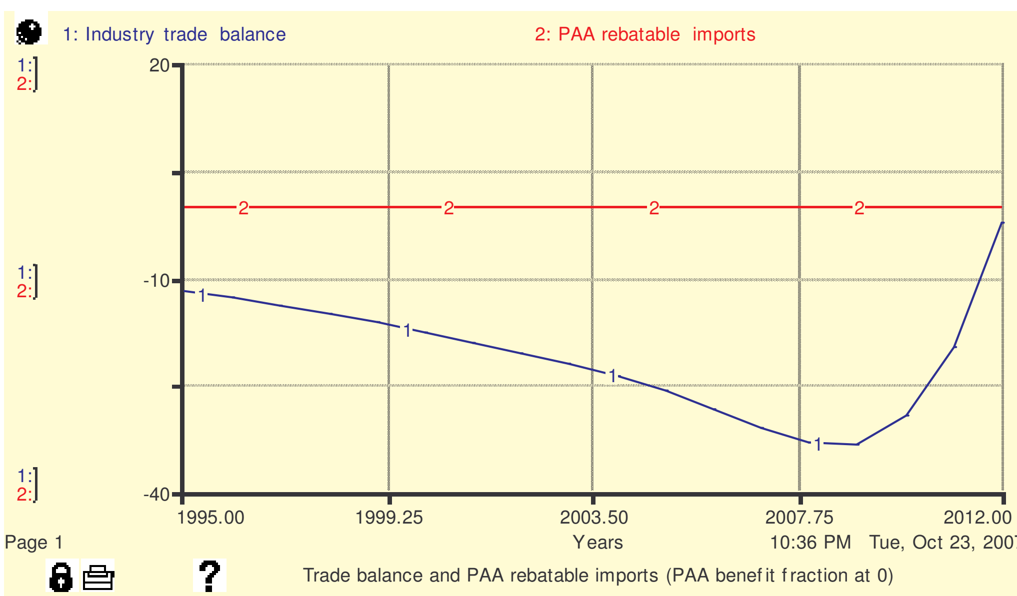

Figure 23: Trade balance and rebatable imports - PAA benefit fraction of 0

The two extreme tests on industry investment that translates into PAA rebates confirmed implicitly that other policy variables affecting the value of PAA qualifying investment can stand extreme case tests. Extreme tests confirm that the model is robust and can behave appropriately under all potential circumstances (Sterman, 2000, p.337).

The third extreme condition test on the model related to working of the IEC. The model was tested when local content benefit fraction of exported automotive products is set at the maximum of 100%. The extreme run showed a progressively increasing value of IRCC rebatable imports. Further still the run showed that the general trend in the industry's trade deficit remained the same but compared to the extreme run on the PAA, the deficit reached higher levels before it started to improve (Figure 24). This was in line with the study hypothesis that rebatable imports had a negative causal effect on the industry trade balance.

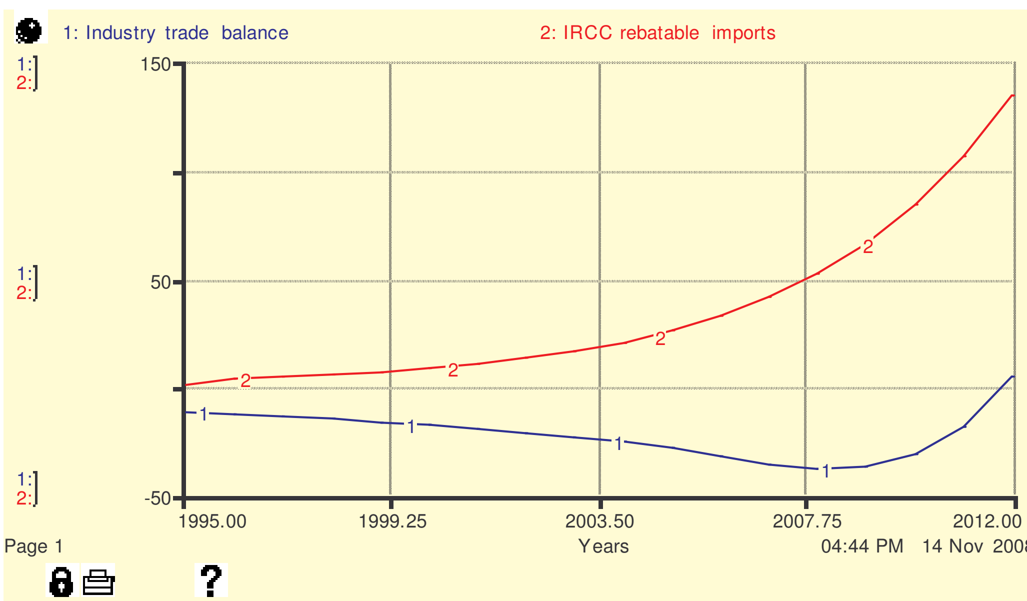

Figure 24: Trade balance and rebatable imports - Exported local content benefit of 100%

Fourth, the model was subjected to the extreme condition test of local content benefit fraction set at 0%, that is, none of the exported local content qualifies for the IEC benefit. The expectation was that the value of rebatable imports would remain 0 throughout and the trade deficit would not reach the high levels shown in Figure 24. This was confirmed in this extreme condition run (Figure 25). Although trade balance started as negative, with no rebatable imports the trade deficit marginally increased for a while but thereafter started to decline, becoming positive after some 10 years.

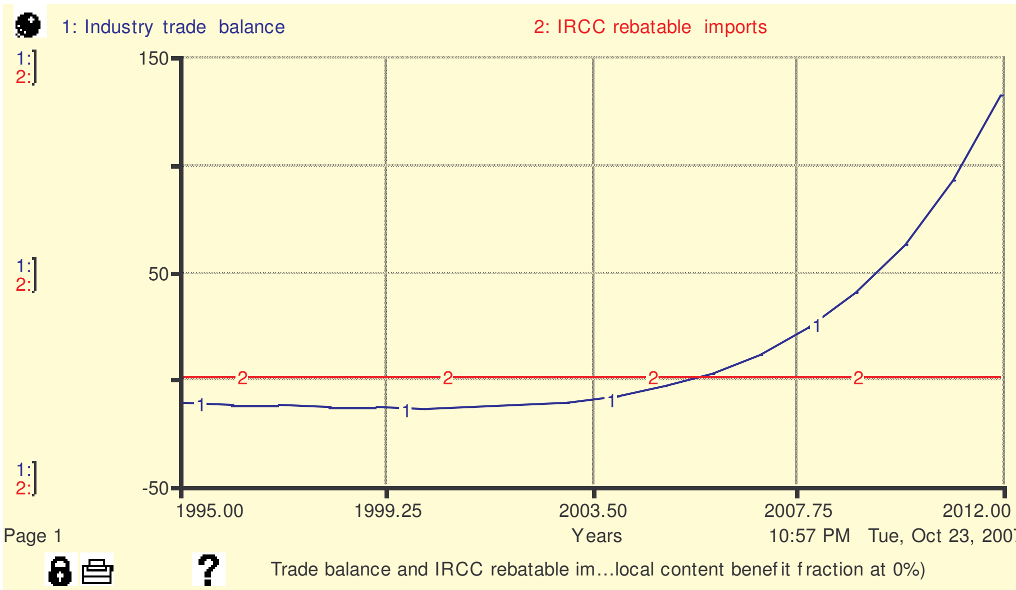

Figure 25: Trade balance and rebatable imports - Exported local content benefit of 0%

The simulation of trade balance trend in Figure 25 was based on the ‘ceteris paribus’ assumption. The reality of removing IEC benefit from South Africa’s automotive industry may be different if one considers what might happen to the industry when the level of incentives is reduced. To the extent that incentives contribute towards making it viable to undertake automotive manufacturing in South Africa, without the IEC incentive, some firms may not find it profitable to locate their manufacturing activities in the country. As such, the rate of investment in the industry is likely to decline. With less investment, it is probable that the export growth rate will not be as high as hitherto presumed. For a more realistic scenario as to what might happen to the trade balance trend when industry is not getting benefit under the IEC dispensation, a decline in investment and export growth, and a probable increase in imports should be taken into account. A revised simulation of the industry trade balance with exported local content benefit set at 0, but with investment growth reduced from 15% to 10%, export growth rate lowered from 27% to 25% and import growth increased marginally to 13% is presented in Figure 26. Import growth was marginally increased to account for the likelihood that without IEC benefit to industry, import penetration would increase due to lower production volumes being planned domestically. But this import growth would, on the other hand be counteracted by less IRCCs being generated.

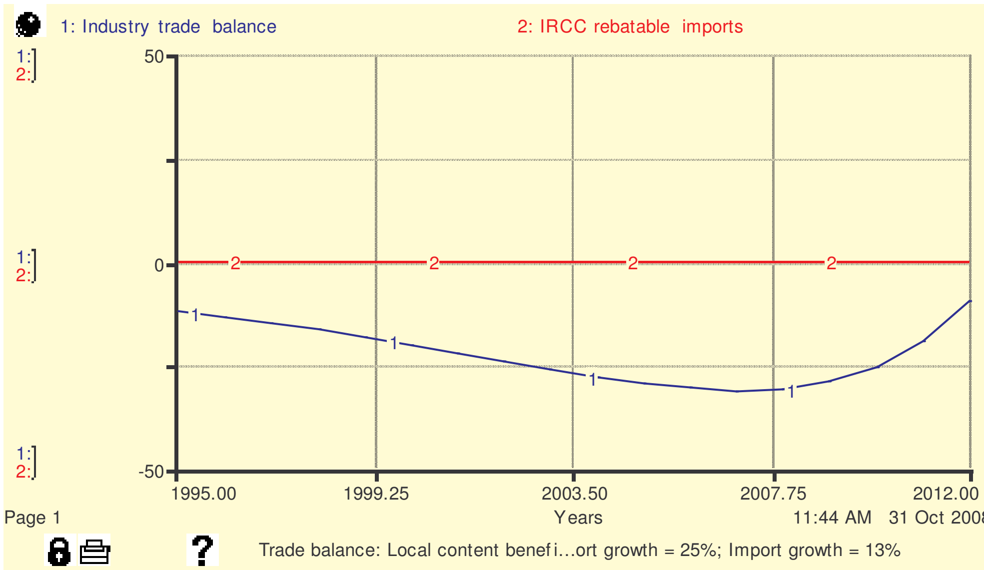

Figure 26: Trade balance and rebatable imports - Exported local content benefit of 0% with lower investment and export growth rate and increased import growth

The new simulation shows that even without IEC benefit, there would still be a significant deterioration in the industry trade balance but not as high as when the IEC is in place. Of course the trade balance trend in Figure 26 is dependent on the choice of the adjusted growth rates, which is a subjective process.

As was noted in the case of PAA, the two extreme tests on exports value that translates into IRCCs rebates confirm that other policy variables affecting such a value can also stand extreme case tests. This is so because such variables simply affect the stock of IRRC generated at any particular time just like the exported local benefit fraction given a particular exports value.

In general, the model behaviour did not show unrealistic results under the extreme tests. Given the nature of the research project, the extreme test also served the purpose of establishing mathematical consistency of the model. If the mathematical equations underlying the structure of the incentives model were to be wrong, likelihood would be high that model behaviour under, at least one extreme condition, would yield illogical results.

6.4.2.3 Surprise behaviour

With the level of imports consistently increasing under the MIDP, driven in part by rebates availed to the industry under the PAA and IEC incentives, one was tempted to conclude that the automotive industry trade deficit would worsen indefinitely. Surprisingly the model showed that the trade deficit would be reversed after some time, if the hitherto realised export and domestic market growth rates were maintained (Figure 27).

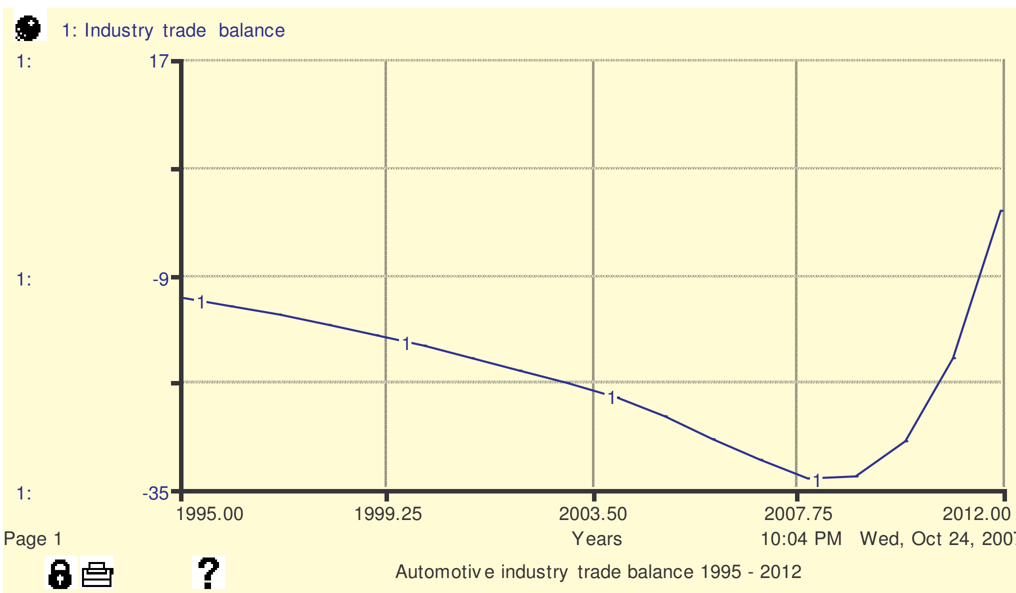

Figure 27: Simulated industry trade balance 1995-2012

The challenge was to make sense and explain why the industry trade deficit will be reversed. The surprise behaviour could potentially mean that the model was completely wrong. This called forth reflection on the working of the MIDP incentives.

First, the increase in both investment and exports that has characterised the South African automotive industry under the MIDP dispensation has led to the increase in rebatable imports. A decision to invest in the country depends on planned production, which in turn depends on the demand of automotive products in the country. The effective industry demand depends on the effective market demand, which is the size of the domestic market plus exports, minus imports. Although there is a portion of imports that is independent of MIDP incentives, rebatable imports are the main drivers of industry imports. As such, increase in rebatable imports has a negative impact on effective market on which production plans are based and hence crowds out investment. By implication, the continuous increase in rebatable imports will ultimately lower the rate of domestic investment and consequently reduce the positive effect of PAA rebates on industry imports in the long term.

Second, the increase in rebatable imports has a direct but switching effect on import growth rate. Initially, increase in the value of rebatable imports will have a significant effect on industry import growth. With the domestic market growth rate being lower than import growth rate, the value of rebatable imports tends to the domestic market size. As this happens, there will be less motivation by industry to import as industry will tend to balance how much to produce for the domestic market and how much to import. Industry has to maintain domestic production in order to qualify for industry incentives. At the extreme, any import rebate earned over and above the size of the domestic market has no value to the recipient since it cannot be used to import; the domestic market will be saturated already. The need to maintain domestic production while taking advantage of rebatable imports will in the long-term, reduce the impact of rebatable imports on import growth rate.

The dual effect of increasing rebatable imports on industry investment and import growth in the long term explains why industry trade deficit cannot continue to deteriorate indefinitely.

6.4.2.4 Integration error test

The integration error test relates to the choice of integration method. One has to select a numerical integration method and time step that yield an approximation of underlying continuous dynamics as accurately as possible (Sterman, 2000, p.873). For a particular model to be believable, it should not be sensitive to the choice of time step or the integration method of choice. In this respect, the model was run with DT set at 1 and 0.5 using Euler's method of integration. It was found that a model outcome, in respect of the reference mode and general behavioural trend, was not fundamentally different if the time step or the method of integration was changed (Figures 28 & 29).

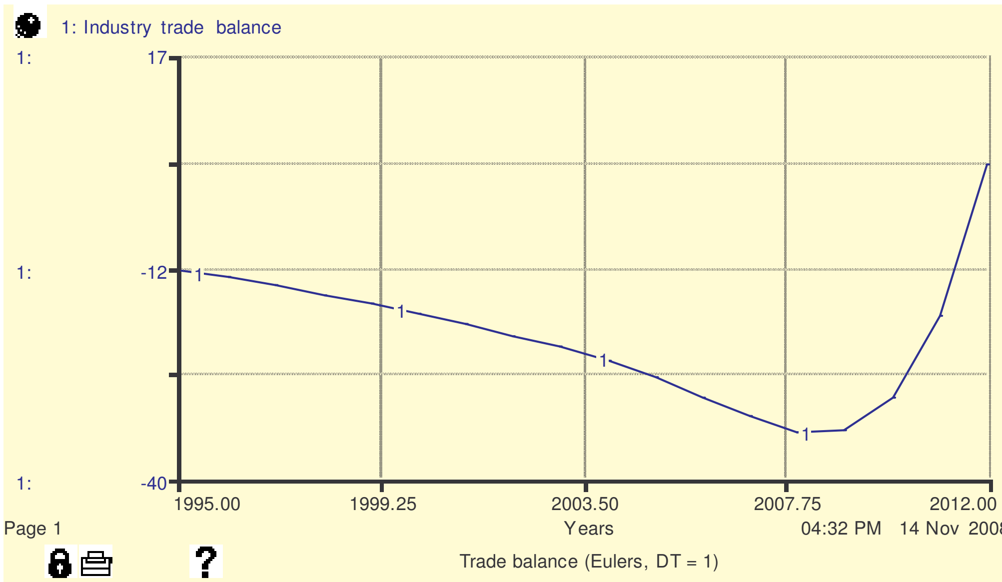

Figure 28: Trade balance - Euler's integration method with DT = 1

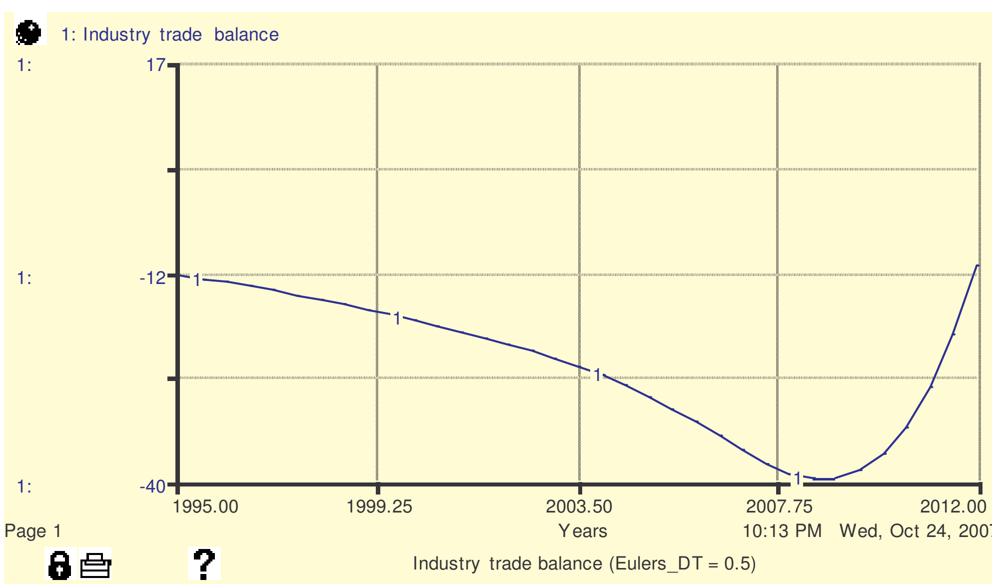

Figure 29: Trade balance - Euler's integration method with DT = 0.5

The model was not tested with the alternative Runge-Kutta integration methods because this model included conveyors and such higher order integration methods are not well suited to discontinuous elements (Sterman, 2000, p.910). Again, from a practical point of view, the Euler integration method simulation outputs were within acceptable range compared to industry performance time series data.

6.5 Model sensitivity to exogenous variables

In order to have some understanding of the extent to which variables assumed exogenous in the model could affect reference mode behaviour, sensitivity analysis of the industry trade balance to investment growth, export and domestic market rates was carried out.

Investment influences trade balance via its effect on PAA rebatable imports, which in turn affect industry imports. The reference mode behaviour was least sensitive to normal investment growth fraction. From 5% through to 15% compound annual growth rate in investment, industry trade balance trend was not significantly different from the reference mode. Significant change in the trade balance trend was realised only when the growth rate was jerked up to 50%, a very unlikely situation (Figure 30). The sensitivity analysis re-affirmed the limited influence of investment-based PAA rebates on overall industry trade balance.

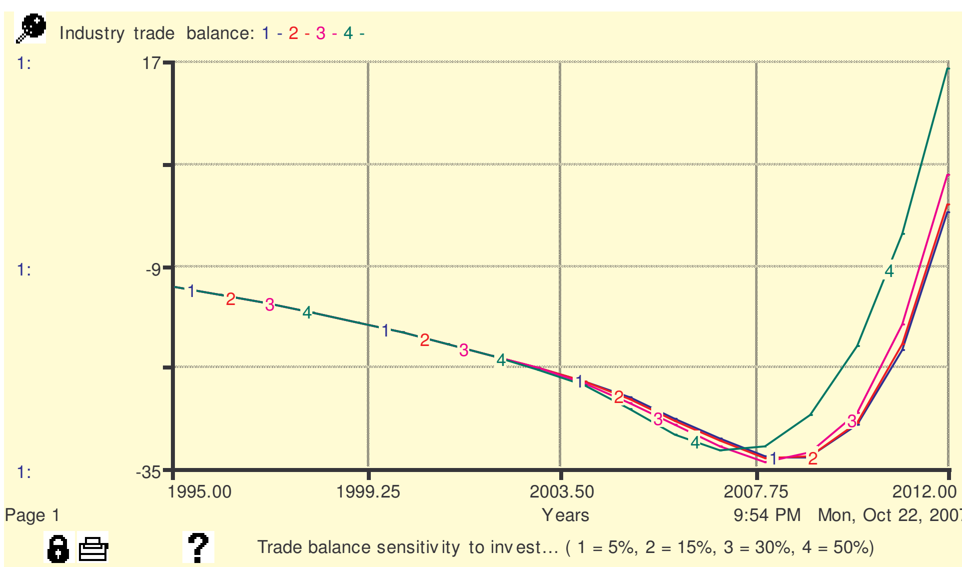

Figure 30: Trade balance sensitivity to investment growth fraction

In terms of industry balance sensitivity to domestic market growth, the trade balance exhibited high sensitivity to changes in the domestic growth rate also. Trade balance sensitivity to domestic market growth fraction set at 9%, 15% and 30% annual growth rate is presented in Figure 31. The trade balance improved with the increase in the domestic market growth fraction.

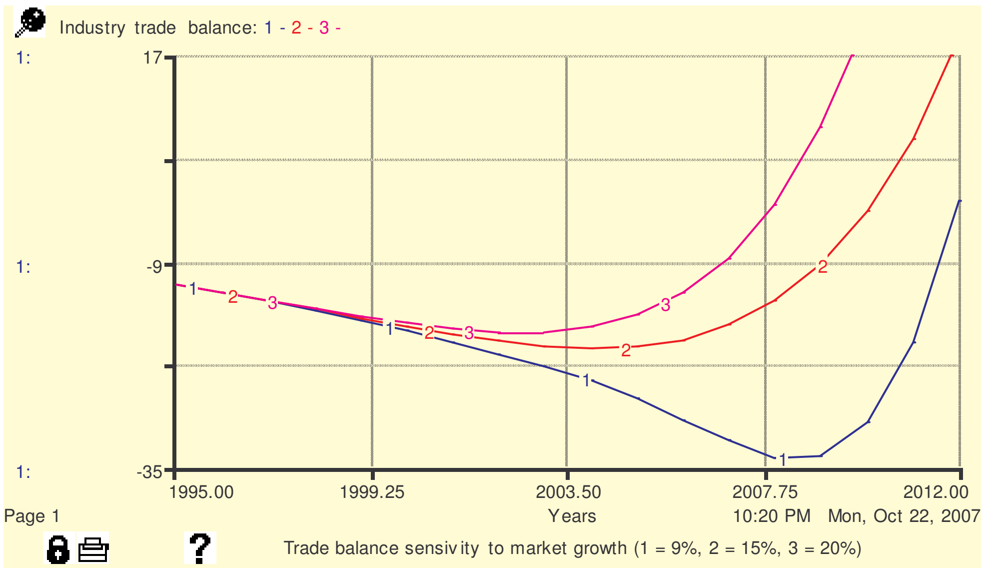

Figure 31: Trade balance sensitivity to domestic market growth fraction

Domestic market growth has an effect on industry investment via the production potential factor. Increase in the domestic market growth fraction induces higher levels of investment increasing the value of rebatable imports via the PAA rebate generation process. Increase in rebatable imports has a positive effect on overall industry imports and hence a negative effect on the industry trade balance. However, due to the model assumption that the impact of rebatable imports and domestic market depend on the ratio between the two, an increase domestic market growth fraction disproportionally increases the domestic market value relative to rebatable imports. Ultimately it lowers the import growth fraction, exerting a positive influence on the industry trade balance. This explains the overall upward shift in the industry trade balance trend as the domestic market growth fraction is adjusted upwards in Figure 31.

Trade balance sensitivity to low and high export growth rates is presented in Figure 32. Trade balance trend with export growth rates set at 15%, 20%, 24%, 27% and 30% respectively is shown. It is evident that the trend at 24% and 30% export growth rates is already substantially different to that at 27%, which was the reference mode export growth rate. As would be expected, trade balance was most sensitive to export growth rate. At very low levels of export growth rate, the trade deficit increased significantly, relative to the reference mode run. At high export growth rates, increase in trade deficit before start of decline was minimal. This could be understood in the context of the resultant high increase in industry exports at high export growth levels without commensurate increase in imports. The high sensitivity of industry trade balance to export growth rate points to the importance of accurate estimation of the rate, otherwise a small under- or overestimation could fundamentally change the model reference mode behaviour.

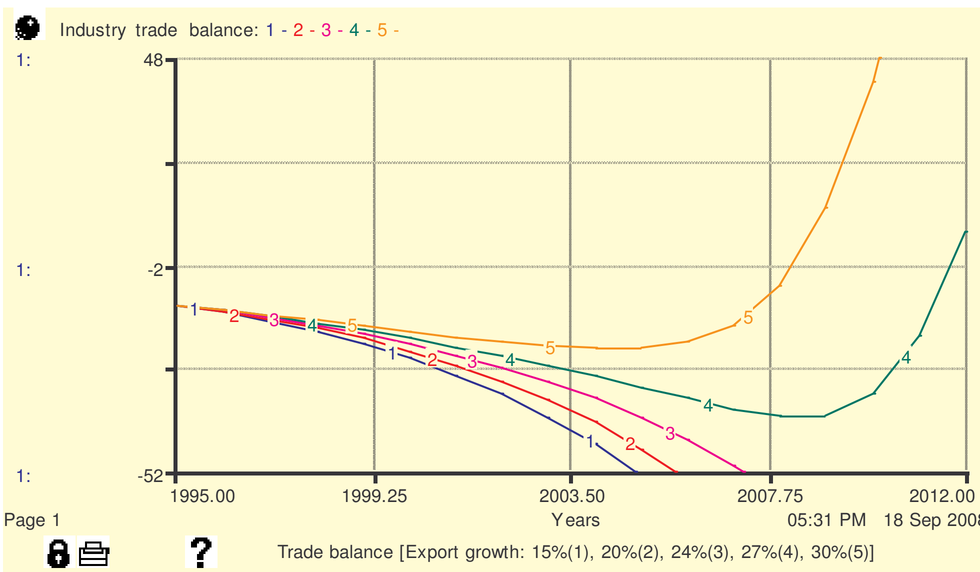

Figure 32: Trade balance sensitivity to export growth fraction

6.6 Exchange rates effect on industry trade balance

During discussions at the MIDP and with experts on the industry, exchange rate was pointed out as a significant determinant of imports growth. This was based on the understanding that domestic currency appreciation makes imports cheaper in the domestic market. Commodity market prices tend to rise easily when upward prices pressures are experienced in the market but the otherwise is not always true. Prices are often ‘sticky’ downwards when downward price pressures are experienced. As such, domestic currency appreciations tend to make importing more profitable as importers are likely to sell the 'cheaply' imported products at market prices prior to the currency appreciation. The suggestion, in this regard, was that changes in exchange rates should be accounted for in the model.

It was noted, however, that although changes in the exchange rates had a direct effect on profits, in the short term, this might not be significant enough to affect industry dynamics. Industry decisions on production and sales are often based on five to seven year business plans. It is very unlikely that industry will diverge from its business plan because of a short term disturbance like increase in profits due to a change in the exchange rate. Such a change in exchange rate is likely to have an effect on industry dynamics only if it is significant and persistent over time.

Another dimension of the exchange rate factor relate to its dual but opposite effect on costs and profits of domestic automotive productive activities. If the local currency appreciates, cost of imported components used in domestic manufacturing declines, but so does the revenue earned from exported products. The question therefore becomes that of comparing currency appreciation production cost reduction and the resultant decrease in export revenue per unit exported emanating from the same currency appreciation. This question was outside the scope of this study.

Again, although a change in exchange rate had the potential to affect the import growth fraction, the effect was not clear and could only come into play if it was persistent, unanticipated and drastic. As such the exchange rate effect on industry dynamics was not explicitly modelled. Model disaggregating, as proposed under the section for further investigation, would inevitably have to consider exchanges rates as one of the many factors, which have a potential to influence imports. Otherwise, historical data on the Rand-US dollar and Rand-Euro exchange rate indices versus automotive trade deficit index (Figure 33) is inconclusive in this regard.

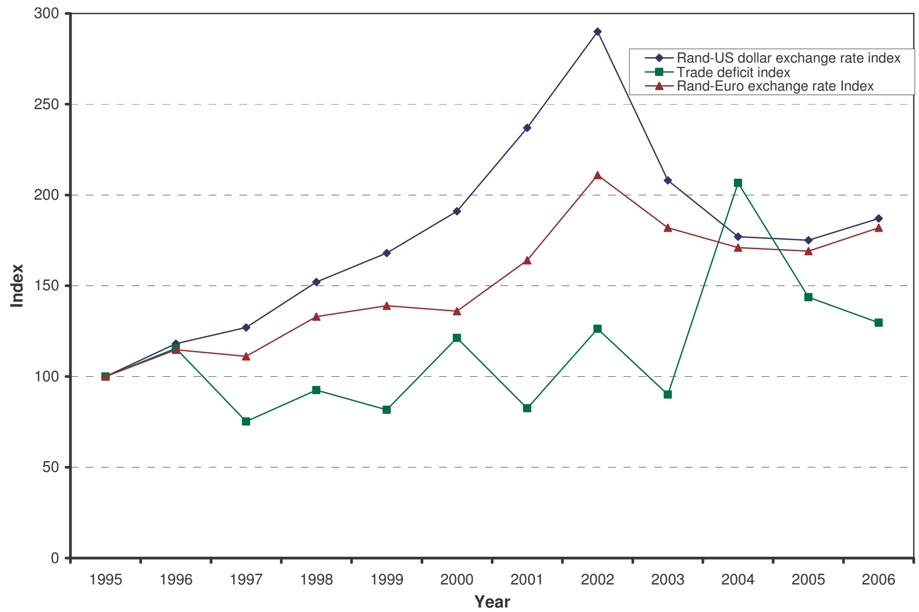

Figure 33: Rand-US dollar/Rand-Euro exchange rate and automotive trade deficit indices

Source: AIEC 2007

6.7 Synthesis

In formalising of an existing policy framework into a system dynamics model, the challenge is to capture the structural set-up of such a policy and relevant policy rules as carefully as possible. Expert opinion on the captured model structure serves the purpose of validating the model structure. Historical quantitative and qualitative data provides a useful base for model parameter estimation. Whereas expert opinion of the developed model structure is a major validation tool, explicit model behavioural tests tend to confirm general mathematical consistency of the model. Having gone through all these processes in developing the PAA-IEC-Trade balance model of the South African automotive industry, it was felt that the developed model could be used, with reasonable confidence, as a tool to test possible industry outcomes relating to policy decisions on PAA and IEC incentives of the MIDP. The model presented a useful scientific tool upon which policy decisions could be tested before they could be implemented. Most important, the model presented a formal policy framework that could be critiqued and objectively improved upon.

7 PAA-IEC Model Extension: Introduction of the Duty Free Allowance Imports and Price Effect on Exports

7.1 Duty Free Allowance

In the initial model, industry rebatable imports, exports and domestic market of vehicles were postulated as the key determinants of domestic production potential. However, another exogenous dispensation, the Duty Free Allowance (DFA), has an effect on automotive industry imports that is almost equivalent to the PAA-IEC rebatable imports. The DFA dispensation allows domestic vehicle manufacturers to import automotive components free of duty to the value equal to 27% of their domestic wholesale value of vehicles sales. Its purpose is to reduce the duty cost related to components for which local manufacturing is not economically feasible. In essence, DFA generated imports adds to industry imports into the country on which no duties are payable. The 'non-paying' duty imports, as previously explained, have a bearing on firms' local production decisions and eventually on domestic investment.

To incorporate the effect of the DFA dispensation, two variables were introduced in the model - duty free allowance (a percentage) and the duty free imports. The value of duty free imports was then captured as a function of the DFA and domestic market for vehicles; the latter variable was already part of the model. Because of the similar effect of duty free imports and rebatable imports on the domestic production potential, the industry rebatable imports variable was replaced with *industry rebatable imports and duty free imports*. The *industry rebatable imports and duty free imports variable* was a summation of rebatable imports generated under the PAA and IEC incentive dispensations and the duty free imports generated by the DFA. Hence, the new postulate was that production potential factor was a function of the industry rebatable imports, duty free imports, exports and domestic market (Figure 34). It should be noted that model calculation of DFA imports could potentially overestimate the value of such imports as domestic sales of locally produced vehicles was a proportion of the domestic market. For the purpose of the reference mode simulation this proportion was taken to be 0.75, from the annual average local vehicle sales as a percentage of local market for the period 1995 to 2006 (NAACAM, 2006)

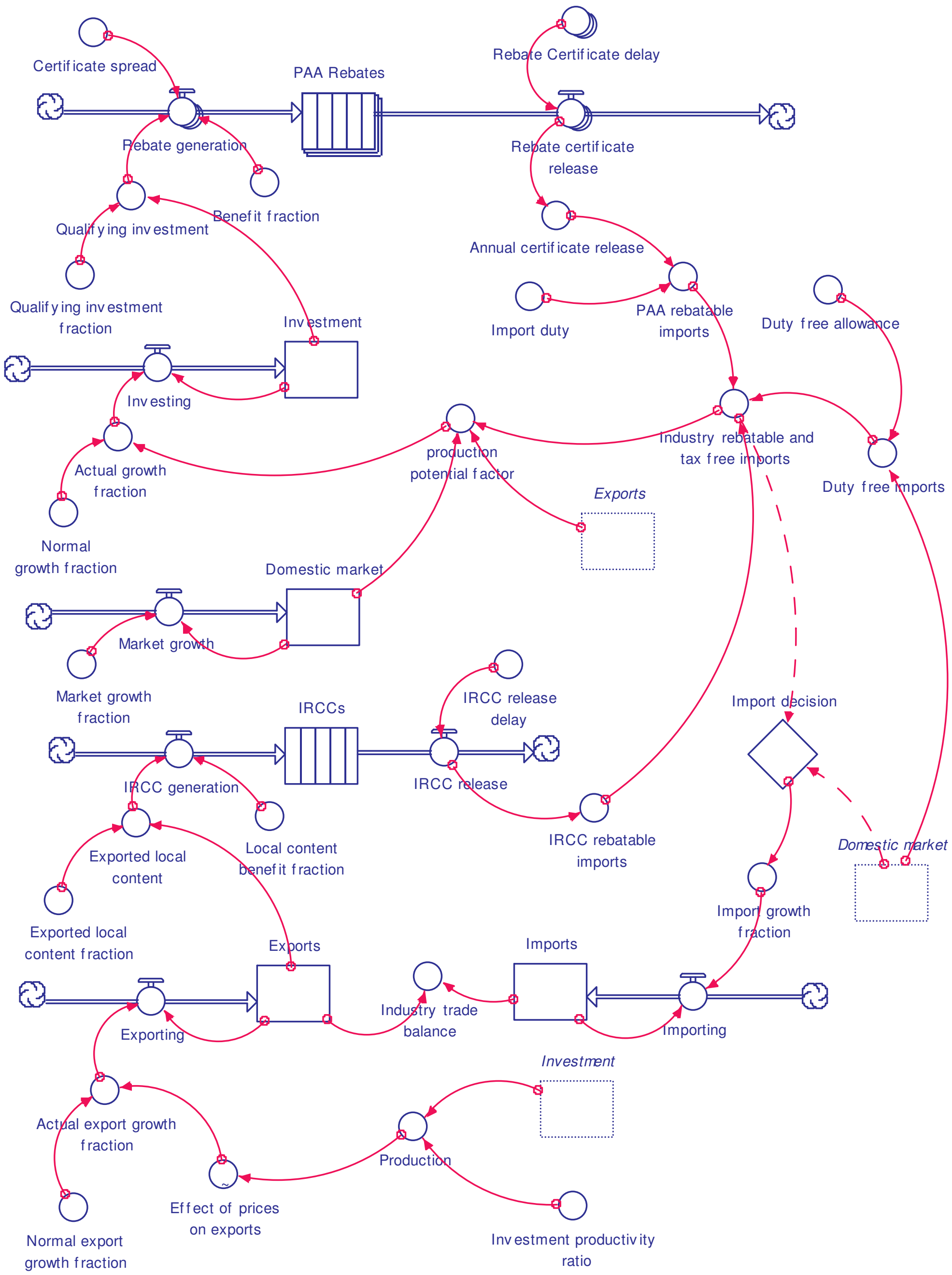

Figure 34: PAA-IEC-DFA Model Structure

7.1.1 Effect of vehicle prices on industry exports

The treatment of the IEC as an exogenous structure to the model had been motivated by initial focus to model, exclusively, the effect of the PAA on industry performance dynamics. The IEC had been introduced in the model only because the incentive augmented the stock of rebatable imports. The PAA model was underestimating the value of rebatable imports. As such, the IEC model structure was important to the research question to the extent that it contributed to the stock of rebatable imports. Again, although there was a theoretical case that increase in production volumes could lower vehicle prices, via the realisation of economies of scale, and the lower vehicle prices could in turn stimulate exports, this had been deemed unrealistic for the South African case. Export of vehicles from South Africa depended, largely, on award of export contracts to South African subsidiaries by their parent companies. Although price was an important factor in the decision to award export contracts, after the award of contract, the price elasticity of demand for exports was constrained by this parent company arrangement until the time to reconsider such contracts.

Nonetheless, the production-price-export loop was theoretically important in the endogenous integrating of the IEC with the PAA model, and in capturing the feedback effect of investment on exports. To capture the price effect on exports emanating from increased production, three variables were introduced in the model – *production*, *investment productivity ratio* and *effect of prices on exports*. Production was specified as a function of investment and investment productivity ratio. The investment productivity ratio was calculated from investment and production historical data for the period 1995 to 2006 (Appendix 6). The effect of prices on exports growth was in turn captured as a graphical function of production, with an underlying assumption that the higher the production levels, the lower was unit price and the higher was exports (Figure 34). It is important to note that the parameter "effect of prices on export growth" was not synonymous to well-known "price elasticity of demand" in this case.

7.2 Extended Models Simulations

7.2.1 Replication of the Reference mode

After the extension of the model to include the DFA and to capture the feedback effect of the PAA dispensation to the IEC model structure via the investment-production-price effect on exports, simulations were carried out to find out how the extended model results compared with the initial model. This was done with a view to establish whether there were significant differences in results to warrant a change of policy conclusions initially noted.

The first simulation was to test the extent to which the new model replicated the study reference mode. The specification that vehicle prices gradually declined with increase in production as presupposed in the economies of scale concept produced reference mode behaviour comparable to that of the initial model (Figure 35). In both cases, industry deficit peaked at some R39 billion before starting to decline. However, the rate of decline was slower in the extended model that included DFA imports. This could be understood in the context of DFA imports upward pressure on industry imports in general.

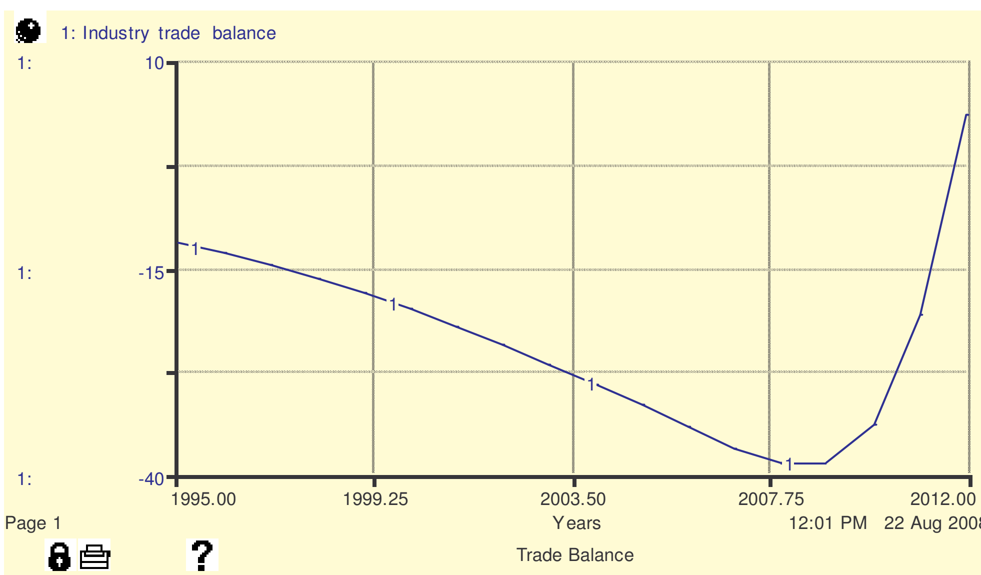

Figure 35: Extended Model Reference Mode

Simulations were then carried out to test the effect of change in the PAA benefit fraction and change in import duty rates on the trade balance trend. In both cases, simulations results showed that a change in these two PAA policy levers had minimum effect on the industry trade balance trend (Figure 36 and Figure 37), the same conclusions as had been reached with the initial model.

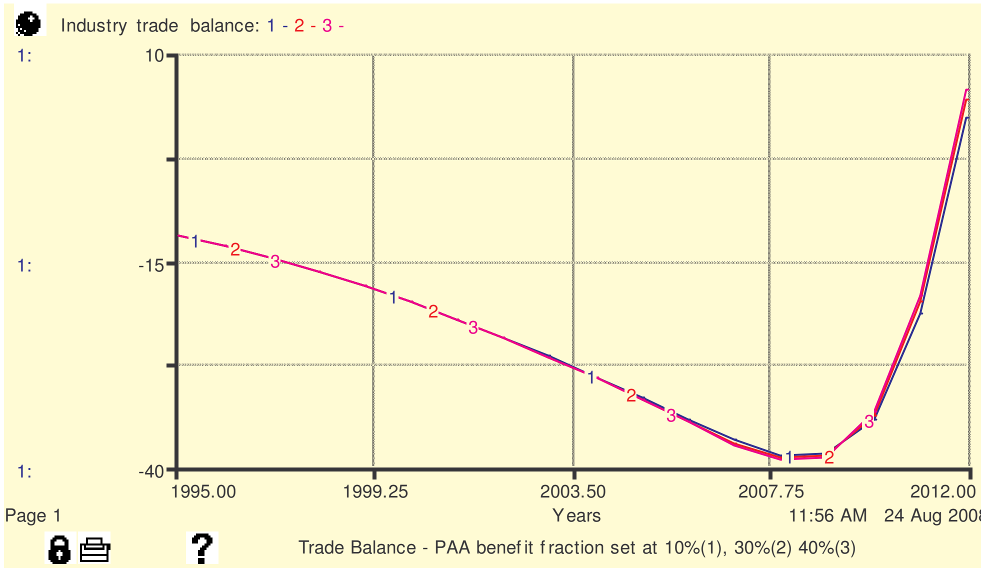

Figure 36: Effect of PAA Benefit Fraction on Industry Trade Balance

Specific to the effect of import duty rate, it was noticeable that the small effect that a reduction in import duty rate had on the industry trade balance trend had declined further after the introduction of DFA imports in the model (Figure 37).

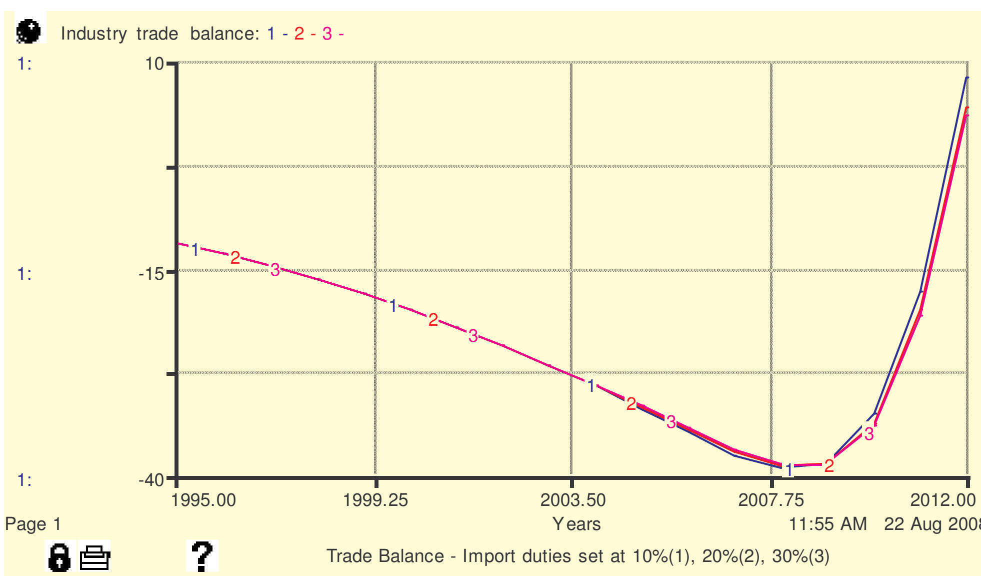

Figure 37: Effect of Import Duty Rates on Industry Trade Balance

Similarly, the effect of changes in the IEC's exported local content benefit fraction on industry trade balance in the extended model was compared to initial model results. After accounting for the increased impact of the combined rebatable imports and DFA enabled imports on the import decision, simulation results were comparable to that of the initial model. A reduction in the exported local content benefit fraction could effectively mitigate against increasing industry deficit trend (Figure 38).

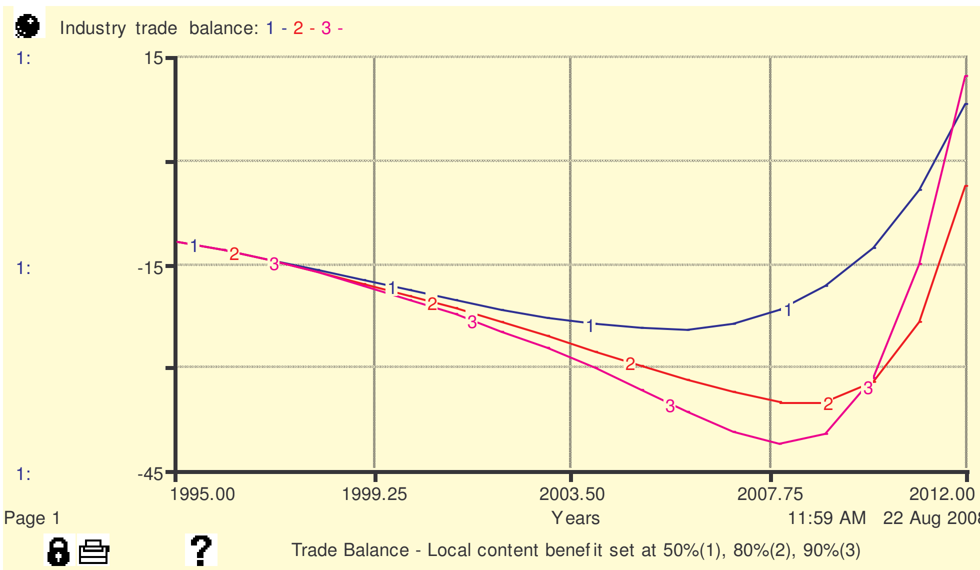

Figure 38: Effect of Exported Local Content Benefit Fraction on Industry Trade Balance

7.3 Synthesis

The effect of the DFA dispensation on the initial model performance was important to the extent that a summation of rebatable imports and duty free imports affected import growth. After accounting for the increased impact of the 'non-paying' duty imports on the local production potential, the extended model simulations results were, largely, similar to the initial model that had excluded the DFA dispensation. The introduction of production and price variables in the model, on the other hand, provided a means of capturing the economic concept of economies of scale and for capturing the feedback effect of investment on exports, linking the PAA model structure to the IEC. The assumption that increase in production results into lower vehicle prices which in turn has a bearing on export growth rate produced coherent results in terms of replication of the study reference mode, but the responsiveness in unit prices to production increase was low.

In all, the model extension did not warrant a change in policy conclusions that had been drawn from the initial model. It should be emphasised that this was the case because the effect of the introduced variables was specified as being minimal to overall industry performance dynamics and the other new variable (DFA imports) only augmented an already existing variable (industry rebatable imports), the effect of which had already been captured. Otherwise simulations of the extended model may be different to that of the initial model. For example, it was noted that a high effect of price reduction on export growth emanating from increased production would lessen the deterioration of trade deficit relative to the reference mode run (Appendix 7).

8 Policy insights

This chapter presents policy insights from the PAA-IEC model simulations. Section one and two discuss insights on policy decisions relating to the PAA and the IEC dispensation respectively. In the last section, time-bound constraints and the substitutability of the PAA with the IEC is explored.

8.1 Policy decisions on the PAA

Implicit to any policy model is a policy variable or a set of variables that can be adjusted in order to influence intended outcomes. In complex systems, with more than one policy variable, system dynamics modelling provides a useful means of identifying high leverage policy variables through estimating variable effect on the situation being modelled. Under the PAA dispensation, there are only two policy variables – the PAA benefit fraction and the import duty. These are the policy variables under direct government control. The delay in the issue of the PAA could be considered as another policy tool, but over time the value of annual certificates to be issued becomes dependent on the previous investment which government cannot control after the approval. As such, policy decisions on the PAA relate fundamentally to adjusting the PAA benefit fraction and/or industry import duties in order to influence the value of rebatable imports generated per specific investment. The immediate product of the PAA and the conduit of the incentive effect to industry dynamics is the value of rebatable imports generated under the dispensation. In order to influence industry performance via the PAA, government policy makers need to have an insight into the effectiveness of each of these two policy levers in determining industry performance. The PAA-IEC model provides a useful tool in this regard. It can be used to estimate the value of the PAA certificates that would be issued in a specific period given a particular investment trend. But most importantly, it can reveal which policy variable is effective in influencing a particular behavioural aspect of the model under scrutiny. In this study, the main variables of interest were industry competitiveness and industry trade balance. However, having established in Chapter 4 that the PAA had little direct effect on industry competitiveness by way of supporting R&D and innovation, subsequent analysis was limited to understanding how the changes in PAA policy variables affect the automotive industry trade balance. First, the model was used to answer the seemingly obvious question whether the PAA rebatable imports were sensitive to the incentive benefit fraction and import duties. Thereafter, the model was used to answer the question which of the two policy levers is more effective in influencing PAA rebatable imports and subsequently the industry trade balance.

8.1.1 Effect of PAA benefit fraction on PAA rebatable imports

A test on PAA rebatable import sensitivity to the PAA investment benefit fraction set at 20%, 30% and 40% was done. The 20% was the prescribed benefit fraction and the intention of the sensitivity tests was to find out how increasing the benefit fraction would affect the value of rebatable imports. Model simulations showed that the increase in PAA rebatable imports was proportional to the increase in investment benefit fraction (Figure 39). Given a specific value of PAA qualifying investment, one could double the value of PAA rebatable imports by simply doubling the PAA benefit fraction. The value of the rebatable imports relative to total industry rebatable imports remained insignificant even at a 40% benefit fraction. For example, the value of industry rebatable imports in 2008 was projected to stand at R49.7 billion while that of the PAA rebatable imports predicted in the same year was a mere R 3.1 billion.

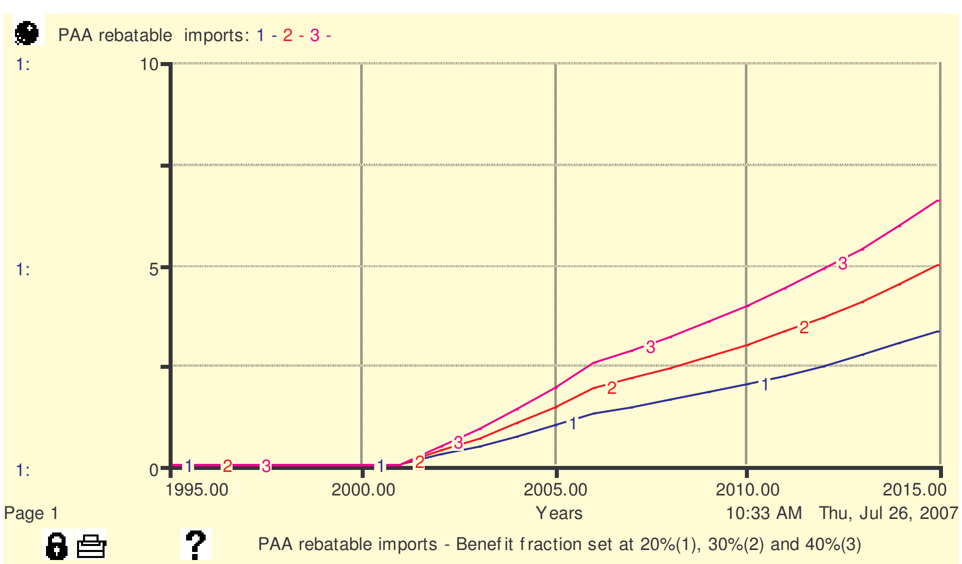

Figure 39: Effect of PAA benefit fraction on PAA rebatable imports

It was acknowledged that this form of linear relationship was uncommon in system dynamics modelling and could only apply when one was still considering the model in piece-wise, before accounting for time and feedback effects. This did not mean, however, that the simulations did not provide useful information. These simulation results provided the building blocks on which model complexity was built.

8.1.2 Effect of change of import duty on PAA rebatable imports

The expectation was that PAA rebatable imports would be highly sensitive to import duty rates. Given a particular value of PAA rebate certificates, the value of PAA rebatable imports increases with the lowering of import duties – PAA rebate certificate value being the value of duty one can offset on imports. As an example, if industry was awarded R10 million worth of PAA rebate certificates, at an import duty rate of 20%, industry would offset duty on imports to the value of R50 million, but if the import duty rate was lowered to 10%, the value of imports on which duty could be offset would increase to R100 million. Figure 40 shows the sensitivity of PAA rebatable imports to import duty rates set at 10%, 20% and 30%. The increase in the value of rebatable imports at 10% import duty rate was more than threefold compared to when import duty rate was set at 30%. The non-linearity of the duty rate effect on PAA rebatable imports emanated from the hyperbolic relationship between PAA rebatable imports and import duty on one hand, and from import duty effect on overall industry rebatable imports that in turn affected domestic investment and hence the generation of PAA rebate certificates on the other. The import duty rate, together with the new value of PAA certificates generated, would then ultimately determine the value of rebatable imports.

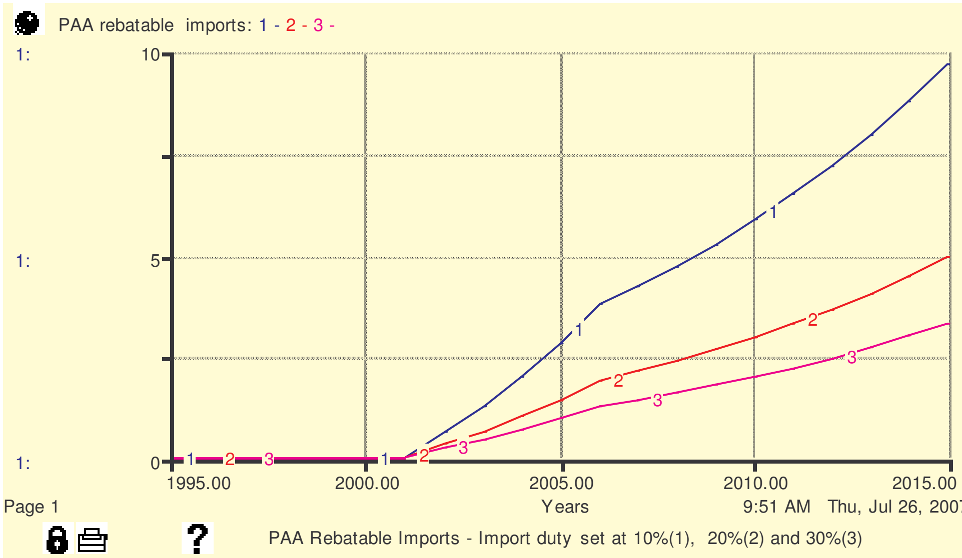

Figure 40: Effect of import duties on PAA rebatable imports

From Figures 39 and 40 it was clear that a change in import duty rate provided a more effective policy lever to influence PAA rebatable imports. Still, compared to overall total industry rebatable imports, the increase of PAA rebatable imports due to a change in import duty rates remained insignificant.

8.1.3 Effect of change of PAA benefit fraction on industry trade balance

The aim of the study was to establish whether and how MIDP incentives influenced overall industry performance trends, specifically the industry trade balance. As such, the effect of change in PAA policy variables on industry trade balance was considered next. Model simulations showed that the effect of such a change on industry trade balance was marginal. Figure 41 shows how industry trade balance trends change with a change in PAA benefit fraction from 20% to 30% and to 40%.

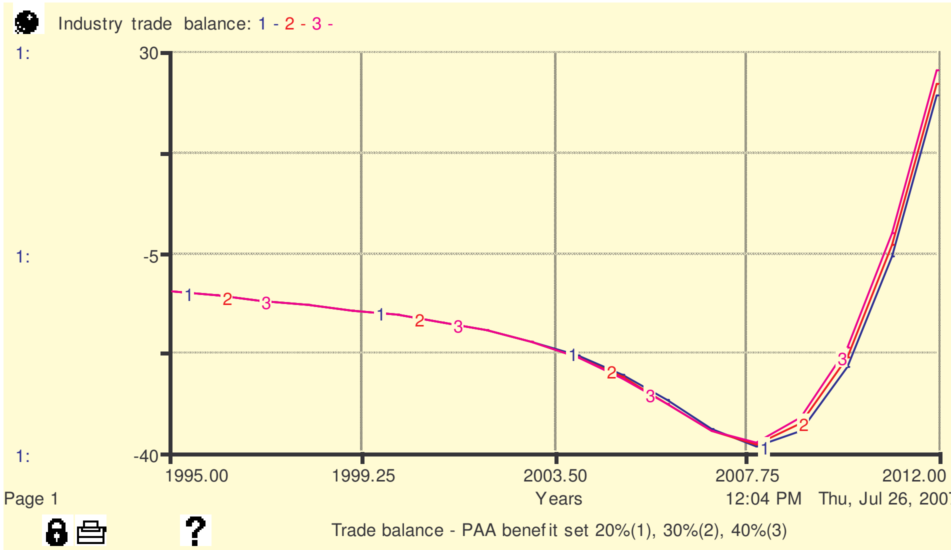

Figure 41: Effect of PAA benefit fraction on industry trade balance

Although a change in PAA benefit fraction did have a noticeable effect on PAA rebatable imports, its effect on the industry trade balance was minimal. This could be attributed to the relatively low value of PAA rebate certificates compared to the overall industry import value. As such, industry benefit from the PAA dispensation could be adjusted without affecting industry trade balance.

8.1.4 Effect of import duty on industry trade balance

Next, a test was done on the effect of change in import duty rate on industry trade balance, as the second PAA policy variable. Model simulations showed that at an import duty of 20% and 30%, the impact of import duty on industry trade was almost synonymous to that of a change in the PAA benefit fraction. The change in the industry trade balance remained minimal. However, as the import duty was lowered further, excessive increase in industry trade deficit was impeded. At import duty of 10%, it was notable that industry trade deficit did not reach levels projected when import duty was at 30%, before it started to improve (Figure 42). Hence, import duty adjustment could be used to influence industry trade balance under the PAA dispensation, but for the duty to have a visible effect, it would have to be reduced to very low rates, a situation which may be almost unrealistic and could yield other industry dynamics outside the scope of this analysis.

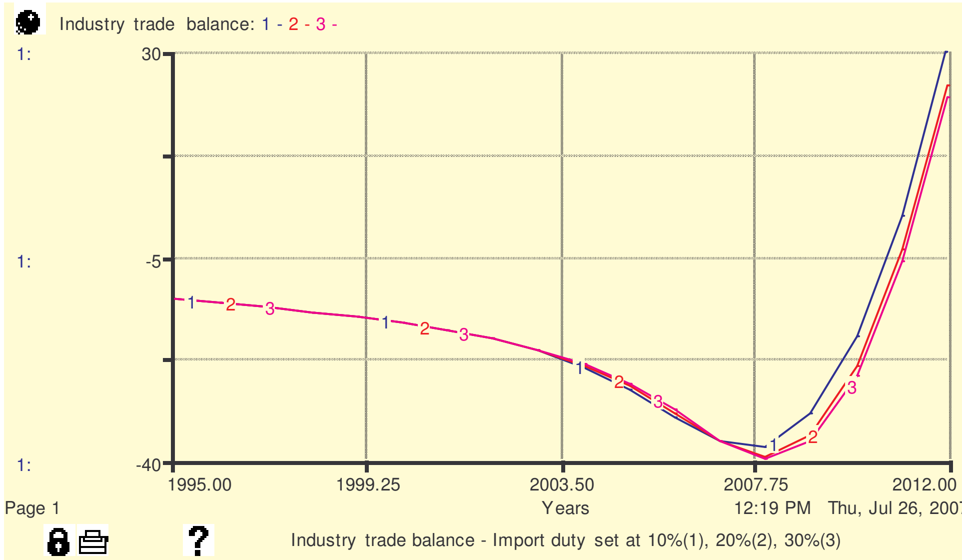

Figure 42: Effects of import duties on industry trade balance

There is another dimension to the import duty reduction that needs to be acknowledged. With the location disadvantage and relatively low production volumes of vehicles in South Africa, the country is a high-cost producer relative to its global competitors in Europe, Asia and Latin America. MIDP incentives make it profitable for local OEMs to produce domestically as long as the domestic market is still protected from cheaper foreign imports. At very low levels of import duties, local OEMs may find it profitable just to import from other low-cost production locations, given that all locally produced models are also assembled in other international locations. The resultant effect will be that the import growth fraction will be higher than the estimated 12% used in the reference mode run. If the domestic market and export growth rates were to remain unchanged, increase in industry imports will result into lower production levels being planned for domestic production and subsequently lower investment growth rates. Hypothetically, if the import duty rate threshold at which industry switches to import rather than domestic production was uniform and immediate at 18% duty level, industry trade deficit would increase to higher levels than captured in Figure 42 before it starts to improve at any import duty rate less than 18% (Figure 43).

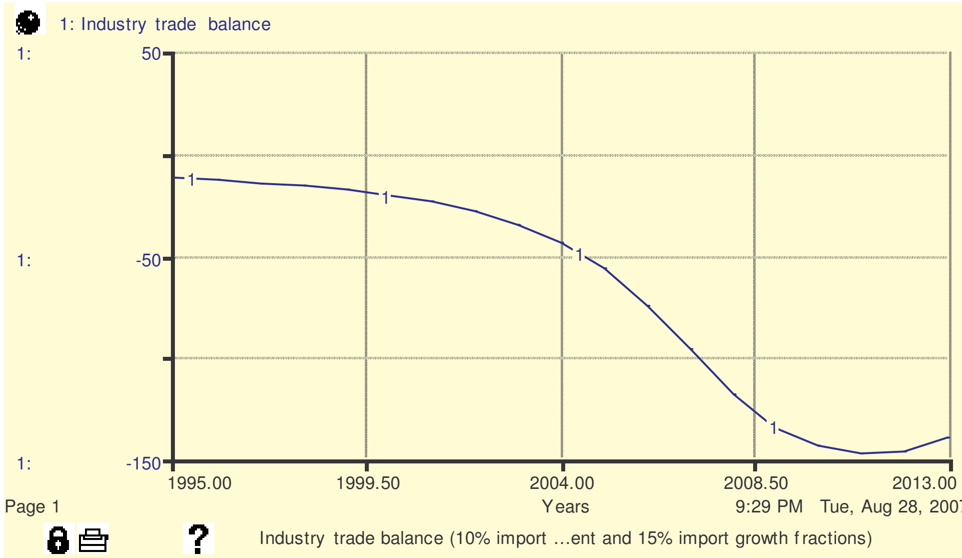

Figure 43: Industry trade balance at 10% duty rate with increased import and decreased export rates

Since the drastic deterioration of industry trade balance as simulated in Figure 43 above has not happened, it can be said with certainty that the 30% duty rate is above a threshold rate at which industry switches to import more than produce. Unfortunately, the exact 'import-switching' duty rate cannot be determined with the available information. Moreover, the rate will be influenced by a number of factors, which could differ for each business case of OEM or OE component manufacturer project. Practically, a more gradual decline in domestic production is likely as an increasing number of projects become globally uncompetitive. The most likely trend of industry balance if the import duties were to be reduced below 30% duty rate would depend on whether the import duty considered is below or above such 'switching' thresholds for projects. If the duty rate is above the threshold, trade balance trends shown in Figure 42 would be more likely, otherwise the Figure 43 trend would apply.

In the nutshell, under the PAA dispensation, policy makers did not have high leverage policy levers to influence industry trade balance. The policy levers at their disposal were, however, effective in benefiting the industry in terms of PAA rebatable imports, particularly in respect of the import duty rate.

8.2 Policy decisions on the Import-Export Complementation

Under the IEC dispensation, policy makers have one effective policy lever under their control – exported local content benefit fraction. It was acknowledged, however, that policy makers could indirectly influence the value of exported local content by use of other policy interventions, but such undertakings lay outside the study scope. Again, the change in the value of exported local content would have essentially had the same dynamic effect on industry performance as a change in exported local content benefit fraction. Hence, only change in exported local content benefit fraction was considered in the analysis.

8.2.1 Effect of the exported local content benefit fraction on industry trade balance

Note should be taken that setting the exported local content benefit fraction at 0% was equivalent to complete neutralisation of the incentive, while setting the benefit fraction at 100%, gave maximum benefit to industry under the IEC dispensation. Since there were no indications, at the time of study, to reduce the benefit fraction below 50%, the model sensitivity to exported local content fraction was tested by setting the fraction at 50%, 80% and at 100%. Simulation results showed that the model was very sensitive to the exported local content benefit fraction. With the fraction set at 50%, there was a minimum deterioration in the industry trade balance relative to the 1995 status, before the deficit started to decline. The low local content benefit fraction led to less rebatable imports being generated under the IEC dispensation, hence mitigation against increase in trade deficit in general. It followed that increase in trade deficit, before the decline set in, was more pronounced at 100% benefit fraction compared to 80% (Figure 44).

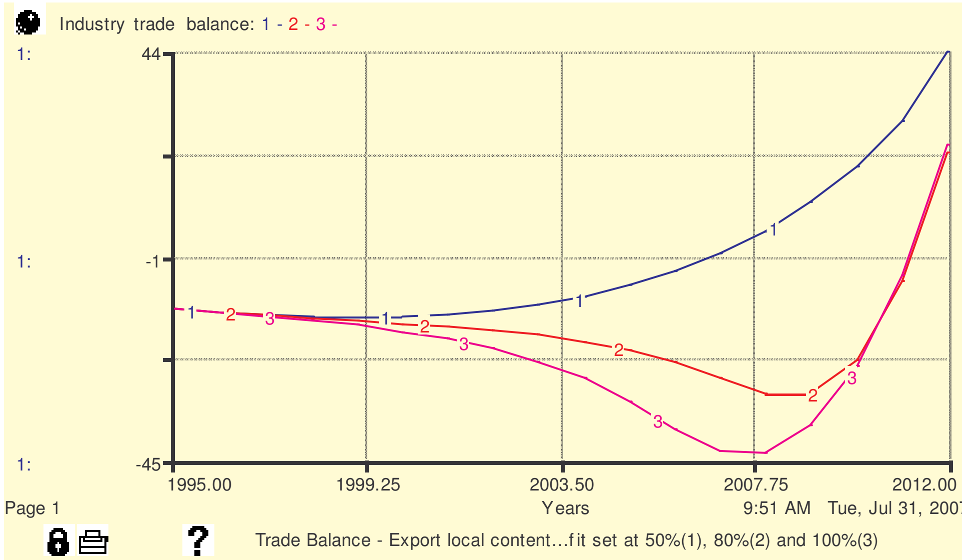

Figure 44: Effect of exported local content benefit fraction on industry trade balance

It is important to note that the analysis above is based on the effect of exported local content benefit fraction on the supply of IRCCs in value terms. An increase in exported local content benefit fraction may also have a 'demand effect' in terms of motivating the industry to export products with higher local content. In order to do so, industry has to increase its local sourcing of products. Local sourcing of products offsets potential imports, hence has a positive effect on the industry trade balance. The opposite results of the supply and demand side effects on the industry trade balance may put into question the soundness of the trade balance trend captured in Figure 44. However, given the limited capacity of the domestic component-manufacturing sector to meet OEM component supply requirements, even if there was intention to increase local sourcing, the increase would not be drastic. As such, it was felt that the effect of change in the exported local content benefit fraction was more likely to increase IRCC supply than increase in local component sourcing. Thus, the contention that Figure 44 was a fair reflection of what would happen if the exported local content benefit fraction were to be changed.

In retrospect and by implication, model simulations pointed to the fact that deteriorating industry trade balance witnessed under the MIDP period could have been minimised by adjusting IEC exported local content benefit fraction. Interpreting model simulation should be done with caution. Simulation results are informative in as far as the overall trade balance trend is concerned, not on what happened at a specific period. In reality, delays and lags have to be taken into account.

The significance of exported local content fraction could be understood in the context of the value of rebatable imports generated under the IEC dispensation and the effect of rebatable imports on overall industry imports. As noted by Richardson and Pugh (1981, p.324):

> *"It is not enough to know that a particular policy improves model behaviour. The critical question is why. What is needed is a fundamental understanding of why a particular policy improves model behaviour"*,

It was important that the effectiveness of exported local content fraction in influencing industry trade balance be considered and understood. Although both industry and IEC rebatable imports were increasing, the latter was increasing at a faster rate. This could be attributed to the fact that the rate of increase in exports, upon which generation of rebatable imports was based, was higher than industry-import growth rate. The increase in industry rebatable imports was further exacerbated the Precious Group Metal (PGM) dispensation for the catalytic converter sector under which 40% of imported precious metal was being treated as local content when exporting catalytic converters. After 2010, the model projected the value of IEC generated rebatable imports tended to reach 50% of the total industry imports (Figure 45). This 'catch-up' process of IEC rebatable imports with total industry imports was predicted to continue. Therefore, to the extent that imports affected industry trade balance and that rebatable imports had a significant influence on industry imports, a change in exported local content benefit fraction would significantly affect the industry trade balance trend. It should be noted that imports cannot increase in perpetuity. At a particular point in time, import growth will be constrained by the size of the domestic market. This aspect was not explicitly modelled. As such the import growth trend in Figure 45 should be interpreted with caution.

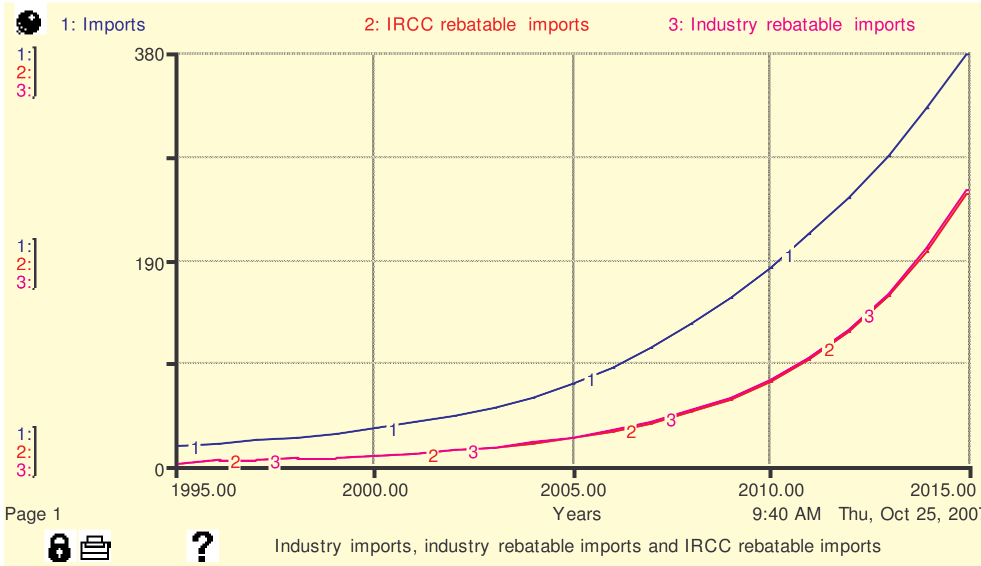

Figure 45: Industry imports, IRCC rebatable imports and industry rebatable imports

8.3 Time-bound constraints of the PAA-IEC incentive dispensation

One of the advantages of system dynamics modelling is that it can reveal time-bound constraints in a particular system. By default, MIDP incentives encouraged imports of automotive products into the country. The expectation was that the enabled exports from the country would be able to offset increase in industry imports. Domestic production would be enhanced rather than crowded out. An important policy question that was not asked was how feasible this assumption was in the medium and long term. An aspect revealed by model simulations was that the offer of incentives in the form of import rebates was not sustainable, given the general industry growth trend in the first 10 years of MIDP incentives. In particular, the domestic market for automotive products had been growing at an annual compound rate of 9% while that of exports, a major source of rebatable imports, was some 27%. Without putting a cap on the value of rebates awardable to industry, the value of rebatable imports had tended towards the value of the domestic market (Figure 46). The motivation to produce locally, for the domestic market, declines as the value of rebatable imports approach levels that can be absorbed by the local market. In the long term, domestic production is likely to stagnate, or decline as industry makes a delicate balance of how much to produce locally given the total value of import rebates received, unless a drastic increase in exports is realised.

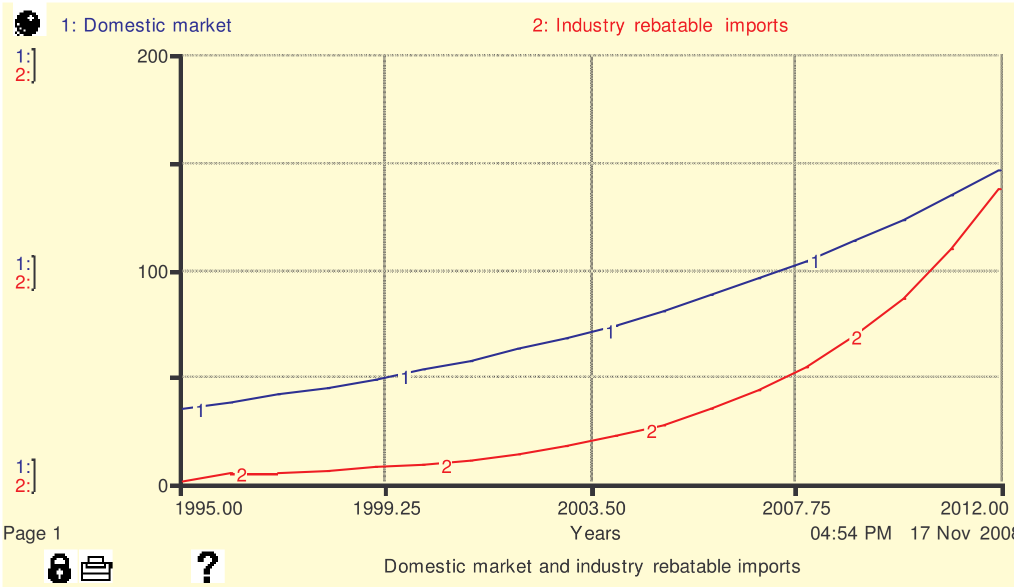

Figure 46: South Africa's domestic automotive market and industry rebatable imports

Import rebates earned over and above import levels that can be absorbed by the domestic market would have no value for industry. In such a situation, industry would be compelled to request that such benefits take a different form, like direct tax deduction on the beneficiary tax account. Model simulation pointed to the fact that the fiscal incentives for the South African automotive industry have a time span in which they could be effective and useful. Over time, however, the incentive model would become self-obliterative and self-defeating in terms of the objectives for which they were intended. Whether the pressure would came from government to limit benefit to industry in terms of the value of rebatable imports, or from industry after realising that it was holding excess rebates, the PAA-IEC model, but primarily the IEC side, would have to be modified.

8.4 Comparison IEC with the PAA incentives

As mentioned in Chapter 1, stakeholders in the industry were concerned that the IEC might be contested under WTO trade regulations. If this were to happen, it would cause serious disruption in automotive business plans in the country and negatively affect investment prospects. As a means of maintaining policy environment stability, there had been suggestions that the possibility of replacing the IEC with increased PAA benefit should be explored, as the PAA was not contestable, being a supply side incentive. Model simulations showed that this was practically impossible. Even if the PAA benefit fraction were to be increased from the then 20% to 100%, the value of rebatable imports it would generate would be significantly lower than rebates the IEC generates under its current policy rules (Figure 47). If the intention was to give industry equal benefits, replacement of the IEC with increased PAA benefit could not realistically achieve this.

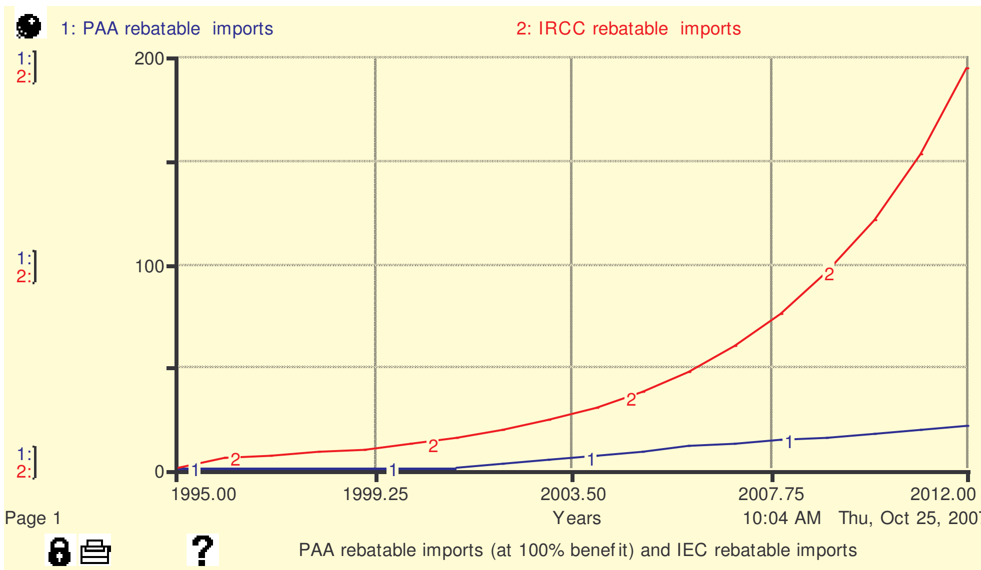

Figure 47: Comparison of PAA rebatable imports (at 100% benefit) and IEC rebatable imports

8.5 Industry performance without the IEC and PAA incentives

An important question to which the model could provide some insight was what would happen to the industry if the PAA and IEC incentives were discontinued. The model captured this situation by disabling effects of rebatable imports to the system. Investment growth faction was lowered due to the high likelihood that investment levels would be less than in situation where the incentives were being given because of the location disadvantages and low economies of scale previously highlighted. In addition, import growth fraction was adjusted upwards, while exports growth fraction was reduced. This was based on the understanding that low investment would negatively affect the country's export potential while increasing the propensity to import at the same time. Without incentives, there was high likelihood that domestic production would decrease, benefit of economies of scale would be lost, industry competitiveness would be lost and ultimately exports based on industry competitiveness would decline. Simulation of the model under these conditions showed that trade deficit increased to higher levels compared to a situation where industry was receiving IEC and PAA incentives. Moreover, improvement of trade deficit after a while, as realised in Figures 41 and 42 did not take place in the simulation period under consideration. Figure 48 represents the likely trend in industry trade balance in a situation of no IEC-PAA incentives.

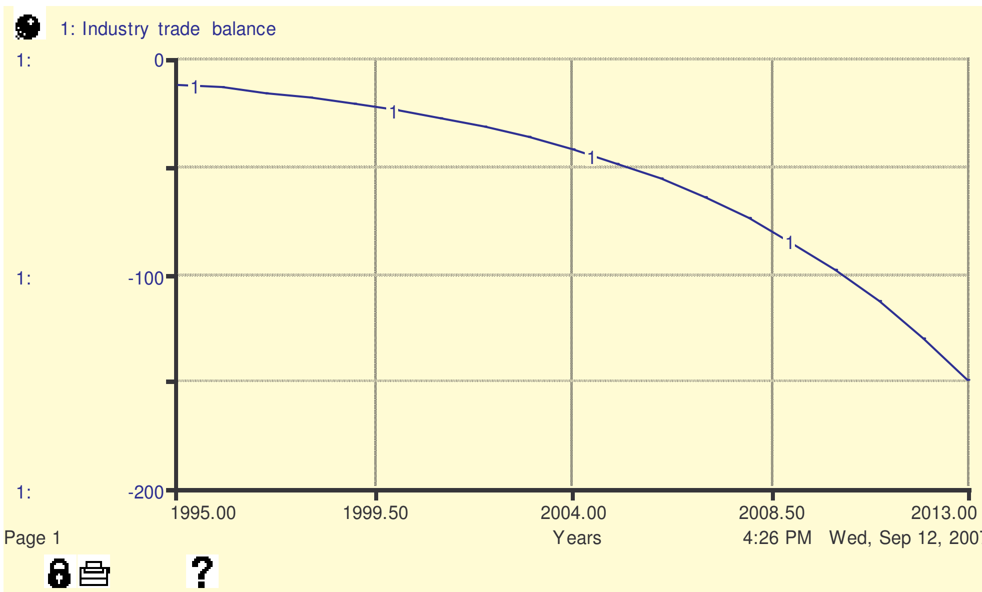

Figure 48: Industry trade balance without IEC-PAA incentives

One could not therefore argue that without the incentives, industry would be in better position as regards its trade balance account. It should be noted, however, that the trade balance trend under the no-incentive scenario was very sensitive to import growth rate fraction. Small changes in import growth rate had a significant impact on industry trade balance.

8.6 Synthesis

The IEC rather than the PAA incentive was the major contributor to the industry trade balance trend. The adjustment of PAA benefit fraction and import duty rate above a particular minimum threshold had little effect on industry trade balance. The IEC, on the other hand, provided a high leverage policy lever to influence the industry trade balance account. The PAA-IEC model was, however, time constrained. Over time, the benefit it availed to industry tended to lose value, as the value of rebatable imports tended towards that which the domestic market could absorb. In terms of the PAA-IEC model supporting the industry competitive objective, the model had no specific policy lever that could be utilised to direct investment into R&D activities. To the extent that R&D was a prerequisite for long-term competitiveness, the PAA-IEC model in this form was a weak policy framework for supporting long-term industry competitiveness.

9 Conclusions

This chapter presents the conclusions of the study in relation to the research question, the study hypothesis, purpose and the specific objectives. A review of how the study answered the research question and met the study objectives in relation to the hypothesis is presented in section one. Study propositions and contribution to prior knowledge are presented in section two and three respectively. Methodological issues and study limitations are presented in section four. The last section looks at areas of further research.

9.1 Closure of the study

The motivation behind the study was the lack of apparent investment in R&D and the deteriorating automotive industry trade balance realised under the MIDP dispensation that put in question the ability of MIDP incentives to support industry competitiveness in the long term as initially envisaged. The study hypothesised that the PAA, as one of the MIDP incentives, was is a significant contributor to the deterioration of the automotive industry trade balance in South Africa but was potentially an effective incentive to support industry competitiveness. A change in value and structure of the incentive had a potential to reverse the deteriorating trade deficit and support competitiveness. Hence the research question for the study was how a change in the PAA structure would impact on the industry trade balance and competitiveness via increased R&D investment.

To answer the research question and meet the specific objectives of the study, an analysis of industry performance under the MIDP incentives was done. A theoretical exploration of the prospects of the PAA in supporting the industry competitiveness objective based on comparable economies to that of South Africa, with a local automotive industry, was also done. It was found that South Africa's automotive industry performance in terms of the MIDP objectives was mixed. Moreover, the success of the PAA as a competitiveness incentive was dependent on the extent to which the incentive would effectively motivate technological innovation in the country's automotive industry. Theoretical literature indicated that each case of industry offer of competitiveness incentives can only be justified on its own merit. A review of the structure and performance of the PAA indicated the incentive had no direct bearing on R&D investment as a perquisite for long term industry competitiveness. This position was further supported by the formal model that showed that under the PAA incentive structure, there was no policy lever to direct investment in R&D and that a change in value and structure of the PAA had minimal effect on industry trade balance trend. Ultimately the modelling of the incentive structure disproved the study hypothesis. The PAA was neither a significant contributor to the deterioration of the automotive industry trade balance in South Africa nor a significant incentive to support competitiveness. Changing policy rules relating to the incentive almost had no bearing on industry competitiveness via increased R&D investment, and on industry trade deficit trend. This did not however lessen the importance of the study in respect of the study purpose. From a practical point of view, the study revealed that the trade deficit could be influenced by changing policy parameters pertaining to the IEC but both the IEC and the PAA were not effective incentives to support long term industry competitiveness. The following section presents theoretical contributions and conclusions of the study.

9.2 Theoretical conclusions

The aim of the study was to develop a formal framework for formulating and evaluating an industrial policy intervention aimed at supporting competitiveness. Given that this was an applied study and used a system dynamics model-building methodology, theoretical conclusions arose from the model building process and model simulations.

Proposition 1: Qualitative articulation of competitiveness policy does not sufficiently take into account the systemic interdependencies and feedback effects within the industry that have a bearing on intended outcomes.

The study showed a tendency to match directly intended outcomes to policy inputs without taking into account the effect of internal interdependencies and dynamics at play in the space between policy inputs and outcomes. This policy articulation gap is presented by Figure 49.

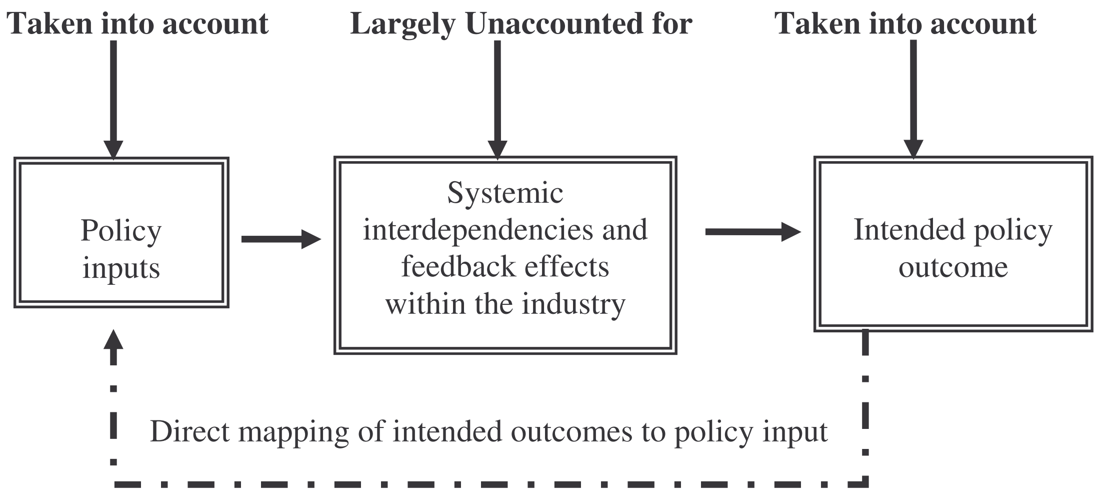

Figure 49: Competitiveness policy articulation gap

Addressing divergence between the intended and realised policy outcomes had always taken the form of revisiting policy input, in the case of MIDP industry incentives, with limited ability to interrogate how the systemic factors within the industry setup could be influencing the intervention. Because of this, some outcomes had come as a surprise to policy makers, yet these could have been anticipated. Specific to this study, the surprise outcome of policy intervention had been the deteriorating industry balance, which can be indicative of industry competitiveness loss in the long term.

There is a general lack of research on how systemic processes within policy frameworks relate to policy interventions, yet understanding systemic influences in any complex system is critical in finding out why well-intentioned policy interventions end up yielding undesired consequences or less than expected outcomes. This study contributes towards filling this knowledge gap by incorporating systemic interdependencies and feedback effects in South Africa's automotive competitiveness policy articulation.

Proposition 2: System dynamics modelling of a policy model can reveal time-bound policy constraints that are implicit to a model structure.

The capturing of feedback effects within a system is one of the fundamental elements of system dynamics modelling. Its importance in policy modelling is fairly well researched and documented. The same applies to using system dynamic modelling to identify high leverage policy variables in a model. What is less researched and less documented is the role of system dynamics modelling in identifying time-bound constraints of policy models. This is critically important in applied policy research. Implicit to most policy model are time-bound constraints, which can be resources constraints or performance convergence to untenable positions. The study showed that in an effort to support industry competitiveness through the offer of investment and export-based rebate allowances, the value of rebatable imports becomes a bigger percentage of the domestic market size. At the extreme, the two can equate. Unless the loss of domestic market share of locally produced products to imports is compensated for by increase in exports, domestic production, for the local market, will be crowded out. The objective of making the local industry competitive as a means of supporting increased domestic production will be completely lost. Of course, this extreme situation cannot happen in practice, but the above analysis points to the fact that at a particular point in time, the PAA-IEC industry support model will have to be modified or changed because of industry convergence to an undesirable state. Not withstanding limitations of use of growth rates in some stocks extrapolations, the study contributes towards adding to the stock of knowledge on the usefulness of system dynamics modelling in terms of exploring the time span under which policy interventions may be useful and identifying internal model constraints that may make a particular policy model obsolete.

Proposition 3: A generic investment and/or export based incentive model does not provide effective policy levers to guide industry to a long-term competitiveness path. At best, it serves as an indirect motivation to invest and export.

Formalisation of existing policy frameworks, often based on intuition, into system dynamics models, as a means of getting better understanding and improving such models, is an area that has not yet received much attention in developing countries. The endogenous approach to policy modelling of system dynamics methodology points to the fact that one has to look for internal factors driving a particular behaviour. In order to influence behaviour, one must have the means to identify model variables that influence behaviour and adjust them accordingly. Existing literature has tended to assume that within a particular model, there will always be such high leverage policy variables. This study shows that there are situations in which a well-intentioned and consensus-based model may fail to have an internal policy lever to influence its ultimate objective. At best, the model may only influence the objective by proxy. The study found sufficient evidence that R&D investment, as a prerequisite for long-term industry competitiveness, had not been taking place, despite the offer of industry incentives. Most importantly, the formal model revealed that that there was no specific policy lever to directly influence industry investment in R&D activities and innovation, hence to influence competitiveness (Lim, 1994, p.834; Wint, 1998, p.281; Frankema & Lindblad, 2006, p.316).

9.3 Contribution to prior knowledge

The main contribution of this study stems from its combination of economic theory on investment, industrial and science policy. Although offer of investment incentives is widely studied in economics as a form of market-correction intervention in case of externalities (Brewer & Young, 1997, p.177; Dupasquier & Osakwe, 2005, p.244; Bwalya, 2006, p.514), a theoretical framework that links the externality concept with competitiveness does not exist. Competitiveness is considered as a separate macro-economic concept relevant to industrial policy.

This study explores the theoretical link between investment, externalities, investment incentives and industry competitiveness. Most studies do not consider the competitiveness element in the investment-investment incentive conundrum. Notwithstanding the ambiguous relationship between investment incentives and investment as proposed by Hall & Jorgenson (1967, p.391) and Hayashi (1982, p.214), theoretical literature rationalises the offer of investment incentives as a means of correcting market imperfections created by investment externalities. In other words, the intention of investment incentives is seen as a means to remove the market distortion created by investment externalities and to ensure that potential investors do not under-invest. The basic assumption of this conventional literature, that the rationale for offer of investment incentives is the existence of investment externalities and hence the need for market correction, is not entirely true or complete. Many countries or entities offer investment incentives, not because there are externalities attributable to investment, but rather to influence the investment externality. Contrary to the proposition that investment incentives are offered, in part, to correct market failure in investment decision-making, the incentives are often intended to influence the investment decisions to the extent that they serve particular objectives. More often than not, the intention is not to correct market imperfection but rather to make markets imperfect in the theoretical sense to meet the political-economic objectives of a country.

The study contributes to establishing a coherent conceptual framework to answer the question of how to offer investment incentives. It also brings out the dimension of incentives as a means to influence investment externalities rather than the conventional approach to such incentives as a means of compensating for investment externalities.

9.4 Methodological considerations and study limitations

Given the nature of the study, methodological considerations and study limitations were interlinked. Study limitations highlighted below had largely to do with the application of the system dynamics modelling protocol.

9.4.1 Choice of model boundary

In system dynamics modelling, the choice of model boundary can be a source of model weakness. The choice of what variables to include and what variables to exclude, depends on factors that the modeller considers important in influencing the model under study internally. This is a subjective process. System dynamics modelling does not provide a specific test or rule of the thumb to determine model boundary adequacy. The onus is on the modeller to use all information available when deciding what variables to be considered endogenous or external to a model. In this regard, the choice of the model boundary for the PAA-IEC model can, therefore, be a potential weakness of the study since it was subjectively done. It should be noted, however, that model boundary decision is a more risky area when it comes to developing hypothetical models. Since this study was on formalisation of an existing policy framework into a system dynamics model, the choice of model boundary was not so contentious. Only the choice of growth rate fractions for the exogenously assumed normal industry investment and export that can be contested, but again, these rates were based on historical data.

There was adequate documentation on how the model worked to allow identification of cause and effect relationships in the situation under study. However, since the model was extended to include feedback effects, which were not explicit in the available information potential model weakness based on boundary choice could not be ruled out completely. Model assumption on the impact of rebatable imports and domestic market on the import growth fraction being an example. Although based on a logical argument, that increase in value of rebatable imports relative to the domestic market would have a positive impact import growth fraction, the weights used could be contested.

9.4.2 Level of model aggregation

Even after establishing model boundary adequacy, the level of model aggregation can be a contentious aspect in system dynamics modelling. The fundamental question here is whether aggregation or disaggregating fundamentally affects model performance and can lead to different conclusions. Specific to this study was the question whether all investment should be taken as homogeneous in the modelling process. As stated previously, the nature of investment that qualifies for the PAA takes the form of land and buildings, plant and machinery, and capitalised research and development expenditure. The model did not disaggregate industry investment by category; as such, one can argue that by not doing so, some dynamics emanating from the different categories of investment could have been omitted. One will have to consider, then, whether the resultant complexity of model disaggregating would be worth the effort in terms of the study objective. This is one of the areas proposed for further study.

9.4.3 Study timing

The study was undertaken in the period when government was reviewing the overall performance of industry incentives**.** As could be expected, it was in the interest of the local industry that the offer of incentives would be continued. Information collected during the period could have been biased towards elevating the importance of incentives to industry performance. There was the possibility that industry stakeholders, excluding government, could have dwelled more on external rather than internal influences in articulating what was influencing industry performance during the period of data collection. There was also a risk that some internal factors that were instrumental in understanding internal industry dynamics could have been deliberately omitted. The use of both qualitative and quantitative data could have mitigated against this, but only partly.

In summary, like any other research project, the study had limitations emanating from the methodological approach used, timing and researcher bias, but these were deemed not significant enough to fundamentally change the contribution of the study to the research problem.

9.5 Areas for further research

One area of further study recommended is the explicit introduction of the disaggregated Cobb-Douglas production function (Frank, 2000, p.296) in the PAA-IEC model. That is, defining output as dependent on capital and labour and thereafter accounting for increase in capital and labour productivity as industry investment increases. Investment could be disaggregated to reflect the different categories like plant, machinery and equipment and R&D expenditure. This will automatically bring into consideration the nature of investment taking place and the role of technology and innovation on the production function and how such effects permeate into overall industry behaviour. Explicit inclusion of labour productivity and employment dynamics will allow the new model to make pronouncements on social objectives from the intervention; a major issue of concern to government and an important determinant for the continued offer of industry incentives.

It may also be useful to explore how the return on investment concept fits into the investment-investment incentives theoretical framework used in this study. One would have assumed that the PAA would have bigger influence on overall industry dynamics via its direct and positive contribution to return on investment being undertaken in the industry. According to the study, this seems not to be the case.

Last, given the degree of importance that the industry and experts attach to the exchange rate, as an explanatory factor for changes in imports and exports, it would be useful to explore how this theoretical assumption applies to the South Africa's automotive. Exchange rate movements have a potential to influence industry exports and imports in nominal value terms, but more important can affect the demand for imports and exports. These issues were outside the scope of this study but could be useful in understanding the future trend of the industry trade balance.

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APPENDICES

Appendix 1: Industry-wide correlation and regression analysis

Variable symbols used in correlation/regression analysis	
Variable	**Symbol**
OEM investment (value)	v1
Production (value)	v2
Domestic market (value)	v3
Exports (value)	v4
Imports (value)	v5
Rebatable imports (value)	v6
Employment	v7
Export unit price	v8
Revenue (exports)	v9
Production (units)	v10
Domestic market (units)	v11
Exports (units)	v12
Imports (units)	v13
Cars and LCVs (units)	v14
Component exports (value)	v15
CBU exports (value)	v16
Total exports (value)	v17

Simple Statistics

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
v1	16	1483	892.53438	23730	400.00000	3576
v2	16	34703	22668	555254	12238	82595
v3	16	33423	22617	534766	11780	88837
v4	16	16519	16705	264300	800.00000	45000
v5	16	27094	20540	433500	6300	72000
v6	11	17338	10572	190723	4800	30416
v7	11	105482	5545	1160298	99162	119100
v8	16	88057	43801	1408919	40000	158361
v9	16	6745	7994	107924	381.00000	22000
v10	16	370261	62199	5924174	295000	525271
v11	16	357243	70381	5715884	283959	564974
v12	16	54194	50687	867108	9500	139912
v13	11	85730	56001	943025	27289	232091
v14	15	222709	31420	3340628	183662	301151
v15	15	8.77287	8.50420	131.59300	0.28700	22.88300
v16	15	5.73493	7.12264	86.02400	0.38100	19.46300
v17	15	14.50780	15.51122	217.61700	0.66800	40.73200

Pearson Correlation Coefficients
Prob > |r| under H0: Rho=0
Number of Observations

	v1	v2	v3	v4	v5	v6	v7	v8	v9
v1	1.00000 16	0.94464 <.0001 16	0.93365 <.0001 16	0.94862 <.0001 16	0.96127 <.0001 16	0.87837 0.0004 11	0.82984 0.0016 11	0.92751 <.0001 16	0.93996 <.0001 16
v2	0.94464 <.0001 16	1.00000 16	0.98934 <.0001 16	0.96688 <.0001 16	0.99174 <.0001 16	0.92862 <.0001 11	0.88421 0.0003 11	0.97792 <.0001 16	0.97094 <.0001 16
v3	0.93365 <.0001 16	0.98934 <.0001 16	1.00000 16	0.92769 <.0001 16	0.98056 <.0001 16	0.85359 0.0008 11	0.94104 <.0001 11	0.94592 <.0001 16	0.93754 <.0001 16
v4	0.94862 <.0001 16	0.96688 <.0001 16	0.92769 <.0001 16	1.00000 16	0.97574 <.0001 16	0.99054 <.0001 11	0.72858 0.0110 11	0.97426 <.0001 16	0.99155 <.0001 16
v5	0.96127 <.0001 16	0.99174 <.0001 16	0.98056 <.0001 16	0.97574 <.0001 16	1.00000 16	0.93429 <.0001 11	0.87798 0.0004 11	0.96859 <.0001 16	0.97388 <.0001 16
v6	0.87837 0.0004 11	0.92862 <.0001 11	0.85359 0.0008 11	0.99054 <.0001 11	0.93429 <.0001 11	1.00000 11	0.67615 0.0224 11	0.97014 <.0001 11	0.98210 <.0001 11
v7	0.82984 0.0016 11	0.88421 0.0003 11	0.94104 <.0001 11	0.72858 0.0110 11	0.87798 0.0004 11	0.67615 0.0224 11	1.00000 11	0.74439 0.0086 11	0.77242 0.0053 11
v8	0.92751 <.0001 16	0.97792 <.0001 16	0.94592 <.0001 16	0.97426 <.0001 16	0.96859 <.0001 16	0.97014 <.0001 11	0.74439 0.0086 11	1.00000 16	0.95982 <.0001 16
v9	0.93996 <.0001 16	0.97094 <.0001 16	0.93754 <.0001 16	0.99155 <.0001 16	0.97388 <.0001 16	0.98210 <.0001 11	0.77242 0.0053 11	0.95982 <.0001 16	1.00000 16
v10	0.85826 <.0001 16	0.90819 <.0001 16	0.92648 <.0001 16	0.82716 <.0001 16	0.90466 <.0001 16	0.69459 0.0177 11	0.96187 <.0001 11	0.82188 <.0001 16	0.84446 <.0001 16
v11	0.75049 0.0008 16	0.80198 0.0002 16	0.86544 <.0001 16	0.65885 0.0055 16	0.79292 0.0002 16	0.45684 0.1578 11	0.95788 <.0001 11	0.67991 0.0038 16	0.68693 0.0033 16
v12	0.93910 <.0001 16	0.93805 <.0001 16	0.89390 <.0001 16	0.99167 <.0001 16	0.95333 <.0001 16	0.98155 <.0001 11	0.67475 0.0227 11	0.94795 <.0001 16	0.98198 <.0001 16
v13	0.88589 0.0003 11	0.87710 0.0004 11	0.94007 <.0001 11	0.76022 0.0066 11	0.88921 0.0002 11	0.70169 0.0161 11	0.93078 <.0001 11	0.77235 0.0053 11	0.78724 0.0040 11
v14	0.61587 0.0145 15	0.78647 0.0005 15	0.83088 0.0001 15	0.63895 0.0103 15	0.74624 0.0014 15	0.43192 0.2126 10	0.93487 <.0001 10	0.71370 0.0028 15	0.63280 0.0113 15
v15	0.97071 <.0001 15	0.95717 <.0001 15	0.93001 <.0001 15	0.99338 <.0001 15	0.98041 <.0001 15	0.98439 <.0001 10	0.66941 0.0342 10	0.96927 <.0001 15	0.97010 <.0001 15
v16	0.92585 <.0001 15	0.96196 <.0001 15	0.92827 <.0001 15	0.99156 <.0001 15	0.96826 <.0001 15	0.99213 <.0001 10	0.72354 0.0180 10	0.95494 <.0001 15	0.99999 <.0001 15
v17	0.95735 <.0001 15	0.96651 <.0001 15	0.93615 <.0001 15	0.99995 <.0001 15	0.98214 <.0001 15	0.99381 <.0001 10	0.69989 0.0242 10	0.96992 <.0001 15	0.99106 <.0001 15

	v10	v11	v12	v13	v14	v15	v16	v17
v1	0.85826 <.0001 16	0.75049 0.0008 16	0.93910 <.0001 16	0.88589 0.0003 11	0.61587 0.0145 15	0.97071 <.0001 15	0.92585 <.0001 15	0.95735 <.0001 15
v2	0.90819 <.0001 16	0.80198 0.0002 16	0.93805 <.0001 16	0.87710 0.0004 11	0.78647 0.0005 15	0.95717 <.0001 15	0.96196 <.0001 15	0.96651 <.0001 15
v3	0.92648 <.0001 16	0.86544 <.0001 16	0.89390 <.0001 16	0.94007 <.0001 11	0.83088 0.0001 15	0.93001 <.0001 15	0.92827 <.0001 15	0.93615 <.0001 15
v4	0.82716 <.0001 16	0.65885 0.0055 16	0.99167 <.0001 16	0.76022 0.0066 11	0.63895 0.0103 15	0.99338 <.0001 15	0.99156 <.0001 15	0.99995 <.0001 15
v5	0.90466 <.0001 16	0.79292 0.0002 16	0.95333 <.0001 16	0.88921 0.0002 11	0.74624 0.0014 15	0.98041 <.0001 15	0.96826 <.0001 15	0.98214 <.0001 15
v6	0.69459 0.0177 11	0.45684 0.1578 11	0.98155 <.0001 11	0.70169 0.0161 11	0.43192 0.2126 10	0.98439 <.0001 10	0.99213 <.0001 10	0.99381 <.0001 10
v7	0.96187 <.0001 11	0.95788 <.0001 11	0.67475 0.0227 11	0.93078 <.0001 11	0.93487 <.0001 10	0.66941 0.0342 10	0.72354 0.0180 10	0.69989 0.0242 10
v8	0.82188 <.0001 16	0.67991 0.0038 16	0.94795 <.0001 16	0.77235 0.0053 11	0.71370 0.0028 15	0.96927 <.0001 15	0.95494 <.0001 15	0.96992 <.0001 15
v9	0.84446 <.0001 16	0.68693 0.0033 16	0.98198 <.0001 16	0.78724 0.0040 11	0.63280 0.0113 15	0.97010 <.0001 15	0.99999 <.0001 15	0.99106 <.0001 15
v10	1.00000 16	0.94547 <.0001 16	0.79877 0.0002 16	0.83793 0.0013 11	0.93351 <.0001 15	0.78308 0.0006 15	0.78644 0.0005 15	0.79046 0.0005 15
v11	0.94547 <.0001 16	1.00000 16	0.61546 0.0112 16	0.85742 0.0007 11	0.98836 <.0001 15	0.55241 0.0327 15	0.53835 0.0384 15	0.55007 0.0336 15
v12	0.79877 0.0002 16	0.61546 0.0112 16	1.00000 16	0.72586 0.0114 11	0.56344 0.0287 15	0.98429 <.0001 15	0.97970 <.0001 15	0.98952 <.0001 15

	v10	v11	v12	v13	v14	v15	v16	v17
v13	0.83793 0.0013 11	0.85742 0.0007 11	0.72586 0.0114 11	1.00000 11	0.61262 0.0597 10	0.83963 0.0024 10	0.81727 0.0039 10	0.83339 0.0027 10
v14	0.93351 <.0001 15	0.98836 <.0001 15	0.56344 0.0287 15	0.61262 0.0597 10	1.00000 15	0.63984 0.0102 15	0.63179 0.0115 15	0.64091 0.0100 15
v15	0.78308 0.0006 15	0.55241 0.0327 15	0.98429 <.0001 15	0.83963 0.0024 10	0.63984 0.0102 15	1.00000 15	0.97028 <.0001 15	0.99381 <.0001 15
v16	0.78644 0.0005 15	0.53835 0.0384 15	0.97970 <.0001 15	0.81727 0.0039 10	0.63179 0.0115 15	0.97028 <.0001 15	1.00000 15	0.99116 <.0001 15
v17	0.79046 0.0005 15	0.55007 0.0336 15	0.98952 <.0001 15	0.83339 0.0027 10	0.64091 0.0100 15	0.99381 <.0001 15	0.99116 <.0001 15	1.00000 15

The REG Procedure
Model: MODEL1
Dependent Variable: v6

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	978120439	326040146	16.36	0.0015
Error	7	139505609	19929373		
Corrected Total	10	1117626048			

Root MSE	4464.23260	R-Square	0.8752
Dependent Mean	17338	Adj R-Sq	0.8217
Coeff Var	25.74761		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-947.91781	5508.20614	-0.17	0.8682
v1	1	-1.26850	6.64903	-0.19	0.8541
v2	1	0.08224	0.47039	0.17	0.8662
v5	1	0.47635	0.68580	0.69	0.5097

The REG Procedure
Model: MODEL1
Dependent Variable: v6

Stepwise Selection: Step 1

Variable v5 Entered: R-Square = 0.8729 and C(p) = 0.1275

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	975578948	975578948	61.81	<.0001
Error	9	142047100	15783011		
Corrected Total	10	1117626048			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	-1095.44605	2632.91975	2732100	0.17	0.6871
v5	0.51570	0.06559	975578948	61.81	<.0001

Bounds on condition number: 1, 1

All variables left in the model are significant at the 0.1500 level.

No other variable met the 0.1500 significance level for entry into the model.

Summary of Stepwise Selection

Step	Variable Entered	Variable Removed	Number Vars In	Partial R-Square	Model R-Square	C(p)	F Value	Pr > F
1	v5		1	0.8729	0.8729	0.1275	61.81	<.0001

The REG Procedure
Model: MODEL1
Dependent Variable: v3

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	7510309036	2503436345	184.78	<.0001
Error	12	162582770	13548564		
Corrected Total	15	7672891806			

Root MSE	3680.83743	R-Square	0.9788
Dependent Mean	33423	Adj R-Sq	0.9735
Coeff Var	11.01292		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-994.43627	2906.51307	-0.34	0.7382
v1	1	-0.00834	3.98536	-0.00	0.9984
v2	1	1.02319	0.33712	3.04	0.0104
v5	1	-0.03980	0.44292	-0.09	0.9299

The REG Procedure
Model: MODEL1
Dependent Variable: v3

Stepwise Selection: Step 1

Variable v2 Entered: R-Square = 0.9788 and C(p) = 0.0125

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	7510139496	7510139496	646.02	<.0001
Error	14	162752310	11625165		
Corrected Total	15	7672891806			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	-833.20972	1594.69088	3173619	0.27	0.6095
v2	0.98711	0.03884	7510139496	646.02	<.0001

Bounds on condition number: 1, 1

All variables left in the model are significant at the 0.1500 level.

No other variable met the 0.1500 significance level for entry into the model.

Summary of Stepwise Selection

Step	Variable Entered	Variable Removed	Number Vars In	Partial R-Square	Model R-Square	C(p)	F Value	Pr > F
1	v2		1	0.9788	0.9788	0.0125	646.02	<.0001

The REG Procedure
Model: MODEL1
Dependent Variable: v1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	5514360	2757180	24.36	0.0004
Error	8	905369	113171		
Corrected Total	10	6419730			

Root MSE	336.40923	R-Square	0.8590
Dependent Mean	1874.82727	Adj R-Sq	0.8237
Coeff Var	17.94348		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	465.74206	231.99787	2.01	0.0796
v3	1	0.02094	0.00940	2.23	0.0566
v6	1	0.02985	0.01932	1.55	0.1608

The REG Procedure
Model: MODEL1
Dependent Variable: v1

Stepwise Selection: Step 1

Variable v3 Entered: R-Square = 0.8169 and C(p) = 3.3882

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	5244088	5244088	40.15	0.0001
Error	9	1175642	130627		
Corrected Total	10	6419730			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	455.26174	249.14186	436176	3.34	0.1009
v3	0.03334	0.00526	5244088	40.15	0.0001

Bounds on condition number: 1, 1

All variables left in the model are significant at the 0.1500 level.

No other variable met the 0.1500 significance level for entry into the model.

Summary of Stepwise Selection

Step	Variable Entered	Variable Removed	Number Vars In	Partial R-Square	Model R-Square	C(p)	F Value	Pr > F
1	v3		1	0.8169	0.8169	3.3882	40.15	0.0001

The REG Procedure
Model: MODEL1
Dependent Variable: v5

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	3603114525	1801557262	220.94	<.0001
Error	8	65232748	8154093		
Corrected Total	10	3668347273			

Root MSE	2855.53734	R-Square	0.9822
Dependent Mean	35745	Adj R-Sq	0.9778
Coeff Var	7.98853		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-414.05492	1969.26395	-0.21	0.8387
v3	1	0.55967	0.07981	7.01	0.0001
v6	1	0.71119	0.16396	4.34	0.0025

The REG Procedure
Model: MODEL1
Dependent Variable: v5

Stepwise Selection: Step 1

Variable v3 Entered: R-Square = 0.9404 and C(p) = 19.8143

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	3449700689	3449700689	142.00	<.0001
Error	9	218646583	24294065		
Corrected Total	10	3668347273			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	-663.74786	3397.66493	927140	0.04	0.8495
v3	0.85516	0.07176	3449700689	142.00	<.0001

Bounds on condition number: 1, 1

Stepwise Selection: Step 2

Variable v6 Entered: R-Square = 0.9822 and C(p) = 3.0000

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	3603114525	1801557262	220.94	<.0001
Error	8	65232748	8154093		
Corrected Total	10	3668347273			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	-414.05492	1969.26395	360482	0.04	0.8387
v3	0.55967	0.07981	401003783	49.18	0.0001
v6	0.71119	0.16396	153413836	18.81	0.0025

Bounds on condition number: 3.6847, 14.739

All variables left in the model are significant at the 0.1500 level.

The REG Procedure
Model: MODEL1
Dependent Variable: v5

Stepwise Selection: Step 2

All variables have been entered into the model.

Summary of Stepwise Selection

Step	Variable Entered	Variable Removed	Number Vars In	Partial R-Square	Model R-Square	C(p)	F Value	Pr > F
1	v3		1	0.9404	0.9404	19.8143	142.00	<.0001
2	v6		2	0.0418	0.9822	3.0000	18.81	0.0025

The REG Procedure
Model: MODEL1
Dependent Variable: v2

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	4486823926	2243411963	962.36	<.0001
Error	8	18649347	2331168		
Corrected Total	10	4505473273			

Root MSE	1526.81642	R-Square	0.9959
Dependent Mean	44230	Adj R-Sq	0.9948
Coeff Var	3.45196		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	3560.28607	1052.93827	3.38	0.0096
v3	1	0.68548	0.04267	16.06	<.0001
v6	1	0.66240	0.08767	7.56	<.0001

The REG Procedure
Model: MODEL1
Dependent Variable: v2

Stepwise Selection: Step 1

Variable v3 Entered: R-Square = 0.9663 and C(p) = 58.0901

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	4353737310	4353737310	258.24	<.0001
Error	9	151735962	16859551		
Corrected Total	10	4505473273			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	3327.72277	2830.43680	23304155	1.38	0.2699
v3	0.96070	0.05978	4353737310	258.24	<.0001

Bounds on condition number: 1, 1

Stepwise Selection: Step 2

Variable v6 Entered: R-Square = 0.9959 and C(p) = 3.0000

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	4486823926	2243411963	962.36	<.0001
Error	8	18649347	2331168		
Corrected Total	10	4505473273			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	3560.28607	1052.93827	26652479	11.43	0.0096
v3	0.68548	0.04267	601554428	258.05	<.0001
v6	0.66240	0.08767	133086615	57.09	<.0001

Bounds on condition number: 3.6847, 14.739

All variables left in the model are significant at the 0.1500 level.

The REG Procedure
Model: MODEL1
Dependent Variable: v2

Stepwise Selection: Step 2

All variables have been entered into the model.

Summary of Stepwise Selection

Step	Variable Entered	Variable Removed	Number Vars In	Partial R-Square	Model R-Square	C(p)	F Value	Pr > F
1	v3		1	0.9663	0.9663	58.0901	258.24	<.0001
2	v6		2	0.0295	0.9959	3.0000	57.09	<.0001

The REG Procedure
Model: MODEL1
Dependent Variable: v2

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	4397964947	2198982473	163.63	<.0001
Error	8	107508326	13438541		
Corrected Total	10	4505473273			

Root MSE	3665.86152	R-Square	0.9761
Dependent Mean	44230	Adj R-Sq	0.9702
Coeff Var	8.28811		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-143223	30476	-4.70	0.0015
v4	1	0.84945	0.10525	8.07	<.0001
v7	1	1.58985	0.30520	5.21	0.0008

The REG Procedure
Model: MODEL1
Dependent Variable: v2

Stepwise Selection: Step 1

Variable v4 Entered: R-Square = 0.8952 and C(p) = 28.1361

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	4033296030	4033296030	76.88	<.0001
Error	9	472177243	52464138		
Corrected Total	10	4505473273			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	15188	3967.49722	768824537	14.65	0.0040
v4	1.24889	0.14244	4033296030	76.88	<.0001

Bounds on condition number: 1, 1

Stepwise Selection: Step 2

Variable v7 Entered: R-Square = 0.9761 and C(p) = 3.0000

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	4397964947	2198982473	163.63	<.0001
Error	8	107508326	13438541		
Corrected Total	10	4505473273			

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	-143223	30476	296800421	22.09	0.0015
v4	0.84945	0.10525	875431126	65.14	<.0001
v7	1.58985	0.30520	364668917	27.14	0.0008

Bounds on condition number: 2.1314, 8.5256

All variables left in the model are significant at the 0.1500 level.

The REG Procedure
Model: MODEL1
Dependent Variable: v2

Stepwise Selection: Step 2

All variables have been entered into the model.

Summary of Stepwise Selection

Step	Variable Entered	Variable Removed	Number Vars In	Partial R-Square	Model R-Square	C(p)	F Value	Pr > F
1	v4		1	0.8952	0.8952	28.1361	76.88	<.0001
2	v7		2	0.0809	0.9761	3.0000	27.14	0.0008

Appendix 2: Dates for Motor Industry Development Council (MIDC) meetings attended

- Meeting of 8 September 2004
- Meeting of 19 October 2004
- Meeting of 1 December 2004
- Meeting of 20 January 2005
- Meeting of 10 March 2005
- Meeting of 21 April 2005
- Meeting of 30 June 2005
- Meeting of 11 August 2005
- Meeting of 6 October 2005
- Meeting of 25 November 2005
- Meeting of 25 January 2006
- Meeting of 8 March 2006
- Meeting of 19 April 2006
- Meeting of 7 June 2006
- Meeting of 19 July 2006
- Meeting of 11 October 2006
- Meeting of 21 February 2007

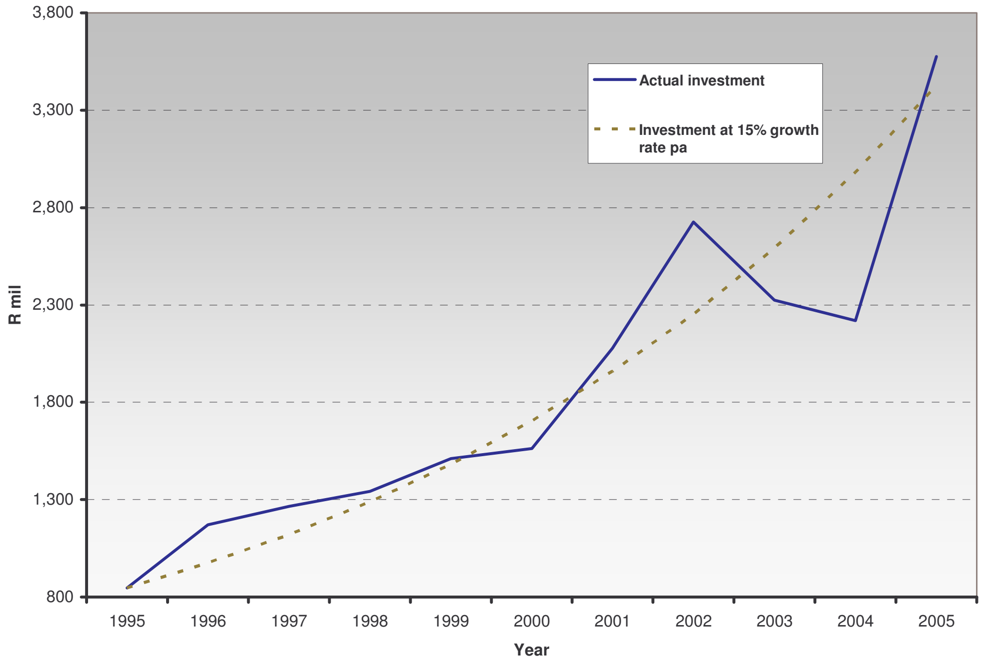
Appendix 3: Expert interviews

Ingrid Metz, International Trade Administration Commission, Manager (A) Tariff Investigations II (First interview on 2 September 2004 at ITAC; follow up discussions, 31 March 2006 and 4 August 2006).

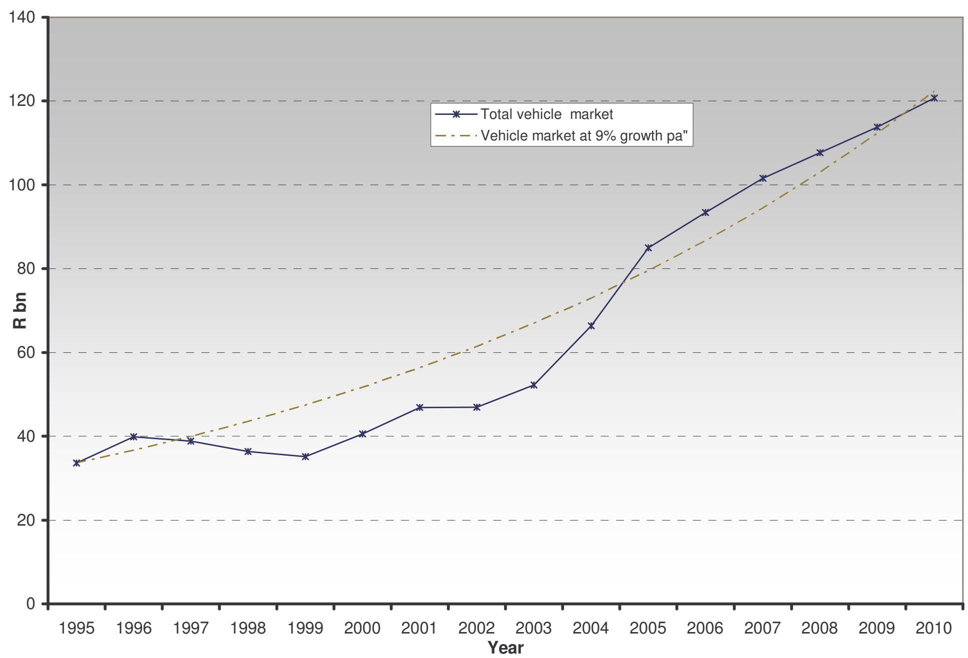
Pieter Goosen, International Trade Administration Commission, Manager (B) Tariff Investigations II (First interview on 2 September 2004 at ITAC, follow up discussions, 31 March 2006 and 4 August 2006).

Andre Botha, System dynamics modelling Consultant, Dynamic Strategies (First session took December 2005. This was followed four sessions in March, July and August 2006. One other session was held on 14 March 2007).

Appendix 4: Comparison between actual and projected values per the exogenous growth fractions used in the reference model simulation



Actual OEM investment and OEM investment projection at 15% growth rate pa



Actual domestic market and domestic market projection at 9% growth rate pa

Appendix: 5: Stella equations for the PAA-IEC model base-run

1. Domestic_market(t) = Domestic_market(t - dt) + (Market_growth) * dtINIT Domestic_market = 33.6 {Rand billion}

INFLOWS:

2. Market_growth = Domestic_market*Market_growth_fraction
3. Exports(t) = Exports(t - dt) + (Exporting) * dtINIT Exports = 4.2 {Rand billion}

INFLOWS:

4. Exporting = Exports*Export_growth_fraction {Rand billion}
5. Imports(t) = Imports(t - dt) + (Importing) * dtINIT Imports = 16.4 {Rand billion}

INFLOWS:

6. Importing = Imports*Import_growth_fraction
7. Investment(t) = Investment(t - dt) + (Investing) * dtINIT Investment = 0.85 {Rand billion}

INFLOWS:

8. Investing = Investment*Actual_growth_fraction {Rand billion}
9. IRCCs(t) = IRCCs(t - dt) + (IRCC_generation - IRCC_release) * dtINIT IRCCs = 0 {Rand billion}
10. TRANSIT TIME = varies
11. INFLOW LIMIT = INF
12. CAPACITY = INF

INFLOWS:

13. IRCC_generation = Local_content__benefit_fraction*Exported_local_content {Rand billion}

OUTFLOWS:

14. IRCC_release = CONVEYOR OUTFLOW
15. TRANSIT TIME = IRCC_release__delay {Rand billion}
16. PAA_Rebates[Annual_Certificate](t) = PAA_Rebates[Annual_Certificate](t - dt) + (Rebate_generation[Annual_Certificate] - Rebate_certificate_release[Annual_Certificate]) * dtINIT PAA_Rebates[Annual_Certificate] = 0 {Rand billion}

INFLOWS:

17. Rebate_generation[Annual_Certificate] = Qualifying_investment*Benefit_fraction/Certificate_spread {Rand billion}

OUTFLOWS:

18. Rebate_certificate_release[1] = CONVEYOR OUTFLOW
19. TRANSIT TIME = Rebate_Certificate_delay[1]
20. Rebate_certificate_release[2] = CONVEYOR OUTFLOW
21. TRANSIT TIME = Rebate_Certificate_delay[2]
22. Rebate_certificate_release[3] = CONVEYOR OUTFLOW
23. TRANSIT TIME = Rebate_Certificate_delay[3]
24. Rebate_certificate_release[4] = CONVEYOR OUTFLOW
25. TRANSIT TIME = Rebate_Certificate_delay[4]
26. Rebate_certificate_release[5] = CONVEYOR OUTFLOW
27. TRANSIT TIME = Rebate_Certificate_delay[5] {Rand billion}
28. Actual_growth_fraction = Normal__growth_fraction*production_potential_factor
29. Annual_certificate_release = ARRAYSUM(Rebate_certificate_release[*]){Rand billion}
30. Benefit_fraction = 0+STEP(0.2, 2001)
31. Certificate_spread = 5
32. Exported_local_content = Exports*Exported_local__content_fraction {Rand billion}
33. Exported_local__content_fraction = 0.7
34. Export_growth_fraction = CGROWTH(27)
35. Import_duty = 0.3
36. Import_growth_fraction = (CGROWTH(12)*Impact_of_rebatable_imports_and__domestic_market_on_imports)
37. Industry_rebatable__imports = IRCC_rebatable__imports+PAA_rebatable__imports {Rand billion}
38. Industry_trade__balance = Exports-Imports {Rand billion}
39. IRCC_rebatable__imports = IRCC_release*1 {Rand billion}

40. IRCC_release__delay = 1
41. Local_content__benefit_fraction = 0.9
42. Market_growth_fraction = CGROWTH(9)
43. Normal__growth_fraction = 0.15
44. PAA_rebatable__imports = Annual_certificate_release/Import_duty {Rand billion}
45. production_potential_factor = (Domestic_market+Exports-Industry_rebatable__imports)/(Domestic_market+Exports)
46. Qualifying_investment = Investment*Qualifying_investment_fraction {Rand billion}
47. Qualifying_investment_fraction = 0.8
48. Rebate_Certificate_delay[1] = 1
49. Rebate_Certificate_delay[2] = 2
50. Rebate_Certificate_delay[3] = 3
51. Rebate_Certificate_delay[4] = 4
52. Rebate_Certificate_delay[5] = 5

Import decision

53. Impact_of_rebatable_imports_and__domestic_market_on_imports = GRAPH(Industry_rebatable__imports/Domestic_market)

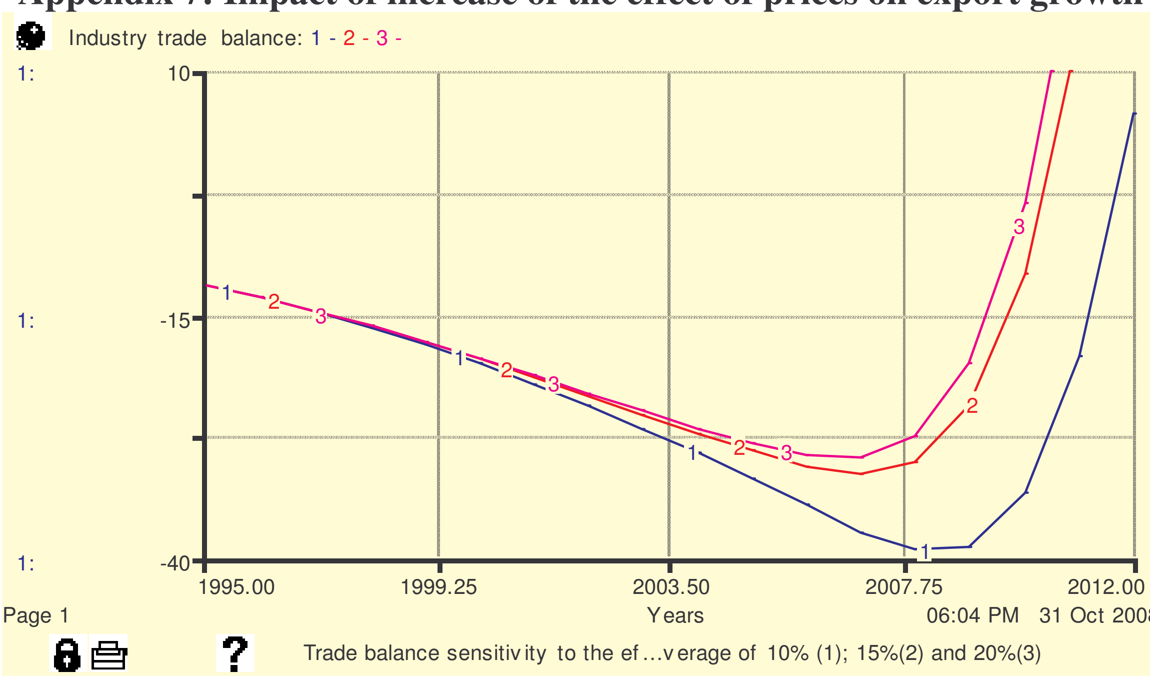
(0.00, 1.00), (0.04, 1.00), (0.08, 1.20), (0.12, 1.31), (0.16, 1.43), (0.2, 1.51), (0.24, 1.61), (0.28, 1.71), (0.32, 1.76), (0.36, 1.76), (0.4, 1.75), (0.44, 1.70), (0.48, 1.60), (0.52, 1.55), (0.56, 1.50), (0.6, 1.46), (0.64, 1.41), (0.68, 1.36), (0.72, 1.35), (0.76, 1.32), (0.8, 1.30), (0.84, 1.29), (0.88, 1.29), (0.92, 1.29), (0.96, 1.29), (1.00, 1.29)

Appendix 6: Automotive investment, production and vehicle prices for the period 1995 to 2006

Year	Automotive investment (Rm)	Vehicle production (Units)	Vehicle prices*
1995	847	389,476	87,568
1996	1,171	386,311	94,748
1997	1,265	326,104	97,306
1998	1,342	312,055	103,437
1999	1,511	326,065	107,885
2000	1,562	357,364	114,465
2001	2,078	406,149	122,593
2002	2,726	404,441	129,213
2003	2,325	421,338	136,530
2004	2,220	453,600	137,799
2005	3,576	525,271	137,643
2006	6,200	587,719	130,761

*Authors estimate from NAAMSA data
Source: NAAMSA Annual Report 2006

Appendix 7: Impact of increase of the effect of prices on export growth



Note: Impact level(s) choice based on sensitivity analysis range used in the main model.

Appendix 8: Automotive industry import duty schedule for the period 1999 to 2012

Year	Import duty (%)	
	Buit-up Light Vehicles	Original Equipment Components
1999	50.5	37.5
2000	47.0	35.0
2001	43.5	32.5
2002	40.0	30.0
2003	38.0	29.0
2004	36.0	28.0
2005	34.0	27.0
2006	32.0	26.0
2007	30.0	25.0
2008	29.0	24.0
2009	28.0	23.0
2010	27.0	22.0
2011	26.0	21.0
2012	25.0	20.0

Source: NAAMSA Annual Report 2002/2006

Appendix: 9: Stella equations for the PAA-IEC-DFA model base-run

1. Domestic_market(t) = Domestic_market(t - dt) + (Market_growth) * dtINIT Domestic_market = 21.51 {Rand billion}

INFLOWS:

2. Market_growth = Domestic_market*Market_growth_fraction
3. Exports(t) = Exports(t - dt) + (Exporting) * dtINIT Exports = 4.2 {Rand billion}

INFLOWS:

4. Exporting = Exports*Actual_export_growth_fraction {Rand billion}
5. Imports(t) = Imports(t - dt) + (Importing) * dtINIT Imports = 16.4 {Rand billion}

INFLOWS:

6. Importing = Imports*Import_growth_fraction
7. Investment(t) = Investment(t - dt) + (Investing) * dtINIT Investment = 0.85 {Rand billion}

INFLOWS:

8. Investing = Investment*Actual_growth_fraction {Rand billion}
9. IRCCs(t) = IRCCs(t - dt) + (IRCC_generation - IRCC_release) * dtINIT IRCCs = 0 {Rand billion}
10. TRANSIT TIME = varies
11. INFLOW LIMIT = INF
12. CAPACITY = INF

INFLOWS:

13. IRCC_generation = Local_content__benefit_fraction*Exported_local_content {Rand billion}

OUTFLOWS:

14. IRCC_release = CONVEYOR OUTFLOW
15. TRANSIT TIME = IRCC_release__delay {Rand billion}
16. PAA_Rebates[Annual_Certificate](t) = PAA_Rebates[Annual_Certificate](t - dt) + (Rebate_generation[Annual_Certificate] - Rebate_certificate_release[Annual_Certificate]) * dtINIT PAA_Rebates[Annual_Certificate] = 0 {Rand billion}

INFLOWS:

17. Rebate_generation[Annual_Certificate] = Qualifying_investment*Benefit_fraction/Certificate_spread {Rand billion}

OUTFLOWS:

18. Rebate_certificate_release[1] = CONVEYOR OUTFLOW
19. TRANSIT TIME = Rebate_Certificate_delay[1]
20. Rebate_certificate_release[2] = CONVEYOR OUTFLOW
21. TRANSIT TIME = Rebate_Certificate_delay[2]
22. Rebate_certificate_release[3] = CONVEYOR OUTFLOW
23. TRANSIT TIME = Rebate_Certificate_delay[3]
24. Rebate_certificate_release[4] = CONVEYOR OUTFLOW
25. TRANSIT TIME = Rebate_Certificate_delay[4]
26. Rebate_certificate_release[5] = CONVEYOR OUTFLOW
27. TRANSIT TIME = Rebate_Certificate_delay[5] {Rand billion}
28. Actual_export_growth_fraction = Normal_export_growth_fraction*Effect_of_prices__on_exports
29. Actual_growth_fraction = Normal__growth_fraction*production_potential_factor
30. Annual_certificate_release = ARRAYSUM(Rebate_certificate_release[*]) {Rand billion}
31. Benefit_fraction = 0+STEP(0.4, 2001)
32. Certificate_spread = 5
33. Duty_free_allowance = 0.27
34. Duty_free_import = Domestic_market*0.75*Duty_free_allowance
35. Exported_local_content = Exports*Exported_local__content_fraction {Rand billion}
36. Exported_local__content_fraction = 0.7
37. Import_duty = 0.3
38. Import_growth_fraction = CGROWTH(12)*Impact_of_rebatable_imports_and__domestic_market_on_import s

39. Industry_rebatable_and__tax_free_imports = IRCC_rebatable__imports+PAA_rebatable__imports+Duty_free_import {Rand billion}
40. Industry_trade__balance = Exports-Imports {Rand billion}
41. Investment_productivity__ratio = 0.02
42. IRCC_rebatable__imports = IRCC_release*1 {Rand billion}
43. IRCC_release__delay = 1
44. Local_content__benefit_fraction = 0.9
45. Market_growth_fraction = CGROWTH(12)
46. Normal_export_growth_fraction = CGROWTH(27)
47. Normal__growth_fraction = 0.15
48. PAA_rebatable__imports = Annual_certificate_release/Import_duty {Rand billion}
49. Production = Investment*Investment_productivity__ratio
50. production_potential_factor = (Domestic_market+Exports-Industry_rebatable_and__tax_free_imports)/(Domestic_market+Exports)
51. Qualifying_investment = Investment*Qualifying_investment_fraction {Rand billion}
52. Qualifying_investment_fraction = 0.8
53. Rebate_Certificate_delay[1] = 1
54. Rebate_Certificate_delay[2] = 2
55. Rebate_Certificate_delay[3] = 3
56. Rebate_Certificate_delay[4] = 4
57. Rebate_Certificate_delay[5] = 5
58. Effect_of_prices__on_exports = GRAPH(Production)
59. (0.00, 0.97), (0.1, 0.99), (0.2, 1.05), (0.3, 1.08), (0.4, 1.09), (0.5, 1.12), (0.6, 1.14), (0.7, 1.16), (0.8, 1.20), (0.9, 1.20), (1, 1.20)
60. Import decision
61. Impact_of_rebatable_imports_and__domestic_market_on_imports = GRAPH(Industry_rebatable_and__tax_free_imports/Domestic_market)
62. (0.00, 0.98), (0.111, 1.04), (0.222, 1.10), (0.333, 1.23), (0.444, 1.38), (0.556, 1.52), (0.667, 1.61), (0.778, 1.49), (0.889, 1.11), (1.00, 0.86)