



UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

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

by

MARTIN KAGGWA

Submitted in accordance with the requirements
for the degree of

**PHILOSOPHIAE DOCTOR
(TECHNOLOGY MANAGEMENT)**

at the

**FACULTY OF ENGINEERING, BUILT ENVIRONMENT
AND INFORMATION TECHNOLOGY**

UNIVERSITY OF PRETORIA

PRETORIA

**STUDY SUPERVISOR : PROFESSOR A POURIS
CO-SUPERVISOR : PROFESSOR JL STEYN**

November 2008



Summary

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

**By
Martin Kaggwa**

Supervisor : Prof A Pouris

Co-supervisor : Prof JL Steyn

Department : Engineering and Technology Management
University of Pretoria

Degree : PhD

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 Complementarity (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 through 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.



Samevatting

Modellering van Suid Afrika se Aansporingsmaatreëls onder die Motornywerheids-ontwikkelingsprogram

deur

Martin Kaggwa

Promotor : Prof A Pouris
Medepromotor : Prof JL Steyn
Departement : Ingenieurs- en Tegnologiebestuur
Universiteit van Pretoria
Graad : PhD

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 motorvervaardigingssektor 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 motorvervaardigingssektor 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.



“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:

- Prof Anastassios Pouris my supervisor, for academic guidance, motivation and encouragement.
- Prof Jasper L Steyn my co-supervisor and manager at the AIDC, for his continuous advice on the direction of the study, facilitation of study resources, caution and periodic reality checks.
- Dr Paulo Fernandes, for his quiet approval of AIDC financial support to my studies.
- Ms Jabulile Manana for telling me to do it and sowing the first seed for this PhD project.
- Mr Fanie Fourie, for giving me a home away from home.
- Mr Monaheng Nkhahle, for being a spring board on which I bounced my weird ideas now and again.
- Ms Sylvia van Straaten, for language editing of the thesis.
- The Statistics Department University of Pretoria for assistance with preliminary data analysis.
- 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.



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



TABLE OF CONTENTS

SUMMARY	II
ACKNOWLEDGEMENT	VIII
DEDICATION	IX
DECLARATION	X
1 INTRODUCTION	1
1.1 OVERVIEW OF THE SOUTH AFRICAN AUTOMOTIVE INDUSTRY	1
1.1.1 The South African economy	1
1.1.2 South African automotive industry	2
1.1.3 South Africa’s automotive industry policy	4
1.2 CHALLENGES FACING SOUTH AFRICAN AUTOMOTIVE INDUSTRY	6
1.2.1 Benefits vis-à-vis costs of the MIDP	6
1.2.2 Deteriorating industry trade balance	7
1.2.3 New requirement on automotive component supply	9
1.2.4 WTO compatibility of MIDP incentives.....	11
1.3 RESEARCH LOGIC AND BROAD ISSUES FOR INVESTIGATION	12
1.3.1 Research problem statement	12
1.3.2 Research question(s).....	12
1.3.3 Purpose of study	12
1.3.4 Objectives of the study	13
1.3.5 Hypothesis	13
1.3.6 Study rationale.....	13
1.3.7 Research approach.....	14
1.4 SYNTHESIS	14
2 THE ADVENT AND PROSPECTS OF INVESTMENT INCENTIVES IN THE SOUTH AFRICAN AUTOMOTIVE INDUSTRY WITH REFERENCE TO COMPARABLE ECONOMIES	16
2.1 INTRODUCTION.....	16
2.2 THE MOTOR INDUSTRY DEVELOPMENT PROGRAMME (MIDP) OF THE SOUTH AFRICAN AUTOMOTIVE INDUSTRY	17
2.2.1 Historical perspective	17
2.2.2 Initial recommendations of the MIDP	18
2.3 TREND OF KEY INDUSTRY VARIABLES IN THE FIRST FIVE YEARS OF THE MIDP	21
2.3.1 Investment	21
2.3.2 Employment	23
2.3.3 Production, import and export, and domestic sales	24
2.3.4 Production.....	24
2.3.5 Imports and exports	25
2.3.6 Domestic sales and market	26
2.3.7 Supplier development	28
2.3.8 Vehicle prices	31
2.4 THE PRODUCTIVE ASSET ALLOWANCE (PAA)	33
2.4.1 Criteria for benefiting from the PAA.....	34
2.4.2 Exclusion and non-qualification for the PAA.....	35
2.4.3 Qualifying value of productive assets.....	35
2.4.4 Application and claiming process for the PAA	36
2.4.5 Industry benefit from the PAA	39
2.5 COMPARATIVE INTERNATIONAL EXPERIENCE ON AUTOMOTIVE INDUSTRY DEVELOPMENT POLICY	40
2.5.1 Australia	40
2.5.1.1 Background of Australian government assistance to the Australian automotive industry.....	40



2.5.1.2	The Australian Automotive Competitiveness and Investment Scheme (ACIS)	41
2.5.2	Thailand	43
2.5.2.1	Thailand's automotive policy under a protected regime	43
2.5.2.2	Liberalisation of Thai Auto Industry	44
2.5.3	Argentina	45
2.5.3.1	Argentine automotive policy	45
2.6	PROSPECTS OF THE PAA FOR THE SOUTH AFRICAN AUTOMOTIVE INDUSTRY	48
2.7	SYNTHESIS	49

3 TO GIVE OR NOT TO GIVE INCENTIVES TO SOUTH AFRICA'S AUTOMOTIVE INDUSTRY: A LITERATURE REVIEW 50

3.1	INTRODUCTION	50
3.2	INVESTMENT AND INVESTMENT INCENTIVES: THEORETICAL UNDERPINNINGS	50
3.2.1	Flexible Accelerator Model	50
3.2.2	Tobin's q theory	52
3.3	FISCAL INVESTMENT INCENTIVES AND INVESTMENT: EMPIRICAL STUDIES	54
3.3.1	Incentives as an effective tool for stimulating investment	55
3.3.2	Ineffectiveness of investment incentives	56
3.4	BENEFITS OF INVESTMENT	60
3.4.1	Externalities and investment	60
3.5	INCENTIVES IN THE SOUTH AFRICAN AUTOMOTIVE INDUSTRY	62
3.6	SYNTHESIS	63

4 THE PRODUCTIVE ASSET ALLOWANCE AND SOUTH AFRICAN AUTOMOTIVE INDUSTRY COMPETITIVENESS..... 65

4.1	INTRODUCTION	65
4.2	R&D INVESTMENT AND INDUSTRY COMPETITIVENESS	66
4.2.1	Definitions	66
4.3	ECONOMIC THEORY ON R&D AND COMPETITIVENESS.....	67
4.4	NEED FOR LOCAL R&D AND TECHNOLOGICAL PROGRESS FOR THE SOUTH AFRICAN AUTOMOTIVE INDUSTRY	71
4.5	INVESTMENT UNDER THE PAA	75
4.6	IMPACT OF THE PAA ON AN INDUSTRY PERFORMANCE	80
4.7	SYNTHESIS	82

5 METHODOLOGY AND RESEARCH DESIGN 83

5.1	METHODOLOGICAL CHOICE	83
5.1.1	MIDP incentives as a complex system problem	83
5.2	SYSTEM DYNAMICS AND SYSTEM DYNAMICS METHODOLOGY	87
5.2.1	System dynamics	87
5.2.2	Principles of system dynamics methodology	89
5.2.3	System dynamics modelling methodology and tools	90
5.2.3.1	Causal loop diagrams	91
5.2.3.2	Stocks and flows	93
5.2.4	Steps in system dynamics modelling	95
5.3	DATA COLLECTION	96
5.3.1	Research location	96
5.3.2	Secondary data	97
5.3.3	Primary qualitative data	101
5.3.3	Expert opinion	104
5.4	QUALITATIVE CONCEPTUALISATION OF MIDP INCENTIVES MODEL	105
5.4.1	Establishment of the reference mode	105
5.4.2	Dynamic hypothesis	106
5.4.3	Model conceptualisation	107
5.4.3.1	Motor Industry Development Programme mental model	107
5.5	SYNTHESIS	109



6 FORMALISATION OF THE PRODUCTIVE ASSET ALLOWANCE OF THE SOUTH AFRICAN AUTOMOTIVE INDUSTRY USING A SYSTEM DYNAMICS APPROACH.....	110
6.1 INTRODUCTION.....	110
6.2 CAUSAL LOOP DIAGRAMS OF THE MIDP INCENTIVES	111
6.2.1 The PAA	111
6.2.2 Import-export complementation arrangement	112
6.3 THE MIDP INCENTIVE MODEL.....	115
6.3.1 PAA model structure	115
6.3.2 Import-export complementation incentive model.....	120
6.4 MODEL VALIDATION AND TESTING.....	124
6.4.1 Model structure tests.....	127
6.4.2 Behaviour tests	129
6.4.2.1 Model behaviour vis-à-vis the reference mode.....	131
6.4.2.2 Model behaviour under extreme conditions	133
6.4.2.3 Surprise behaviour	138
6.4.2.4 Integration error test.....	139
6.5 MODEL SENSITIVITY TO EXOGENOUS VARIABLES	141
6.6 EXCHANGE RATES EFFECT ON INDUSTRY TRADE BALANCE.....	143
6.7 SYNTHESIS	145
7 PAA-IEC MODEL EXTENSION: INTRODUCTION OF THE DUTY FREE ALLOWANCE IMPORTS AND PRICE EFFECT ON EXPORTS	146
7.1 DUTY FREE ALLOWANCE	146
7.1.1 Effect of vehicle prices on industry exports	148
7.2 EXTENDED MODELS SIMULATIONS	149
7.2.1 Replication of the Reference mode.....	149
7.3 SYNTHESIS	151
8 POLICY INSIGHTS	153
8.1 POLICY DECISIONS ON THE PAA.....	153
8.1.1 Effect of PAA benefit fraction on PAA rebatable imports	154
8.1.2 Effect of change of import duty on PAA rebatable imports	155
8.1.3 Effect of change of PAA benefit fraction on industry trade balance	156
8.1.4 Effect of import duty on industry trade balance	157
8.2 POLICY DECISIONS ON THE IMPORT-EXPORT COMPLEMENTATION	160
8.2.1 Effect of the exported local content benefit fraction on industry trade balance.....	160
8.3 TIME-BOUND CONSTRAINTS OF THE PAA-IEC INCENTIVE DISPENSATION	163
8.4 COMPARISON IEC WITH THE PAA INCENTIVES	164
8.5 INDUSTRY PERFORMANCE WITHOUT THE IEC AND PAA INCENTIVES	165
8.6 SYNTHESIS	166
9 CONCLUSIONS.....	168
9.1 CLOSURE OF THE STUDY	168
9.2 THEORETICAL CONCLUSIONS.....	169
9.3 CONTRIBUTION TO PRIOR KNOWLEDGE	172
9.4 METHODOLOGICAL CONSIDERATIONS AND STUDY LIMITATIONS	173
9.4.1 Choice of model boundary.....	173
9.4.2 Level of model aggregation	174
9.4.3 Study timing	174
9.5 AREAS FOR FURTHER RESEARCH	175
REFERENCES	177
APPENDICES	187

LIST OF FIGURES

Figure 1: Automotive industry trade balance: South Africa.....	8
Figure 2: Imports as a percentage of total passenger vehicle sales in South Africa.....	9
Figure 3: Global automotive industry structure.....	10
Figure 4: The Productive Asset Allowance application process	37
Figure 5: Productive Asset Allowance claiming process	38
Figure 6: Policy and technological progress.....	80
Figure 7: Event view of the world	84
Figure 8: Closed investment incentive loop.....	86
Figure 9: Description of causal loop symbols.....	93
Figure 10: Generic presentation of stocks and flow diagrams.....	94
Figure 11: Reference mode for the study of the increasing trade deficit of the South's automotive industry (Period in years).....	106
Figure 12: Static uni-directional MIDP incentive model.....	108
Figure 13: MIDP investment-investment incentive causal loop diagram.....	112
Figure 14: Import-export complementation causal loop diagram.....	114
Figure 15: PAA stock-flow diagram.....	117
Figure 16: Industry investment feedback loop.....	118
Figure 17: Closed loop stock-flow diagram for the PAA.....	119
Figure 18: Import-export complementation stock-flow diagram.....	121
Figure 19: Combined PAA-IEC model structure.....	122
Figure 20: PAA-IEC-Trade Balance model structure.....	124
Figure 21: Model replication of the reference mode behaviour	132
Figure 22: Trade balance and rebatable imports - PAA benefit fraction of 1.....	134
Figure 23: Trade balance and rebatable imports - PAA benefit fraction of 0.....	134
Figure 24: Trade balance and rebatable imports - Exported local content benefit of 100%	135
Figure 25: Trade balance and rebatable imports - Exported local content benefit of 0%	136
Figure 26: Trade balance and rebatable imports - Exported local content benefit of 0% with lower investment and export growth rate and increased import growth.....	137
Figure 27: Simulated industry trade balance 1995-2012	138
Figure 28: Trade balance - Euler's integration method with DT = 1.....	140
Figure 29: Trade balance - Euler's integration method with DT = 0.5	140
Figure 30: Trade balance sensitivity to investment growth fraction.....	141
Figure 31: Trade balance sensitivity to domestic market growth fraction.....	142
Figure 32: Trade balance sensitivity to export growth fraction.....	143
Figure 33: Rand-US dollar/Rand-Euro exchange rate and automotive trade deficit indices	145
Figure 34: PAA-IEC-DFA Model Structure.....	147
Figure 35: Extended Model Reference Mode.....	149
Figure 36: Effect of PAA Benefit Fraction on Industry Trade Balance	150
Figure 37: Effect of Import Duty Rates on Industry Trade Balance.....	150
Figure 38: Effect of Exported Local Content Benefit Fraction on Industry Trade Balance	151



Figure 39: Effect of PAA benefit fraction on PAA rebatable imports	154
Figure 40: Effect of import duties on PAA rebatable imports.....	156
Figure 41: Effect of PAA benefit fraction on industry trade balance	157
Figure 42: Effects of import duties on industry trade balance.....	158
Figure 43: Industry trade balance at 10% duty rate with increased import and decreased export rates.....	159
Figure 44: Effect of exported local content benefit fraction on industry trade balance .	161
Figure 45: Industry imports, IRCC rebatable imports and industry rebatable imports ..	163
Figure 46: South Africa's domestic automotive market and industry rebatable imports	164
Figure 47: Comparison of PAA rebatable imports (at 100% benefit) and IEC rebatable imports	165
Figure 48: Industry trade balance without IEC-PAA incentives	166
Figure 49: Competitiveness policy articulation gap	170



LIST OF TABLES

Table 1: Growth competitiveness index ranking 2005	2
Table 2: South African automotive industry: OEMs and major platforms in 2006.....	3
Table 3: Global automotive manufacturing 2004 (World total was 64.2 million units)....	4
Table 4: Development of automotive policy in South Africa.....	5
Table 5: MIDP phase down of import duties.....	19
Table 6: Investment expenditure by South African vehicle assemblers	23
Table 7: Employment in the South African automotive industry - 1995 to 2000.....	24
Table 8: South Africa vehicle production, import, exports and domestic market size - 1995 to 2000	28
Table 9: South Africa's automotive component sourcing - 1996 to 2000	30
Table 10: South Africa's consumer and vehicle prices indexes.....	31
Table 11: Pull and push factors explaining investment location decisions	57
Table 12: Contribution of capital, labour and technical progress to output growth (%) ..	68
Table 13: Factors contributing to productivity increase	73
Table 14: Investment expenditure by South African vehicle manufacturers - 1995 to 2004	77
Table 15: South Africa's R&D intensity in 2000.....	77
Table 16: Domestic market share of locally produced vehicles and vehicle export growth rate in South Africa.....	78
Table 17: System dynamics modelling process in classic literature.....	95
Table 18: South's automotive industry performance 1990 - 2005	99
Table 19: Hypothesised relation among industry performance variables.....	100
Table 20: Correlation between automotive industry variables	101
Table 21: Summary table of tests for building confidence in system dynamics models	126
Table 22: Model parameters for the PAA-IEC-Trade balance model	131