ECONOMIC ANALYSIS OF INTRA-INDUSTRY TRADE: THE CASE OF SOUTH AFRICA'S AUTOMOTIVE INDUSTRY

by

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SUMMARY

Over recent years, international trade flows of automotive products have experienced rising trends. Thus, the need to gain a better understanding of trade theories that could explain such trade flows. Until recently, the theoretical and empirical distinction of intra-industry trade (IIT) into patterns of horizontally differentiated (by variety) intra-industry trade (HIIT) and vertically differentiated (by quality) intra-industry trade (VIIT) has become crucial because each IIT pattern may potentially be influenced in different manners by country and industry factors (Greenaway, Hine & Milner, 1995).

The objective of this thesis is twofold. Firstly, to measure the empirical significance of IIT in the automobile industry between South Africa and its bilateral trading partners and to decompose total IIT (TIIT) into VIIT and HIIT patterns. Secondly, to develop empirical models to investigate potential country- and industry-specific determinants of IIT patterns in the South African automobile industry. The empirical strategy adopted in this thesis is a gravity model spanning the period 2000 to 2007. The automobile industry is a principal industrial sector in the South African economy contributing notably to trade, investment, employment and national output. The structure and conduct of the industry is aligned with several elements of IIT theories and thus represents an important and fascinating case of IIT patterns to investigate. Therefore, the findings of this thesis will be valuable to trade policy analysts and manufacturers in the local and global automotive industries.

According to the objectives, the significance of IIT is estimated using the trade overlap index and the empirical separation of total intra-industry trade (TIIT) into VIIT and HIIT is conducted using the threshold method. The empirical results reveal the presence of significant levels of IIT in automotive trade flows between South Africa and its bilateral trading partners. In accordance with theoretical expectations, the empirical investigation signifies the existence of high shares of VIIT dominating TIIT in the South African automobile industry. Moreover, the empirical analysis postulates that, within VIIT, the domestic automobile industry potentially produces and exports high quality automotive products proposing that such VIIT can be partly explained by fragmentation and international production processes.

Next, gravity models are estimated to investigate the determinants of IIT patterns in the automobile industry. The econometric results of the gravity models of VIIT, HIIT and TIIT are statistically and economically significant in the context of the fixed effects method of estimation and in accordance with new trade theories. The empirical results reveal that relative difference in economic size, trade openness, foreign direct investment (FDI) and tariffs stimulates VIIT, whilst distance, economies of scale and automotive assistance negatively affect it. Conversely, relative difference in economic size, FDI and automotive assistance negatively affects HIIT, whereas trade openness and depreciation of the exchange rate positively influences it. Thus, the findings of the thesis assert that IIT patterns of VIIT and HIIT in the automobile industry are influenced differently by country and industry determinants, revealing that the theoretical and empirical distinction of TIIT is important. The thesis proposes advancing trade liberalisation and deregulation of the South African automobile industry that could attract greater efficiency-seeking FDI complementary to trade and as a consequence enhance IIT levels.

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With love to Keira and Paulo

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ABBREVIATIONS

AGOA	Africa Growth Opportunity Act
AIDC	Automotive Industry Development Council
APDP	Automotive Production and Development Programme
APEC	Asia-Pacific Economic Community
BTI	Board of Trade and Industry
CBU	Completely built-up unit
CGE	Computable general equilibrium
CIF	Cost, insurance and freight
CKD	Completely knocked-down
CompCom	Competition Commission of South Africa
CPI	Consumer price index
CEPII	Centre d'Etudes Prospectives et d'Informations Internationales
DFA	Duty-free allowance
DTI	Department of Trade and Industry
EFTA	European Free Trade Area
EoS	Economies of scale
ERA	Effective rate of assistance
EU	European Union
FDI	Foreign direct investment
FGLS	Feasible generalised least squares
FOB	Free on board
FPE	Factor–price equalisation
FTA	Free trade agreement
GATT	General Agreement on Tariffs and Trade
GDP	Gross domestic product
G-L	Grubel-Lloyd
GLS	Generalised least squares
GM	General Motors
GMM	Generalised method of moments
GNI	Gross national income
GNP	Gross national product
HIIT	Horizontally differentiated IIT
H-O	Hecksher-Ohlin

H-O-S	Hecksher-Ohlin-Stolper
H-O-V	Hecksher-Ohlin-Vanek
HS	Harmonised system
ICT	Information, communication and technology
IE	Integrated equilibrium
IEC	Import–export complementation
IIT	Intra-industry trade
ILO	International Labour Organisation
IMF	International Metalworkers' Federation
IMF	International Monetary Fund
IMS	Integrated manufacturing strategy
IRCC	Import rebate credit certificates
ISIC	International Standard Industrial Classification
IT	Information technology
LABORSTA	ILO database on labour statistics
LCP	Local Content Programme
M	Imports
MERCOSUR	Southern American Common Market (Mercado Comun del Sur)
MIDP	Motor Industry Development Programme
MITG	Motor Industry Task Group
MFN	Most favoured nation
MFP	Multifactor productivity
MNC	Multinational corporations
MRTC	Mid-Term Review Committee
NAAMSA	National Association of Automobile Manufacturers of South Africa
NAFTA	North American Free Trade Agreement
NTBs	Non-tariff barriers
OECD	Organisation of Economic Cooperation and Development
OEMs	Original equipment manufacturers
OICA	International Organisation of Motor Vehicle Manufacturers
OLS	Ordinary Least Squares
OWT	One-way trade
PAA	Productive Asset Allowance
PTA	Preferential trade agreement

R&D	Research and Development
REER	Real effective exchange rate
ROW	Rest of the world
SACU	Southern Africa Customs Union
SADC	Southern Africa Development Community
SITC	Standard International Trade Classification
SCM	Subsidies and countervailing measures
STAN	Standard Industry
SVI	Small vehicle incentive
TDCA	Trade Development and Co-operation Agreement
TRIMS	Trade and Related Investment Measures
UK	United Kingdom
UNCTAD	United Nations Conference on Trade and Development
USA	United States of America
VIIT	Vertical differentiated IIT
VWSA	Volkswagen South Africa
WDI	World Development Indicators
WTO	World Trade Organization
X	Exports

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION AND OVERVIEW

With the progress experienced in trade liberalisation initiatives, developing countries are increasingly engaging in intra-regional trade and intra-industry trade (IIT) to benefit from trade expansion and foreign investment flows. The extant IIT literature is extensive but the majority of empirical studies are conducted from the perspective of developed countries, whilst limited studies analyse the determinants of IIT from the perspective of developing nations. Furthermore, the majority of empirical studies of IIT are conducted within an economy-wide framework, including countless manufacturing sectors and sub-sectors and do not focus on a *single* industry or sector. This thesis is concerned with the empirical investigation of the determinants of IIT patterns in a developing country context, namely South Africa, moreover focusing on a principal industry identified by the government's Department of Trade and Industry (DTI) as a strategic sector and catalyst for the development and growth of the South African economy and the African region as a whole. The industry under study in this thesis includes motor vehicles (automobiles), and automotive and related products as classified under the Harmonised System (HS) Commodity Description and Coding System 6-digit product classification (see Appendix A).

1.2 THE SIGNIFICANCE OF AUTOMOTIVE TRADE IN WORLD TRADE

The significance of trade in automotive products with regard to world trade is shown in Table 1.1. In 2007, the proportion of automotive[1] trade in terms of world merchandise trade was estimated to be 8.6 per cent. Moreover, in 2007, trade in automotive products accounted for 12.5 per cent of world manufacturing (WTO, 2008). In the global automotive industry, between 2000 and 2006, the significant reorganisation of production trends and reallocation of world output shares occurred. The global picture shows increasing shares of automotive production in global output for the Asia-Pacific region (13.5 to 22.6 per cent) and Eastern

1 In this study, 'automotive' products or 'automotives' includes both finished products (finished vehicles) and intermediate products (components) within the industry whereas 'automobile industry' and 'automotive industry' are used interchangeably and refers to the 'industry' or sector.

Europe (4.6 to 5.4 per cent) and falling shares for the North American Free Trade Agreement (NAFTA) region (30.3 to 23.7 per cent) and Western Europe (29.4 to 24.8 per cent) over the seven-year period (IMF, 2007).

Table 1.1 Trade share of automotive products in total merchandise and in total manufactures by region, 2007

Share in total merchandise	**Exports (%)**	**Imports (%)**
World	8.7	8.7
North America	11.9	12.6
South and Central America	4.2	9.5
Europe	11.3	9.8
Commonwealth of Independent States	1.5	12.6
Africa	1.3	9.6
Middle East	1.3	10.2
Asia	7.0	3.1
Australia, Japan and New Zealand	18.5	5.0
Other Asia	3.5	2.5
Share in manufactures	**Exports (%)**	**Imports (%)**
World	12.5	12.5
North America	16.4	17.3
South and Central America	13.8	13.8
Europe	14.4	13.6
Commonwealth of Independent States	5.9	16.4
Africa	6.7	14.1
Middle East	6.2	13.5
Asia	8.5	4.8
Australia, Japan and New Zealand	24.2	8.8
Other Asia	4.2	3.8

Source: WTO (2008), International Trade Statistics

The biggest contributors to the Asia-Pacific region's progress in automotive production are the emerging economies of China, India and Thailand, achieving production volume percentage increases of 15.9, 8.4 and 4.2 per cent respectively between 2000 and 2006 (IMF, 2007). Several countries in the Asia-Pacific region have become increasingly attractive for foreign direct investment (FDI) inflows and for multinational corporations (MNCs) to operate in and set up manufacturing bases.

Developments of IIT (simultaneous exporting and importing of products within a particular industry) became widespread during the 1980s and occurred as a consequence of trade openness and rising economic growth rates, as well as accessible trading environments facilitating flows of goods and services and investments across multiple borders. In automobile industries, the roles of MNCs and FDI are most important in international production sharing[2] (Nordas, 2005), and these are effortlessly facilitated by favourable trading arrangements and enabling government policies. Such industries are typically strategic industries containing strong linkages with 'related' industries and they account for significant shares of domestic manufacturing output and employ large numbers of the labour force. As IIT levels for several industries (such as electronics, apparel, footwear, automotives, etc.) have risen in recent years, the automobile industry provides an opportunity for a case study of trade patterns such as vertically differentiated IIT (VIIT) and international production fragmentation.

1.3 BACKGROUND OF THE SOUTH AFRICAN AUTOMOBILE INDUSTRY

The South African automobile industry has undergone significant structural reforms since the late 1980s and early mid-1990s. The local industry comprises both vehicle assembly operations and auto parts and component manufacturing that are well established and integrated into the global production networks of major auto producers. Together, they contribute an estimated 21 per cent of South Africa's manufacturing output (NAAMSA, 2007). Table 1.2 displays the key performance indicators for the local industry for 1995 and 2006. The local industry provides an impetus for economic development and growth for the national economy and the African region. In 2001, under the auspices of the DTI, an Integrated Manufacturing Strategy (IMS) was launched where the auto industry was nominated as one of strategic sectors in the national economy that expelled the potential for accelerated expansion and growth.

Although not shown in Table 1.2, the industry employs large numbers of people and attracts significant foreign investment. Despite successful exporting of automotive products, the

2 In the industrial organisation literature, the term 'international production sharing' is used interchangeably with the terms 'fragmentation', 'vertical specialisation', 'outsourcing', and 'intra-product specialisation', among others.

industry remains a net import user of foreign exchange as reflected in the industry's widening trade balance of R12.2 billion in 1995 to R33.4 billion in 2006 (NAAMSA, 2007).

Table 1.2 The South African automotive industry: key performance indicators, 1995 and 2006

Description of activity	1995	2006
Automotive industry contribution to GDP[3]	6.5%	7.53%
Capital expenditure by OEMs	R1,5 m[*]	R6,2 bn
Vehicles produced (units)	389,392	587,719
Export value (automobiles and components)	R4,2 bn	R55,1 bn
Vehicles exported (units)	15,764	179,859
Export destinations for vehicles and components above R1 million per annum	62	120
Productivity (average number of vehicles produced per worker)	10	15,5
New vehicle sales	399,967	714,315
Number of passenger car derivatives	228	1,600
Number of model platforms	42	21
Models with production volumes > 40,000 units	0	4

Source: NAAMSA (2007)
*Note: *2000 figure*

There are eight vehicle manufacturers or original equipment manufacturers (OEMs) and several importers of vehicles, producing almost 600,000 vehicles.[4] From the perspective of the auto components manufacturing industry, there are 150 registered suppliers and about 400 independent components and parts suppliers (NAAMSA, 2005). The top five automotive components exported include catalytic converters, stitched leather components, tyres, engines and engine parts (NAAMSA, 2006).

The Motor Industry Development Programme (MIDP) is the government policy that governs operations in the automobile industry. This policy was introduced in September 1995 and is expected to end in 2012. Most of the major MNCs are well represented in the local industry, facilitating international production sharing and foreign investment flows. Government

3 The automobile sector here comprises vehicle assembly, component manufacturing, tyres, and motor trade, which includes retailing, distribution, servicing and maintenance (NAAMSA, 2007).
4 Domestic production of vehicles includes cars, and light, medium and heavy commercial vehicles (NAAMSA, 2007).

support measures, such as generous export incentives offered under the MIDP make it very attractive for MNCs to conduct business and expand operations in the local industry and economy.

In light of the above, the application of IIT theory to the South African automotive industry will be an important contribution to the IIT literature and valuable to trade analysts and vehicle and component manufacturers. Little work has been conducted on investigating country and industry factors of IIT patterns for a *single* sector or industry. The objective of this thesis is to develop empirical models of IIT patterns among South Africa and its major automotive trading partners (see Appendix B for the list of countries used in the study). More specifically, IIT will be empirically separated into horizontally differentiated intra-industry trade (HIIT) and VIIT patterns. Few empirical investigations have been carried out to appreciate the determinants of IIT in intermediate goods since most previous IIT studies have examined the determinants associated with finished goods. This thesis draws hypotheses from models of HIIT and VIIT for final and intermediate goods, including fragmentation theory of international production and develops a methodology to empirically test determinants of HIIT and VIIT patterns using panel data econometric techniques.

According to the extant empirical literature, the gravity modelling equation is proficient in investigating bilateral trade flows and provides an ex-post analysis approach. Several authors argue that gravity models lack theoretical foundations and are thus devoid of economic theory. However, according to Feenstra, Markusen & Rose (2001), gravity-type specifications can be derived from several diverse theoretical trade models. Moreover, recent developments in the empirical trade literature encompass improvements in the theoretical foundations (Anderson & van Wincoop, 2003).

1.4 STATEMENT OF THE RESEARCH PROBLEM

The long-term growth and sustainability of the South African automobile industry is highly dependent on international trade. Thus, the importance of discovering and understanding the theoretical underpinnings that drive automotive trade flows in the South African automobile industry. The theoretical and empirical distinction of total intra-industry trade (TIIT) into patterns of HIIT and VIIT has become crucial because each IIT pattern may potentially be influenced in different manners by country and industry factors (Greenaway, Hine & Milner, 1995).

Firstly, this thesis seeks to identify and examine trade patterns between South Africa and its main bilateral trading partners in the automobile industry. Secondly, it sets out to empirically investigate potential country- and industry-specific determinants of expanding the share of IIT in total trade in the South African automobile industry. There is evidence to suggest that expanding the share of IIT patterns in total trade may tend to impose lower factor market adjustment costs relative to increasing the share of one-way trade (OWT) in total trade (Helpman & Krugman, 1985), because any displaced factors will be reallocated *within* industries instead of *between* industries which are applicable to the latter. Finally, policy implications will be inferred from the empirical investigations that could be valuable for trade policy analysts and manufacturers of automotive products and contribute to future automotive policy debates.

1.5 HYPOTHESES OF THE THESIS

1.5.1 Hypothesis (I)

Intra-industry trade in the automotive industry (automobiles and intermediate products) is expected to be dominated by vertically differentiated (by quality) IIT.

From Hypothesis (I), country and industry specific factors will be investigated according to several secondary hypotheses that can be grouped together under the umbrella of Hypothesis (II) as follows:

1.5.2 Hypothesis (II): Secondary hypotheses of determinants of IIT (HIIT and VIIT) include:

Hypothesis (i): To determine whether the average market size of South Africa and its main automotive trading partners affects all IIT patterns.

Hypothesis (ii): To ascertain whether the average standard of living between bilateral partners influences all IIT patterns in the South African automobile industry.

Hypothesis (iii): To determine whether relative difference in economic size between bilateral partners influences all IIT patterns.

Hypothesis (iv): To determine whether geographical distance influences IIT patterns between bilateral trading partners in the automobile industry.

Hypothesis (v): To investigate the effects of regional integration on IIT patterns in the automobile industry.

Hypothesis (vi): To examine whether foreign direct investment promotes IIT patterns in the automobile industry.

Hypothesis (vii): To investigate whether trade openness influences IIT patterns in the South African automobile industry.

Hypothesis (viiii): To ascertain whether tariffs applied to the automobile industry have significant effects on IIT patterns.

Hypothesis (ix): To investigate the way automotive assistance applied to the automobile industry may affect IIT patterns.

Hypothesis (x): To ascertain whether economies of scale is a determinant of IIT patterns in the automobile industry.

Hypothesis (xi): To analyse the impact of product differentiation on IIT patterns in the automobile industry.

Hypothesis (xii): To assess the impact of the exchange rate on the intensity of IIT patterns in the automobile industry.

Hypothesis (xiii) To examine the impact of the trade imbalance on IIT patterns.

1.6 JUSTIFICATION OF THE THESIS

There are several reasons that justify the research to be undertaken in this thesis. Firstly, South African studies of IIT are relatively unexploited as reflected in the number of published papers (Al-Mawali, 2005; Damoense & Jordaan, 2007; Isemonger, 2000; Parr, 1994; Peterssen, 2002; 2005; Sichei, Harmse & Kanter, 2007). Besides South African IIT studies, most IIT empirical research are conducted on trade between developed countries or North–North trade, while less has been done to understand trade between developed and developing countries, also referred to as North–South trade. Thus, this thesis is an extension of the scholarship in the area of applied international trade, namely the study of IIT from a developing country perspective and applied to one of South Africa's most strategic manufacturing sectors. It is important to highlight here that almost all of the previous South African IIT research has been conducted on an economy-wide basis, incorporating numerous industries and ignoring the study of a single industry (Al-Mawali, 2005; Isemonger, 2000;

Parr, 1994), with the exception of the study by Sichei *et al.* (2007). Thus, the need for empirical IIT research applied to a specific key industry. This study differs from Al-Mawali (2005) in that his study investigated only country-specific determinants of vertical and horizontal IIT patterns, whereas this thesis sets out to investigate both country-specific and industry-specific determinants of VIIT and HIIT for a specific strategic South African manufacturing industry. The study by Damoense & Jordaan (2007) provides a methodology to test the determinants of IIT patterns in South Africa's automobile industry. This thesis is an extension of the published article by Damoense & Jordaan (2007).

Secondly, this thesis provides an empirical investigation of the patterns and determinants of IIT in the automobile industry for South Africa and its major automotive trading partners. Such an empirical investigation of the South African automobile industry has not been done before and is warranted in view of the challenges facing the domestic industry and the significance of South Africa's automotive trade in terms of global automotive trade. Thus, this study is expected to provide the first empirical evidence on the patterns and determinants of IIT in the South African automobile industry. The principal country and industry-specific determinants that are investigated in this thesis include the relative difference in economic size of bilateral trading partners, distance, trade openness, FDI related to MNCs' activities, economies of scale (EoS), government (automotive) assistance, tariffs, exchange rates and product differentiation.

Thirdly, the focus on the automobile industry represents an important case of IIT to study for several reasons. The structure and conduct of the industry is aligned to IIT theory and international production and fragmentation theory. In addition, the industry is an important export industry attracting noteworthy foreign investment and it contributes significantly to jobs and the nation's gross domestic product (GDP). Trade in automotives is not only important for South Africa but also offers a key ingredient for regional development in Africa. According to the DTI, South Africa is expected to increase the domestic production of vehicles to 1.2 million units by 2020. The DTI notes a number of challenges in the industry, which include sustainable foreign investments and the inadequate manufacturing capacity of component suppliers, among others. This is likely to be met by increasing trade and competitiveness and the achievement of sustainable foreign investment, hence providing support for such an investigation. Accordingly, it is important to gain a better understanding of the fundamentals and underpinnings of trade theory that explains such an important industry. Although policy reforms and their likely impact on the domestic industry is discussed in Chapter 4, the evaluation of the impact of automotive policy on South Africa is beyond the scope of this thesis and does not form part of the objectives outlined in Section 1.7.

1.7 OBJECTIVES OF THE RESEARCH

(i) To empirically measure the intensity and composition of bilateral IIT levels in the South African automobile sector

(ii) To segregate total IIT into VIIT and HIIT patterns in the South African automobile industry

(iii) To identify and investigate country- and industry-specific determinants of bilateral total IIT, VIIT and HIIT in the automobile industry

(iv) To assess whether VIIT and HIIT patterns are affected differently by country and industry determinants.

(v) To contribute to the debate and make recommendations for future automotive trade and industry policy derived from the preceding objectives.

1.8 RESEARCH METHODOLOGY

After first establishing automotive trade flows as intra-industry using the trade-type methodology (Fontagné & Freudenberg, 1997; Fontagné, Freudenberg & Gaulier, 2005), this thesis proceeds to determine the patterns of IIT, that is, the extent of VIIT and HIIT that exists between South Africa and its main bilateral trading partners in the automobile industry. The distinction between VIIT and HIIT is important (Greenaway *et al*. 1994; 1995) because each IIT pattern could be influenced differently by the same factors. The decomposition of total IIT into shares of VIIT and HIIT is done using the threshold method (Abd-el-Rahman, 1991) based on unit value (price) differences.

Secondly, an augmented gravity modelling approach is adopted by using panel data econometrics to investigate country- and industry-specific determinants of patterns of total IIT (TIIT), VIIT and HIIT in the South African automobile industry. The gravity modelling approach comprises an *ex-post* analysis using historical time series and cross-section data (panel data) to examine the effects of factors that have already happened.

Thirdly, three regression equations are estimated separately, namely VIIT, HIIT and TIIT using explanatory variables derived from new trade theory and informed by the empirical trade literature to empirically investigate the potential determinants of IIT patterns as indicated in Section 1.5.

1.9 SCOPE OF THE THESIS

This thesis is concerned with two issues: to identify and understand trade patterns in the South African automobile industry and to empirically analyse the potential country-specific and industry-specific determinants of bilateral IIT patterns between South Africa and its major trading partners in the automobile industry. The study spans the period 2000 to 2007. The automobile industry represents an important case of IIT to study in the context of South Africa's involvement in world automotive trade and the extent of IIT in the domestic automobile industry.

The automobile industry is an important foreign exchange earner, a recipient of foreign direct investment, a domestic employer and is a significant producer of vehicles and component parts in the world market.[5] In recent years, the industry has been faced with substantial reforms in trade and industrial policy in the face of the restructuring of global automotive production and supply chains and intense competition from emerging economies such as China and India.

It is important to emphasise at this point that the purpose of the study is not to investigate the impact of government policy on the automobile industry and the welfare of the nation, although policy implications and recommendations for trade policy will be provided based on the findings of this study.

1.10 CHAPTER OUTLINES OF THE THESIS

Chapter 1: This chapter provides the introduction of the thesis and supplies the general construction for the rest of the thesis. Besides the introduction, Section 1.2 outlines the significance of automotive trade in relation to world trade and Section 1.3 provides the

5 South Africa produce about 0.75 per cent of total world vehicle production and is ranked 20th lagging behind Brazil but leading Australia, Sweden and Taiwan (NAAMSA, 2007).

background of the domestic automotive industry. Next, Section 1.4 provides the statement of the research problem, Section 1.5 highlights the hypotheses to be tested and Section 1.6 discusses the justification of the thesis. Sections 1.7 and 1.8 outlines the research objectives and research methodology to be undertaken and this is then followed by the scope of the thesis, which is given in Section 1.9. Section 1.10 provides an outline of the thesis, including a brief description of the chapter contents. Section 1.11 concludes the chapter.

Chapter 2: This chapter adopts the following sequence: In Section 2.2, a theoretical review of the IIT literature is given providing both theoretical models of HIIT and VIIT in sections 2.2.1 and 2.2.2, respectively. Section 2.3 offers a discussion on the world integrated equilibrium (IE) approaches to HIIT and VIIT patterns. Section 2.4 provides a theoretical discussion on international production of fragmentation theory, which is important for explaining trade in intermediate goods. In Section 2.5, the main issues of the literature presented in this chapter are discussed and concluding remarks are offered.

Chapter 3: This chapter of the thesis has the following sequence: Section 3.2 reviews previous IIT studies conducted for South Africa. Next, Section 3.3 provides a survey of the empirical literature of the determinants of IIT trade patterns. Section 3.4 supplies discussions of IIT empirical studies with special reference to selected industries. The last section of this chapter, Section 3.5, summarises and offers some concluding remarks.

Chapter 4: This chapter is ordered as follows: Section 4.2 elicits an overview of automotive policy reforms in the South African automobile industry, focusing on why policy reforms have been initiated and the consequences thereof. The next section, Section 4.3, provides a synopsis of the industry's performance, highlighting the impact of policy reforms on the automobile industry with reference to structure of the industry, production and sales, productivity, employment, exports and the automotive trade balance. Section 4.4 summarises and concluding remarks follow.

Chapter 5: This chapter adopts the following format: Section 5.2 revisits the theoretical motivation for measuring and investigating IIT patterns. In Section 5.3, the methodology for empirically measuring and separating bilateral IIT into shares of VIIT and HIIT patterns is discussed. Section 5.4 discusses the data used in the empirical analysis. In Section 5.5, the empirical results of the patterns of IIT between South Africa and 20 selected bilateral trading partners in the automobile industry over eight years (2000–2007) are discussed. Section 5.6 concludes with a summary of this chapter.

Chapter 6: This chapter proceeds in the following manner: Besides the introduction, Section 6.2 provides a review of the evidence of IIT patterns in the South African automobile industry. Section 6.3 presents and develops the econometric model specification for investigating the bilateral IIT patterns to be estimated, namely pooled, fixed effects and the random effects models, using Ordinary Least Squares (OLS). In the following section, Section 6.4 supplies a description of the data and data sources used in the regression analysis. The next section, Section 6.5, contains a description of the empirical determinants and hypotheses of IIT patterns to be investigated. Section 6.6 summarises and concludes this chapter.

Chapter 7: The chapter proceeds in the following way: Section 7.2 provides the univariate characteristics of the variables used in the econometric investigation. Next, Section 7.3 presents the econometric results of the pooled, fixed effects and random effects models. Section 7.4 provides a discussion of the estimation results and Section 7.5 presents a summary of the main findings and gives concluding remarks.

Chapter 8: This is the final chapter of the thesis and is ordered as follows: Section 8.2 presents the main findings of the thesis. In Section 8.3, policy recommendations inferred from the findings of the thesis are provided. Finally, Section 8.4 presents some of the limitations of the thesis and offers some insights for areas of future research arising from the limitations.

1.11 CONCLUDING REMARKS

This introductory chapter has outlined the general background of the thesis, including the format and contents of subsequent chapters that will be presented.

CHAPTER 2

THEORETICAL REVIEW OF THE INTRA-INDUSTRY TRADE LITERATURE

2.1 INTRODUCTION

This chapter provides a survey of the theoretical literature on IIT, as well as international fragmentation production theory with special reference to the determinants of IIT in the automobile industry (inclusive of both final goods and intermediate goods). The chapter is presented as follows: In Section 2.2 of this chapter, a theoretical review of the IIT literature is given, providing both theoretical models of horizontally differentiated IIT (HIIT) and vertically differentiated IIT (VIIT) in Sections 2.2.1 and 2.2.2, respectively. Section 2.3 provides a discussion of the world integrated equilibrium (IE) approaches to VIIT and HIIT patterns. The following section, Section 2.4, offers a discussion on international production theory of fragmentation which is important for explaining trade and the exchange of intermediate goods within a specific industry. Section 2.5 presents the main issues of the literature discussed in this chapter and provides concluding remarks.

2.2 REVIEW OF THE THEORETICAL INTRA-INDUSTRY TRADE LITERATURE

Classical trade theories, such as Ricardian and traditional Hecksher-Ohlin (H-O) models, are based on comparative advantage in homogeneous goods that are produced in a perfect competitive setting between countries across different industries. Trade between such countries is primarily characterised by differences in factor endowments and production technologies. In the international trade literature, inadequate empirical support for the H-O hypothesis of inter-industry trade or one-way trade (OWT) in world trade led to the emergence of *new trade theories* in the 1980s (Eaton & Kiezkowski, 1984; Falvey, 1981; Falvey & Kierzkowski, 1987; Flam & Helpman, 1987; Helpman, 1981; Helpman & Krugman, 1985; Krugman, 1979; 1980; Lancaster, 1980; Shaked & Sutton, 1984). In other words, traditional H-O trade models could not satisfactorily explain trade between countries possessing similar factor endowments.

New trade theories of IIT refer to the simultaneous trading of a product within a specific industry and exist under imperfect competition, EoS and product differentiation. This trade theory of IIT does not necessarily require comparative advantage since it stems from differentiated products and scale economies. As the IIT literature progressed, it became apparent that not all IIT could be adequately described by imperfect competition and EoS. For instance, Davis (1995) argues that increasing EoS may not be a necessary condition for IIT, which is capable of existing even under constant returns to scale. As a result, second-generation IIT theories were initiated, namely, horizontal IIT (HIIT) and vertical IIT (VIIT) theories. Horizontal product differentiated IIT refers to two-way trade of similar quality products with different attributes (Bergstrand, 1990; Dixit & Stiglitz, 1977; Helpman, 1981; Helpman & Krugman, 1985; Krugman, 1981; Lancaster, 1979; 1980) whereas VIIT relates to the two-way trade of similar products with different varieties of quality (Falvey, 1981; Falvey & Kierzkowski, 1987; Flam & Helpman, 1987; Shaked & Sutton, 1984).

Much of the work on IIT empirically measures the intensity of IIT using the unadjusted Grubel & Lloyd (G-L) index (1975), despite the well-publicised biases and shortcomings associated with the measure.[6] In the empirical IIT literature, a number of variations of the G-L index can be found, yet the unadjusted measure is still widely used and remains in many circles the preferred measure for determining the degree of IIT between bilateral trading partners. However, it is also generally accepted in the empirical literature that the G-L index is inappropriate for determining the pattern of IIT that is, distinguishing between VIIT and HIIT in total IIT (TIIT). Until the mid-1990s, empirical studies of IIT lacked the ability to distinguish between HIIT and VIIT. The distinction between HIIT and VIIT was pioneered by Abd-el-Rahman (1991) and Greenaway, Hine & Milner (1994; 1995). They claim that it is important to make this distinction because there are different theoretical foundations and determinants that are relevant to each pattern of IIT (Greenaway *et al.* 1995). The trade theories of HIIT and VIIT are discussed at this juncture.

2.2.1 Theoretical models of horizontal intra-industry trade (HIIT)

HIIT models are based on assumptions of monopolistic competition and increasing returns to scale (Helpman & Krugman, 1985; Krugman, 1980) and imply that the exchange of products occurs between similar-sized trading partners that possess comparable factor endowments,

6 The methodology used for the empirical measurement of the intensity of IIT will be discussed in detail in Chapter 5 of this thesis.

relative costs and technology strengths. In these models, the demand side reflects the diverse varieties of products favoured by consumers, while the supply side reflects the production of different product varieties supplied under decreasing costs where quality varieties are similar. Markusen & Venables (2000) extend the Helpman & Krugman (HK) (1985) model to pay attention to the role of MNCs and trade costs in HIIT.

Within HIIT, a further distinction can be made with respect to two alternate models, namely, the neo-Chamberlinian model, also referred to as the "love for variety approach" (Dixit & Stiglitz, 1977; Krugman 1980; 1982) and the neo-Hotelling model, also known as the "ideal variety approach" (Helpman, 1981; Lancaster; 1980). Although the production sides of the two models are similar, their respective demand sides differ (Senoglu, 2003). In the neo-Chamberlinian model, consumers attempt to consume as many different varieties of a particular product as possible, whereas in the neo-Hotelling model, consumers have diverse preferences for substitutable varieties of a particular product that they regard as ideal. All of these theoretical models examined HIIT for final products traded and not for trade in intermediate products. Ethier (1982) provides a theoretical framework for HIIT for trade in intermediate products and his model is sketched in Section 2.2.1.2 of this chapter.

2.2.1.1 Final products

The model assumes a two-country, two-industry framework, where one industry is capital-intensive and the other is relatively labour-intensive. This model explicitly assumes monopolistic competition and the production of differentiated products. In addition, the existence of EoS is introduced in the presence of fixed costs (Helpman & Krugman, 1985), thus each variety is produced under decreasing average costs.

The demand side is derived from Dixit & Stiglitz (1977) and is organised according to an open economy framework (Krugman, 1979) where different product varieties are demanded by identical consumers ("love for variety model") initially in a closed economy. In Krugman (1979), identical utility functions for all consumers are presented and each variation (v) of the product enter the utility function symmetrically and can be written as:

$$U = \sum_{i=1}^{n} v(c_i), \qquad v^{'} > 0, v^{''} < 0 \qquad (2.1)$$

where c_i indicates consumption of the ith product by the representative consumer, v', and v'' denotes first and second derivatives of v with respect to c_i. In Equation (2.1), a positive relationship between the number of goods consumed and the level of utility of the individual exists. In the model, the symmetry assumption implies that all varieties are produced in the same quantities and sell at the same price in the state of equilibrium. Equation (2.2) can be re-written from the previous equation as:

$$U = \sum_i c_i^{\theta} \quad 0 < \theta < 1 \qquad (2.2)$$

Suppose n goods are initially consumed and prices are identical and equal to one and that the representative consumer's income level is given by I. Then, $\bar{c} = I/n$ implies that the individual consumer ought to have consumed the same quantity of a unit of good $\bar{c}$.

Under such initial conditions, the utility levels of each representative consumer can be shown as:

$$U = (n) = n\bar{c}^{\theta} \qquad (2.3)$$

Now, if we suppose further that the consumer with the same income, I, is offered nk goods to consume, where $nk > n$ indicates that the product variety is larger, $k > 1$. Equation (2.4) below illustrates this point:

$$U(nk) - U(n) = n\bar{c}^{\theta}(k^{1-\theta} - 1) \qquad (2.4)$$

It follows that the consumption of each good is now lower; however, higher utility levels can be attained even though income, I, and prices have remained unchanged.

Next, the demand elasticity facing each individual producer can be expressed as:

$$\varepsilon_i = -\frac{v'(c_i)}{v''(c_i)c_i}, \qquad \text{where } \frac{\partial \varepsilon_i}{\partial c_i} < 0 \qquad (2.5)$$

Accordingly, the production function is given in Equation (2.6), where the number of labour units (l) is required to produce x_i quantities of the homogenous good i.

$$l = \alpha + \beta x_i \qquad \alpha, \beta > 0 \qquad (2.6)$$

As there are no barriers to entry and exit, the long-run equilibrium condition of zero economic profit can be written as:

$$\pi = P_i x_i - (\alpha + \beta x_i) w = 0 \qquad (2.7)$$

Where (w) is the competitive wage rate corresponding to l input and P_i is the price of the good, α is the fixed cost parameter and β denotes constant unit costs; such that αw denotes the fixed costs and βw denotes the constant marginal costs of a representative firm. Thus, each representative firm maximises profits according to Equation (2.7) with respect to x_i

$$P(x_i)\left(1 - \frac{1}{\varepsilon_i}\right) = \beta w \qquad (2.8)$$

ε is the elasticity of demand as shown in Equation (2.8) and derived from Equation (2.5).

Now, each firm has monopoly power over the production of their differentiated product and the maximisation of each firm's profits occurs by equating marginal revenue (*MR*) with marginal cost (*MC*). In addition, the determination of the equilibrium price that each representative firm will charge occurs at the equality of price (P_i) and average cost (*AC*), which is also equal to average revenue (*AR*). This is shown in Equation (2.9):

$$P_i = \left(\frac{\alpha}{x_i} + \beta\right) w \qquad (2.9)$$

If α > 0, there exist EoS in production with increasing returns to scale whereby (l / x_i) declines as x_i rises, since the presence of a sole producer of a specific kind of differentiated good is assumed to possess monopoly power over that good.

The assumption of a symmetric utility function implies that the marginal utility of each variety is identical. In addition, the assumption of relatively costless production of different varieties on the supply side implies that each firm solely produces one variety of the differentiated product and therefore has no incentive to reproduce another firm's product variety. Consequently, each firm will produce only one differentiated variety of the product.

Since differentiation is costless, output by a representative firm can be illustrated as:

$$x_i = Lc_i, \qquad L = \sum_{i=1}^{n} l_i \tag{2.10}$$

Let (L) be the labour force and (l) be the number of labour units supplied to produce x_i of good i. The total number of product varieties (n) produced by firms will depend on labour requirements as indicated by the cost function (li). Equation (2.10) illustrates that production of x_i by the representative firm can be determined by the multiplication of c_i by L. Thus, Equation (2.10) can also be written as:

$$P = \frac{\alpha}{L_C} + \beta \tag{2.11}$$

Then, the condition for full employment can be expressed as:

$$L = \sum_{i=1}^{n} \left[\alpha + \beta x_i\right] \tag{2.12}$$

In Equation (2.13), n denotes the degree of product variety and the number of product varieties is unidentified.

Then,

$$n = \frac{L}{l_i} = \frac{L}{(\alpha + \beta x_i)} \tag{2.13}$$

From Equations (2.4) and (2.6), where the former expresses the utility function and the latter reflects the production function. Profit maximisation occurs where $MR = MC$.

Now, when trade is allowed, each representative consumer is expected to maximise his or her utility in accordance with Equation (2.14):

$$U = \sum_{i-1}^{n} v\left(c_i\right) + \sum_{i=n+1}^{n+n^f} v\left(c_i\right) \tag{2.14}$$

where products 1, …, n will be produced at home and products n + 1, … n + n^f will be produced in the foreign country. With the introduction of the foreign country when trade is allowed, the size of the joint or average market, and consequently the size of the labour force (L), increases thereby increasing the number of product varieties available for consumption to both nations. From Equation (2.15), each country will produce (*n*) number of variety products proportional to its labour force (*L*) as given by:

$$n = \frac{L}{\alpha + \beta x_i} \text{ and } n^f = \frac{L^f}{\alpha + \beta x_i} \qquad (2.15)$$

In post-trade equilibrium, the total number of product varieties n_T available to both domestic and foreign consumers increases.

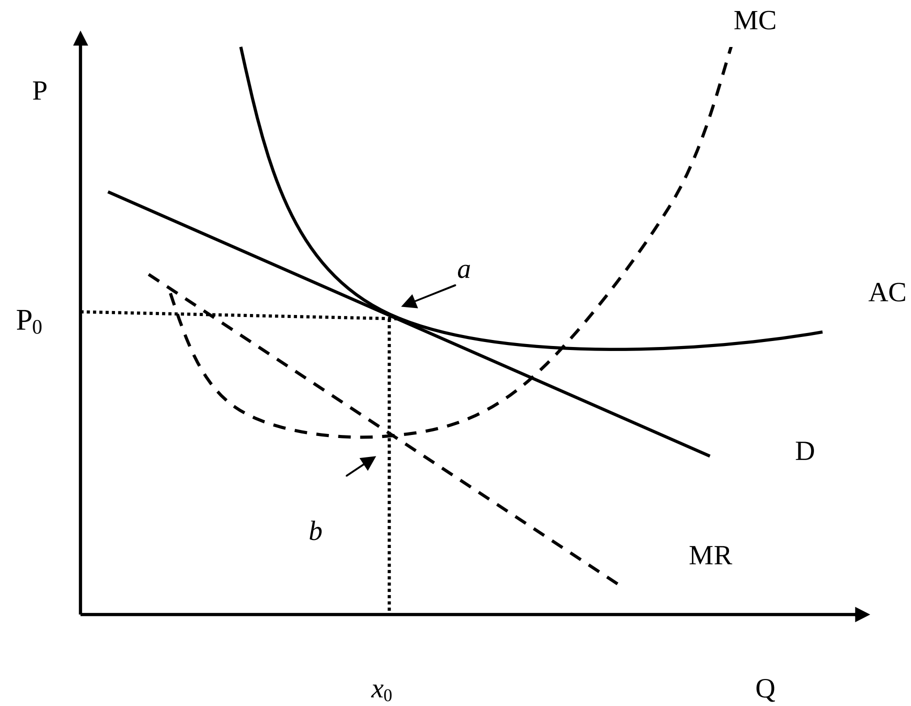
$$n_T = \frac{(L + L^f)}{l_i} = n + n^f \qquad (2.16)$$

In Equation (2.16), L^f is the labour force in the foreign country and n^f refers to the number of varieties produced in that country. Consequently, in the presence of trade (and absence of any trade barriers), welfare gains can be reaped by both countries as there are now a greater number of ($n + n^f$) variety products; that is, domestic varieties and foreign varieties produced, available in both markets. In post-trade, domestic and foreign consumers achieve higher utilities compared to autarky. From a supply perspective, the existence of EoS leads to lower unit costs and competitive prices, thereby also increasing welfare.

Figure 2.1 provides a visual representation of the standard textbook IIT model for a representative firm under monopolistic competition. In this model, the *D* curve is downward sloping, reflecting the degree of product differentiation of the output produced and declining average costs (*AC*). It also reflects the extent of EoS in the production of only a few varieties of the product. The optimal level of output is illustrated at point x_0 by charging P_0.

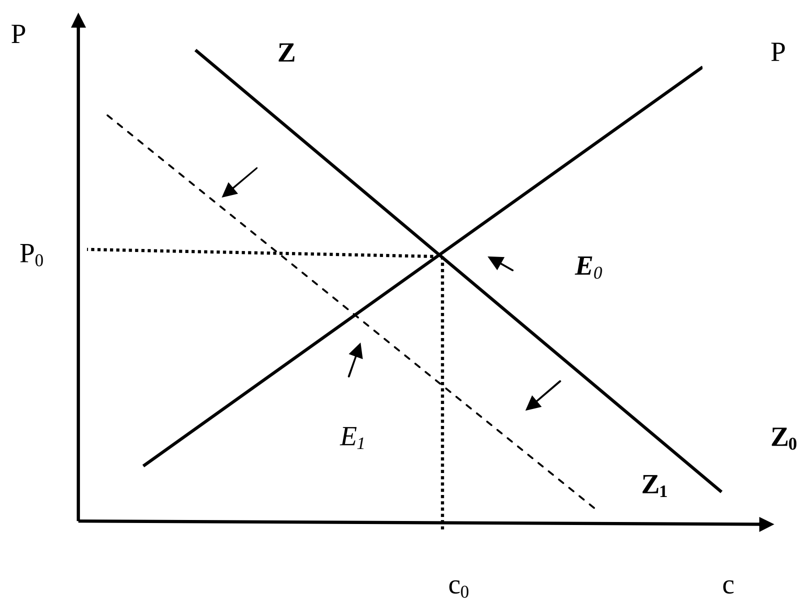
In Schmidt & Yu (2000), a theoretical model is derived from Helpman & Krugman (1985) that allows for firm heterogeneity in export markets and proves that EoS are positively related to the volume of IIT and the share of industry trade in production. In this model, the exporting firm (traded products) can achieve lower or equal average costs (EoS) compared to firms producing non-traded products.

Figure 2.1 The firm's output solution under IIT



Source: Salvatore (2007)

Figure 2.2 Market equilibrium in Krugman's model



Source: Krugman (1979)

Figure 2.2 shows that in pre-trade the *PP* schedule is upward-sloping and this is represented in Equation (2.7), whereas the *ZZ* schedule depicts Equation (2.10) and is downward-sloping. The two schedules intersect at point E_0 in Figure 2.2 where the equilibrium price level, P_0, and the level of individual consumption, c_0, for each variety of the good is determined. The output level of each representative firm, x_0, can be obtained by c_0 multiplied by L. In equilibrium post-trade, the *ZZ* schedule shifts to the left to Z_1Z_1 thereby causing an increase in production and a reduction in equilibrium prices for each variety of the product as well as expanding the diversity of varieties produced. Therefore, as trade becomes more open, greater product differentiation is expected as international competition tends to encourage either country to leave the industry or to manufacture a novel differentiated variety. E_1 denotes the new trade equilibrium, namely IIT equilibrium. Although, per capita consumption decreases with IIT, the decrease is not proportional to the increased consumption experienced by the total population.

There are several limitations that arise from this HIIT model. The model is inadequate for identifying which product varieties are likely to be imported or exported and is unable to predict the pattern and direction of trade. Some of these limitations were later addressed by Krugman (1985). In addition, a principal inadequacy of HIIT models is addressed in the study by Markusen & Venables (2000), which extends Helpman & Krugman's (1985) model to endogenously include the activities of MNCs and the existence of trade costs (tariffs). The Markusen & Venable's (2000) model asserts that the presence of MNCs reduces but does not necessarily eliminate potential agglomeration effects. These researchers show that multinationals displace trade by decreasing the demand and price of capital in the home country thereby reducing factor price differences and encouraging agglomeration activities. In their model, they assume that MNCs trade off high fixed costs against improved market access. A further expansion of IIT models is provided by Kikuchi, Shimomura & Zheng (2006), which extends the Chamberlinian-Ricardian trade model (Krugman, 1979) with a *continuum* of industries to show that the extent of cross-country technical differences among industries plays an important role as a determinant of IIT within each industry.

2.2.1.2 Intermediate products

The model developed by Ethier (1982) describes HIIT in intermediate products and is sometimes referred to as “love of variety for inputs”, which is the equivalent of the “love of variety model for final products” by Dixit & Stiglitz (1977) and Krugman (1980; 1982). In Ethier’s model, final products are assembled on a costless basis using a bundle of intermediate products.

(*k*) and (*l*) are the inputs used to produce (*z*) quantity of units of some variety of intermediate good, since costs of production and the quantity of production are identical across all monopolistically competitive firms. Each variety of the intermediate good is produced with the same cost function as shown in Equation (2.17):

$$s = n(\sigma z + \gamma) \qquad (2.17)$$

In Equation (2.17) *s* refers to the quantity of factor bundles of *k* and *l* used by *n* domestic firms that are allocated to the production of *z*, where *σ* and γ are constant marginal cost and fixed cost parameters respectively.

In this model, Ethier (1982) identifies two kinds of EoS, namely, firm-level EoS (*national returns to scale*) whereby component firms internalise EoS and gain efficiency from lower unit costs when output and plant size increases, and external EoS (*international returns to scale*), which apply to manufacturers of final products and can be achieved from lower unit costs as a result of industry or market expansion. In this model it is important to note that external EoS occur as a result of greater division of labour instead of bigger plant size. Thus, intermediates are produced and influenced by internal EoS whereas final products are produced under external EoS and are thus external to the individual firm.

In equilibrium, the demand curve faced by the individual component producer is given by:

$$z = z_f \left(\frac{q^f}{q} \right)^{\frac{1}{1-\Psi}} \; 1 > \psi > 0 \qquad (2.18)$$

Where q and q^f are the domestic and foreign prices respectively of the intermediate product and z^f is the use of a foreign-produced variety of intermediates (products). Also, in Equation

(2.18), $\frac{1}{1-\Psi}$ denotes the elasticity of substitution between intermediate goods. If Ψ increases, it implies that components can effortlessly be substituted between the components used in the final products sector. Furthermore, if so, it is expected that the degree of product differentiation will be lower with higher Ψ .

As with firms producing final products, each component firm maximises profits where $MR = MC$ and, as a result, the price of each intermediate part can be expressed in equation (2.19):

$$q = \frac{-T'(s)a}{\Psi} \quad T'(s) < 0 \text{ and } T''(s) < 0 \qquad (2.19)$$

In Equation (2.19), the expression *T'(s)* represents the relative price of factor combinations for the production of intermediates and is a strictly concave transformation function between intermediates and final products based on the Hecksher-Ohlin-Stolper (H-O-S) theorem.

Equation (2.20) illustrates the profit outcome of a representative component producer:

$$\pi_c = qz + T'(s)[\sigma_c + \gamma_c] \qquad (2.20)$$

where π_c denote profits, σ constant marginal costs and γ is the fixed cost parameter. On the assumption that intermediate products are produced by monopolistically competitive firms, long-run profits become zero due to the exit and entry of firms participating in the market. Now, only one component producer can produce one variety type since each producer possesses monopoly power over the differentiated product in equilibrium.

The production function for component manufacturing firms as is derived from Equation (2.20) and can be written as:

$$z = \frac{b\Psi}{a(1-\Psi)} \qquad (2.21)$$

In a closed equilibrium setting, Equation (2.22) shows the number of varieties of intermediate products produced by the domestic firm as:

$$n = \frac{(1-\Psi)s}{\gamma} \tag{2.22}$$

In free-trade equilibrium, the total number of intermediate varieties produced can be expressed as:

$$n_{\Theta} = n + n^{f} \frac{(1-\Psi)}{\gamma}\left(s + s^{f}\right) \tag{2.23}$$

Equation (2.23) indicates that there is a greater supply of component varieties in post-trade equilibrium compared to the situation of pre-trade equilibrium. Moreover, by utilising increasing returns to scale in production, every producer of each component variety has the ability to produce greater quantities compared to autarky.

Although Ethier's (1982) model is capable of predicting the volume of IIT between two countries in intermediate products, among others, it fails to predict the direction of IIT and is unable to identify the specialisation of a particular component variety by each country.

2.2.2 Theoretical models of vertical intra-industry trade (VIIT)

Models of VIIT are largely derived from neo-Hecksher-Ohlin (H-O) trade theory based on quality differences that are highly positively related to price (unit) differences. In the H-O model, a perfectly competitive market is assumed and firms do not require increasing returns to scale in production to produce varieties of different qualities. The varieties of qualities are created by differences in factor intensities, human capital and physical capital. This implies that higher quality products are associated with higher prices since such products tend to have intensive capital requirements. On the demand side, higher income consumers tend to consume high quality products while low income consumers tend to consume lower quality products.

An extension of the neo-H-O model by Falvey & Kierzkowski (1987) implies that countries with abundant capital will produce a greater variety of differentiated quality products that can be distinguished by price and quality. Trade in vertically differentiated products has also been examined in the context of a natural oligopoly (see Shaked & Sutton, 1984) and using a Bertrand model (see Skeath, 1995).

VIIT can best be described by the trade models of Falvey (1981), Falvey & Kierzkowski (1987) and Flam & Helpman (1987), which do not violate the fundamental premise of H-O-S theory when incorporating product differentiation. In the case of VIIT, countries with larger differences in factor intensities, endowments, technologies and per capita income levels tend to exchange VIIT flows. Under these trade models, the North (developed countries) and South (developing and emerging economies) tend to exchange products that are vertically differentiated by quality. VIIT is located in different production stages and can be explained by specialisation along quality varieties within a specific industry (Fontagné *et al*., 2005).

Falvey & Kierzkowski (1987) reveal that countries with abundant relative capital tend to produce larger varieties of differentiated products which are distinguishable according to price and quality. In terms of the demand perspective, consumers rank alternative varieties according to the degree of quality of the products, with the demand for each quality being expressed as a function of income and price. Therefore, a typical consumer is expected to prefer high quality (HQ) products to low quality (LQ) products, but since consumer choice is constricted by income levels consumers initially consuming LQ products can substitute toward HQ products as income levels rise, *ceterus paribus*.

In addition to the case of VIIT for final goods, Feenstra & Hanson (1996; 1997) develop an outsourcing model to examine trade in intermediate goods between North and South countries. These theoretical models will be discussed next.

2.2.2.1 Final products

Falvey (1981) adopts a partial equilibrium model where trade happens in a two-country, two-good and two-factor model initially in a closed economy. This model assumes a large number of firms in each industry in a perfectly competitive setting producing varieties of different qualities in the absence of increasing returns to scale in production.

In an open economy context, Equations (2.24) and (2.25) express the respective cost functions of the domestic country (c) and the foreign country (c^f) for any given levels of quality (α) and returns to capital for each country, respectively, r and r^f.

$$c = w + \alpha_i r \qquad (2.24)$$

$$c^f = w^f + \alpha_i r^f \qquad (2.25)$$

Let w and r be the wage rate of labour (L) and the rental rate of capital of the given stock of capital supplies (K), respectively. The parameter α denotes the capital-labour ratio (K/L) and determines the degree of quality of the final product. This implies that HQ products typically require higher degrees of capital intensity which in turn commands higher prices.

This model further assumes that the home country is better endowed with K and the foreign country is well endowed with L. Further, K is industry-specific and perfectly mobile domestically but immobile across international borders. Thus, the K (L) is higher (lower) in the domestic (foreign) country while L (K) is larger (smaller) in the foreign (home) country, which implies that $w > w^f$ and $r^f > r$. The key theoretical idea behind this theory is that differences in relative factor endowments determine relative factor prices, which in turn determine relative comparative advantage (disadvantage).

The home country enjoys a comparative advantage in a range of HQ differentiated products whereas the foreign country benefits from comparative advantage in an assortment of LQ differentiated products and is shown in the following expression:

$$c(\alpha_m) - c^f(\alpha_m) = 0 \quad \text{or} \left(w + \alpha_m r\right) - (w^f + \alpha_m r^f) = 0 \qquad (2.26)$$

In Equation (2.26), if α_m is classified as the marginal quality for a range of different quality products, then:

$$\alpha_m = \frac{w - w^f}{r^f - r} \qquad (2.27)$$

Comparative advantage in the home country occurs when:

$$\left[c(\alpha_m) - c^f(\alpha_m)\right] < 0 \qquad (2.28)$$

and

$$c(\alpha_m) - c^f(\alpha_m) = \frac{w - w^f}{\alpha_m}(\alpha_m - \alpha_i) \qquad (2.29)$$

According to Equations (2.28) and (2.29), the home (foreign) country has a comparative advantage in producing product quality types that requires capital-intensive (labour-intensive) procedures exceeding the marginal quality (α_m). On the other hand, the home (foreign) country experiences comparative disadvantage in product qualities requiring greater capital-saving (labour-saving) techniques.

$$c(\alpha_i) - c^f(\alpha_i) = \frac{w - w^f}{\alpha_m}(\alpha_m - \alpha_i) \qquad (2.30)$$

Equation (2.30) shows that the domestic country (high-wage) will produce and specialise and subsequently export products with qualities above the margin ($\alpha_i > \alpha_m$) and import those products with qualities below the margin ($\alpha_i < \alpha_m$).

Next, given that $w^f < w$, $\frac{(w - w^f)}{\alpha_m} < 0$, (2.31)

Consequently,

$$\left[c(\alpha_m) - c^f(\alpha_m)\right] < 0 \text{ if } \alpha_m < \alpha_i \qquad (2.32)$$

Accordingly, Equation (2.32) shows that the home country possesses a comparative advantage in the production of relatively HQ products that require capital-intensive procedures.

Falvey & Kierzkowski (1987) extend the model of Falvey (1981) allowing the same basic demand and supply structures, except that this latter model relates consumer demand for quality to income levels. In line with Linder's hypothesis (1961), the Falvey & Kierzkowski (1987) model explains the existence of VIIT based on disproportionate incomes such that different income levels guarantee that all available product qualities along the spectrum will be demanded by both countries. Now, even though consumers may have similar preferences in terms of quality, every individual's income ensures that only one type (quality) of the differentiated product is demanded.

In their model, on the supply side, Falvey & Kierzkowski (1987) show that the comparative advantage in producing HQ products becomes larger as the capital-abundant country moves upward along the quality spectrum. In other words, technology differences (labour productivity) and capital intensities are linked to the production of quality products. Moreover, monopolistic competition is no longer a necessary condition for VIIT and the model assumes large price (unit value) differences to distinguish between different quality varieties.

A modification of Falvey & Kierzkowski's (1987) model was formulated by Flam & Helpman (1987); their trade model assumes two sectors, one that is perfectly competitive and the other is monopolistically competitive. Accordingly, Flam & Helpman (1987) postulate that countries of the North produce and export high quality (HQ) products, whilst countries of the South manufacture and export inferior or low quality (LQ) products, as the former adopts production techniques that are capital-intensive while the latter employ labour-intensive techniques combined with limited technologies. This implies that the North is more likely to export products that exhibit higher relative unit values of exports to imports (RU^{XM}), where the unit values of exports (UV^X) are greater than the unit values of imports (UV^M); whereas the South tends to export products that possess lower relative unit values (RU^{XM}), where UV^X is less than UV^M. In the case of demand, consumers from the North boasting higher income levels are inclined to consume and purchase HQ products, while lower income consumers from the South tend to consume LQ products.

2.2.2.2 Intermediate products

The closest model that provides a theoretical perspective for VIIT in intermediate products is Feenstra & Hanson's (1997) outsourcing model. In this model, each domestic (North) and foreign country (South) is endowed with two factors of production, namely, *K* and *L* as in previous models. However, *(L)* is now split into a skilled labour (*H*) component and an unskilled labour *(L)* component. In the final analysis, the model predicts that outsourcing by MNCs has been an important factor in rising relative demand for skilled labour in the South (home country) and that FDI increases the share of relative wages for skilled labour in both countries.

Initially, no international factor mobility is assumed, and relative factor endowments (*H*, *L* and *K*) and relative factor prices (q_i, w_i and r_i) between the two countries are presented in Equations (2.33) and (2.34).

$$\frac{H}{L} > \frac{H^f}{L^f}; K > K^f \quad (2.33) \text{ and } \frac{q}{w} > \frac{q^f}{w^f}; r > r^f \qquad (2.34)$$

Equation (2.35) presents the production function for intermediate inputs, which assumes a Leontief technology of the two kinds of labour:

$$x(z) = A_i \left[\min \left\{ \frac{L(z)}{a_L(z)}, \frac{H(z)}{a_H(z)} \right\} \right]^{\theta} \left[K(z) \right]^{1-\theta} \qquad (2.35)$$

Where *x(z)* denotes the quantity of the intermediate (input) good *z*, *L(z)* and *H(z)* refer to the quantities of unskilled and skilled labour respectively, and *K(z)* refers to the capital stock used in the manufacture of *z*. Also in Equation (2.35), the parameter A_i is a constant reflecting some technological difference between North and South (home and foreign country) and the parameter θ represents that proportion of total labour (*L*, *H*) costs, while $(\theta - 1)$ is the proportion of *K* costs in the total production good *z*, because the relationship between *K* and *L* assumes a Cobb-Douglas technology.

The single final good (*Y*) is assembled from a range of intermediate *z* goods denoted by index $z \in [0,1]$. There are *N* stages of processing and production used in the final assembly of the finished product and production stages are defined in terms of skill intensity. To produce each unit of *z* requires the use of *L*, *H* and *K* inputs, where $a_H(z)$ and $a_L(z)$ represent respectively the quantity of skilled and unskilled labour combined with *K*.

The minimum unit cost function of producing *x(z)* can be expressed as:

$$c_i(w_i, q_i, r_i; z_i) = B\left[w_i a_L(z) + q_i a_H(z) \right]^{\theta} r_i^{1-\theta} \qquad (2.36)$$

Where $c_i(w_i, q_i, r_i; z_i)$ denotes the minimum cost function to produce one unit of *x* at home; and w_i, q_i and r_i are the wages of unskilled labour (*L*), skilled labour (*H*) and the rental of capital (*K*) respectively. In addition, *B* is some constant and can be described as:

$$B_i \equiv \theta^{\theta} (1-\theta)^{-(1-\theta)} A_i^{-1} \qquad (2.37)$$

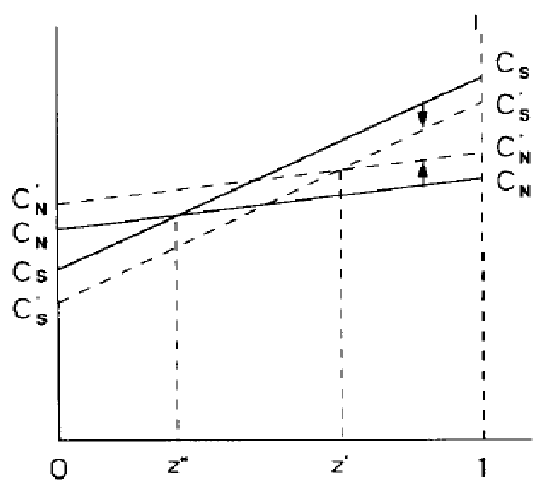
In Equation (2.38), *z** defines the equilibrium of trading intermediates between the two countries where the minimum cost loci are equated where:

$$c_f(w_f, q_f, r_f; z_f^*) = c(w, q, r, z^*) \qquad (2.38)$$

Equation (2.38) implies that the South (foreign country) is expected to specialise in the production of relatively less or unskilled-intensive products utilising L intensively; $z \in [0, z^*)$ whereas the North (home country) is expected to specialise in the production of relatively high-skilled intensive z products employing H intensively; $z \in (z^*, 1]$.

The model predicts that capital flows (FDI) (or outsourcing) from the North to the South will increase the returns to capital (r^f) in the North and reduce the returns to capital (r) in the South. Outsourcing activities impose long-run effects on wages in both countries. From the perspective of the home country (North), the relative demand for skilled labour increases with outsourcing activities to the foreign country. This is expected to increase the relative wage of skilled labour (L) in the home country (North), as z^* is raised as well as the relative wage of skilled labour (L) in the foreign country. Outsourcing from MNCs from North to South or capital inflows to the South according to Feenstra & Hanson's (1997) model are illustrated in Figure 2.3. The South has a comparative advantage in the production of relatively less skill-intensive z, while the opposite is true for the North. C_SC_S and C_NC_N denote the minimum cost loci for the South and North respectively, according to Equation (2.38). Given the assumptions about relative prices, C_SC_S lies below C_NC_N for z products and z^* determines trading equilibrium where the minimum cost loci are equal.

Figure 2.3 Outsourcing and capital movements from North to South



Source: Feenstra & Hanson (1997)

Suppose capital flows (such as FDI) from North to South or outsourcing activities are increased, C_SC_S shifts downward whereas C_NC_N shifts upward (as indicated by the direction of the arrows) causing z^* to increase to z' as shown in Figure 2.3. The increase in z^* implies that an increase in the relative capital accumulation in the South will in turn result in an increase in the relative demand for skilled labour (*H*) in both countries with a positive impact on relative wages of skilled labour in both countries. This model also implies that both nations are better off, although wage inequality may rise.

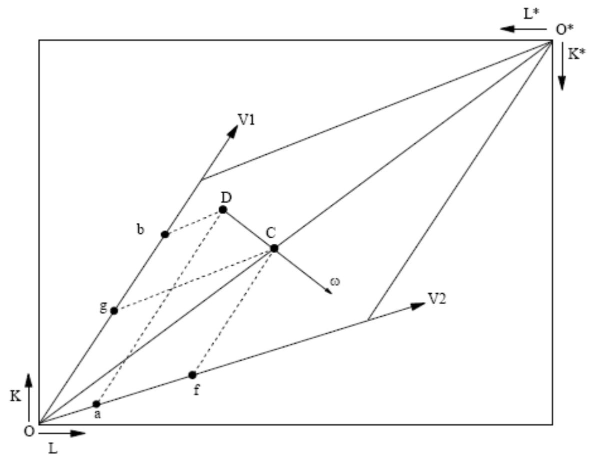
Some argue that VIIT models may involve sizeable adjustment costs and lead to displacement of resources. Since VIIT models are largely based on the idea that VIIT products are distinguishable by quality determined by large price or unit value differences, an obvious shortcoming is that large price or unit value differences may in fact reflect high unit costs instead of high quality as is assumed. Further refinement of the methodologies to determine quality differences is needed. Models of VIIT are closely connected to models of fragmentation theory developed by Deardorff (1998; 2001); Jones & Kierzkowski (1990; 2001) and adopted by Chen, Kondratowicz & Yi (2005). The theory of the fragmentation of international production will be discussed in Section 2.4 of this chapter.

2.3 WORLD INTEGRATED EQUILIBRIUM (IE) APPROACH TO IIT

In the world integrated equilibrium (*IE*) approach developed by Helpman & Krugman (1985) for conceptualising IIT, net factor content of balanced trade according to the Hecksher-Ohlin-Vanek (H-O-V) theorem is assumed. In addition, the existence of some combination of resource allocation (benchmark) of the world is assumed based on the notion that both goods and production factors are perfectly mobile (Davis, 1995). On the demand side, the assumption of identical homothetic preferences implies unit income elasticity and that the share of income spent on goods is the same for both domestic and foreign households and is invariant to income (Dixit & Stigler, 1977).

In Figure 2.4 the popular Edgeworth box is used to depict the production outcomes of two goods ($j = 1,2$) and two factors of production (L, K) for each country ($k = 1,2$). The world endowment of L and K are depicted along the width and height of the box, respectively. The slope of the ray from connecting each country's origin denotes the capital-labour (K/L) ratios. The domestic endowment of L is measured by the horizontal distance from O and the vertical distance measures the K endowment. In the same way, the foreign endowment of L^* is measured by the horizontal distance O^* and the endowment of K^* is measured by the vertical distance. In the Edgeworth box, the domestic country is capital abundant whilst the foreign country is labour abundant. The net factor content of trade is the difference between the net factor content of consumption and the net factor content of production. In Figure 2.4, the net factor content of trade is illustrated by subtracting the factor content of the imported good (*V2*) from that of the exported good (*V1*). Within the world *IE* a set of allocations (factor price equalisation) of factor endowments can be constructed that will allow countries to attain all of the benefits of the fully integrated world by trading in goods alone.

Figure 2.4 Economic distance and HIIT



Source: Fontagné and Freudenberg (1997)

Consider a one-period model where income (*Y*) is absorbed in consumption and expressed as:

$$Y_k = rK_k + wL_k \tag{2.39}$$

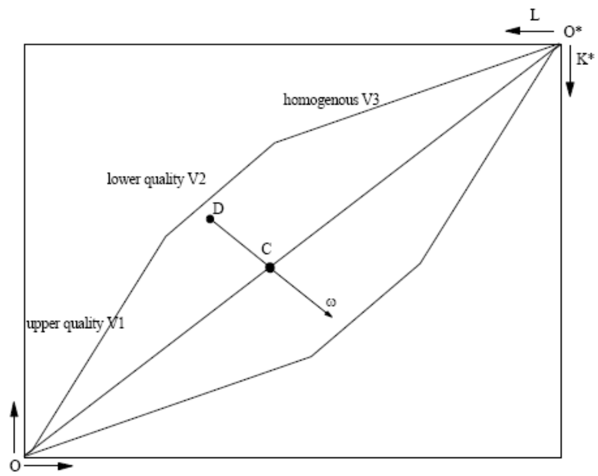
In Figures 2.4 and 2.5, the world income or consumption line *OO** is separated into shares of national (*OC*) and foreign (*CO**) incomes. Line *DC* denotes economic distance or differences in factor endowments between trading nations. The world *IE* relies on the idea that the endowment point *D* lies within the factor price equalisation (FPE) set defined by the vectors v_j and expressed as:

$$v_j = \left[a_{Kj}(r), a_{Lj}(w) \right] \tag{2.40}$$

where goods are produced at full employment in a general equilibrium context. The basis of the world *IE* is that the net factor content of one-way trade (OWT) is positively associated with the difference in relative factor endowments between trading nations. In contrast, net factor content of IIT corresponds negatively to differences in relative factor endowments involving trading partners.

According to Figure 2.4, in the home country *oa* and *ob* show factor contents in production and *og* and *of* show factor contents relevant to consumption in homogenous and horizontally differentiated products respectively. The distance *gb* refers to the net content of exports (net exports) of *differentiated* production of good 1 by the home country and the distance *fa* involves net factor content of OWT of *homogenous* good 2.

Figure 2.5 Economic distance and VIIT



Source: Fontagné and Freudenberg (1997)

The greater the relative economic distance *DC* the larger the net factor content of balanced trade (OWT). This simply means that OWT is positively related to economic distance, whereas the share of HIIT is negatively related to it.

As proposed by Falvey (1981) and Falvey & Kierzkowski (1987), price differences are associated with different production functions leading to diverse qualities. As already mentioned, high prices (large variable costs) replicate high quality in VIIT. Higher quality is assumed to be related to larger quantities of *K* inputs per *L* input, thus each quality variety is associated with a given vector of input. Again, following Vanek's (1968) theorem, net factor content of balanced trade occurs at *DC* irrespective of the pattern of IIT.

In Figure 2.5, OWT is now associated with non-zero net factor content of balanced trade, whereas IIT under vertical differentiation reflects different factor contents corresponding to different qualities traded as a result of the experience of internal redistributive pressures. In Figure 2.5, vectors *V1*, *V2* and *V3* represent high and low qualities of differentiated goods and homogenous goods respectively. Further, Figure 2.5 illustrates that greater relative economic distance is now positively associated with VIIT.

2.4 FRAGMENTATION THEORY OF INTERNATIONAL PRODUCTION

Fragmentation theory of international production is typically applied to the production and trading of intermediate products (components and parts) used in the production and assembly of final products (Ethier, 1982). As explained above, the theory of IIT is applied to both the trade in final goods and the trade in intermediate goods. Thus, trade in intermediate products can be examined in the context of horizontal specialisation (Ethier, 1982) and vertical specialisation (Ando, 2006; Arndt, 1997; Chen *et al.*, 2005; Feenstra & Hanson, 1996; 1997; Wakasugi, 2007). However, recent studies of VIIT include the theory of product fragmentation and/or outsourcing. According to Kimura (2006) the basis of fragmentation theory originates from the location of fragmented production blocks in different locations as a result of cost saving emanating from a reduction in the overall costs of production, especially if the cost of service links necessary for connecting production blocks is low enough. More specifically, Kimura, Takahashi & Hayakawa (2007) argue that international production networks are driven by the advancement in information and communication technologies (ICT) and transport infrastructures (freight, rail and road) contributing to favourable costs of service connections (trade barriers, institutional factors, etc.) necessary to facilitate trade across multiple borders thereby offering locational advantages that contribute to overall lower production costs.

International production networks have become apparent in numerous industries and products, including clothing, footwear and automobiles (Jones & Kierzkowski, 2005). Studies concerned with fragmentation theory are derived from international trade theory and the industrial organisation of the firm. Earlier studies of fragmentation include Deardorff (1998; 2001), Feenstra & Hanson (1996; 1997) and Jones & Kierzkowski (1990; 2001). Fragmentation has been receiving more attention in the empirical literature in recent years (Kimura, 2006; Kimura *et al.*, 2007), Ando (2006), Athukorala (2007), Wakasugi (2007) and

Chung & Deardorff (2008).[7] There are several reasons that contribute to the emergence of fragmentation-based trade; they include lower international transport costs, trade openness, government policy and relative wage differences, among others.

Deardorff (2001) develops a simple trade model of fragmentation using both Ricardian and H-O theories. He defines fragmentation[8] as the splitting of a production process into several production phases that can take place in different geographical locations with the end result of producing the same final product. This thesis will discuss the basic theoretical foundation of fragmentation theory using Deardorff (2001) in the context of the H-O framework for two small open economies (Country A and Country B) with two sectors and three goods, where good *Z* is the intermediate good and goods *X* and *Y* are the usual final goods. Key assumptions underlying this model include the idea of costless fragmentation.

In particular, Deardorff (2001) uses Helpman & Krugman's (1985) world *IE* approach to demonstrate that fragmentation of production increases the possibility of factor price equalisation (FPE). In the absence of fragmentation and outsourcing, the FPE region is indicated by the parallelogram O_AFO_BF' shown in Figure 2.6. Now, in the presence of international fragmentation, the FPE region expands to $O_AGFO_BG'F'$ also shown in Figure 2.6. He shows that the expansion of the FPE region occurs as a result of two fragmented vectors O_AG and *GF* arising from the duplication of vector O_AF of output *X*.

This can be illustrated as follows: Suppose that the allocation of resources occurred at point *E* in the absence of fragmentation. Thus, position E is outside the FPE region without any fragmentation. Country A would have produced only *X*, while Country B may have produced a combination of *X* and *Y*. With fragmentation, Country A can reallocate resources to the production of the capital intensive fragment of intermediate good *Z*, thereby raising the return to capital (*r*) and reducing the return to labour (*w*). Thus, point *E* is now positioned inside the FPE region as this has expanded with the emergence of fragmentation activities.

7 Ando (2006), Aturokulo (2007), Kimura (2006); Kimura *et al*, (2006); 2007), Wakasugi (2007) examined trade in intermediate products in East Asia trade and Chung & Deardorff (2008) consider the case of manufacturing in Chile's manufacturing sector.
8 The expression "fragmentation" was initiated by Jones & Kierzkowski (1990; 2001).

Deardorff (2001) infers several effects of fragmentation trade from theoretical models:

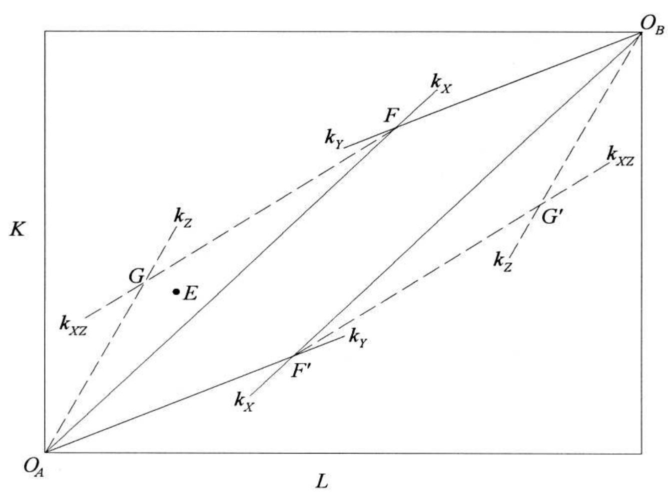
(i) If the prices of goods remain unchanged, then fragmentation must necessarily increase the value of output of any country where it occurs as well as that of world trade.

(ii) If fragmentation causes price adjustments, then such fragmentation can lead to the deterioration of a country's terms of trade and in turn lower its welfare.

(iii) In the presence of fragmentation of production, it is possible, although not necessary, that the ownership of some factors may lose even if the country gains as a whole.

(iv) In the absence of fragmentation, if factor prices are not equalised, then the subsequent occurrence of fragmentation will enhance the opportunity for factor prices to become equalised across countries.

Figure 2.6 Fragmentation-based trade models

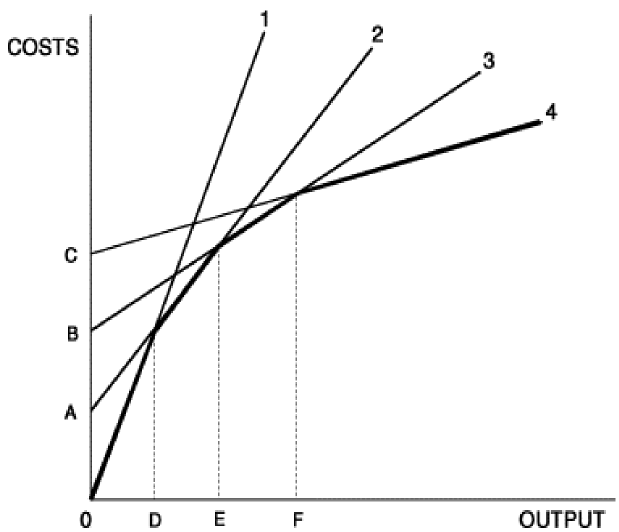


Source: Deardorff (2001)

In Jones & Kierzkowski's (1990; 2001; 2005) fragmentation model, they emphasise that the production process hinges on the idea of using service links to connect vertically integrated production processes into separate fragments (production blocks) that can be produced in different parts of the world. Importantly, it is crucial to distinguish between *production blocks* and *service linkages* (Jones & Kierzkowski, 1990). In Jones & Kierzkowski (2005), constant returns to scale (CRS) occur inside production blocks whilst increasing returns to scale associated with fixed costs and higher output can be found *within* service links (transport, communication and other coordinating activities), thereby reducing the service costs of connecting the fragments of the production process and thus encouraging international fragmentation of the production process to be carried out in various geographical locations. Thus, the model postulates that increased outsourcing contributes to lower total production costs attributable mainly to the costs of services connecting production fragments that do not rise in equal proportion to the level of output. Further, reduced service link costs tend to discourage national agglomeration production activities.

Figure 2.7 below shows how the extent of fragmentation can be encouraged as the service link costs necessary for connecting fragments of production stages in different locations are lowered at any given output level. In Figure 2.7, costs of production and output levels are measured along the vertical and horizontal axes respectively.

Figure 2.7 Fragmentation and the costs of production



Source: Jones & Kierzkowski (2005)

In Figure 2.7,[9] starting from the origin, *Ray 1* denotes the costs of production associated with a singular production block with constant returns to scale (CRT) for a particular location. Also in Figure 2.7, line segment 2 with vertical intercept *0A* indicates production activities taking place in an alternate geographic location in an attempt to take advantage of differences in factor costs, productivities and endowments. Production in these two locations reveals total lower marginal costs (*MC*) (shown by slope *A2*) which are associated with fixed costs

9 A ray is a geometric line that starts at one point (such as the origin) and extends to infinity (with no end point), whereas a line segment is a geometric line that has two end points.

(denoted by *0A*) relevant to the service link costs required to coordinate such fragmentation activities between the two locations. Fragmentation will only be profitable and cost-effective for output levels exceeding *0D*.

Next, line segments 3 and 4, also in Figure 2.7, illustrate greater degrees of fragmentation associated with diminishing total marginal costs (*MC*), especially when taking advantage of international factor price differences relevant to a given pattern of fragmentation. Note that slopes $0C < 0B < 0A$ reveal lower service connection fixed costs spread over increasing production levels $0D < 0E < 0F$. Therefore, average costs (*AC*) and marginal costs (*MC)* are reduced when fragmentation possibilities increase. The integrated minimum cost schedule is illustrated by the solid line schedule in Figure 2.7, which implies increasing returns to scale associated with greater degrees of fragmentation occurring at production levels *D–F*. The model is based on the restrictive assumption that CRS occurs within production blocks, while service link costs do not vary with rising production levels but decrease with greater degrees of fragmentation. Thus, the model postulates that lower service link costs lead to greater degrees of fragmentation and disagglomeration of production activities.

The role of multinational firms and FDI activities in international fragmentation production and vertical specialisation is important (Fukao, Ishido & Ito, 2003; Feenstra & Hanson, 1998; Yeaple, 2003). As MNCs conduct and manage production activities across several geographical locations, a range of production fragments or blocks can be produced by their affiliates or subsidiaries located anywhere in the world. Developing nations are becoming increasingly concerned with global outsourcing (efficiency-seeking FDI) and fragmented production activities, especially in sectors where the involvement of multinational firms and their FDI strategies are significant. North–South FDI by MNCs is prevalent mainly to avoid tariff and non-tariff barriers (horizontal FDI) and to take advantage of factor price differences (vertical FDI). Yeaple (2003) argues in favour of complex FDI strategies (combination of horizontal FDI and vertical FDI) for North–South trade.

2.5 SUMMARY AND CONCLUDING REMARKS

This chapter summarised theoretical models of HIIT and VIIT in the context of final products and intermediate products. In summary, HIIT trade is largely caused by monopolistic competitive practices and EoS. The ineffectiveness of HIIT theory from the viewpoint of FDI and outsourcing and production networks (Okubo, 2004) has led to the extensive use of VIIT models for this purpose. On the other hand, VIIT is formulated on the basis of perfectly competitive markets where the presence of EoS in production is not a necessary condition. In the case of VIIT, countries with larger differences in factor intensities, endowments, technologies and per capita income levels tend to exchange VIIT flows while the opposite is true for HIIT. VIIT largely explains trade between the North (developed countries) and South (developing and emerging economies) which tend to exchange products (final products and intermediate products) that are vertically differentiated by quality.

The main issues relevant to the theory of fragmentation of international production have also been discussed. Theoretical models for trade in intermediate goods and fragmentation of international production appear to be lacking in the trade literature (Deardorff, 1998; 2001; Ethier, 1982; Feenstra & Hanson, 1996; 1997; Jones & Kierzkowski, 1990; 2001; 2005) and are based on some restrictive assumptions. Thus, there is a need to develop more rigorous theoretical models for international fragmentation theory.

CHAPTER 3

EMPIRICAL REVIEW OF THE DETERMINANTS OF INTRA-INDUSTRY TRADE PATTERNS

3.1 INTRODUCTION

The principal objective of this chapter of the thesis is to provide an empirical review of the determinants of IIT patterns. The empirical evidence supporting IIT theories of horizontally differentiated IIT (HIIT) and vertically differentiated intra-industry (VIIT) is extensive. In particular, a large proportion of empirical studies validate the importance of country-specific factors, such as market size, living standards, absolute and relative economic distance and geographical distance in determining the intensity of IIT. The industry-specific factors, such as EoS, product differentiation and industry structure, are among the common factors that have been empirically tested in the IIT literature. Additional determinants that have also been assessed in the empirical literature include regional integration, FDI associated with MNCs, and trade barriers, among others. The success of investigating the impact of industry-specific factors on IIT patterns has been limited in the empirical literature. On the other hand, the examination of country factors on IIT patterns has performed better. This has led to most studies focusing on investigating the impact of country and industry factors on IIT patterns separately.

This chapter is structured as follows: Section 3.2 provides a review of the past IIT studies conducted for South Africa. Section 3.3 provides a survey of the empirical literature of the determinants of IIT patterns followed by a revision of industry studies of IIT (fabric, textiles and apparel, automobile and automobile parts, information and technology [IT] industries, and food processing industry, etc.) in Section 3.4. Lastly, Section 3.5 summarises and concludes the chapter.

3.2 PREVIOUS SOUTH AFRICAN INTRA-INDUSTRY TRADE STUDIES

Most of the empirical studies conducted for South Africa (Isemonger, 2000; Parr, 1994; Peterssen, 2002; 2005; Sichei *et al*., 2007), although useful, did not partition total IIT (TIIT) into HIIT and VIIT patterns, with the exception of Al-Malwali (2005). Using HS data, Isemonger (2000) and concludes the existence of rising IIT levels for the South African economy for the period 1993 to 1996, in contrast to predictions by Simson (1987) and Parr

(1994). In Al-Mawali (2005), IIT was disentangled into HIIT and VIIT and henceforth empirically examined several country-specific determinants of TIIT, HIIT and VIIT for South Africa's manufacturing sector (SITC) covering the period 1994 to 2004. His study employed Kandogan's (2003a; 2003b) methodology to decompose TIIT into horizontal IIT and vertical IIT patterns, instead of using the traditional G-L index. In his study, he established that market size, geographical distance, trade barriers and trade intensity are significant influences affecting South Africa's bilateral IIT. His study did not consider the impact of industry-specific determinants on IIT patterns for South Africa.

More recently, the IIT research conducted for South Africa includes an empirical investigation of factors that determine IIT in selected services (airfreight, education and training, financial services, legal services, etc.) between South Africa and the United States for the period 1994 to 2002 (Sichei *et. al.*, 2007). This study indicated that differences in per capita income and market size negatively affect IIT, while US FDI positively affects unaffiliated IIT in selected services. The study concludes that South Africa–US IIT in selected services is largely influenced by country factors that are similar to those affecting IIT in final products between North–South trade. Accordingly, their study was unable to decompose TIIT into VIIT and HIIT due to data constraints.

It is important to point out that almost all of the previous South African IIT research has been conducted on an economy-wide or manufacturing-wide basis (Al-Malwali, 2005; Isemonger, 2000; Parr, 1994) highlighting the need for IIT research focusing on specific industries. Thus, this thesis differs from previous studies conducted for South Africa in that it investigates both country- and industry-specific determinants of IIT patterns for a strategic industrial sector in South Africa.

3.3 AN EMPIRICAL REVIEW OF THE DETERMINANTS OF INTRA-INDUSTRY TRADE LITERATURE

As already mentioned, the majority of past studies examine the role of country-specific factors, such as market size, living standards, absolute and relative economic distance and geographical distance on IIT patterns. On the other hand, fewer studies have examined industry-specific factors on IIT patterns. Likewise, fewer studies have examined the determinants of IIT in intermediate products and components (Ando, 2006; Fukao *et al.*, 2003; Türkan, 2005; 2009). Moreover, the empirical IIT research investigating determinants of IIT patterns is sparse for single industries and sectors (Montout *et al*., 2002; Kind & Hathcote, 2004). Thus, the empirical IIT literature focusing on a single industry is less explored.

3.3.1 Economic size

According to the empirical literature, the larger the size of the market as proxied by the bilateral average of GDP of the two partners *i* and *j*, the greater the benefits that can be derived from potential EoS (supply) and the greater the demand for differentiated products thereby contributing to higher levels of IIT. Almost all empirical IIT studies examine the impact of this variable on IIT and its patterns have found that it positively influenced IIT (Al-Mawali, 2005; Byun & Lee, 2005; Chemsripong, Lee and Agbola, 2005). Thus, a larger average market size is expected to benefit from the potential EoS in production and trade and, as a result, increases the variety and quality of differentiated products for HIIT and VIIT respectively.

3.3.2 Standard of living

Several empirical studies measure average standard of living by using GDP per capita expressed as an average of the bilateral trading partners *i* and *j*. Countries with high levels of per capita incomes are associated with high levels of economic development, and thus are expected to increase the share of IIT. The level of per capita income (GDPC) is also sometimes used as a proxy for the level of capital-labour ratio (supply perspective) (Helpman & Krugman, 1985), as well as a proxy for the ability to purchase better varieties and sophistication of differentiated products (demand perspective) (Lancaster, 1980).

3.3.3 Economic distance

Similar to market size, absolute economic distance as proxied by absolute difference in per capita income levels between trading partners is commonly used. According to the Linder (1961) hypothesis, trade between countries that possess similar per capita incomes will be intensified if country *i* specialises in producing differentiated products and exports these products to country *j* with similar demand compositions. According to Helpman & Krugman (1985), *a priori*, the more similar the relative factor endowments between *i* and *j*, the higher the intensity of bilateral HIIT. A negative sign for HIIT (Helpman & Krugman, 1985) is expected where absolute economic distance is proxied by differences in capital-labour endowment ratios as used in Clark &Stanley (1999). Conversely, the larger the gap in per capita income or GDP per capita (or capital-labour ratio) between trading partners *i* and *j*, the higher the level of bilateral VIIT. Thus, if the absolute difference in per capita GDP between countries is large, the share of VIIT in total IIT is likely to increase and thus a positive sign for this explanatory variable is hypothesised as in Falvey & Kierzkowski (1987).

It is also argued that large per capita income gaps between trading partners *i* and *j* occur as a result of greater levels of inequality of economic development and have been investigated by Hirschberg, Sheldon & Dayton (1994), Gullstrand (2002), Kind & Hathcote (2004). Durkin & Krygier (2000) and Fukao *et al*. (2003) find evidence of a positive association between differences in GDP per capita with VIIT reflecting larger differences in relative wages that stimulates VIIT. The study by Gullstrand (2002) focuses on analysing demand patterns and VIIT between the North (EU countries) and the South (lower income countries reveals that income distribution, per capita income (and their interaction) and average market size are important for VIIT. The implication is that the two partners can typically specialise in different varieties of quality so long as production occurs with differing intensities (Gullstrand, 2002). Moreover, several studies use additional explanatory variables, such as public expenditure on education, electric power consumption per capita, and so forth in an attempt to capture similarities and dissimilarities between trading partners (Zhang, van Witteloostuijn & Zhou, 2005).

3.3.4 Relative difference in economic size

Several studies use relative difference in economic size or relative economic distance to capture the influence of the relative difference in factor proportions and endowments between nations. It is regarded as a better measure than absolute difference in market size, as the second measure is sensitive to the trading partner’s size whereas the former is standardised and normalised to one. Fontangé, Freudenberg & Péridy (1997) found that VIIT is positively influenced by a larger relative difference in economic size, implying that dissimilar countries in respect of factor endowments and technologies trade in products differentiated by quality (Falvey & Kierzkowski, 1987). On the other hand, a larger relative difference in economic size negatively affects horizontal IIT, indicating that similar countries trade in products differentiated by variety (Helpman & Krugman, 1985). In the context of international production and fragmentation, the market size of the trading partner is expected to promote larger fragmentation of the production process between nations (Türkan, 2009). In the studies by Fontagné & Freudenberg (1997), Thorpe & Zhang (2005) and Zhang & Li (2006), the difference in economic size is positively associated with VIIT and negatively associated with HIIT.

3.3.5 Geographical distance

The geographic proximity between bilateral trading partners *i* and *j*, as measured by a distance variable, is presented in the empirical IIT literature as a key determinant influencing IIT. Greater distances impose large transport costs and trade costs thereby reducing the intensity of IIT. Most empirical studies find that geographical distance negatively influences IIT (Fukao *et al*., 2003; Chemsripong *et al*., 2005; Türkan, 2005; Okubo, 2007). However, several studies find IIT to be positively influenced by distance (Kind & Hathcote, 2004; Zhang *et al*., 2005). As a result of greater regional integration, advancements in ICT and a reduction in international transport costs (shipping, air and road), it may be that distance does not necessarily deter IIT as is commonly assumed.

MNCs outsource various stages of processing, production and sub-assembly to developing countries. The emergence of international production sharing requires establishing strong and cost-effective production and service links. Thus, huge international transport costs adversely affect VIIT. Besides geographical distance as a proxy for trade costs, Clark (2005) uses *ad valorem* shipping charges as a proxy for international transport charges as a determinant of VIIT. As expected, international transport charges negatively influence the vertical share of IIT.

3.3.6 Foreign direct investment and multinational involvement

In recent years, advancing globalisation and the rise of international production networks have led to increased intra-firm trade through FDI flows related to multinational activities especially in the world automobile industry. Rising IIT and increasing FDI are associated with increasing multinational activity, as firms locate parts of their production operations across countries (OECD, 2002). The empirical literature suggests a positive relationship between IIT and multinational firm activity but an ambiguous relationship between IIT patterns and FDI (Aturupane *et al*., 1999). Multinational firms and their FDI strategies play a pivotal role in fragmentation theory of international production and VIIT (Feenstra & Hanson, 1997; Fukao *et al*., 2003; Kimaru, 2006). Several studies have empirically examined the effects of FDI on IIT and presuppose that it is strongly associated with the activity levels of multinational firms (Lee, 1992; Hu & Ma, 1999). This is so, because it becomes very difficult to empirically disentangle FDI from MNC activities given the complex integration strategies of MNCs and FDI strategies (Yeaple, 2003). More specifically, Yeaple (2003) shows that MNCs can be both vertically and horizontally integrated by establishing affiliates and structure of FDI in some foreign nations to benefit from factor price differentials and in other nations to avoid transport costs. Thus, it is commonly assumed that most FDI flows are consistent with multinational activities, especially in the context of developing countries where MNCs set up foreign affiliates to produce relatively labour-intensive component products that can be re-exported for assembly back to the host developed countries (North–South FDI flows and trade).

Several studies examine the influence of FDI on IIT trade patterns and conclude that the larger the FDI, the greater the levels of IIT. Veeramani (2009) assesses the impacts of FDI associated with multinational engagements and considers interactions with trade barriers on the intensity of IIT in India’s manufacturing industries. He reports FDI to be positively correlated with IIT, suggesting that IIT levels increase with greater multinational involvement. He also finds interactions between trade barriers and FDI to negatively influence IIT, reflecting the presence of horizontal multinational activities associated with market-seeking FDI which displaces IIT. The study by Okubo (2007) investigates the role of technology transfer through Japanese FDI on IIT between Japan and selected Asian countries using a simultaneous equations approach. The study concludes that the transfer of Japanese technology via FDI as proxied by technology exports of Japanese affiliates improves VIIT levels.

The empirical literature also shows that FDI can affect horizontal and vertical patterns of IIT in different ways (Zhang & Li, 2006; Chang, 2009). Zhang & Li (2006) find FDI to be positively influenced by HIIT and negatively influenced by VIIT. Similarly, Chang (2009) find that FDI positively influence HIIT and negatively influence VIIT in the IT industry among US, Asian and EU markets. On the other hand, Zhang *et al*. (2005) find a negative sign on the FDI coefficient, implying that greater FDI activities displace trade and reduce VIIT, resulting in some agglomeration effects of FDI. Thus, a negative sign on the FDI coefficient implies that VIIT and FDI may act as trade substitutes, as hypothesised by Caves (1981). Other authors such as Fukao *et al*. (2003) and Wakasugi (2007) examine the role of FDI in the context of VIIT for East Asia trade and find a positive relationship between FDI and the share of VIIT. Aturupane *et al*. (1999) and Zhang *et al*. (2005) reveal a positive relationship between FDI and VIIT.

3.3.7 Trade barriers

Trade barriers is used as a proxy for trade costs and includes natural barriers (distance, land and border), manmade barriers (cultural and language) and tariff and non-tariff barriers (NTBs). See Anderson & van Wincoop (2004) for a survey of trade costs and their effects on IIT, suggesting that trade costs do indeed matter. Hence, the level of trade barriers has important implications for the level of IIT. Since trade barriers are difficult to measure, the majority of empirical studies use tariffs as a proxy for trade barriers (Lee, 1992; Al-Mawali, 2005; Kind & Hathcote, 2004; Veeramani, 2009), although imperfect in capturing the effects of NTBs. The influence of NTBs on IIT has received less attention in the IIT empirical literature compared to tariffs. Fontagné & Freudenberg (1997) attempt to identify the impact of NTBs on HIIT and VIIT in their study of IIT in the European Union (EU). Sharma (2004) uses a measure of the effective rate of assistance (ERA) instead of tariffs as a proxy for trade barriers to examine their influence on IIT in Australian manufacturing. In Kimura *et al.* (2007), he argues that duty drawbacks assist in reducing the impact of trade barriers by reducing tariffs and thus reinforce IIT. The effect of NTBs on IIT has not been adequately explored in the IIT empirical literature (Gruen, 1999).

Most studies find that a reduction in trade barriers (tariffs) increased IIT (Hellvin, 1996; Sharma, 2004; Zhang *et al*., 2005; Veeramani, 2009). Sharma (2004) examines the impact of artificial trade barriers as measured by the ERA on Australia's manufacturing IIT patterns and find that it negatively influenced both VIIT and HIIT in the pre-liberalisation period. In contrast, there are a limited number of studies that reveal a positive relationship between trade barriers and IIT (Kind & Hathcote, 2004; Al-Mawali, 2005). In particular, Al-Mawali (2005) relates the positive impact of the level of tariffs on bilateral IIT in South Africa's manufacturing sector to provisions of the MIDP that is argued to encourage multinational activity. However, the tariff data used in his study was not specifically applied to the automobile industry as is done in this study. Kind & Hathcote (2004) use tariff data applied to the clothing sector and find a similar positive impact of tariffs on IIT between the US and fabric-trading partners.

Besides tariffs, this study introduces a novel industry explanatory variable, namely automotive assistance, which can take the form of several instruments, for example duty drawbacks, subsidies and investment incentives, and so forth that are typically provided under the direction of selective government policy aimed at strengthening the domestic industry especially protecting producers to increase domestic production in an attempt to enhance exports and to provide employment. This variable is expected to capture the effects of assistance or protection afforded to a *selected* industry such as the automobile industry on the intensity of IIT patterns. The description of the proxy for this explanatory variable will be discussed in Chapter 6 of the thesis.

3.3.8 Economies of scale

According Krugman & Helpman (1985) and others, EoS is a vital determinant for the existence of IIT in the production of differentiated products in the context of monopolistic competition. Schmitt and Yu (2001) establish a positive causal link between the degree of EoS, the volume of IIT and the share of trade in production. By contrast, Davis (1995) and Bernhofen (2001) argue that EoS may not be a necessary condition for the presence of IIT. The empirical literature proposes the examination of the effects of EoS on IIT levels (Aturupane *et al*., 1999; Byun & Lee, 2005; Faustino & Leitão, 2007; Montout *et al*., 2002; Sharma, 2004; Thorpe & Zhang, 2005;).

A number of studies use minimum efficient scale (MES) as a proxy for EoS (Clark, 1993; Hu & Ma, 1999; Montout *et al*., 2002). In the case of HIIT, Montout *et al.* (2002) find a negative sign on the MES coefficient for a small number of firms, whereas Aturupane *et al*. (1999) reveal a positive sign on the MES coefficient for a large number of firms in the context of VIIT suggesting that greater EoS stimulates VIIT. Other studies reveal a positive sign on the EoS coefficient for HIIT and IIT (Hu & Ma, 1999; Sharma, 2004) and a negative coefficient for VIIT (Byun & Lee, 2005). The study by Veeramani (2009) argues that the negative sign on the MES coefficient indicates that product homogeneity discourages IIT (HIIT). Typically, when scale economies are large (small), it is associated with increased (low) output which is concentrated in a small (large) number of firms or plants resulting in lower (higher) cost per unit of output thereby reinforcing (reducing) IIT. Clark (2005); Türkan (2005) and Faustino & Leitão (2007) find no statistical evidence of EoS influencing the intensity of IIT patterns.

Alternately, a negative coefficient is also found on MES for VIIT, supporting the argument that larger plant sizes are conversant with lower units costs of production thus reducing the incentive to outsource production activities and thereby reducing the propensity to engage in IIT differentiated by quality (Clark & Stanley, 1999; Feenstra & Hanson, 1997; Türkan, 2005) especially in the context of international production and fragmentation of the production process.

3.3.9 Regional integration

Several studies assess the impact of regional integration on levels of IIT (Menon & Dixon, 1996; Sharma, 2004; Montout *et al.*, 2002; Chemsripong *et al.*, 2005; Umemoto, 2005; Chang, 2009). Trade agreements serve to reduce trade barriers between trading countries and therefore cause an increase in IIT. Most studies reveal a positive relationship between regional integration and IIT. Montout *et al.* (2002) confirm the significant role of regional integration in NAFTA on IIT for the automobile industry. In the study by Chemsripong *et al.* (2005), the entry of Thailand into the APEC stimulated IIT in manufactured goods with other APEC partner countries. Similarly, Umemoto (2005) argues that the Korea–Japan FTA is likely to contribute to significant growth of IIT in automotive parts between them. In Chang's (2009) investigation of the determinants of VIIT and HIIT in the information technology (IT) industry among Asian, the US and EU markets, he argues that regional trade associations such as the Association of South East Asian Nations (ASEAN) strengthen VIIT in the IT industry between Asian and EU firms. By contrast, a few studies reveal that regional integration is associated with lower IIT (Al-Malwali, 2005; Chang, 2009) indicating that regional integration may in fact be a barrier to the expansion of IIT with trading partners.

3.3.10 Product differentiation

According to theory, the degree of product differentiation (PD) is an important determinant of IIT. Thus the degree of product differentiation on IIT patterns has been assessed by a number of authors (Hellvin, 1996; Hu & Ma, 1999; Bernhofen & Hafeez, 2001; Sharma, 2004; Clark, 2005; Veeramani, 2009; Faustino & Leitão, 2007; Chang, 2009). However, the empirical results of the effects of product differentiation on IIT are quite mixed. Several studies differentiate between vertical product differentiation and horizontal product differentiation (Bernhofen & Hafeez, 2001; Byun & Lee, 2005; Faustino & Leitão, 2007). Bernhofen & Hafeez's (2001) investigation of industry determinants of IIT in an oligopolistic framework uses demand (industry) size and two product differentiation proxies, namely relative differences in R&D intensity and relative differences in value added per worker. All industry coefficients exhibited the expected negative signs *a priori* according to the reciprocal-markets model whereby differences in demand size and industry productivity increase the intensity of IIT.

In Byun & Lee (2005), horizontal product differentiation is positively associated with HIIT, reflecting the greater degree of product differentiation (demand size) by variety the higher the HIIT levels. Some empirical studies of IIT report no statistical evidence to support the claim that product differentiation has any significant impact on the intensity of IIT (Sharma, 2004; Veeramani, 2009), indicating that the degree of product differentiation is not important in explaining IIT. The insignificant findings of the impact of the product differentiation variable on IIT may be attributable to the reliability of the difference proxies for product differentiation as an explanatory variable. Byun & Lee (2005) argue that an improved measure of product differentiation is perhaps warranted to improve its significance as an explanatory variable for explaining IIT patterns. On the other hand, Hu & Ma (1999) and Chang (2009) find a positive association between VIIT and PD.

3.3.11 Trade openness

There is evidence that the extent of trade openness is also a key factor influencing IIT patterns. Several studies use a variable of trade orientation as some measure of openness to trade and find that it positively influences the strength of IIT. Following Balassa & Bauwens (1987), Lee (1992) and others (Clark, 2005; Thorpe & Zhang, 2005; Zhang & Li, 2006), trade orientation is proxied by constructing the residuals from a regression of per capita trade on per capita income and population.

Related to trade openness, Sharma (2004) investigates the influence of trade liberation on determinants of IIT. In Sharma's (2004) study of Australian manufacturing, he decomposes IIT into components of HIIT and VIIT for pre- and post-liberalisation episodes. He finds trade barriers measured by the effective rate of assistance (ERA) to have a significant negative impact on both HIIT and VIIT patterns prior to liberalisation but no meaningful impact post-liberalisation. Also, the study by Chemsripong *et al.* (2005) investigates the determinants of IIT in manufacturers between Thailand and APEC countries. They consider pre-APEC and post-APEC scenarios. In the pre-APEC period, their results indicate that differences in levels of economic development, transport and information costs (geographical distance) were negatively related to IIT, while similarities in levels of economic development, capital intensity, culture and trade openness were positively related to IIT. In the post-APEC era, economic size is positively related to IIT although the effect was weaker. This study does not distinguish between HIIT and VIIT.

3.3.12 Exchange rate

Few studies examined the impact of the exchange rate on IIT levels (Hirchberg *et al*., 1996; Fontagne *et al*., 1997; Montout *et al*., 2002; Byun & Lee, 2005; Thorpe & Zhang, 2005; Sichei *et. al*., 2007). The trade literature is unclear regarding the influence of the exchange rate on IIT (Thorpe & Zhang, 2005). In Montout *et al.* (2002), depreciation of the bilateral exchange rate positively influenced both HIIT and VIIT in NAFTA's automobile industry. On the other hand, Hirchberg *et al*. (1996) found that the exchange rate negatively influenced IIT, while Türkan (2009) found no significant impact of the exchange rate on IIT.

3.3.13 Miscellaneous factors

Additional factors such as technology differences between trading partners (technology gap) and technology intensity have been assessed on IIT by Clark (2005), Al-Malwali (2005) and Sichei *et al*. (2007). The outcome of human capital differences on IIT types has also been investigated by Torstensson (1996), Al-Malwali (2005), Türkan (2005), Byun & Lee (2005) and Faustino & Leitão (2007). In addition to geographical barriers, other natural trade barriers (such as landlockedness and common border) and manmade barriers (such as culture and common language) were also found to influence IIT. The impact of landlockedness (Al-Mawali, 2005), common border (Hirschberg *et al*., 1994) and common language (Kimaru *et al*., 2007) and culture (Chemsripong *et al*., 2005) have also been considered by several authors, where landlockedness was found to deter IIT while common border, language and culture stimulates IIT.

Despite the fact that most empirical studies investigate the determinants of IIT for trade in final products, very few studies seek to understand the determinants of IIT in intermediate goods (Türkan, 2005; 2009; Fukao *et al*., 2003; Ando, 2006; Kimaru, 2007). The study by Türkan (2005) investigates the determinants of IIT for trade in total, final and intermediate products. In his study, Türkan (2005) examines bilateral trade data for manufacturing between Turkey and nine OECD countries over the period 1985 to 2000. He found that country-specific factors contributed the most explanatory power for both IIT in final and intermediate products relative to industry-specific factors that exhibited weak explanations for both IIT categories. In other words, industry-specific factors could not adequately explain IIT in final and intermediate goods. In his study he also established that IIT in intermediate goods is positively influenced by average size and human capital differences, whilst negatively affected by distance and differences in GDP per capita.

3.4 EMPIRICAL EVIDENCE OF DETERMINANTS OF IIT PATTERNS WITH SPECIFIC REFERENCE TO INDUSTRY

Empirical IIT studies have been conducted in several industries; namely food processing sector (Hirschberg *et al.*, 1994); milk products (Fertö, 2005); toy industry (Tharakan & Kerstens, 1995); fabrics (Kind & Hathcote, 2004); textiles and apparel (Clark & Reese, 2004), electrical machinery and components (Fukao *et al*., 2003), machinery parts and components (Ando, 2006; Kimaru, *et al*., 2007) and the IT industry (Chang, 2009). The latest IIT studies applied to the automobile and auto parts industries that analysed several determinants of bilateral IIT (HIIT and VIIT) include Montout *et al*. (2002), Umemoto (2005) and Türkan (2009) for NAFTA, Korea–Japan and Austria respectively.[10] The impacts of several determinants on IIT patterns investigated in these studies have already been discussed in Section 3.3 of this chapter under various (appropriate) subheadings.

Kind & Hathcote (2004) examine IIT between the US and ninety-two countries for four SITC categories in the fabric industry. Their main findings suggest that levels of economic development, market size and the trade deficit are negatively correlated with IIT, while trade barriers and distance are positively associated with it. However, their study does not consider the determinants of pattern of IIT in the fabric industry. Chang (2009) investigates the determinants of VIIT and HIIT in the IT industry among the Asian, US and EU markets. He concludes that per capita GDP, FDI, product differentiation and regional integration, among others, are key determinants of VIT and HIIT in the IT industry in the Asia, US and EU regions. More specifically, his study revealed that the dominant IIT pattern in the IT industry is HIIT and that IT firms' FDI strategies emerge to be market-seeking in host regions.

10 Umemoto (2005) and Türkan (2009) are unpublished working papers.

The study by Montout *et al*. (2002) examines the structure and determinants of IIT for the automobile and automotive parts industries in NAFTA using HS 6-digit level data. Their study distinguishes between goods of varying quality (of different unit values) from trade in varieties of goods (of similar unit values). According to Montout *et al*. (2002), the primary determinants of HIIT between NAFTA's automotive trading partners include economic distance and market size. The only industry variable, namely MES (as a proxy for EoS), was found to be negatively correlated with HIIT in the case of automobiles. Montout *et al.* (2002) conclude that the substantial rise in HIIT in NAFTA's automobile industry may reflect the international production strategies of multinational firms.

In Umemoto (2005), the determinants of HIIT and VIIT between Japan and Korea were investigated using HS 6-digit level data for automotive parts. The econometric results reveal that smaller differences in market size and transportation costs are major factors positively influencing IIT between Korea and Japan. This study concludes that the Korea–Japan FTA (regional integration) is likely to stimulate IIT in automobile parts. In this study, the effects of country factors on IIT patterns were examined, whilst no industry factors were considered.

The latest unpublished study by Türkan (2009) examines country determinants of VIIT and international fragmentation of the production process for Austria's automobile parts industry. In his study he finds that average market size, differences in per capita GDP and FDI positively influence VIIT, whereas distance negatively affects it. One shortcoming of his study is the fact that the author does not consider the impact of industry-specific variables on VIIT and the fragmentation process of production.

3.5 SUMMARY AND CONCLUDING REMARKS

This chapter of the thesis provided an empirical review of the determinants of IIT, VIIT and HIIT literature. More specifically, several empirical determinants and their impact on IIT, VIIT and HIIT were discussed.

This thesis improves on previous studies by investigating *country-specific* variables as well as attempting to include several *industry-specific* variables that may potentially influence IIT in the automobile industry. More specifically, the thesis investigates the potential impact of relative differences in economic size, geographical distance, regional integration, FDI associated with MNC activities, exchange rate, degree of product differentiation, EoS, tariffs and automotive assistance, trade openness and the trade imbalance on VIIT and HIIT patterns in the South African automobile industry. This thesis introduces a new industry factor to be considered in the investigation of the determinants of IIT patterns, namely, the impact if automotive assistance on the intensity of IIT patterns between the bilateral trading partners in the automobile industry.

CHAPTER 4

TRADE POLICY REFORMS AND PERFORMANCE OF SOUTH AFRICA'S AUTOMOBILE INDUSTRY

4.1 INTRODUCTION

This chapter of the thesis provides a descriptive analysis of automotive policy reforms and the performance of the domestic industry. The chapter is ordered as follows: Section 4.2 elicits an overview of the development of automotive policy reforms in the South African automobile industry over the past five decades or so, focusing on why policy reforms were initiated and the consequences thereof. Also in Section 4.2, a brief discussion covering the key elements of the new policy, namely, the Automotive Production and Development Programme (APDP), which is expected to be implemented in 2013, is offered. Section 4.3 provides a synopsis of the impact of policy reforms on the industry's performance with reference to the structure of the industry, production and sales, productivity, employment, automotive employment and the automotive trade balance for the period 1995 to 2007. It is important to point out that the data for certain industry variables provided and discussed here are obtained mainly from various issues of NAAMSA's annual reports and are quoted in *South African rand* values. This differs from the trade data and data for economic variables used in the empirical investigations of this thesis, especially in Chapters 5 and 7, where data is measured in *US dollar* terms. Finally, Section 4.4 summarises the chapter and offers concluding remarks.

Subsequent to years of intense protectionist policies, the automobile industry in South Africa experienced major trade policy reforms and in recent years the policy stance has become more liberalised (see Damoense & Agbola, 2009). The automobile sector contributes some 7.53 per cent of the national economy's gross domestic product (GDP) and employs over 320,000 persons[11] (NAAMSA, 2007). The industry is also the largest manufacturing sector in South Africa accounting for about 21 per cent of manufacturing output. The domestic automobile industry is ranked 20th in the world according to total vehicle production,

11 The automobile sector here includes vehicle assembly, manufacturing of vehicle components, tyres and motor trade (motor trade includes vehicle retailing, distribution, servicing and maintenance).

preceding Australia, Sweden and Taiwan by producing some 600,000 units of total vehicles or completely built-up units (CBUs). By 2020, domestic vehicle production is expected to double (1.2 million units) (DTI, 2008). In 2006, shares of automotive exports and imports in the national economy's total merchandise exports and imports were estimated to be 8.5 per cent and 15.5 per cent respectively (WTO, 2008). South Africa mainly exports CBUs to Japan, Australia, EU countries and the United States of America (NAFTA); with respective shares (as a percentage of the value of total CBU exports) of 29 per cent, 20 per cent, 20.2 per cent and 11 per cent (NAAMSA, 2007).

Trade and industrial policy in the South African automotive industry has received much attention in recent years. Automotive policy since 1989 has become increasingly export-orientated as a reaction to the changing international competitive environment. Recent amendments to government policy and the changing economic environment have meant that the industry may become increasingly fragile. The MIDP has been operational since September 1995 and is expected to run until 2012. Mid-term Reviews (MTRs) of the MIDP occurred in 1998/1999, 2002/2003 and 2005/2006 and resulted in the MIDP being extended twice until 2007 and 2012 respectively. The main thrust of the MTR (2002/3) includes a programme of further tariff reductions as well as the phasing down of import–export complementation (IEC) provisions as indicated in Table 4.2. Black (2007) argues that the IEC (export subsidy) is inconsistent with World Trade Organization (WTO) rules and largely led to the 2005/06 MTR of the MIDP.

The DTI argues that zero tariffs are actually applied to South African vehicles through the import rebate credit certificate (IRCC) system that neutralises the impact of import tariffs (CompCom, 2005). This is confirmed by Twine, who states that the MIDP is a duty neutral programme if it operates optimally (*Business Report*, 2005). Several authors have discussed the impact of policy reforms taking place in the South African automotive industry extensively in the South African economic literature with differing views (Black, 2001; Black and Mitchell, 2002; Black, 2007; Damoense & Simon, 2004; Damoense & Agbola, 2009; Flatters, 2003; 2005).

In recent years, trade agreements have been established between South Africa and several regions. South Africa as part of South Africa Customs Union (SACU) has developed important ties with countries of the North American Free Trade Agreement (NAFTA) through the Africa Growth Opportunity Act (AGOA) established in January 2001. Under AGOA, complete duty exemptions on most CBUs and CKDs are obtainable (*FocusReports*, 2006). For instance, through the AGOA, BMW SA has been awarded the opportunity to export left-hand drive 3-series models to the USA, and DaimlerChrysler SA to export new C-Class models, including left-hand drive models, also to the USA (DTI, 2004). The European Free Trade Area (EFTA) and preferential trade agreements (PTAs) have recently been established with India and MERCOSUR in 2004.

4.2 AUTOMOTIVE POLICY REFORMS IN SOUTH AFRICA

4.2.1 Local content programme

Historically, the industrial development of the industry developed within a general framework of protectionist policies through the use of prohibitive tariffs, quantitative restrictions (QRs) and mandatory domestic content protection. Table 4.1 provides an overview of policy reforms in the South African automobile industry from 1961 to 2012. In June 1961, the government introduced domestic content requirement policy that operated under Phases I to VI of the Local Content Programme (LCP) which ran until August 1995. The overall objective of the LCP was to encourage increased usage of domestic components for assembling final motor vehicles. In June 1961, the government implemented Phase I of the LCP with the primary objective of promoting the gradual development of the South African automotive manufacturing industry. Phase I of the LCP continued until June 1964. Under this scheme, the local content on components of vehicles was increased from 15 per cent to 40 per cent on a weight basis (BTI, 1988).

Between 1 July 1964 and the end of 1969, Phase II of the LCP was applied to the industry. The salient feature of the Phase II of LCP was the “manufactured model” scheme where the local content target was set at 45 per cent based on weight. Producers were allowed to declare and classify their models as “manufactured” when the specified target of 45 per cent was achieved. This scheme provided assemblers with bonus import permits as well as exempting them from paying excise duties based on the achievement of their local content levels. By the end of 1969, the local content target had risen to 55 per cent on a weight basis.

Table 4.1 Evolution of government interventionist policies in the automobile industry

Period	Automotive policy	Key elements
1961–1989	Phase I–V of LCP	Local content policy (LCP) scheme introduced with varying mandatory weight-based domestic content targets.
1989–1995	Phase VI of LCP	Local content requirements amended to a value-based system. An excise duty rebate scheme was introduced.
1995–2000	MIDP (including the Reviews of 1998/9, 2003 and 2005)	Local content regulations abolished. Tariff phase-down schedule for imported vehicles (CBUs) and components (CKDs) reduced to 40 per cent and 30 per cent respectively by 2002. Tariffs were reduced on average by 3.5 per cent and 2.5 per cent per annum respectively for CBUs and CKDs. Import-export complementation (IEC) scheme introduced. Similar to the excise duty rebate system. Duty-free allowance (DFA) and small vehicle incentive (SVI) schemes implemented.
2000–2007		Tariff phase-down continued until 2007, reaching 30 per cent for CBUs and 25 per cent for CKDs. Tariffs were reduced by 2 and 1 per cent per annum for CBUs and CKDs respectively. IEC phase-down schedule begins from 2003 through to 2007. The DFA scheme remains in operation. The SVI scheme to be phased down and eventually discontinued by 2003. The introduction of the Productive Asset Allowance (PAA) of 20 per cent in 2002.
2008–2012		Tariff phase-down is expected to continue until 2012, reaching 25 per cent for CBUs and 20 per cent for CKDs. Tariff rates are expected to decrease by 1 per cent per annum from 2008 until 2012. IEC phase-down continues and is expected to reach 70 per cent by 2012. The DFA scheme remains until 2012. The PAA remains at 20 per cent until 2009.

Sources: DTI (2008); Damoense &Agbola (2009c)

The year 1970 was a standstill year during which all domestic manufacturers were expected to attain a *net* local content of 50 per cent[12]. Phase III of the LCP was introduced on 1 January 1971 and lasted until December 1976. In terms of Phase III, net local content of manufactured vehicles was required to rise to 66 per cent by the end of 1976. The excise duty rebate scheme was adjusted to account for the net measure of local content target. Phase IV

12 Certain imported materials such as components manufactured from imported unprocessed materials, imported unmachined materials and imported unmachined castings and forgings were also treated as local materials for local content analysis (BTI, 1979).

of the LCP was characterised as a standstill period with no increments in local content targets, and commenced on 1 January 1977 and lasted until December 1979. The two-year standstill period, 1977 to 1979, was granted to OEMs so that they could consolidate their profitability status given the severe losses that they had incurred under Phase III (BTI, 1988). This was particularly with regard to the fall in vehicle sales volumes that had occurred during the sharp economic downturn between September 1974 and December 1977.

Phase V of the LCP was introduced on 1 January 1980 and continued until the end of February 1989. The minimum weight-based local content target under this phase remained at 66 percent. During this time, local content was based on a weighted average measure, which allowed models that achieved less than the prescribed 66 per cent target to be offset by other models that had achieved more than the 66 percent local content target levels (Black, 1991). That is, OEMs were not required to achieve the target percentage on every individual model but across the entire model range. Prior to the mid-1980s, export growth in automotive products was inadequate. In 1985, for the first time, export incentives were awarded to OEMs to encourage automotive export growth. This came in the form of an export credit of R4 per kilogram (BTI, 1988). Phase V did not succeed in reducing excessive net foreign exchange consumption by the motor industry and led to a shift in the assessment of domestic content from a weight-based programme (Phase I–V) to a *value-based scheme*; namely Phase VI of the LCP. Part of the failure of Phase V can be attributed to significant disinvestment by US-based OEMs, namely Ford and General Motors (GM), as a result of sanctions and political instability in the South African economy.

The government pursued export-orientation strategies to promote the industry, with Phase VI of the LCP being implemented on 1 March 1989. However, protection levels for completely built-up units (CBUs) remained at prohibitive levels (Black, 1996). Imported CBUs were subject to a 100 per cent *ad valorem* import duty plus a 15 per cent import surcharge on passenger cars (5 per cent on commercial vehicles) equal to 115 per cent (MITG, 1994). The Phase VI scheme assessed local content in terms of *value* instead of *weight* as in the previous five phases. The objective of policies implemented under Phase VI was to significantly reduce the industry's import bill by at least 50 per cent (BTI, 1989). The focus of this programme remained the objective of saving foreign currency with an emphasis on enhancing automotive exports. A key feature of the Phase VI programme was the import-export arrangements linked to value-based domestic content targets. Eligible automotive exports could count as local content value, while export credits in lieu of reductions in foreign exchange usage on imports were granted, which contributed significantly to the growth of automotive exports. This meant that real local content levels were actually reduced from 66 to 50 per cent (Black, 2001). Total automotive exports grew at a compound annual average growth rate of about 28 per cent in real South African rand terms under Phase VI over the period 1989 to 1994 (Damoense & Simon, 2004). Even though the industry experienced rapid export growth, Phase VI did not adequately lessen foreign exchange usage by the motor industry as the policy had intended.

Other failures associated with Phase VI include the proliferation of new vehicle models and small production volumes, high vehicle prices, cost pressures and inadequate domestic content levels incorporated in assembled vehicles. As a result of several challenges faced by the local industry coupled with global and institutional changes, the South African government implemented a new policy (MIDP) that recognised the importance of greater trade liberalisation and foreign investment. Under the MIDP, domestic content regulations were abolished and a process of tariff reduction was applied to assembled vehicles and components.

4.2.2 Motor Industry Development Programme (MIDP): 1995–2012

4.2.2.1 MIDP (Phase I): 1995–2000

The first phase of the MIDP started in September 1995 and was projected to last until 1999. Owing to the stagnant performance of the automotive industry in the 1970s through to the 1990s, a reform of automotive policy emerged following recommendations made by the Motor Industry Task group (MITG) in accordance with WTO and GATT obligations. The MIDP became effective in September 1995 and reflected an increasing gearing of policy towards expanding the export possibilities of OEMs and component producers. The MIDP can be distinguished from Phase VI by the fact that excise duties were replaced by tariffs and no minimum local content regulations applied. In addition, the programme imposed a gradual reduction in tariff rates for passenger cars and motor components. Despite the lowering of import tariffs, protection of the local motor industry still remained high by world standards. Other key features of the MIDP include the introduction of a duty-free allowance (DFA) and a small vehicle incentive (SVI) scheme.

The principal objectives of the MIDP include (DTI, 1998; NAAMSA, 1999):

(i) Developing a globally integrated and competitive domestic motor vehicle and component auto industry.

(ii) Stabilising long-term employment levels in the industry.

(iii) Improving the affordability and quality of vehicles.

(iv) Advancing the promotion of exports and improving the sector's trade balance.

(v) Contributing significantly to the economy's growth and development.

From the initial year of the MIDP, tariffs on imported CBUs were reduced to 65 per cent, while tariffs on original equipment components (CKDs) were lowered to 49 per cent. According to the tariff phase-down schedule, tariffs on CBUs were to be reduced gradually to 40 per cent and tariffs on CKDs to 30 per cent over an eight-year period by the year 2002. It is important to highlight that the tariff phase-down programme has proceeded faster than the requirements of WTO regulations. The reduction in tariffs in the automotive industry has led to greater demand for imported CBUs and imported components used in local assembly and exporting of CBUs.

The MIDP's export support scheme, the IEC, was introduced to encourage OEMs and component suppliers to further enhance the exporting of automotive parts and passenger vehicles. The idea was that OEMs must earn sufficient foreign exchange by exporting in order to partly compensate for the foreign exchange used to import the necessary components. The local content value of exports may be used to rebate the duty payable on CBUs and CKDs. Import rebate credit certificates (IRCCs) were issued and then used to offset duties payable. However, IEC arrangements contribute to higher effective rates of protection for the industry (Flatters, 2003).

Other government support mechanisms include a duty-free allowance (DFA) equal to 27 per cent of the manufacturer's wholesale value of the vehicle, which may be rebated against the duty payable on imported CKDs. The rationale behind the introduction of the DFA was to permit OEMs to import certain high value auto parts, which were not available locally or were relatively expensive on world markets, partly or fully duty-free. In addition to the DFA, the SVI offered a further allowance of 3 per cent for every R1,000 below a wholesale vehicle price of R40,000. The aim of the SVI was to promote the production of smaller, cheaper fuel-efficient motorcars. The scheme has supported the reduction in price of entry-level vehicles causing price wars in the lower end of the vehicle market, which benefited vehicle buyers. The lowering of tariffs in conjunction with the IEC and the DFA presented component manufacturers with the opportunity for flexible sourcing arrangements for foreign suppliers.

4.2.2.2 MIDP (Phase II): 2000–2007

In July 1999, a Mid-term Review Committee (MTRC) was established to review the impact of the latest MIDP on the automotive industry. The MTRC recommended, among other things, a further reduction in tariffs on imported components and assembled vehicles from 2002 up till 2007; tariffs on CBUs should be lowered by 2 per cent annually until the tariff reaches 30 per cent in 2007. In terms of CKDs, the Committee recommended a tariff reduction from 30 per cent in 2002 to 25 per cent by 2007; a reduction of 1 per cent annually. In 2004, import duty rates of 36 and 28 per cent were applied to imports of CBUs and automotive components respectively (DTI, 2004).

According to Table 4.2 columns 2 and 3, tariffs fell by 2 per cent per annum from 2002 to 2007 and thereafter will decline by 1 per cent per annum until the MIDP expires in 2012. Also in Table 4.2, columns 4 and 5 provide the phase-down schedule for IEC provisions according to eligible export performance until 2012. Importantly, export credits (import rebate credit certificates) granted against imports are tied to export performance. In addition, the existing DFA of 27 per cent remains part of the policy.

Over the last two decades, fundamental structural shifts have occurred in the composition of the South African car market and the production of smaller, cheaper and more fuel-efficient models especially encouraged by the SVI allowance scheme under the MIDP. This trend is in line with worldwide demand patterns for cars. However, the SVI allowance has resulted in a distortion in the small car segment of the vehicle market by way of imposing higher welfare costs on the local industry. It is argued that the SVI gave firms an incentive to continue producing and promoting vehicles that embodied dated technology and were possibly of lower quality. The MTRC proposed a phasing-out programme for the SVI, which would be gradual so as to limit the adverse impact that its eventual sudden withdrawal might have on the industry. The SVI was phased out in 2003.

Table 4.2 Provisions under the MIDP (as amended according to the Review of 2003) until 2012

Year	Import duty		Value of export performance	Ratio of exports to imports in value terms		
	Built-up vehicles (%)	Original equipment components (%)	Built-up vehicles & components (excl. tooling)	Components, HV & tooling *exported*: CBU light motor vehicles *imported*	Components, vehicles & tooling *exported*: Components, HV & tooling *imported*:	CBU light vehicles
1999	50.5	37.5	100	100:75	100:100	
2000	47.0	35.0	100	100:70		
2001	43.5	32.5	100	100:70		
2002	40.0	30.0	100	100:65		
2003	38.0	29.0	94	100:60		
2004	36.0	28.0	90	100:60		
2005	34.0	27.0	86	100:60		
2006	32.0	26.0	82	100:60		
2007	30.0	25.0	78	100:60		
2008	29.0	24.0	74	100:60		
2009	28.0	23.0	70	100:60		
2010	27.0	22.0	70	100:60		
2011	26.0	21.0	70	100:60		
2012	25.0	20.0	70	100:60		

Source: NAAMSA (2007)
*Notes: *HV= heavy motor vehicles, CBU=completely built-up units.*
***PAA and DFA will remain until 2012*

Initially, under the MIDP, OEMs were allowed to import component parts equivalent in value to export components by earning export credits. Export credits will now be lowered gradually, although not removed completely, under the revised MIDP. From 2007, OEMs and component producers earned less export credits for the exporting of automotive products to offset imports thereby effectively reducing the export subsidy to the industry. The policy aims to achieve a balance in support of both export automotive products and domestic motor products in an attempt to encourage localisation and maintain higher export volumes.

Another government support scheme, the productive asset allowance (PAA), was introduced in 2002. The introduction of the PAA aims to assist in platform rationalisation and to encourage investments. PAA duty credits are calculated at 20 per cent of qualifying investment value in qualifying assets, which will be spread in equal amounts over a period of five years. This duty credit will only be allowed to offset duties applied to imported cars and is likely to contribute to increased importation of CBUs. A disadvantage of the PAA is that it benefits vehicle assemblers and not component producers.

Vehicle prices remain a contentious issue in South Africa. The DTI (1999) argues that vehicle price inflation increased slower than the consumer price index (CPI) under the MIDP, indicating that real vehicle prices have dropped since its inception. In support, NAAMSA (2007) argues that the vehicle inflation index has been consistently lower than the CPI. For example, in 1995 and 2003, consumer prices increased by 8.7 and 5.9 percent compared to vehicle price inflation (VPI) increasing by 8.2 and 3.9 per cent respectively for the same period. However, the computed vehicle price inflation index (Statics South Africa) may not necessarily be an accurate measure of vehicle prices. A recent investigation into domestic vehicle prices by the Competition Commission of South Africa (CompCom, 2005) suggests that vehicle prices may in fact be in the region of 15 per cent higher relative to car prices in Europe. Therefore, there is potential for vehicle prices to drop more if tariffs are further liberalised, subsidies are lowered and greater EoS are experienced.

Flatters (2003) argues that although nominal tariffs have been falling, effective protection in the industry remains high. This is supported by Damoense & Agbola (2009), who adopt a partial equilibrium methodology initially developed by Takacs (1992), to investigate the impact of policy reforms on the welfare of consumers, producers and society as a whole. The results of the simulation analysis comparing the impact of policy for 1996 and 2006 indicate that, following the removal of domestic content requirements and reduction in tariffs, there has been a significant reduction in consumer welfare loss and societal deadweight loss in the automobile industry, while tariff revenue to the South African government has significantly decreased. The results demonstrate that further reductions in tariffs applied to CBUs and CKDs are expected to result in a larger decrease in efficiency losses, thus leading to an improvement in the performance of the South African automobile industry (see Damoense & Agbola, 2009).

4.2.2.3 MIDP (Phase III): 2008–2012

Phase III of the MIDP is based primarily on the recommendations of the 2002/03 MTR of the MIDP. The amendments made to the MIDP became effective in 2008 and are expected to continue until 2012. The third phase of the MIDP is set to provide transitional support for the introduction of a new programme when the MIDP expires in 2012. Starting from 1 January 2008, tariffs applied to imported CBUs and CKDs will be phased down by 1 percent per annum to reach a level of 25 percent and 20 percent respectively by 1 January 2012. The IEC scheme will continue to be phased down according to Table 4.2, producing a reduction of 4 per cent per annum in the eligible export value of exports for import credit purposes until 2009.

The valuation of eligible exports for the purposes of import duty rebates will remain at 70 per cent per annum from 2009 until 2012 when the IEC will eventually be discontinued and the MIDP expires. It has been argued that IEC (export subsidy) provisions is countervailing to WTO rules. The DFA of 27 per cent will continue to operate during the remaining term of the MIDP.

4.2.3 Automotive and Production Development Programme (APDP)

The proposal of the 2005/06 MIDP MTR led to the eventual announcement of the APDP on 30 August 2008, which is expected to begin in 2013 and last until 2020. As part of the MTR of 2005/06, the PAA is expected to be replaced by the automotive investment assistance (AIA) starting in June 2009 and ending in 2020.

The main features of this novel programme are summarised in Table 4.3. Not surprisingly, the IEC scheme (export subsidy) will be discontinued and replaced by a production incentive allowance (PIA) (production subsidy) as of 2013. The DTI (2008) argues that the production incentive allowance is predicted to stimulate increasing domestic value (content) levels along the automotive supply value chain that can potentially contribute to positive employment effects.

Table 4.3 Automotive and Production Development Programme (APDP)

Key features of APDP	Description	Period
Automotive investment assistance (AIA)	AIA is expected to replace the PAA and will be equal to 20 per cent of qualifying investment awarded over a three-year period. AIA is expected to be supplemented by discretionary company specific allowances.	June 2009-2020
Tariff 'freeze' programme	Tariffs to remain at 25 and 20 per cent for CBUs and CKDs respectively for the period 2012 (final year of MIDP) until 2020.	January 2013-2020
Local assembly allowance (LAA)	Duty credits available to OEMs based on 18–20 per cent of the value of domestically produced LMVs.	
Production incentive allowance (Value-added support)	PIA is expected to replace IEC. Duty credits of between 50–55 per cent of value-added can be rebated by OEMs.	

Source: DTI (2008)

According to the DTI (2008), the support offered by the local assembly allowance is expected to encourage high volume vehicle production in accordance with the 2020 production target of doubling vehicle production (600,000 to 1.2 million units of vehicles). The new APDP discontinues several mechanisms of the MIDP which appears to be substituted with more sophisticated incentive structures, as argued by Damoense & Simon (2004). A surprising feature of the APDP is the implementation of a tariff 'freeze' programme. One motivating argument put forth by the DTI (2008) for the fixed applied tariff levels of 25 and 20 per cent for CBUs and CKDs respectively is necessary to provide protection for the domestic industry so as to validate the existence of continued local vehicle assembly in South Africa. The industry faces major challenges in view of the credit crisis and the global recession to intensify the components industry by increasing manufacturing capacity. The strength of first-tier suppliers that have established international production connections with MNCs has forced smaller local component firms to exit the industry (*FocusReports*, 2006).

4.3 PERFORMANCE OF SOUTH AFRICA'S AUTOMOBILE INDUSTRY: IMPACT OF POLICY REFORMS

In order to place key performance indicators in perspective, the growth and development of the local industry following policy reforms over the period 1995 to 2006 are shown in Table 4.4.

Table 4.4 Performance of the South African automobile industry, 1995–2006

Performance indicators	1995	2003	2006
Production (thousands of vehicles)	389,476	421,965	587,719
Domestic sales	373,712	295,304	407,860
Export sales	15,764	126,661	179,859
Exports % domestic production (%)	4	30.0	30.6
Imports % of local market (%)	5.5	22.8	42.9
New vehicle sales revenue (R billion)	-	59,4	118,4
Employees (thousand of persons)	308,600	304,900	320,400
Automotive exports (R billion)	4,2	40,7	55,1
Automotive imports (R billion)	16,4	49,8	88,5
Automotive trade balance (R billion)	(12,2)	(9,1)	(33,4)

Source: NAAMSA annual reports, various

Since the inception of the MIDP in 1995, domestic production has increased by about a third, which is mainly attributable to export sales of CBUs increasing from 15,764 to 179,859 units from 1995 to 2006; a phenomenal increase of over 1,000 per cent. On the other hand, domestic sales of CBUs increased by only 9 per cent for the same period. In addition, the value of export components (CKDs) increased from R3,318 million to R30,503 million between 1995 and 2006. The share of CKD exports in total automotive exports declined from 83 per cent to 38 per cent, while the share of CBU exports increased from 17 per cent to 42 per cent from 1995 to 2006.

On the import side, vehicle imports as a percentage of the local market increased from 5.5 per cent in 1995 to 42.9 per cent by 2006. The tariff policy as part of the MIDP has partly contributed to rising imports as tariffs fell from 65 per cent in 1995 to 32 and 26 per cent respectively for CBUs and CKDs by 2006. This clearly illustrates that the livelihood of the South African automobile manufacturing industry is highly dependent on trade, providing a case for probing trading patterns in the automobile industry.

4.3.1 Structure of the industry

Table 4.5 shows vehicle production by each of the eight South African OEMs for 2006 to 2007. These eight original equipment manufacturers (OEMs) (Volkswagen SA, Daimler-Chrysler SA, BMW SA, Toyota SA, Nissan SA, Ford Motor Company of SA, General Motors SA and Fiat Auto SA), produce a little under 600,000 total vehicle units per annum in South Africa. Besides the eight OEMs, there are approximately 150 registered and some 400 independent component suppliers of automotive parts (NAAMSA, 2005). As shown in Table 4.5, between 2006 and 2007, General Motors, Ford and Fiat experienced significant reductions in total vehicle production in the South African market. Overall, total vehicle production fell by 9.1 per cent between 2006–2007.

Post-1995, all OEMs are currently majority foreign owned. The changing global environment and national policies have led to the re-entering of the US MNCs (GM and Ford) after disinvesting in the early 1980s. Since the mid-1990s, the automotive industry has been one of the most successful recipients of FDI inflows in all of South Africa’s manufacturing industries, especially through increased foreign ownership of local OEMs by multinational firms (Toyota Japan, General Motors, DaimlerChrysler, etc.). Local OEMs are now largely integrated into the global production networks of multinational auto firms (Damoense & Simon, 2004).

Table 4.5 Vehicle production by OEM in South Africa, 2006–2007

OEM	2006	2007	% Change
Cars			
BMW	54,782	50,168	–8.4
Fiat	2,680	1,516	–43.4
Ford	29,424	11,797	–59.9
General Motors	29,219	10,737	–63.3
Mercedes-Benz	34,696	23,335	–32.7
Nissan	11,034	13,205	19.7
Toyota	45,590	53,787	18.0
Volkswagen	127,057	111,473	–12.3
Total cars	334,482	276,018	–17.5
Commercial vehicles			
DAF	365	425	16.4
Fiat	4,450	2,578	–42.1
Ford	49,152	56,790	15.5
Land Rover	2,250	2,650	17.8
Ford Total	51,402	59,440	15.6
Isuzu	24,120	22,085	–8.4
MAN	3,207	3,575	11.5
Mazda	19,140	23,713	23.9
Mercedes-Benz	8,279	6,637	–19.8
Mitsubishi	7,680	8,586	11.8
Nissan	33,661	35,586	5.7
Scania	1,530	1,590	3.9
Toyota	97,160	91,898	–5.4
Volkswagen	1,023	1,079	5.5
Volvo Truck	1,220	1,280	4.9
Total commercial vehicles	253,237	258,472	2.1
Total vehicles	**587,719**	**534,490**	**–9.1**

Source: *Ward's World Vehicle Data Book* (2008)

Table 4.6 provides comparative statistics of the South African automobile industry and selected automobile producing nations, including Australia, India, Brazil and others in an international context. Automobile industries in developing and developed countries are naturally pivotal to their national economies for several reasons already mentioned. Comparative domestic production and sales data (units of vehicles), employment data and data of several indicators are reported in Table 4.6. For instance, the importance of these industries in their national economies' manufacturing and trade accounts are shown by looking at the export and import shares of automotive products in terms of the economy's total merchandise exports and imports, ranging from 0.8 per cent (India), 1.5 per cent (China), 13.9 per cent (Turkey) and 15.3 per cent (South Africa).

Table 4.6 also shows that Australia and South Africa are both net importers of vehicles as vehicle production is lower than consumption. Australia produces only about a third of vehicles (717,743 units) consumed domestically, whereas South Africa produces 78,218 units of vehicles less than the quantity of vehicles purchased domestically, with imports accounting for the shortfall. As net exporters of vehicles, Spain, Brazil and Turkey produce significantly more than is consumed domestically; 50, 80 and 20 per cent, respectively. It is often argued that the numbers of OEMs are too many given the limited size of the domestic market (Damoense & Simon, 2004). Table 4.6 also computes the average number of vehicles produced per OEM, indicating that South African and Australian OEMs produce 66,811 and 83,060 units of vehicles respectively, which is significantly lower than the other comparators, such as China (555,154 units), Brazil (330,091 units) and Turkey (219,883 units).

Overall, South Africa compares inadequately to emerging automotive producers such as Brazil, India and China as shown in Table 4.6. For instance, eight OEMs are too many given the relatively small size of the domestic market. Reducing the number of OEMs and promoting efficient production techniques are recommended. Additionally, research and development (R&D) activities in the South African automotive industry is low by international standards and should be increased.

Table 4.6 Comparative indicators of selected automotive producing nations, 2007

Country/Indicator	South Africa	India	China	Australia	Sweden	Spain	Turkey	Brazil
Domestic production (thousand units) (a)	534	2,250	8,882	332	316	2,890	1,099	2,971
Domestic sales (thousand units) (b)	613	1,990	8,792	1,050	359	1,939	622	2,486
(a)-(b)*	(79)	260	90	(718)	43	951	477	485
Number of OEMs** (c)	8	13	16	4	2	15	5	9
(a)/(c)#	67	173	555	83	181	193	220	330
Employment♣ (thousand no.) (d)	131	297	2,538	45	85	220	183	479
Persons per vehicle	6.1	82.5	33.2	1.4	1.9	1.5	7.4	7.5
Automotive export share in merchandise exports (%)♦	8.5	2.6	1.5	2.6	-	-	13.9	9.5
Automotive import share in merchandise imports (%)♦	15.3	0.8	2.3	11.8	-	-	9.5	6.2
GDP per capita (US$ bn)	3,823	748	1,015	42,569	46,446	22,730	1,267	3,837
GDP % annual growth	5.1	9.2	11.4	3.9	2.6	3.8	5.0	5.4

Sources: Compiled from various publications: *Ward's Automotive Data Book* (2008), WTO (2008), LABORSTA (ILO, 2009).

*Notes: *The difference between domestic production and domestic sales indicates the direction of trade in vehicles (units), where negative values (in parenthesis) denotes net importers and positive values denotes net exporters.*

***Number of vehicle manufacturers (OEMs) only*

♣ LABORSTA, SIC data, China.online and Indiastatonline, includes vehicles and parts.

#Average number of vehicles produced per OEM

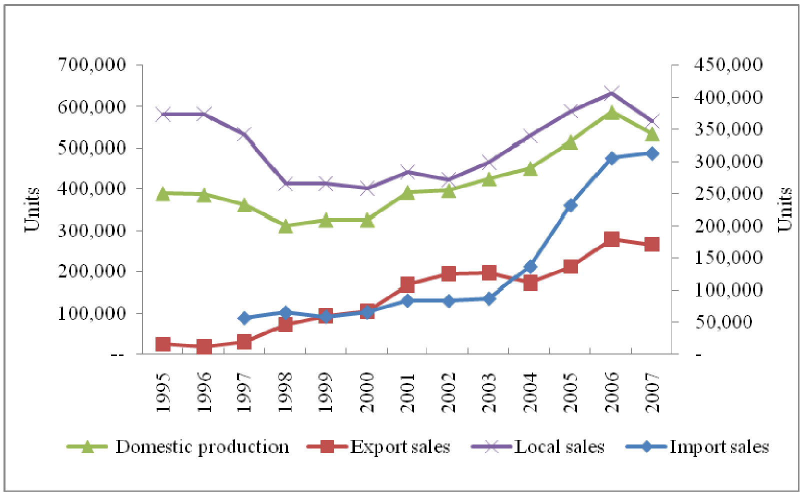
♦2006 values (WTO, 2008)

4.3.2 Production and sales

In 1995, at the start of the MIDP, domestic production slowed down until 1998 and then began to increase steadily from 2002 until 2006. The gap between domestic production and local sales has become smaller since 1995 indicating some lowering of export sales of CBUs. On the other hand, the importation of CBUs increased sharply from 2003. Figure 4.1 describes trends in domestic vehicle production and import sales of CBUs.

According to the President of NAAMSA, the number of model platforms (models) has declined from 42 to 22 models and the average volume per model has increased from 8,515 to 22,609 units. Presently, domestic content levels in CBUs range from 40 per cent to over 60 per cent. Net profits before tax as a measure of industry profitability of all OEMs increased more than fourfold from R2,032 million in 1995 to R8,744 million in 2006 (NAAMSA, 2007). Profitability has been positively influenced by the stable macroeconomic environment, strong consumer demand, investment and trading conditions and government policy.

Figure 4.1 Domestic vehicle production and vehicle imports (units), 1995–2007



Source: Computed from Quantec database and NAAMSA (2007)
*Notes: *Vehicle production includes passenger cars, light medium and heavy commercial vehicles.*
***Domestic production equals sales of locally produced CBUs (local sales) and exports sales of CBUs.*
****Import sales data from 1997–2007*

As shown in Table 4.7, capital expenditures by OEMs increased substantially from R846,8 billion in 1995 to R3,095 billion in 2007 (NAAMSA, 2002; 2007). However, from 2006 to 2007, capital expenditure declined to almost half from R6,249 billion to R3,095 billion. The uncertainty of the MIDP is cited as the main reason for lower investments in the industry (NAAMSA, 2008). According to Table 4.7, in 2007, 79 per cent of total capital expenditure involves OEM support in respect of export related investments and production facilities.

Table 4.7 Capital expenditure for new vehicle manufacturing, 1995–2007

Description	**1995 (Rm)**	**2000 (Rm)**	**2003 (Rm)**	**2007 (Rm)**
Product, local content, export investments and production facilities	733,8 (0.87)	1800,1 (0.84)	1989,4 (0.86)	2458,7 (0.79)
Land and buildings	34,9 (0.04)	109,7 (0.07)	141,5 (0.06)	382,4 (0.12)
Support infrastructure (IT, R&D, Technical, etc.)	788,1 (0.09)	140,6 (0.09)	193,9 (0.08)	254,4 (0.08)
Total	**8,468**	**1561,5**	**2324,8**	**3095,5**

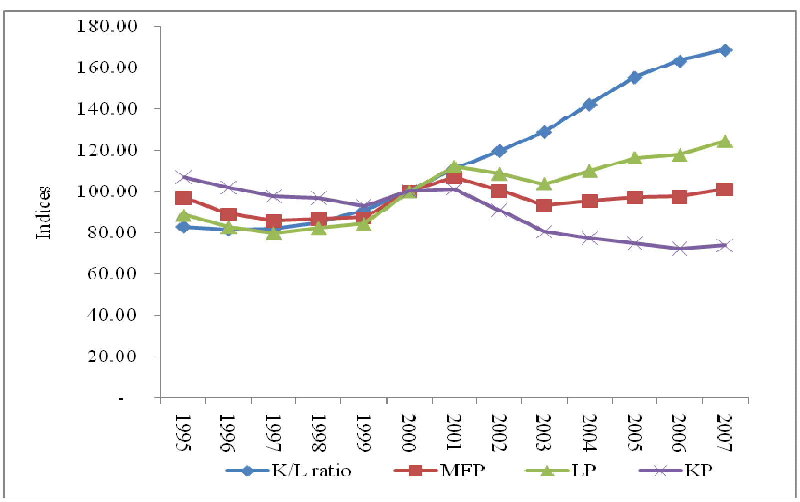
Source: NAAMSA Annual reports, various issues
Notes: Figures in parenthesis denotes shares in total capital expenditure

In 2002 to 2003, significant investments for exports were undertaken by OEMs, which include Toyota investing R3,5 billion to double production capacity within three years, VWSA investing R2 billion, BMW SA investing R2,1 billion for production of the new-generation 3-series BMW, and so on (DTI, 2003). More recently, in 2006, GM invested 330 US billion dollars in the production of Hummer vehicles and VWSA invested 1 US billion dollars for new models, a new paint facility and a new truck and bus assembly plant (*FocusReports*, 2006). These investment programmes have largely been driven by the government's MIDP incentive programme. From Table 4.7, there is a need to increase the proportion of support infrastructure (IT, R&D, Technical, etc.) in total capital expenditure, which is currently less than 1 per cent.

4.3.3 Productivity

Figure 4.2 shows the relationship between multifactor productivity (MFP), labour productivity (LP), capital productivity (KP) and the capital-labour ratio (K/L) for the automobile industry for the period 1995 to 2007. A slight upward trend in MFP performance is observed over the period. MFP is typically used as a measure of production efficiency and is regarded as a better measure of each of the productivity indices; that is, how effectively the combinations of labour and capital inputs are used in production operations.

Figure 4.2 Productivity indices and capital-labour ratio, 1995–2007



Source: Computed from Quantec database
Notes: Index 2000 = 100
Industry trends, motor vehicles parts and accessories (SIC data 381–383)

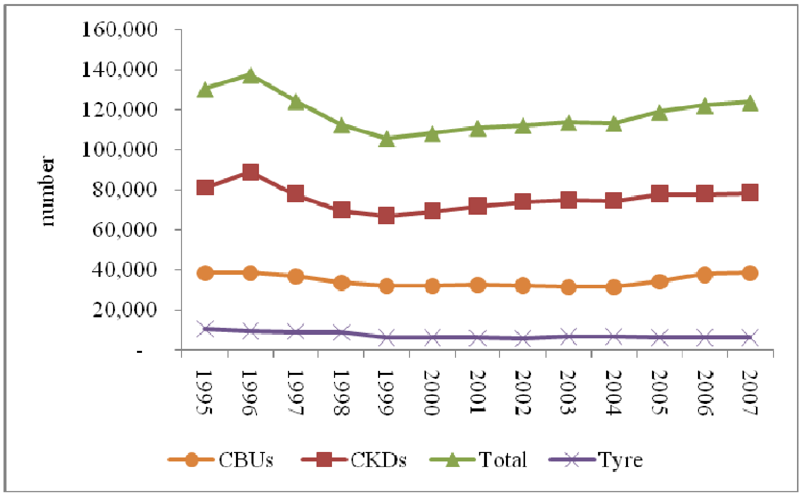
Capital per worker is increasing as greater usage of capital inputs (e.g. tooling and machines) makes the use of labour more effective. Between 1995 and 2007, the number of formal industry workers increased by an average annual growth rate (weighted) of 1.04 per cent and fixed capital stock increased by 8.35 per cent over same the period, reflecting a small increase in employment and substantial technological progress in automobile manufacturing respectively. Rising labour productivity (3.74 per cent) and falling capital productivity (–3.26 per cent) trends reveal some substitution of labour inputs in favour of fixed capital inputs in the automobile industry. In addition, real fixed investment realised a 13.72 per cent average annual growth rate over the 1995 to 2007 period.

According to Figure 4.2, the upward trend in the capital-labour (K/L) ratio reflects the high capital intensity of the automobile industry, which grew at an annual average rate of 7.23 per cent between 1995 and 2007. Alleyne & Subramanian (2001) reveal that South Africa produces and exports (comparative advantage) capital-intensive products relative to labour-intensive products when trading with higher income trading partners, despite its labour abundance. Furthermore, as illustrated in Figure 4.2, the relationship between MFP and the capital-labour ratio (K/L) can be viewed as an indication of downsizing and greater mechanisation in the automobile industry.

4.3.4 Industry employment

Figure 4.3 show trends in the industry’s employment levels for the period 1995 to 2007. In 1995, 38,621 workers were employed in vehicle manufacturing and 81,000 workers in component manufacturing (NAAMSA, 2003). By 2007, 38,700 and 78,500 persons were employed in assembly and component manufacturing respectively (NAAMSA, 2007). More specifically, between 1995 and 2007, employment in vehicle assembly, component manufacturing and the total industry increased by 0.20 per cent and decreased by –3.09 per cent and –2.02 per cent respectively. Flatters (2003) argue that the export subsidisation programme under the MIDP may have been successful in increasing automotive exports but has also resulted in jobs being sacrificed.

Figure 4.3 Industry employment, 1995–2007



Source: NAAMSA (2002; 2007)
Notes: Projected value based on Jan–Jun 2007

4.3.5 Automotive exports

The automobile sector in South Africa has experienced substantial growth in trade and foreign investment in recent years. The success of automotive exports has largely been stimulated by the provisions of the MIDP, especially the IEC arrangements whereby OEMs have the opportunity to rebate import duties for export purposes. This has led to South African OEMs increasing production for export markets.

The share of component exports in total automotive exports in nominal rand terms has been decreasing: 83 per cent in 1995 to 58 per cent in 2006. Conversely, the share of CBU exports in total automotive exports in nominal rand terms has been increasing: 17 per cent in 1995 to 42 per cent by 2006[13]. The rise in share of CBU exports is mainly attributable to MNCs operating in the South African vehicle market and cross-border connections facilitated by reduced international transport costs providing opportunities to exports.

[13] Note that the value of the export shares in this chapter differs from that reported in Chapter 5. This chapter (Chapter 4) uses NAAMSA data in *South African rands* whilst Chapter 5 adopts HS 6-digit data in *US dollars* to compute the respective shares of automotive exports. Overall, the findings are similar in that both chapters report falling shares of CKD exports and rising CBU exports.

Table 4.8 shows South Africa's main automotive trading partners for exports of CBUs and automotive components. In 2006, South Africa exported 71.8 per cent of the value of total component exports (CKDs) and 20.2 per cent of the value of total CBU exports to countries of the EU (United Kingdom, Germany and France).

Table 4.8 South Africa's automotive exports by region/country, 2000–2006

Automotive exports	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
	(Rb)	(Rb)	(Rb)	(Rb)	(Rb)	(Rb)	(Rb)
South Africa to world	20,0	30,0	40,1	40,7	39,2	44,7	54,4
Light vehicles	7,0	10,9	16,4	18,7	17,0	21,4	23,9
Automotive components	12,6	18,6	22,9	21,3	21,7	23,3	30,5
South Africa to NAFTA	%	%	%	%	%	%	%
Light vehicles	7.3	17.9	22.6	19.5	13.9	3.8	10.9
Automotive components	10.1	12.5	11.1	8.9	8.4	11.1	11.0
South Africa to EU	%	%	%	%	%	%	%
Light vehicles	52.8	37.6	29.9	19.5	24.5	23.6	20.2
Automotive components	69.8	70.5	70.85	69.9	71.2	71.4	71.8
South Africa to SADC	%	%	%	%	%	%	%
Light vehicles	11.9	9.2	10.2	5.6	3.9	4.2	4.7
Automotive components	5.6	5.8	6.2	5.8	5.5	4.6	4.3
South Africa to other	%	%	%	%	%	%	%
Light vehicles:							
Australia	12	10	11	15	19	24	20
Japan	11	13	18	35	32	35	29
Other	54	31	22	9	7	9	14
Automotive components:							
Australia	-	0.8	1.4	2.3	2.1	2.8	1.7
Japan	-	1.7	3.2	2.6	2.3	1.2	2.4
MERCOSUR (Argentina/Brazil)	0.4	0.5	0.4	0.7	0.3	1.0	0.9
Other	-	14.0	13.0	14.5	14.3	14.1	11.6

Source: Compiled from NAAMSA various annual reports

The share of CBUs from SA to the EU in 2006 shows a drop from 52.8 per cent in 2000. Also in 2006, South Africa exported 10.9 per cent of the value of total component exports and 11.0 per cent of the value of total CBU exports to the United States, a member of the North American Free Trade Area (NAFTA). Table 4.8 also shows that exports of automotive products to selected countries (Australia, Japan and China) of the APEC and Brazil (MERCOSUR) are steadily increasing.

4.3.6 Automotive industry trade balance

The automobile industry is a large net consumer of foreign currency; in 2006 automotive imports amounted to R88,5 billion and exports were valued at R55,1 billion. As indicated in

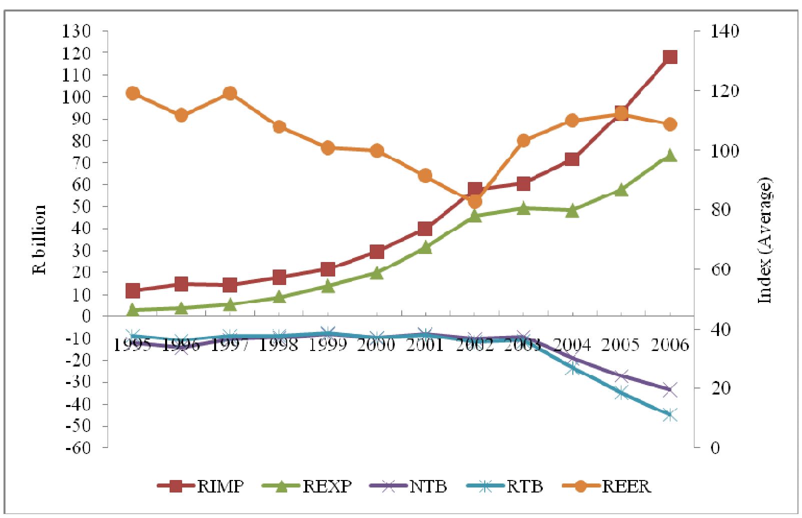
Table 4.9, despite the local industry's exceptional growth in automotive exports it remains a net importer of automotive products and experienced an automotive trade deficit of R33,4 billion in 2006. The value of the automotive trade deficit is significantly weaker in real terms (R44.7 billion).

Table 4.9 South Africa's automotive industry trade balance, 1995–2006

Year	Imports (Rb)	Exports (Rb)	Trade Balance (Rb)
1995	16,4	4,2	(12,2)
1996	19,2	5,1	(14,2)
1997	17,2	6,6	(10,6)
1998	19,9	10,1	(9,8)
1999	22,8	14,8	(8,0)
2000	29,7	20,0	(9,7)
2001	38,0	30,0	(8,0)
2002	50,2	40,1	(10,1)
2003	49,8	40,7	(9,1)
2004	58,0	39,2	(18,8)
2005	72,5	45,3	(27,2)
2006	88,5	55,1	(33,4)

Source: NAAMSA (2007)
Notes: Nominal values.

Figure 4.4 Automotive industry trade balance and the real effective exchange rate (REER), 1995–2006



Source: Author's compilation from NAAMSA (2007), SARB (2009).

The volatile exchange rate has important pass-through effects for the industry's trade deficit. Figure 4.4 shows movements in the real effective exchange rate (REER) for the period 1995 to 2007. Between 1995 and 2001, the REER depreciated, contributing to some improvement in the value of the trade deficit balance from R12.2 billion to R8.0 billion. On the other hand, from 2002 to 2005, the REER appreciated contributing to an increase in the real value of imports (RIMP) relative to the value of exports (REXP), causing an enlargement of the industry's trade deficit from R8.8 billion to R44.7 billion in real terms. Of course, the lowering of tariffs applied to the industry also contributed to rising real imports. Tariffs were reduced from between 40 and 30 per cent in 2002 to between 32 and 26 per cent in 2006.

4.4 SUMMARY AND CONCLUSIONS

The automobile industry in South Africa remains regulated and protected despite liberalisation efforts by the government since 1995. The South African government has succeeded in constructing the auto industry into a successful exporting sector on the back of extensive government support (tariff assistance and export subsidisation). However, this has not occurred without costs to consumers and certain industry stakeholders. It is well known in international trade theory that such mechanisms cause distortionary effects and tend to largely protect producers by increasing effective protection to the industry and also contributing to greater welfare losses imposed on vehicle consumers and society.

In view of the new industry policy that is expected to be introduced in 2013, the stance of the government is to keep tariffs fixed at 20 and 25 per cent for CKDs and CBUs respectively, while at the same time discontinuing the import–export complementation (IEC) scheme and subsequently replacing it with production subsidies (see Table 4.6). Theoretically, compared to tariffs and export subsidies (as the IEC scheme), production subsidies appear to be less distortionary as they result in the avoidance of increasing inefficient domestic production and subsequent losses in consumer surplus. Therefore, the introduction of production subsidies as part of the APDP is expected to have a more positive impact on consumer welfare than export subsidy-type measures. Further tariff liberalisation is also recommended for future automotive policy.

A concerning fact is the inability of the industry to create sustainable jobs, in view of the fact that the local industry is facing important challenges caused by globalisation and intense competition from emerging economies. The MIDP's IEC scheme have mainly facilitated

OEM investment strategies and have contributed to improved machinery and tooling, and technology improvements the OEMs' contribution to supporting infrastructure (IT, R&D, technical, etc.) is very low and should be encouraged to increase to at least to 5 per cent of total capital expenditures by the end of 2020.

Overall, trade in automotive products in the South African automobile industry is significant and is vital for the growth and development of the local industry and national economy. Thus, a useful exercise is to better understand the pattern of trade underlying this strategic industry and the determinants thereof. Since increasing the share of IIT types in total trade in the automobile industry is expected to yield less expensive adjustment costs compared to increasing the share of inter-industry trade in total trade, IIT should be encouraged. Thus, the potential impacts of country and industry determinants on IIT patterns in the South African automobile industry are important to investigate. These are the main hypotheses presented in this thesis and will be discussed and evaluated in Chapters 5 through to 8.

CHAPTER 5

MEASURING INTRA-INDUSTRY TRADE IN SOUTH AFRICA'S AUTOMOBILE INDUSTRY

5.1 INTRODUCTION

The purpose of this chapter is to indentify trade patterns in the South African automobile industry by empirically analysing bilateral IIT shares in the industry[14] between South Africa and 20 major auto trading partners spanning the period 2000 to 2007. More specifically, trade patterns are identified and placed into four categories, namely: (i) total intra-industry trade (IIT) (two-way trade) comprising (ii) horizontally differentiated intra-industry trade (HIIT) and (iii) vertically differentiated intra-industry trade (VIIT); as well as (iv) inter-industry trade or one-way trade (OWT). This distinction between HIIT and VIIT patterns is important because there are different theoretical foundations and determinants that are relevant to each pattern of IIT (Greenaway *et al.* 1994; 1995). For instance, HIIT is largely driven by imperfect competition and economies of scale (EoS), whilst VIIT is more likely to occur as a result of factor endowment differences and perfect competition.

This chapter is organised as follows: Section 5.2 revisits the theoretical motivation behind IIT models and Section 5.3 provides the methodology used to empirically measure bilateral shares of IIT and one-way trade (OWT) in the automobile industry in South Africa, including disaggregating total IIT into VIIT and HIIT patterns. Section 5.4 discusses the data used in the empirical analysis and Section 5.5 reports the empirical results and discusses the trade patterns of automotive products. Also in Section 5.5, quality trade patterns inside VIIT are considered and, finally, Section 5.6 summarises and offers some concluding remarks.

5.2 MEASURING INTRA-INDUSTRY TRADE: THEORETICAL MOTIVATION REVISITED

Classical trade theories are based on comparative advantage in homogeneous goods that are produced in a perfectly competitive setting between countries across different industries. Trade between such countries is primarily characterised by differences in factor endowments

[14] The automobile industry includes both finished products (automobiles) and automotive parts and automotive components (intermediate products). See Appendix A for description of HS codes.

and production technologies. In the international trade literature, inadequate empirical support for the H-O hypothesis of OWT led to the emergence of new trade theories in the 1980s. New trade theories of IIT refer to the simultaneous trading of a product within a specific industry, which exists under imperfect competition, EoS and product differentiation. As the IIT literature progressed, it became apparent that not all IIT could be adequately described by imperfect competition and EoS. However, Davis (1995) and others argue that increasing EoS may not be a necessary condition for IIT since IIT can be present even under constant returns to scale.

This distinction between HIIT and VIIT was pioneered by Abd-el-Rahman (1991) and Greenaway *et al.* (1994; 1995). It is, as already mentioned, important to distinguish between HIIT and VIIT as there are different theoretical foundations and determinants that are relevant to each pattern of IIT (Greenaway *et al.* 1995). HIIT models are based on assumptions of monopolistic competition and increasing returns to scale (Krugman, 1980; Helpman & Krugman, 1985) and imply that the exchange of products occurs between similar sized trading partners who possess comparable factor endowments, relative costs and technology strengths. In these models, the demand side reflects the diverse varieties of products favoured by consumers, while the supply side reflects the production of different product varieties supplied under decreasing costs, where quality varieties are similar. Markusen & Venables (2000) extend the Helpman & Krugman (HK) (1985) model to pay attention to the role of MNCs and trade costs in HIIT. The ineffectiveness of HIIT theory from the viewpoint of FDI and outsourcing and production networks (Okubo, 2004) has led to the extensive use of VIIT models for this purpose.

On the other hand, VIIT can best be described by the trade models of Falvey (1981), Falvey & Kierzkowski (1987) and Flam & Helpman (1987) and are formulated on the basis of perfectly competitive markets where the presence of EoS in production is not a necessary condition. In the case of VIIT, countries with larger differences in factor intensities, endowments, technologies and per capita income levels tend to exchange products differentiated by quality. According to these trade models, the North (developed countries) and South (developing and emerging economies) tend to exchange products that are vertically differentiated by quality. VIIT is located at different production stages and can be explained by specialisation along quality varieties within a specific industry (Fontagné *et al*., 2005).

Falvey & Kierzkowski (1987) maintain that countries with abundant relative capital tend to produce larger varieties of differentiated products that are distinguishable according to price and quality. According to Flam & Helpman (1987), countries of the North produce and export high quality (HQ) products, while countries of the South manufacture and export inferior or low quality (LQ) products, as the former adopts production techniques that are capital-intensive while the latter employ labour-intensive techniques combined with limited technologies. This implies that the North is more likely to export products that exhibit higher relative unit values of exports to imports (RU^{XM}), where unit values of exports (UV^{X}) are greater than the unit values of imports (UV^{M}), whereas the South tends to export products that possess lower relative unit values (RU^{XM}), where $UV^{X} < UV^{M}$. From the demand perspective, consumers in the North that possess higher income levels are inclined to buy and consume HQ products, while lower income consumers in the South tend to consume LQ products.

Recent studies of VIIT include the theory of product fragmentation and outsourcing initiated by Jones & Kierzkowski (1990; 2001), Feenstra & Hanson (1998) and Deardorff (1998; 2001). These trade models hinge on the idea that production processes are positioned in different parts of the world, where increasing returns to scale and the division of labour imply that production can be separated into phases where specialisation can occur. As a result factor price differences and higher profits are realised (Jones, Kierzkowski & Leonard, 2002; Arndt & Kierzkowski, 2006). Kimura *et al.* (2007) argue that international production networks are driven by the advancement in information and communication technologies (ICT) and transport infrastructures (freight, rail and road), contributing to the favourable costs of service connections or links (trade barriers, institutional factors, etc.) necessary to facilitate trade across multiple borders, thereby offering locational advantages that contribute to overall lower production costs.

Empirical evidence on the fragmentation theory of production, especially in the context of VIIT, is somewhat scant. Several authors have investigated factors affecting fragmentation, outsourcing and vertical specialisation for East Asia trade (Ando, 2006; Fukao *et al*., 2003; Kimura *et al*. 2007; Wakasugi, 2007). Product fragmentation (outsourcing) is enabled by several factors, including the conduct of MNCs and FDI, government policy and relative wage differences, among others (Ando, 2006; Fukao *et al*., 2003; Okubo, 2007). Inside VIIT, when HQ products are produced by lower income countries (relative export unit values exceed import unit values), VIIT can in part be explained by vertical specialisation and underpinned by fragmentation theory (see Ando, 2006). A simple illustration of vertical specialisation is provided in Appendix G. For example, the supply value chain involves three countries and highlights the back and forth transactions of trade across multiple geographical locations.

5.3 METHODOLOGY TO MEASURE INTRA-INDUSTRY TRADE PATTERNS

Several variations of the Grubel & Lloyd (G-L) indicator are used to measure the extent of IIT, yet the standard measure is still widely used despite disagreements that remain unresolved in the empirical literature (Fontagné & Freudenberg, 2001). An alternative approach by Fontagné & Freudenberg (1997), following Abd-el-Rahman (1991), proposes a superior methodology to distinguish between inter-industry (one-way trade) and intra-industry trade (IIT). Thus, the unadjusted G-L index is inappropriate for determining patterns of IIT, that is, to separate VIIT and HIIT. There are several methods that disentangle IIT into shares of HIIT and VIIT[3] for example, Falvey (1981) and Falvey & Kierzkowski (1987) propose a methodology for determining the pattern of IIT using differences in prices (unit values used as proxy for price) to reflect differences in the quality of products.

According to the G-L method, the computed index measures the share of IIT that forms part of balanced trade, representing the overlap between exports and imports of total trade between countries *i* and *j* for a given industry *k*. There are several variations of the G-L index in the empirical literature. The standard (unweighted) G-L index at the product level *k*, is written below:

$$GL_{ij,kt} = \frac{\left(X_{ij,kt} + M_{ij,kt}\right) - \left|X_{ij,kt} - M_{ij,kt}\right|}{\left(X_{ij,kt} + M_{ij,kt}\right)} \qquad (5.1)$$

where $GL_{ij,kt}$ = the Grubel & Lloyd (G-L) index which measures IIT between country *i* and country *j*; X = value of country *i*'s exports of product *k* to country *j*; M = the value of country *i*'s imports of product *k* from country *j* and *t* = period.

[3] See also methodology by Kandogan (2003a; 2003b).

The value of the computed G-L index lies between 0 and 1, where any integer equal or close to 0 implies that total trade is inter-industry trade (one-way trade) and any integer equal or close to 1 implies that total trade is IIT (two-way trade). Two empirical biases associated with the standard G-L index include the categorical or aggregation bias and the trade imbalance bias, both of which contribute to the inaccuracy of the degree of IIT (Lloyd, 2001). In this thesis, the aggregation bias is significantly minimised because disaggregated (HS 6-digit) product-level data is used to compute the share of IIT. The trade imbalance may lead to the misinterpretation of the degree of IIT, causing the G-L index to be biased downward. The alternative methodology proposed by Fontagné & Freudenberg (FF) (1997), originally developed by Abd-el-Rahman (1991) to distinguish between OWT (one-way trade) and IIT (two-way trade) and is computed as follows:

$$FF_{ij,kt} = \frac{Min(X_{ij,kt}, M_{ij,kt})}{Max(X_{ij,kt}, M_{ij,kt})} \geq 10\% \qquad (5.2)$$

where X = exports and M = imports, *i* = home country, *j* = partner country and *k* = product in period *t*.

This alternative index considers trade as IIT when the value of the minority trade flow represents at least 10 per cent of the majority trade flow. In other words, if there is significant trade overlap as measured by Equation (5.2), IIT is identified. Otherwise, OWT occurs. This technique is not as widely used in the empirical IIT literature (Ando, 2006; Fontagné *et al.*, 2005; Montout *et al.*, 2002) and is also sometimes referred to as the “trade type method”. Here total trade (TT) is separated into shares of OWT and IIT.

Once the trade flow has been identified as IIT[4], the share of IIT can be empirically separated into horizontal product differentiation (HIIT) and vertical product differentiation (VIIT) using the methodology advocated by Falvey (1981) and Falvey & Kierzkwowski (1987). These authors presume that differences in price (unit value) are reflected in differences in quality. This method of disentangling IIT is often referred to as the “threshold method” and is used in the empirical literature to separate IIT into its two trade patterns. Unit values of exports

4 It is accepted in the literature that if the computed index is lower than 10 per cent for any given product category, then trade may be considered to be OWT, otherwise IIT exists.

(imports) are calculated by dividing export (import) values by the corresponding export (import) quantities. HIIT in industry *k* exists if the criterion below is satisfied:

$$1-\alpha \leq \frac{UV_{ij,kt}^{X}}{UV_{ij,kt}^{M}} \leq 1+\alpha \qquad (5.3)$$

where UV = unit value of exports (X) and imports (M) of the home country = *i*, *j* = partner country, *k* = product in period *t* and α = specified threshold (unit value) = 25 per cent. In previous studies, Abd-el-Rahman (1991), Greenaway *et al*. (1994), Aturupane *et al*. (1999) and Fontagné & Fredenberg (1997) uses unit values of 15 per cent and 25 per cent (where $\alpha = 0.15$; $\alpha = 0.25$). In this study 25 per cent is employed.[5]

Now, VIIT in industry *k* exists when:

$$\frac{UV_{ij,kt}^{X}}{UV_{ij,kt}^{M}} < 1-\alpha \text{ or } \frac{UV_{ij,kt}^{X}}{UV_{ij,kt}^{M}} > 1+\alpha \qquad (5.4)$$

Thus, if unit values of exports relative to imports fall inside the specified range as shown below then HIIT is present:

$$0.75 \leq \frac{UV_{ij,kt}^{X}}{UV_{ij,kt}^{M}} \leq 1.25 \qquad (5.5)$$

otherwise VIIT occurs.

It follows that products are considered to be vertically differentiated (differing in quality) if relative unit values of exports to imports (RUV^{XM}) exceed 25 per cent (where α = 0.25) or fall outside a specified range of ± α. By contrast, products are considered horizontally differentiated (differing in variety) when relative unit values of exports to imports (RUV^{XM}) fall within the range of ± α. According to Nielson & Luthje (2002) two difficulties arise with this method ("threshold method"). Firstly, price differences (or unit value differences) are not

5 The choice of the specified threshold value is arbitrary. In this thesis a simple robustness test was performed by randomly setting α = 15 and 35 per cent. As suggested by Greenaway *et al.* (1994) and Fontangé and Freudenberg (1997), the findings are insensitive to the chosen range and thus do not alter the main findings of the study.

necessarily correct proxies for differences in quality and, secondly, this method does not appear to be steady, especially at the product level, since unit price differences may fluctuate from one year to the next.

The relative shares of HIIT, VIIT and OWT are computed at the product level and then aggregated up to the industry level to obtain the respective trade patterns or shares of HIIT, VIIT and OWT. It follows that total trade (TT) can be separated as:

$$TT = VIIT + HIIT + OWT \qquad (5.6)$$

A summary of the steps followed in the methodology is provided in Appendix C. Furthermore, within the empirical measurement of VIIT, a distinction is made between high quality (HQ) and low quality (LQ) vertically differentiated products. With reference to Equation (5.4), HQ or superior quality products are present if relative export to import unit values (RUV^{XM}) exceed $(1+\alpha) = 1.25$, otherwise inferior quality product differentiation exists where relative export to import unit values (RUV^{XM}) are less than $(1-\alpha) = 0.75$, where $\alpha = 0.25$. This disaggregation of quality patterns within VIIT explains product specialisation between countries according to production quality within a specific industry.

5.4 DATA SOURCES AND DESCRIPTION

The period covered by this thesis spans eight years from 2000 to 2007. All data used are in current US dollars and were obtained from the Quantec database. Within this framework, bilateral shares of IIT indices (VIIT, HIIT and TIIT) for automotive and related products are constructed for trade between South Africa and 20 selected trading partners.[6] These countries have been chosen because they are South Africa's largest trading partners and together account for almost 90 per cent of South Africa's total automotive trade value and represent most geographical regions of the world. In the case of NAFTA, the chapter explores South African trade with the United States of America (USA) because automotive trade between South Africa and the USA accounts for 90 per cent of NAFTA's trade with South Africa.

6 United States of America (NAFTA); Australia, Japan, China, Hong Kong, Taiwan, Thailand, Republic of Korea, India (Asia-Pacific region); United Kingdom, Germany, France, Spain, Italy, Sweden, Turkey (EU and Europe); Brazil (MERCOSUR); and Angola, Mozambique and Zambia (Africa).

In this chapter, HS 6-digit level product data are used, as they are the most disaggregated international dataset available for minimising the aggregation bias and providing a detailed analysis of trade patterns. The importance of using product-level data instead of industry-level data for investigating VIIT according to the different stages of production and intermediate parts is discussed in Fontagné *et al*. (2005). Within the automobile industry all meaningful automotive and 'related' products are included in the ivestigation. HS87 '*motor vehicles and other vehicles for transport of persons'*; including other HS chapters (categories) such as HS98 '*original equipment components*; HS84 (engine and engine parts are categorised as part of '*general machinery*'), and HS85 (generators and alternators are categorised as part of '*electrical machinery*') and so forth contain important parts and components of automobiles. A brief illustration of the data is provided in Table 5.1.

H87 (2-digit) includes all H87 4-digit and 6-digit categories – by summing all H87 4-digit categories the export and import values for H87 2-digit categories and so on are obtained. Appendix A provides a complete list of the HS codes and descriptions that make up the automobile industry.

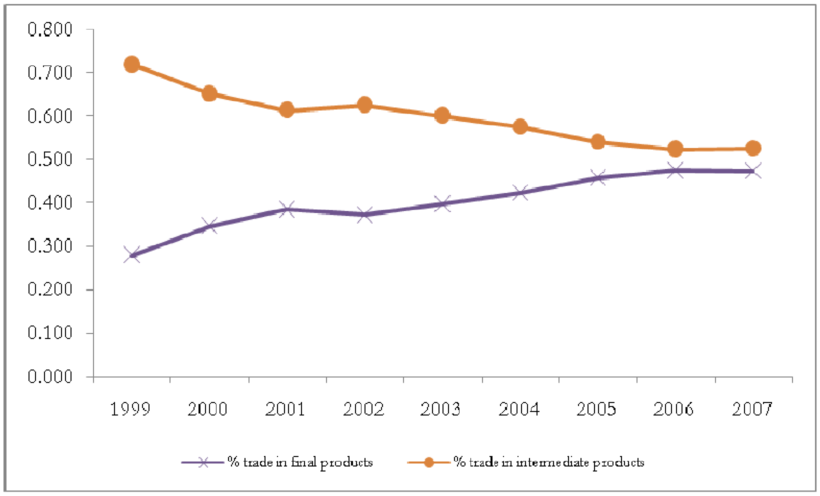
Table 5.1 Illustration of HS87 2-digit, 4-digit and 6-digit coding and descriptions

Code	Description
H87	Vehicles other than railway, tramway
H8703	Motor vehicles for transport of persons (except buses)
H870321	Automobiles, spark ignition engine of < 1000 cc
H870322	Automobiles, spark ignition engine of 1000–1500 cc
H870323	Automobiles, spark ignition engine of 1500–3000 cc
H870324, etc.	Automobiles, spark ignition engine of > 3000 cc

5.5 EMPIRICAL RESULTS AND DISCUSSION OF TRADE PATTERNS

This section of the chapter presents the empirical analysis and results of the relative importance of each trade pattern in the South African automobile industry. Firstly, the chapter investigates trade flows between South Africa and the rest of the world (ROW) and, secondly, between South Africa and selected bilateral trading partners. Inside the South African automobile industry, as shown in Figure 5.1, trade in final products (finished vehicles) and trade in intermediate products (automotive components) with the ROW accounted for 28 per cent and 72 per cent, respectively, of total automotive products in 1999.

Figure 5.1 Shares of trade in automobiles and trade in components (%), 1999–2007



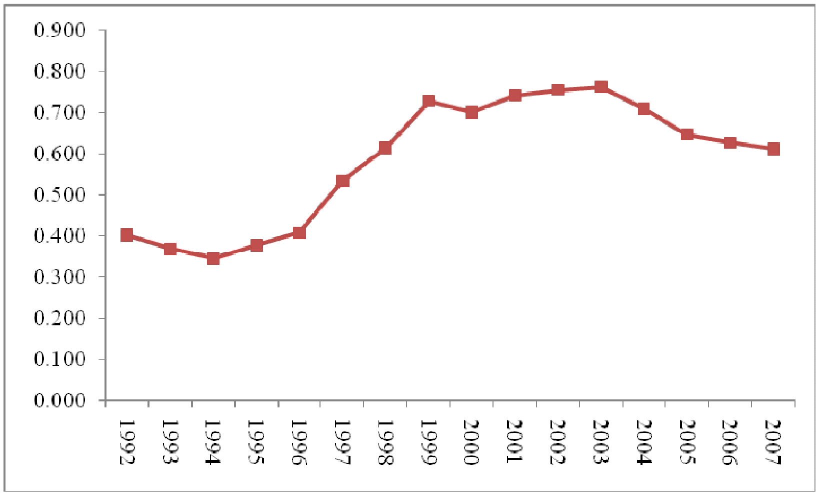
Source: Author's own calculations, Quantec data

By 2007, the share of trade in final products had increased to 52.6 per cent, whereas the share of trade in intermediate products had decreased to 47.4 per cent. A possible reason for the rising trend in the share of final vehicles traded and the declining share of automotive components traded is the competitive pressures emanating from emerging market economies and the uncompetitiveness and challenges associated with manufacturing capacity facing component producers in the South African market. In addition, MIDP benefits tend to favour vehicle assemblers and not necessarily component manufactures. Figure 5.1 displays these trends.

5.5.1 Trade patterns with the rest of the world (ROW)

The development of IIT as measured by the G-L index over the period 1992 to 2007 for *all* automotive products (some 120 product categories) summed up to the aggregate industry level for trade between South Africa and the ROW, is presented in Figure 5.2. Figure 5.2 also shows that during the early 1990s aggregate industry shares of IIT (using the G-L index) were relatively low, ranging between 34.6 and 40.9 per cent. During the 2000s, the share of IIT for total automotive products had increased to 76.2 per cent by 2003 but subsequently declined, reaching 61.2 per cent in 2007.

Figure 5.2 Development of IIT (G-L index) in the South African automobile industry 1992–2007



Source: Author's own calculations, Quantec data

Using the trade type and threshold methodologies, IIT, VIIT, HIIT and OWT shares in the automobile industry are computed for the period 2000 to 2007. In Figures 5.3(i) and 5.3(ii), the shares of IIT patterns for final products and intermediate products reveal the dominance of VIIT for trade with the ROW in both cases. Interestingly, the shares of IIT (and VIIT) for automobile components decreased from 31.5 (25.7) to 24.6 (21.8) per cent from 1999 to 2007, while the shares of IIT (and VIIT) for finished automobiles increased from 23.3 (21.4) to 43.6 (42.5) per cent for the same period.

Figure 5.3 Trends in trade patterns with ROW: finished vehicles and components, 1999–2007

Figure 5.3(i) Finished vehicles

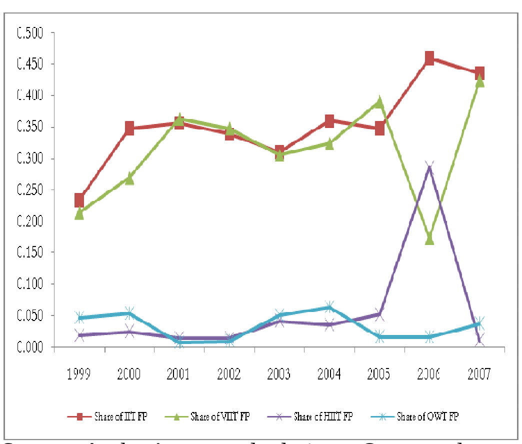
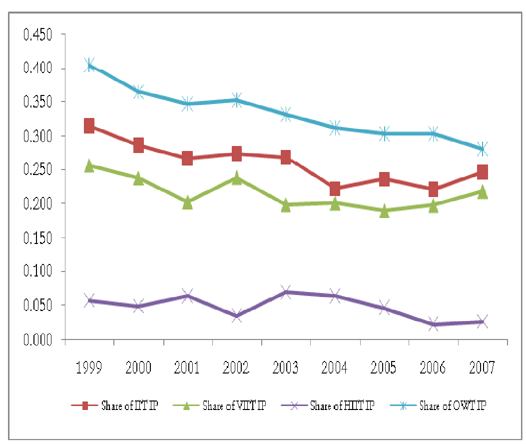


Figure 5.3(ii) Automobile components



Source: Author's own calculations, Quantec data
Note: Shares of IIT, VIIT, HIIT and OWT for final products (FP) and intermediate products (IP) are computed as a proportion of total automotive trade.

In addition, Figures 5.3(i) and 5.3(ii) illustrate the shares of VIIT consistently exceeding the shares of HIIT, apart from 2006 for finished vehicles. In this instance, the share of VIIT closely follows the share of IIT, except for 2006, where the share of HIIT increased (share of VIIT decreased) substantially from 5.2 (39.1) in 2005 to 28.6 (17.3) per cent in 2006 and then subsequently declined to 1.1 (42.5) per cent in 2007, aligned with previous years.

Closer investigations at the intra-product level between SA-ROW unveil a shift from VIIT to HIIT as a result of changing unit value (or price) differentials from a large unit value (UV) (or price) gap to a very small UV gap, for example for '*H870323: Automobiles, spark ignition engine of 1500-3000cc*' for one year (2005–2006). This is an obvious caveat associated with the threshold method, when UVs are used as a proxy for average prices (as mentioned previously). However, at the bilateral level, the product category H870323 is consistently reported to be vertically differentiated over the study period.

Thus, the findings of the thesis claim the existence of significant levels of VIIT in the automobile industry, indicating that automotive products traded between South Africa and the ROW (total world trade) are differentiated by quality. This result is not surprising and reveals that VIIT is the dominant trade pattern of IIT between South Africa and world trade. In contrast, the share of HIIT at the aggregate industry level with the ROW is very low, with several product categories identified as horizontally differentiated (by variety) intra-product trade.

5.5.2 Trade patterns with bilateral trading partners

Table 5.2 provides an overview of the direction of automotive trade between South Africa and its main bilateral trading partners. The total value of automotive trade between South Africa and its bilateral trading partners increased from US$ 6.5 billion in 2000 to US$ 21.9 billion in 2007. According to Table 5.2, Germany, Japan and the USA are South Africa's top three bilateral trading partners in automotive products, accounting for a little over 50 per cent of total South African automotive trade.

This is not surprising since these countries are the homes of South Africa's largest four MNC affiliates, namely Toyota (Japan), Volkswagen (VWSA) (Germany), General Motors (GM) and Ford (USA) (IMF, 2007). According to Table 5.2, between 2000 and 2007, Germany and USA's trade shares fell more than 10 percentage points and 2 percentage points respectively, whereas Japan's trade share increased by some 3 percentage points. Table 5.2 also presents substantive growth rates of the total trade values of the automotive products of emerging economies, such as China, India and Thailand, with South Africa between 2000 and 2007. These countries have become attractive production centres for MNCs and FDI inflows in recent times.

Table 5.2 Direction of trade in the South African automobile industry, 2000 and 2007

Country	***Total trade value (US$) (2000)**	**% Share of SA trade (2000)**	***Total trade value (US$) (2007)**	**% Share of SA trade (2007)**	**% Change (2000–07)**	****Net export values (US$) (2007)**
Germany	2,373,580,777	36.2	5,200,778,190	23.7	119	(2,771,768,430)
Japan	1,439,496,838	22.0	4,266,290,288	19.4	196	(699,607,415)
USA	443,574,180	7.0	1,820,677,968	8.3	310	(330,745,148)
UK	437,580,778	7.0	1,238,864,051	5.6	183	(2,188,667,908)
Australia	174,690,152	3.0	996,023,376	4.5	470	808,289,786
Spain	99,533,916	2.0	729,787,505	3.3	633	(148,592,840)
Brazil	86,781,098	1.3	667,426,212	3.0	669	(559,187,638)
Thailand	60,309,700	1.0	660,480,065	3.0	995	(650,656,267)
Republic Korea	110,331,679	2.0	655,966,158	3.0	495	(633,375,642)
China	40,411,955	1.0	642,425,401	2.9	1,490	(604,216,837)
France	133,284,209	2.0	459,818,202	2.1	245	(148,592,840)
Sweden	87,746,509	1.0	329,005,339	1.5	275	(198,149,779)
India	21,258,852	0.3	276,975,584	1.3	1,203	(260,164,124)
Italy	150,265,269	2.0	244,021,325	1.1	62	(180,449,949)
Zambia	52,840,172	0.8	150,744,237	0.7	185	149,823,645
Taiwan	99,863,269	2.0	144,390,477	0.7	45	(83,777,033)
Turkey	16,156,697	0.2	124,233,701	0.6	669	(75,995,861)
Angola	8,579,445	0.1	72,381,501	0.3	745	71,856,893
Mozambique	70,103,160	1.0	57,757,940	0.3	0.4	68,564,285
Hong Kong	25,454,019	0.4	30,827,323	0.3	127	22,433,406
*Total world (ROW)	6,564,817,397		21,979,889,902		235	(8,525,107,106)

Source: Author's own calculations, Quantec data
*Notes: *Total trade values are calculated from selected HS product categories and summed up to the industry level.*
Figures in parenthesis denote negative net exports (X < M), otherwise positive net exports (X > M), where X = export value and M = import value.

Table 5.3 reports bilateral shares of IIT and OWT for total automotive products for three years; 2000, 2003 and 2007. A comparison of Table 5.3 and Appendix E reveals significant divergences in the degrees of IIT using the trade type method and the G-L methodology respectively.

Table 5.3 Bilateral shares of IIT and OWT for total automotive products, 2000, 2003 and 2007

Country/ region	Trade type	Year 2000	Year 2003	Year 2007
NAFTA				
USA	Share IIT	0.506	0.191	0.571
	Share OWT	0.494	0.809	0.429
Asia-Pacific				
Japan	Share IIT	0.116	0.284	0.749
	Share OWT	0.884	0.716	0.251
India	Share IIT	0.095	0.400	0.080
	Share OWT	0.905	0.600	0.920
Taiwan	Share IIT	0.010	0.076	0.056
	Share OWT	0.990	0.924	0.944
China	Share IIT	0.022	0.277	0.065
	Share OWT	0.978	0.723	0.935
China Hong Kong	Share IIT	0.070	0.064	0.010
	Share OWT	0.930	0.936	0.990
Thailand	Share IIT	0.010	0.017	0.023
	Share OWT	0.990	0.983	0.977
Rep Korea	Share IIT	0.009	0.014	0.007
	Share OWT	0.991	0.986	0.993
Australia	Share IIT	0.054	0.109	0.148
	Share OWT	0.946	0.891	0.852
MERCOSUR				
Brazil	Share IIT	0.216	0.461	0.084
	Share OWT	0.784	0.539	0.916

Country/ region	Trade type	Year 2000	Year 2003	Year 2007
Europe				
Germany	Share IIT	0.531	0.379	0.309
	Share OWT	0.469	0.621	0.691
UK	Share IIT	0.558	0.434	0.454
	Share OWT	0.442	0.566	0.546
Spain	Share IIT	0.128	0.108	0.387
	Share OWT	0.872	0.892	0.613
France	Share IIT	0.177	0.236	0.456
	Share OWT	0.823	0.764	0.544
Sweden	Share IIT	0.006	0.073	0.136
	Share OWT	0.994	0.927	0.864
Italy	Share IIT	0.174	0.251	0.214
	Share OWT	0.826	0.749	0.786
Turkey	Share IIT	0.156	0.193	0.055
	Share OWT	0.844	0.807	0.945
Africa				
Zambia	Share IIT	0.249	0.101	0.011
	Share OWT	0.751	0.899	0.989
Mozambique	Share IIT	0.160	0.187	0.018
	Share OWT	0.839	0.813	0.982
Angola	Share IIT	0.009	0.003	0.006
	Share OWT	0.991	0.997	0.994

Source: Author's own calculations, Quantec data

Computed IIT shares in the automobile industry for South Africa with the ROW are shown in Figure 5.4(i) and reveal the supremacy of VIIT in total IIT over the 2000 to 2007 period. As shown in Figure 5.4(ii), shares of IIT have been rising for South Africa–Japan trade and the share of VIIT largely explains IIT between the two dissimilar bilateral partners, increasing from 11.6 per cent in 2000 to 74.9 per cent in 2007. South Africa–USA IIT shares (and VIIT shares) are significant at 50.6 (50.1) per cent and 57.1 (48.1) per cent in 2000 and 2007 (see Figure 5.4(iii)). In the case of trade between South Africa and the UK (see Figure 5.4(iv)) and South Africa and Germany (see Figure 5.4(v)), shares of IIT (and VIIT) declined from 55.5 (53.3) per cent and from 53.1 (48.1) per cent in 2000 to 45.4 (43.7) per cent and 30.9 (28.6) per cent, respectively in 2007. Despite IIT shares declining, shares of VIIT remain significant.

Figure 5.4 Trends in automotive trade patterns between South Africa and bilateral trading partners, 2000–2007

Figure 5.4(i) South Africa–ROW

Figure 5.4(ii) South Africa–Japan

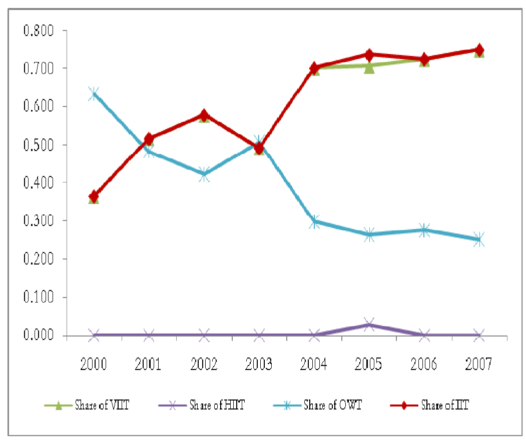


Figure 5.4(iii) South Africa–USA

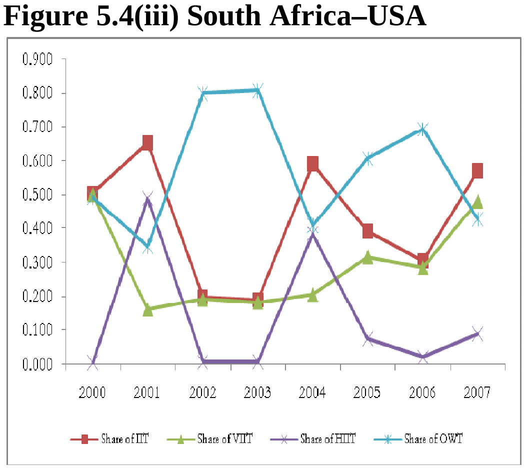


Figure 5.4(iv) South Africa–UK

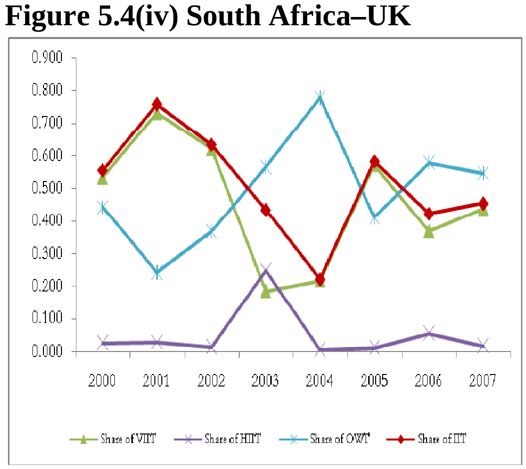


Figure 5.4(v) South Africa–Germany

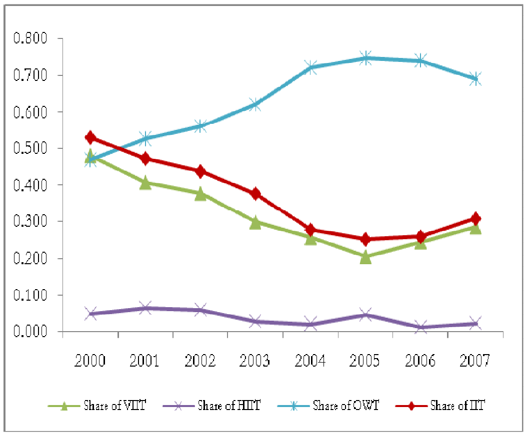
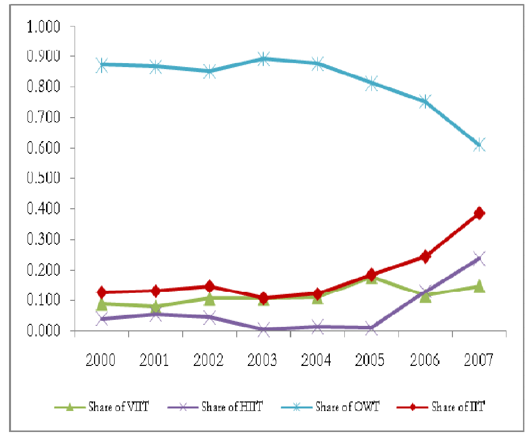


Figure 5.4(vi) South Africa–Spain



Source: Author's own calculations, Quantec data

For both the UK and Germany there seems to be an increasing trend in the respective shares of OWT (falling respective shares of IIT). In the case of the former, as shown in Figure 5.4(iv), the picture appears to be quite complex revealing no visible trend. According to the bilateral shares of trade patterns, the share of OWT of 44.2 per cent in 2000 increased to 54.6 per cent in 2007. At the same time, as the share of OWT rises, the sum of the shares of VIIT and HIIT (= IIT) must fall (in accordance with Equation 5.6), which is not clearly visible in Figure 5.4(iv). However, on average over the 2000 to 2007 period, IIT (and VIIT) and OWT shares are equal to 50.8 (45.8) per cent and 49.1 per cent respectively. Interestingly, in the latter country case, the share of OWT of 46.9 per cent in 2000 increased significantly to 69.1 per cent by 2007. Trade in automotive products between South Africa and Germany can be explained by growth of automotive products between the bilateral partners as a result of export agreements established with German automotive MNCs.

Shares of IIT increased for trade between South Africa and Spain (12.8 to 38.7 per cent) and South Africa and France (17.7 to 45.6 per cent) with shifting trade patterns from OWT to IIT over the period 2000 to 2007 revealed for these bilateral partners. Although, IIT was dictated by VIIT from 2000 to 2005, the shares of HIIT rose significantly in 2006 for both countries. At the intra-product level, the rise in the share of HIIT happens as a result of changes in relative unit value differences from large to small in one or a few product categories. However, the share of VIIT exceeds the share of HIIT in TIIT for South Africa–Spain trade (Figure 5.4(vi)) and for South Africa–France trade (Figure 5.4(vii)). This apparent dominance of OWT is observed for several European countries (Italy, Sweden and Turkey). However, in

2007, the shares of IIT for Italy (21.4 per cent), Sweden (13.6 per cent) and Turkey (5.5 per cent) are largely described by VIIT, as shown in Figures 5.4(viii)–(x) respectively.

Figure 5.4(vii) South Africa–France

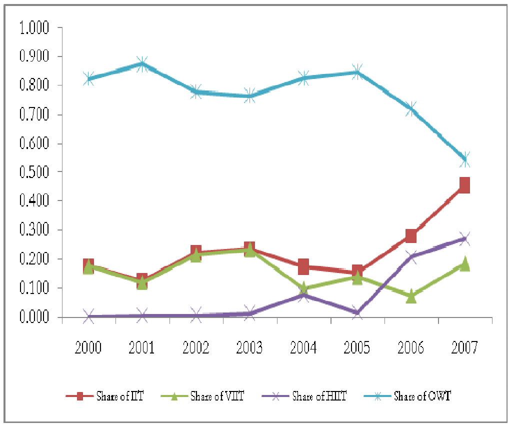


Figure 5.4(viii) South Africa–Italy

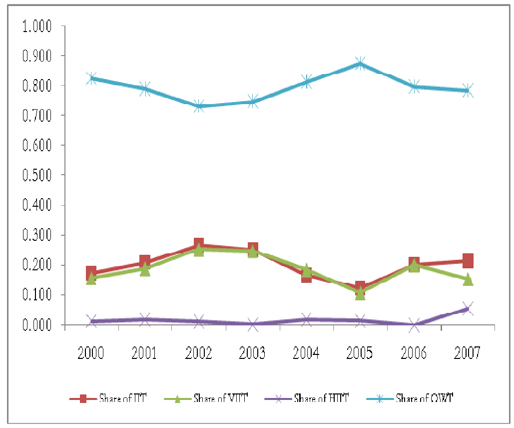


Figure 5.4(ix) South Africa–Sweden

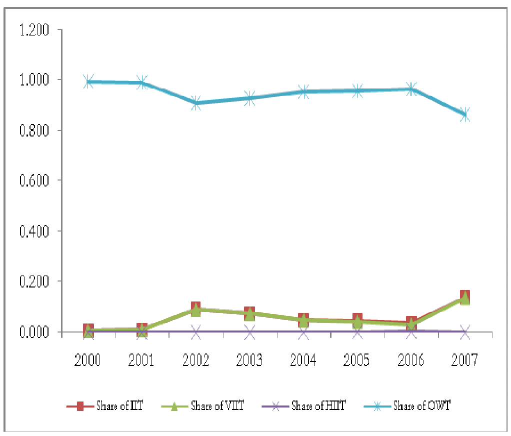


Figure 5.4(x) South Africa–Turkey

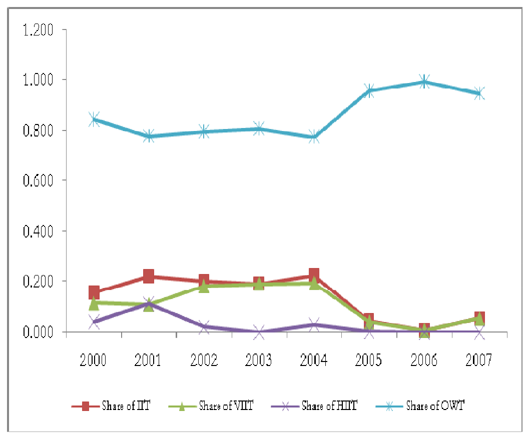


Figure 5.4(xi) South Africa–India

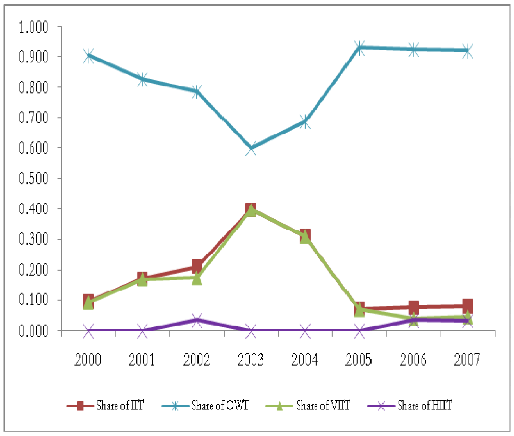
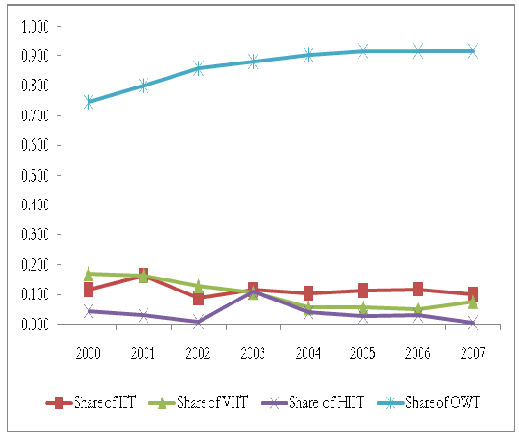


Figure 5.4(xii) South Africa–Brazil



Source: Author’s own calculations, Quantec data

Bilateral trade between South Africa and India reveals declining shares of IIT (and VIIT) from 40.0 (40.0) per cent in 2003 to 8.0 (4.7) per cent in 2007 (see Figure 5.4(xi)). Moreover, consistently falling shares of IIT (and VIIT) are observed for South Africa–Brazil trade from 21.6 (17.7) per cent in 2000 to 8.4 (7.7) per cent in 2007 (see Figure 5.4(xii)). Albeit, experiencing lower levels of IIT, the share of VIIT exceeds the share of HIIT for both countries. Since 2000, South Africa (SACU) has been engaging in several trading arrangements with European countries under the European Union Trade, Development and Cooperation Agreement (TDCA), with the USA as part of NAFTA under the Africa Growth Opportunity Act (AGOA), and with India and MERCOSUR (Southern Common Market). The emergence of such bilateral trading arrangements has contributed to rising trade and foreign investments in the domestic industry. Several authors concede that high IIT levels can be achieved through greater regional integration, and that higher IIT levels typically occur between members of a trade bloc rather than between non-members (Montout *et al.*, 2002).

Trade patterns in respect of IIT and OWT shares between South Africa and Thailand, Taiwan, Republic of Korea, China, China (Hong Kong) and Australia are reported in Table 5.3. Apart from Australia and Hong Kong, these countries are important net exporters of automotive products to South Africa (see Table 5.2). Bilateral shares of IIT (and VIIT) declined in South Africa–China trade from 27.7 (27.3) per cent in 2003 to less than 10 per cent in 2007 (see Figure 5.4(xiii)), implying a shift from IIT toward OWT.

Figure 5.4(xiii) South Africa–China

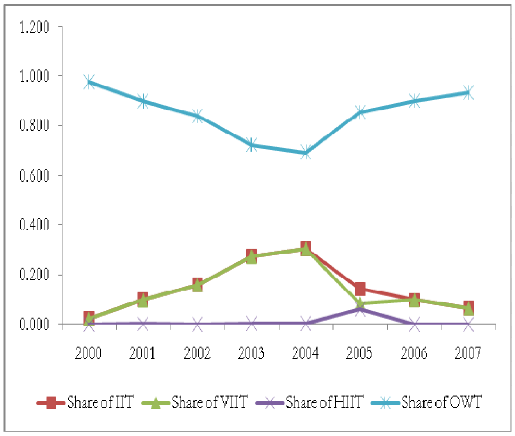
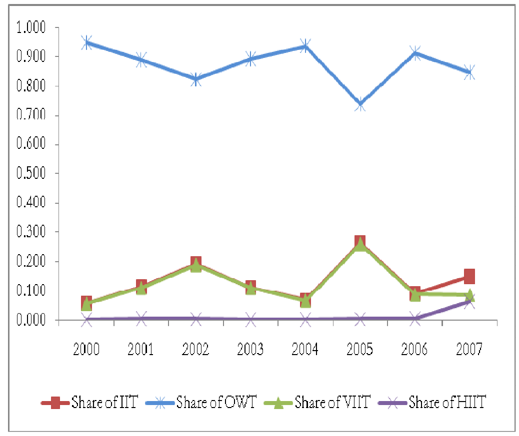


Figure 5.4(xiv) South Africa–Australia

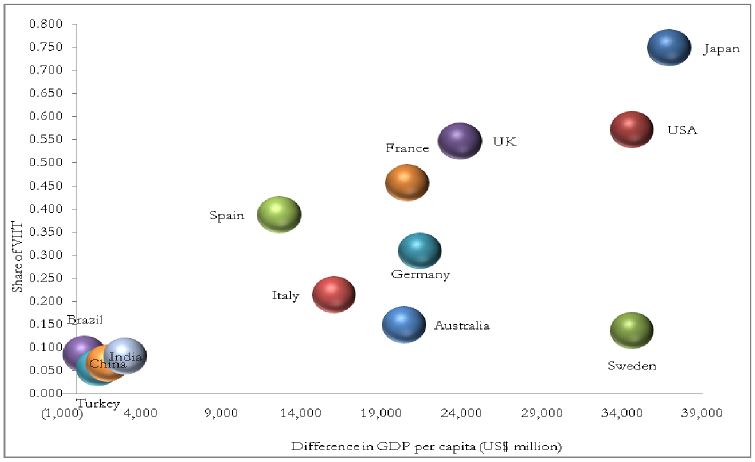


Source: Author's own calculations, Quantec data

Very low levels of IIT (and VIIT) are also reported for South Africa–Australia's trade pattern as shown in Figure 5.4(xiv); 5.4 (5.4) per cent and 14.8 (8.5) per cent in 2000 and 2007 respectively. In addition, the trade position between South Africa and African countries (Zambia, Mozambique and Angola) is presented in Table 5.2. Accordingly, bilateral automotive trade flows are dominated by OWT, with South African mainly exporting automotive products to African destinations with very little imports coming from them. The implication is that OWT remains the most important trade pattern, especially between South Africa and its lower-income trading partners, largely driven by traditional trade theory of comparative advantage and specialisation.

The findings attest to VIIT theoretical expectations, according to which dissimilar countries measured by differences in GDP per capita (i.e. larger differences in income, factor endowments, human capital, technology intensity, etc.) and tend to engage in producing and trading in vertical products (differentiated by quality). Figure 5.5 provides an illustration of the relationship between bilateral shares of VIIT and differences in GDP per capita between South Africa and its trading partners. Typically, smaller (larger) differences in GDP per capita imply that countries possess similar (diverse) demand and supply structures. As expected, a somewhat positive association between increasing differences in GDP per capita and bilateral shares of VIIT can be observed in Figure 5.5. Differences in GDP per capita (also often referred to as economic distance) are now calculated as the absolute difference between the GDP per capita of the bilateral trading partners (Fontagné & Freudenberg, 1997).

Figure 5.5 Bilateral shares of VIIT and differences in GDP per capita, 2007



Source: Author's own calculations, Quantec data

As can be seen in Figure 5.5, the obvious exceptions are Sweden and Australia, which appear to be "outliers in VIIT". A possible explanation for this is that they are relatively low-volume automotive producers and possess high per capita income levels – both producing over 300,000 units of vehicles annually (OICA, 2009). Thus, from the perspective of supply, they appear to be more similar to South Africa in that they enjoy smaller differences in vehicle production (used as a proxy for industry size)[8] and probably face similar production challenges. By contrast, differences in GDP per capita between South Africa and the two bilateral partners are huge. Thus, low shares of IIT and VIIT associated with large differences in GDP per capita conform to traditional trade theory, which is evidently the dominant trade pattern for these outlier countries (see Figures 5.4(ix) and 5.4(xiv)). As a result, the relationship between the share of VIIT and differences in GDP per capita are somewhat ambiguous.

In summary, then, as reported in Figures 5.4(i)–(xiv), bilateral shares of IIT can be largely explained by VIIT, while shares of HIIT are significantly smaller and sometimes non–existent. This is in accordance with the theoretical expectations of HIIT and VIIT theories.

8 Australia and Sweden produce 334,617 and 366,020 units of total vehicles respectively, compared to South Africa's production of 534,490 total vehicle units in 2007 (OICA, 2009).

Furthermore, OWT remains important for automotive trade flows between South Africa and several other countries.

5.5.3 Quality trade patterns within VIIT

After establishing that bilateral shares of IIT in the South African automobile industry are dominated by VIIT, this chapter further investigates quality trade patterns of automotive products within VIIT. With reference to Section 5.2, Equation (5.4) is used to compute and identify shares of high quality (HQ) differentiated VIIT and low quality (LQ) differentiated VIIT automotive products by comparing relative export to import unit values (RUV^{XM}). Accordingly, within VIIT, when export unit values exceed import unit values, products can be classified as HQ vertical products, otherwise LQ vertical products. For SA–ROW trade in automobile components, a clear transition from LQ VIIT (42.2 per cent) to HQ VIIT (83.3 per cent) in 2000 and 2007 is revealed. By contrast, the trend for trade in finished vehicles is less apparent, although there is seemingly some deterioration of quality from 83.7 per cent in 2000 to a share of 57.4 per cent of HQ VIIT being reported for 2007.[9] The average shares of HQ VIIT (and LQ VIIT) for intermediate products and final products are 60.4 (39.6) and 39.3 (60.7) per cent respectively over the period 2000 to 2007. Especially since 2004, the average shares of HQ VIIT for total automotive products (SA–ROW) were reported to be 61.9 per cent. At the bilateral level, Appendix F reports relative shares of LQ and HQ VIIT for 2000 and 2007 for selected bilateral partners.[10] From Appendix F, the findings reveal that, for the most part, South Africa exports HQ vertical products to trading partners such Japan, Germany, China and India while, on the other hand, LQ vertical products are seemingly traded with Australia, UK and France.

The findings of this chapter are contrary to the view that lower income (South) countries produce and export LQ vertical products, while high income (North) countries produce and export HQ vertical products. These results are supported by Alleyne & Subramanian (2001) and reveal that South Africa produces and exports (comparative advantage) capital-intensive

9 RUV^{XM} for SA–ROW for trade in finished products and trade in intermediate products are not reported. Values are available from the authors.
10 VIIT is subdivided into HQ VIIT and LQ VIIT. In this instance, the shares of HQ VIIT and LQ VIIT are equal to 1 or total VIIT share.

products with higher income trading partners, despite its apparent labour abundance. Similar findings have been reported by Ando (2006) for trade in machinery parts and components in East Asia, confirming the presence of back and forth transactions of trade in intermediates. Thus, the thesis proposes that VIIT can be partly described by production fragmentation theory (see Ando, 2006). This is evident in the South African automobile industry, where automotive products with high export unit values (associated with high quality) are produced and exported from South Africa and traded with several high income countries. Recently, Mercedes-Benz SA (MBSA) won the top international award for the quality of C-Class vehicles built at its East London assembly plant and exported to the USA (van Zyl, 2009). MNCs and vertical FDI occur largely through technology transfers, knowledge management (‘knowhow’) and quality control mechanisms provided to affiliates (Okubo, 2004) in order to support high quality production processes in host countries.

In the case of the South African automobile industry, this occurrence may be indirectly linked to MIDP policy which encourages MNC and FDI activities in the domestic market, including the transfer of production technologies, which have become more accurate in recent years (Nordas, 2005). Granted, it is not conclusive that price gaps or RUV^{XM} differences are always associated with quality differences, as they may in fact be connected to cost differences, especially in the context of trade deficits (Aiginger, 1997). Special attention should be given to reducing manufacturing production costs and improving manufacturing capabilities, especially in the components sector if the sector is to become competitive.

5.6 SUMMARY AND CONCLUDING REMARKS

In this chapter, the trade patterns of automotive products traded between South Africa and its bilateral trading partners were identified and analysed. Firstly, the degree of IIT was evaluated using the G-L index. Given the widely publicised biases associated with the G-L index, the trade type method was adopted to compute shares of two-way trade (IIT) and one-way trade (OWT) using HS 6-digit disaggregated data within the automobile industry. Secondly, using the threshold method, the share of IIT was decomposed into HIIT and VIIT patterns. Finally, flows in vertical IIT automotive trade were identified as being either of high quality (HQ) VIIT or low quality (LQ) VIIT.

The key findings of this chapter of the thesis are as follows. Firstly, although trade flows in automotive products reveal significant IIT levels, especially for large partner countries, OWT remains omnipresent for several other countries. Secondly, the empirical results reveal the existence of high shares of VIIT, dominating TIIT between South Africa and its trading partners. This reflects differences in income levels, factor endowments, human capital and technology intensities between dissimilar trading nations. Thirdly, in terms of VIIT there is no consistent evidence that lower income countries produce and export lower quality differentiated (automotive) products while high income countries do the opposite. This development may also be explained by the capital-intensive nature of the domestic automobile industry despite the nation's labour abundance. Thus, this chapter also propose that VIIT can be partly explained by the fragmented process with regard to the internationalisation of production, where the functions and conduct of MNCs (and corresponding FDI), trade and service link costs and differences in relative wages, among other things, are important determinants (Fukao *et al*., 2003; Kimura *et al*. 2007; Wakasugi, 2007). Finally, bilateral shares of HIIT in total automotive trade are less important in the South African automobile industry, implying that differentiation in consumer preferences may play a minimal role in IIT determination.

A limitation of the data used in this chapter is that it does not disaggregate total automotive trade into trade in final products (assembled automobiles) and trade in intermediate products (components) for bilateral partners. However, this might not be as important, since both finished vehicles and automobile components are largely explained by VIIT and have been investigated for SA–ROW trade. Future research should explore the quality gap more closely, since unit value differences may reflect cost differences and not necessarily reflect quality differences as is commonly assumed.

Given that IIT levels are evident and significant in the South African automobile industry, as indicated in this chapter, an empirical investigation of the effects of industry-specific and country-specific determinants of IIT trade patterns is warranted. Thus, Chapter 7 of this thesis empirically investigates country and industry-specific determinants that could potentially improve bilateral IIT levels between South Africa and its trading partners and, as a consequence, inform IIT facilitation and trade and industrial policies applicable to the automobile industry. The next chapter, Chapter 6, provides the econometric methodology employed in this thesis and presents the hypotheses of the empirical determinants to be tested.

CHAPTER 6

ECONOMETRIC MODEL SPECIFICATION AND HYPOTHESES OF THE EMPIRICAL DETERMINANTS

6.1 INTRODUCTION

This aim of this chapter is twofold. Firstly, it sketches the econometric procedure employed in the empirical investigation of this thesis and, secondly, it provides a discussion of the empirical hypotheses of the determinants of bilateral vertical and horizontal IIT patterns to be tested. These empirical determinants are thus the explanatory variables used in the regression analysis. Generally, past empirical studies have been classified into country-specific determinants and industry-specific determinants of IIT patterns. According to the empirical literature, overwhelming support has been found in favour of country-specific factors of IIT, whilst the evidence for industry-specific determinants of IIT has been less supported. This thesis investigates the effects of both country-specific and industry-specific variables on IIT patterns in the South African automobile industry.

This chapter is ordered as follows: Section 6.2 provides a review of the evidence of IIT patterns in the automobile industry, as computed and discussed in Chapter 5. Section 6.3 presents the econometric model specifications used to investigate the potential empirical determinants of VIIT and HIIT patterns in the South African automobile industry. In particular, the econometric specifications of pooled, fixed and random effects models are presented in Sections 6.3.1, 6.3.2 and 6.3.3 respectively. Next, a description of the data and data sources is presented in Section 6.4. Section 6.5 provides a discussion of the hypotheses of the empirical determinants (explanatory variables) of VIIT, HIIT and TIIT to be tested. Finally, Section 6.6 of this chapter is summarised and conclusions are provided.

6.2 EVIDENCE OF INTRA-INDUSTRY TRADE PATTERNS IN THE AUTOMOBILE INDUSTRY

As discussed in detail in the previous chapter, on examining bilateral IIT between South Africa and 20 partner countries in the automobile industry, this thesis finds evidence that the local industry is largely dominated by the share of VIIT (*differentiated by quality*) in TIIT. For reference purposes, it should be borne in mind that the computed bilateral shares of TIIT, VIIT, HIIT and OWT for selected trading partners for 2000 and 2007 are reported in Appendix F and trends are displayed in Figures 5.4(i)–5.4(xiv).

In the discussion below, shares of VIIT and HIIT in TIIT are computed and reported as follows: [(VIIT/TIIT) + (HIIT/TIIT) = 1 (= TIIT)] in order to illustrate the dominance of the VIIT pattern over HIIT in TIIT respectively. This computation differs from that in Chapter 5, where the shares of VIIT and HIIT in TT were reported as follows: [(VIIT/TT) + (HIIT/TT) + (OWT/TT) = 1 (= TT)], where TT denotes total trade. Also, for reference purposes to Chapter 5, in the discussion below, the shares of VIIT and HIIT in parenthesis refers to the latter computation.

Accordingly, VIIT is the dominant IIT pattern for South Africa–ROW automotive trade, where the share of VIIT in TIIT is equal to 87.1 and 94.3 per cent in 2000 and 2007 respectively. By contrast, the share of HIIT in TIIT is low, reaching 12.9 per cent in 2000 and falling to 5.72 per cent in 2007. Bilateral IIT between South Africa–Japan (11.6 to 74.9 per cent) and South Africa–USA (50.6 to 57.1 per cent) reveal rising levels over the 2000 to 2007 period, with VIIT being the dominant IIT trade pattern reaching levels of 100.0 per cent and 84.2 per cent respectively of TIIT in 2007. Declining IIT trends were experienced by Germany (53.1 to 30.9 per cent) and UK (55.8 to 45.4 per cent) between 2000 and 2007. Nonetheless, by 2007, VIIT accounted for 92.6 and 96.3 per cent of TIIT for Germany–UK respectively. Shifting trade patterns from OWT to IIT between South Africa–Spain (12.8 to 8.7 per cent) and South Africa–France (17.7 to 45.6 per cent) are illustrated. Interestingly, for Spain and France, HIIT (61.8 and 59.2 per cent of TIIT respectively) exceeds that of VIIT (38.2 and 40.8 per cent respectively) in 2007, implying that these countries prefer trading products differentiated by variety with South Africa.

Diminishing shares of IIT are revealed for trade between South Africa and India and South Africa–Brazil for the same period, although IIT is still dictated by VIIT. Significant bilateral VIIT is found for South Africa–Brazil between 2000 and 2007 (79.2 to 91.6 per cent of TIIT) and for South Africa–India between 2003 and 2007 (100.0 to 58.8 per cent of TIIT). Although experiencing low levels of TIIT, VIIT is the still the dominant IIT pattern for Italy (72.9 per cent), Turkey (100 per cent), Australia (57.4 per cent), China (100.0 per cent) and Sweden (100 per cent) in 2007.

As has already been shown in Table 5.3, trade with several Asia-Pacific countries, including Thailand, Taiwan, Republic of Korea and China (Hong Kong) reveals minimal IIT levels and the apparent dominance of OWT. Similarly, trade between South Africa and Mozambique, Zambia and Angola is dominated by OWT.[15] Interestingly, bilateral IIT levels for South Africa–Zambia and South Africa–Mozambique were in excess of 10 per cent in early 2000, but then decreased substantially to less than 2 per cent by 2007.

To summarise (see Chapter 5), the findings signify the existence of high shares of VIIT dominating intra-industry trade between South Africa and its trading partners in the automobile industry. This reflects differences in income levels, factor endowments, human capital and technology intensities between dissimilar trading nations. Although not illustrated or discussed here, in terms of VIIT, South Africa produces and exports high quality vertical differentiated automotive products. This is contrary to theoretical expectations (Falvey & Kierzkowski, 1987; Flam & Helpman, 1987) that lower income countries produce and export low quality vertical products while the opposite is true for higher income nations[16]. There is evidence that VIIT in the automobile industry can be partially underpinned by the theory of fragmentation of the internationalisation of production, whereby factors such as relative factor endowment and wage differences, MNC activities and FDI, trade and service link costs and government policy, among other things, are important (Fukao *et al*., 2003; Kimura *et al*., 2007; Wakasugi, 2007). The findings also indicate that HIIT is not particularly significant in the South African automobile industry, while OWT explained in terms of the traditional trade models of comparative advantage remains omnipresent for trade between South Africa and several of its trading partners.[17]

Accordingly, in terms of the results reported in Chapter 5, only 13 countries report feasible intra-industry trade levels that can be meaningfully decomposed into VIIT and HIIT patterns (see also Table 5.3 and Appendix F).[18] In the light of this finding, 13 of the 20 countries are employed in the gravity models of VIIT, HIIT and TIIT, which are to be estimated in Chapter 7.

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15 Although bilateral IIT levels for Zambia and Mozambique are greater than 10 per cent, they were not included in the gravity model owing to the unavailability of data for most of their explanatory variables.
16 It is therefore not surprising that difference in GDP per capita as an explanatory appear insignificant in the estimated models.
17 Similar findings have been reported by Ando (2006) for auto industry trade in East Asia. He argues that auto trade in developing countries can largely be explained by OWT attributable to the import-substituting policies adopted by these countries.
18 It is common practice in the empirical literature to declare the existence of IIT when the computed index is at least 10 per cent.

6.3 ECONOMETRIC MODEL SPECIFICATION

This thesis adopts a three-dimensional panel dataset (time t, reference country i and partner country j) to conduct an econometric investigation of the determinants of IIT patterns covering the years 2000 to 2007. More specifically, this thesis adopts a gravity model as first proposed by Isard (1954) and adopted later by others (Deardorff, 1984; Pölyhönen, 1963; Tinbergen, 1962) to examine and make predictions about bilateral trade flows. The gravity modelling approach is an *ex-post* analysis using historical time series and cross-section data (panel data) to explain effects that have already happened.

The gravity model used in this thesis is derived from Newton's (1687) universal law of gravitation written as:

$$F = G\frac{m_1 m_2}{r^2} \qquad (6.1)$$

According to Equation (6.1), (F) is the size of the gravitational force between two point masses m_1 and m_2, (G) is the gravitational constant and r^2 is the squared distance between m_1 and m_2. The law states that the force of gravity (F) is positively related to the mass of two attracting bodies (as measured by average market size) and inversely related to the square of their distance (as measured by trade costs) (Piermatini & Teh, 2005). In recent years the gravity model has gained renewed interest in the theoretical international trade literature (Anderson & van Wincoop, 2003).

6.3.1 Pooled model

The pooled model approach, also often referred to as the constant coefficient approach, is the most simplistic approach and ignores cross-sectional and time dimensions of the pooled data.

The panel regression model is specified (Baltagi, 2005) as:

$$y(z)_{ijt} = \alpha_n + \beta x'_{it} + u_{ijt} \text{ i=1....N; t=1...T} \qquad (6.2)$$

where: y_{ijt} = IIT indices between the home country i and its trading partner j for period t, and (z) varies over TIIT, VIIT and HIIT. More specifically, the dependent variable $y(z)_{itj}$ is the share of IIT in total trade that varies over TIIT, VIIT and HIIT, where the computed shares of each trade pattern fall between 0 and 1. x_{nit} is a K-dimensional vector of explanatory variables, including country-specific and industry-specific variables, with variation in dimensions n and t; where α_n = country effect, $n = 1 \ldots N$, $t = 1 \ldots T$ and u_t = white noise disturbance term that is independent and randomly distributed with $(\mathrm{E}\,u_{it}) = 0$; Var (u_{it}) = $\sigma^2 \succ 0$. The specific effects (α_n and δ_t) can be treated as fixed parameters or random parameters, namely a fixed effects model and a random effects model.

$$u_{ijt} = \mu_{ij} + v_{ijt} \qquad (6.3)$$

u_{it} = unobservable individual effect and varies over t and v_{it} = the rest of the disturbance effect similar to the usual disturbance term. According to Equation (6.3), v_{itj} is assumed to be homoskedastic and uncorrelated over time, whereas μ_{ij} is time-invariant and homoskedastic across individual cross-sections. This model can be estimated by OLS, which necessitates the assumptions of best linear unbiased and efficient (BLUE) estimators, where $E\{x_{it}u_{it}\} = 0$.

The pooled model is the most restrictive model compared to the fixed effects and random effects models and implies the inexistence of heterogeneity between cross-sections or individual countries within the panel. This means that it assumes that all countries tend to respond to changes in the explanatory variables in a similar fashion. In some cases estimations from the pooled model can yield inefficient and biased results because of the restrictive assumptions of no individual and time effects. However, the individual effects can be estimated using fixed effects or random effects models.

6.3.2 Fixed effects model

From Equations (6.2) and (6.3), the fixed parameters to be estimated include, α_{it} and β_{it} with $u_{it} \sim IID(0,\sigma^2_u)$ and x_i are assumed to be independent of v_{it} for all i and t. Under classical OLS assumptions, fixed effects assume that the explanatory variables are uncorrelated with the unobservable characteristics in α_{it} and μ_i, thus $E\{\bar{x}_t u_i\} = 0$ such that the fixed effects estimator is BLUE. Fixed effects models can be estimated by Least Square Dummy Variables (LSDV) or using the WITHIN approach.

With the LSDV approach, a dummy variable for each i can be shown (Verbeek, 2008):

$$y_{it} = \sum_{m=1}^{N} \alpha_j d_{im} + X_{it}\beta + u_{it} \quad (6.4)$$

where N = dummy variables, d_{im} = 1 if $m = j$ and 0 otherwise. OLS can be used to estimate α and β. The implied estimator for β is referred to as the LSDV estimator as shown in Equation (6.4).

$$E\left\{(x_{it} - \overline{x}_i)u_{it}\right\} = 0 \quad (6.5)$$

Accordingly, the OLS estimator is BLUE in the presence of fixed effects assumptions. A similar approach entails the LSDV estimator experiencing a significant loss of degrees of freedom and potential multicollinearity among explanatory variables as a result of the inclusion of many dummies.

Next, the WITHIN estimation also assumes individual effects but requires that the data be demeaned, as the individual effects cannot be directly estimated and thus use a Q matrix, where Q can be defined as:

$$Qy = QX\beta + Qv \quad (6.6)$$

The Q matrix transforms the data by obtaining deviations from the means WITHIN each cross-section. This is done by pre-multiplying Q by the previously performed (original) OLS model.

Where $\tilde{y} = Qy$ is a $NT \times 1$ vector and $\tilde{X} = QX$ is a $NT \times K$ matrix (6.7)

Following Baltagi (2005), the OLS estimator can be classified and written as:

$$\hat{\beta} = \left(X'QX\right)^{-1} X'Qy \text{ and } \operatorname{var}(\tilde{\beta}) = \sigma_v^2 (X'QX)^{-1} = \sigma_v^2 (\tilde{X}'\tilde{X})^{-1} \quad (6.8)$$

The WITHIN fixed effects model can be expressed as:

$$\overline{y}_{it} - y_{i.} = \beta(x_{it} - \overline{x}_{i.}) + (v_{it} - \overline{v}_{i.}) \quad (6.9)$$

Equation (6.9) represents a regression model in deviations from the individual means and therefore excludes individual effects (α_i) and is referred to as the WITHIN transformation, which can be solved and derived from first-order conditions. Thus, the OLS estimator for (β) is obtained from the transformed model shown in Equation (6.9).

Consequently, the LSDV estimator is equivalent to the WITHIN estimator (Verbeek, 2008).

6.3.3 Random effects model

If N is randomly extracted from a large population, random effects will be more efficient than fixed effects. This modelling approach permits variation across cross-sections and assumes that the individual error components are not correlated with one another. Moreover, fixed effects models may suffer from loss of degrees of freedom as a result of having too many parameters to be estimated. This can be avoided by employing the random effects approach if (μ_i) is assumed to be sufficiently random. Thus, $\mu_{it} \sim IID(0,\sigma^2_{\mu})$ and $v_{it} \sim IID(0,\sigma^2_{v})$.

In the random effects approach, the estimation of random effects using OLS is inappropriate, thus a more complex structure is required since it is assumed that the intercepts are random and can be obtained by using the Generalised Least Squares (GLS) estimator, which is based on the orthogonality assumption that the unobserved effects are uncorrelated with explanatory variables, $E\{\overline{x}_i, \alpha_i\} = 0$. Thus, the GLS estimator is unbiased and consistent in the presence of random effects assumption.

According to Baltagi (2005) and taken from Equation (6.3), the variance covariance-matrix Ω requires the use of GLS and can be expressed as:

$$\Omega = E(uu') = Z_{\mu}E(\mu\mu')Z'_{\mu} + E(vv') = \sigma^2_{\mu}(I_N \otimes J_T) + \sigma^2_{v}(I_N \otimes I_T) \quad (6.10)$$

where $\otimes$ is the kronecker product operator, I is the identity matrix and J is a matrix containing unitary elements. In Equation (6.11), the variances are homoskedastic such that:

$$\text{var}(\mu_{it}) = \sigma^2_{\mu} + \sigma^2_{v} \forall\, i,t \quad (6.11)$$

However, the covariance matrix reveals the presence of serial correlation over time between the disturbances for the same cross-section. Thus, using GLS to estimate Ω^{-1}, which is a $NT \times NT$ matrix to obtain the GLS estimator of the regression coefficients.

In order to find the Ω matrix, as derived from Wansbeek and Kapteyn (1982a; 1982b; 1983), replace J_T with $T\bar{J}_T$ and I_T with $E_T + J_T$. Subsequently, Ω matrix simplifies to:

$$\Omega = \left(T_\mu^2 + \sigma_v^2\right)\left(I_N \otimes \bar{J}_T\right) + \sigma_v^2\left(I_N \otimes E_T\right) = \left(T\sigma_\mu^2 + \sigma_v^2\right)P + \sigma_v^2 Q \qquad (6.12)$$

The Ω^{-1} matrix can be expressed as:

$$\Omega^r = \left(\sigma^2\right)^r P + \left(\sigma^2\right)^r Q \qquad (6.13)$$

In Equation (6.14), let *r* be an arbitrary scalar

$$\sigma_v^2 \Omega^{-\frac{1}{2}} = Q + \frac{\sigma_v}{\sigma_1} P \qquad (6.14)$$

Thus, GLS can be obtained as weighted least squares by pre-multiplying the original equation (6.2) (in vector form) by Equation (6.15) and performing OLS on the transformed regression that inverts a matrix of dimension *K+1*, which can then be estimated.

Then, $y^* = \sigma_v \Omega^{-\frac{1}{2}} y$ possesses the typical element $y_{it} - \theta \bar{y}_{i.}$, such that $\theta = 1 - \left(\frac{\sigma_v}{\sigma_1}\right)$. The GLS estimator is obtained by the OLS estimator in a transformed model expressed as (Verbeek, 2008):

$$\left(y_{it} - \vartheta_i \bar{y}\right) = \alpha(1-\vartheta) + (x_{it} - \vartheta \bar{x}_i)\beta + v_{it} \qquad (6.15)$$

where $\vartheta = 1 - \psi^{\frac{1}{2}}$ and $\psi = \frac{\sigma_u^2}{\left(\sigma_u^2 + T\sigma_\alpha^2\right)}$

In summary and according to Verbeek (2008), the fixed effects model is conditional on the individual (α_i's): $E\left\{y_{it} \middle| x_{it}, \alpha_i\right\} = x'_{it}\beta + \alpha_i$ and requires that the regressors be uncorrelated with (α_i's). Conversely, the random effects model is not conditional on the individual (α_i's), as it integers them out and allows inferences to made regarding the population, $E\left\{y_{it} \middle| x_{it}\right\} = x'_{it}\beta$, and assumes that the regressors will be correlated with (α_i's).

6.4 DATA SOURCES AND DESCRIPTION

As already mentioned in Chapter 5, harmonised system (HS) 6-digit product level data were used to compute bilateral shares of TIIT, VIIT and HIIT spanning the period 2000 to 2007. Data sources of the variables used in the econometric investigation are summarised in Table 6.1.

Table 6.1 List of variables used in the econometric analysis

Variable	Description	Data source
Trade data	HS 6-digit product-level data for automotive and related codes were used to compute TIIT, VIIT and HIIT indices	Quantec database
AGDP	Average market size (AGDP) where GDP is used to calculate the bilateral average of GDP between *i* and *j*	WDI Quantec database
GDPC	Average standard of living (GDPC) where the bilateral average of GDP per capita between *i* and *j* is computed.	WDI Quantec database)
RDGDP	Relative difference in economic size (RDGDP) is an index (Balassa & Bauwens, 1988), computed. (see Equation 6.11)	WDI Quantec database)
ELECONS	Difference in electric power consumption per capita (ELECONS) between *i* and *j*	WDI Quantec database)
WDIST	Great circle distance between country *i* and *j*, where the weight is the ratio of GDP of country *j* to the sum of total GDPs of all its trading partners is used to derive weighted distance (WDIST)	Mayer & Zignago (2006)
DIST	Great circle distance (DIST) between capital cities of trading partners *i* and *j*.	Mayer & Zignago (2006)
REG	Dummy variables equal to1 if countries *i* and *j* have trading arrangements, otherwise 0 (European Union and NAFTA) (REG).	DUM
TAR	Average MFN applied automotive tariff rates (TAR) HS 6 digit level (average of H87...) between *i* and *j*	WTO
AA	Automotive assistance (AA) is proxied by the bilateral average of number of paid employed workers in automotive industry[a] between *i* and *j*	LABORSTA (ILO, 2009)
FDI	Inward FDI stocks[b] (million US$) as a percentage of gross fixed capital formation (GFCF)	UNCTAD, FDI Stat
EXR	Nominal effective exchange rate (EXR) of the rand: Average period for 15 trading partners.	IMF Quantec database
	Bilateral South African rand and US dollar exchange rate (EXR)	SARB Quantec database
EoS	Total vehicle production (units) between *i* and *j*	OICA
PD	Product differentiation (PD) as computed by the revised Hufbauer index	Fontagné *et al.* (1997)
TO	Trade openness (TO) is computed as the residuals from a regression of per capita trade on per capita income and population	Stone & Lee (1995)
TIMB	Control variable is computed and defined as net trade as a proportion of total trade	Quantec database

Notes: [a]Values for China and India are obtained from www.chinaonline.com and www.indiastat.online, respectively.
[b]FDI stocks is the value of the share of their capital and reserves (including retained profits) attributable to the parent enterprise, plus the net indebtedness of affiliates to the parent enterprise.

Trade data is taken from the Quantec database and is reported in US dollars. A final sample of 13 selected countries is used in this thesis accounting for around 76 per cent of South Africa's total automotive trade.[19] Thus, serious difficulties were encountered in finding appropriate and consistent *industry data* because such data, especially for South Africa and several of its trading partners, are not reported in mainstream databases such as OECD STAN, and suchlike, and are therefore not easily obtainable; consequently, there were some missing observations in the dataset. In most cases, missing data of explanatory variables were replaced with growth rates based on previous years.

Country variables such as GDP, GNI per capita and population were obtained from the World Bank's World Development Indicators (WDI) database. FDI data were obtained from FDI Stat online (UNCTAD). Historical MFN automotive tariff data at the HS 6-digit level were obtained from the WTO's International Trade and Tariff database.

The International Organisation of Motor Vehicle Manufacturers (OICA) website provides annual data on motor vehicle production for each country, while industry employment data were taken mainly from LABORSTA database (ILO, 2009). However, missing industry employment data for China and India were obtained from Chinaonline.com and Indiastatonline.com (SIC data is concorded with HS data). In the case of South Africa, missing industry employment data were obtained from the Quantec database. Bilateral distance data were obtained from Mayer & Zignago (2006) (see CEPII website).

6.4.1 Dependent variable(s)

The dependent variable in this study is the share of IIT that varies over TIIT, VIIT and HIIT, where the computed shares of each trade type lie between 0 and 1. It is important to point out that very few studies have used the trade type methodology (Fontagné & Freudenberg, 1997) to empirically measure the intensity of IIT and to subsequently separate TIIT into VIIT and HIIT patterns as is done in this thesis (Ando, 2006; Fontagné *et al*., 2005; Montout *et al.*,

19 The final sample of countries is determined by the intensity of IIT and available data used as proxies for explanatory variables, especially in respect of industry-specific variables which were inadequate for several countries.

2002). In turn, the computed indices of the shares of TIIT, VIIT and HIIT are then used as dependent variables in a gravity model specification.[20]

Past empirical studies have adopted different econometric specifications and transformations of the dependent variable; however, Balassa & Bauwens (1988) and others (Greenaway & Milner, 1986) argue that the estimation results derived from different model specifications do not alter the estimation results significantly. To this end there is no consensus regarding the best econometric specification to adopt for investigating the determinants of IIT patterns (Zhang *et al.*, 2005). This thesis adopts a lin-log model specification, using OLS to estimate the determinants of IIT patterns as are adopted in several other empirical studies. Appendix D provides a list of existing empirical studies of determinants of IIT patterns, including signifying the econometric specifications employed in these studies.

6.5 HYPOTHESES OF EMPIRICAL DETERMINANTS OF IIT PATTERNS IN THE AUTOMOBILE INDUSTRY

Several country- and industry-specific hypothesised relationships have been identified in the empirical literature to analyse the determinants of the bilateral shares of TIIT, VIIT and HIIT patterns in the automobile industry (see Table 6.2 for expected signs of the explanatory variables). All explanatory variables used in the regression analysis are expressed in natural logarithms. The thesis performs empirical analyses using pooled, fixed effects and random effects models for three regression models of TIIT, VIIT and HIIT. The determinants and hypotheses of IIT patterns, which are also the explanatory variables, are discussed below.[21]

6.5.1 Relative difference in economic size (RDGDP)

Hypothesis (1): The greater the relative difference in economic size between trading nations, the larger the share of VIIT and the smaller the share of HIIT.

20 The majority of studies use the G-L (1975) index as the dependent variable; others have used the Brülhart (1990) index, the Nilsson (1994) index and the Kandogan methodology (2003a; 2003b) to measure the extent of IIT and, in turn, to decompose it into VIIT and HIIT.

21 This thesis also experimented with the usual country factors, such as market size (bilateral average of GDP of *i* and *j*), average of standard of living (average of GDP per capita), absolute difference in GDP per capita, difference in electric power consumption per capita and the exchange rate. The inclusion of these explanatory variables yielded unsatisfactory results in the final estimations as a result of a high degree collinearity between the explanatory variables, and was consequently omitted from the final model.

Most empirical studies reveal a statistically significant relationship between the share of IIT and relative difference in the size of the economies of the trading partners. As in Balassa (1986) and Balassa & Bauwens (1987), the relative difference in market size is expressed as:

$$RDGDP_{ij,kt} = 1 + \frac{[w \ln w + (1-w)\ln(1-w)]}{\ln 2}$$

$$\text{where } w \equiv \frac{GDP_i}{GDP_i + GDP_j} \qquad (6.16)$$

GDP = gross domestic product and $RDGDP_{ijt}$ = relative difference in GDP between country *i* and *j*, where the $RDGDP_{ijt}$ varies between 0 and 1 and is independent of the absolute market size of the partner country.

On the production side, countries similar in size tend to trade more in different varieties of products (Helpman & Krugman, 1985), thus a negative relationship between horizontal IIT and the relative difference in economic size is expected. In addition, according to Linder's (1961) hypothesis, countries similar in size demand a greater variety of differentiated products. Alternately, according to the H-O hypothesis (Falvey, 1981; Falvey &Kierzkowski, 1987), countries with larger relative differences in factor endowments, proportions and technologies will trade more, thus, a positive relationship between VIIT and relative difference in market size is expected. The sign for TIIT will depend on the dominant pattern of IIT and therefore there is no *a priori*.

6.5.2 Geographic distance (WDIST)

Hypothesis (2): The greater the geographical distance between trading partners, the lower the shares of all IIT patterns.

Geographic distance is typically used as a proxy for transport costs, insurance costs, delivery times and market access barriers. Many studies use kilometres or miles to measure geographic distance between the capital cities of trading partners. Since the commonly used distance variable (Hu & Ma, 1999; Lee, 1992; Sharma, 2004; Veeramani, 2009) is time invariant, it could not be estimated in Equation (6.2) using the fixed effects model specification. However, Martinez-Zarzoso & Nowak-Lehman (2001) recommend estimating a second stage regression model, where individual effects are regressed on the distance variable (DIST), as well as other time-invariant explanatory variables (see footnote 29). Nevertheless, this thesis adopts the weighted distance (WDIST) variable, which varies over time (Balassa, 1986; Stone & Lee, 1995), as a proxy for geographical distance between countries *i* and *j*, where the weight is the ratio of GDP of country *j* to the sum of total GDPs of all its trading partners and is computed as follows:

$$WDIST_{ij,kt} = \frac{DIST_{ij} * GDP_{jt}}{\sum_{j=1}^{13} GDP_t} \qquad (6.17)$$

As greater distances between trading partners leads to lower IIT shares, a negative relationship between the share of VIIT, HIIT and TIIT and the distance parameter is expected, according to the IIT empirical literature.

6.5.3 Trade openness (TO)

Hypothesis (3): The greater the degree of trade openness, the larger the shares of VIIT, HIIT and TIIT.

Several studies use a trade orientation (TO) variable as a proxy for trade openness (Chemsripong *et al*., 2005; Thorpe & Zhang, 2005; Clark & Stanley, 2003; Clark, 2005; Zhang & Li, 2006). The TO variable is estimated by constructing residuals from a regression with trade (exports plus imports) per capita as the dependent variable and population and gross national income per capita as explanatory variables (Stone & Lee, 1995). The expected sign is positive for TO for all IIT patterns.

6.5.4 Foreign direct investment (FDI)

Hypothesis (4): The greater the levels of efficiency-seeking FDI, the larger the shares of VIIT; alternately, the smaller the shares of HIIT.

FDI and its effects on IIT and its patterns have been investigated in the empirical literature (Hu & Ma, 1999; Byun & Lee, 2005; Zhang *et al*., 2005; Zhang & Li, 2006; Veeramani, 2009; Chang, 2009). Generally, FDI is hypothesised as being positively correlated with the share of VIIT, HIIT and TIIT. More specifically, a positive sign on the FDI coefficient is regarded as efficiency-seeking FDI which tends to facilitate trade. However, a negative sign on the FDI coefficient suggests that FDI may substitute for trade and this FDI type is known as market-seeking FDI (Behrman, 1972)[22].

Levels of FDI in the automobile industry are typically associated with high levels of MNC involvement, technology transfers and specialisation in production plants located in different countries. Now, in the absence of industry-level FDI data, this thesis uses inward FDI stocks as a percentage of gross fixed capital formation (GFCF) to capture the amount of FDI activities by MNCs in South Africa (proxied for the automobile industry). Two proxies were used to capture FDI effects on IIT patterns. Both the actual and the absolute difference in inward FDI stocks as a percentage of GFCF between South Africa and its bilateral trading partners (FDI1 and FDI2, respectively, see Table 6.2) were employed in the econometric analysis.

6.5.5 Economies of scale (EoS)

Hypothesis (5): The larger the EoS, the larger the share of HIIT, whilst the direction of the share of VIIT is indeterminate.

Scale economies represent an important determinant of IIT levels (Byun & Lee, 2005; Thorpe & Zhang, 2005; Veeramani, 2009). In the case of HIIT, the existence of EoS provides a motivation for multinational firms to spread fixed costs of knowledge capital across multiple plants and thereby reduce average costs as output expands. On the other hand, in the case of VIIT, motives are generated when there are different factor intensities combined with different factor endowments across countries. However, the influence of the number of firms has implications for EoS (Aturupane *et al*., 1999) thus the predicted sign for scale economies depends largely on the market structure of the industry. The empirical IIT literature proposes a limited number of methods to measure EoS.[23]

22 According to Behrman's (1972) FDI typology; there are four types of FDI, namely resource-seeking, efficiency-seeking, market-seeking and strategic asset-seeking.
23 Value added per establishment (Sharma, 2004); gross output per establishment (Byun & Lee, 2005); average size (output value) of largest firms accounting for approximately one-half of industry output divided by total industry output (Veeramani, 2007), among others.

A common proxy for EoS in past studies is minimum efficient scale (MES) (Aturupane *et al*., 1999; Hu & Ma, 1999; Montout *et al*., 2002; Clark & Stanley, 2003).[24] In particular, Montout *et al*. (2002) argue that an index of scale economies captures the relative productivity associated with larger firms *vis-à-vis* smaller firms in the automobile industry. In this study, an MES index is constructed by using the method employed by Montout *et al*. (2002) and initially used by Menon, Greenaway & Milner (1999):

$$MES = \frac{OT_i / N_i(4)}{OT_i / N_i(n\text{-}4)} \tag{6.18}$$

where: TO = total output in the home country i, $N_i(4)$ = number of persons employed in the four largest firms, and N_i (n–4) = the rest of the persons employed. Accordingly, a negative relationship is hypothesised between MES and the share of HIIT, whereas there is no *a priori* for VIIT.

However, in this thesis, as a result of data availability for the panel of countries under thesis, a new measure is used to examine the impact of EoS on bilateral IIT in the automobile industry. Here, the bilateral average of total vehicle production (units) (EoS1) and the absolute difference in total vehicle production (units) (EoS2) between trading partners i and j is computed as proxies for EoS (See Table 6.2). The limitation of this proxy for EoS as a determinant of IIT is that it applies largely to industry level rather than firm or plant level.[25]

6.5.6 Automotive assistance (AA)

Hypothesis (6): The predicted sign for automotive assistance and its impact on IIT patterns is indeterminate as there is no a priori.

Automotive assistance refers to any form of 'assistance' (tariffs, NTBs and fiscal measures, etc.) offered to foreign firms or MNCs for embarking on FDI activities. Trade and industrial policy applied to automotive industries for the most part include a set of trade barriers such as

24 The signs on the MES coefficients for several studies are interpreted in various ways by authors and also depend on the proxies used to measure EoS.

25 The proxy for EoS used in this thesis is more applicable as a measure of external EoS than of firm-level or internal EoS. Future research will explore improved proxies for firm-level EoS.

import tariffs and NTBs,[26] including various fiscal incentives, that potentially offset import tariffs payable (Ando, 2006). Kimura *et al*. (2007), argue that duty drawbacks (rebateable credits) assist in reducing the impact of trade barriers, which enhances IIT. Even though such protection measures may reduce nominal tariff barriers, they actually increase effective protection for the industry (Flatters, 2003; 2005), insulating inefficient domestic producers from international competition and subsequently lowering IIT levels. In this instance a negative sign on the AA coefficient is expected.

The argument in favour of government fiscal assistance for 'selected' industries, such as the automobile industry, refers to the attractiveness of MNC foreign investment inflows, employment benefits, technology spillovers and export opportunities, especially given the limited size of domestic markets (Kumar & Gallagher, 2007). However, others argue that higher effective protection (although reducing nominal protection) makes for inefficient vehicle production and imposes negative welfare effects on society as a whole (Flatters, 2003; Damoense & Agbola, 2009). It can be argued that by lowering incentives such as export subsidies, some firms will be forced to leave (inefficient), thus reducing the number of firms or plants (increasing EoS and specialisation) and resulting in higher output and trade thus contributing to rising IIT levels. Consequently, a positive sign on the AA coefficient is predicted.

This thesis attempts to investigate the influence AA as proposed by Gruen (1999), especially from the perspective of the effects of protection and government support on the levels of IIT in the automobile industry in South Africa. It should be noted that it is has been a challenging exercise to find a suitable proxy to measure AA, particularly in a panel setting. Nevertheless, this thesis adopts as proxy a measure of the bilateral average of paid workers in the automobile industry between partner countries *i* and *j*. The use of employment data to compute a proxy for AA is reasonable, as Kumar & Gallagher (2007) cite various examples

26 Examples of non-tariff barriers (NTBs) include quantitative restrictions (QRs) and administered protective measures such as local content requirements, countervailing duties, anti-dumping measures, differential rules of origin, and so forth.

of jobs provided by MNC auto firms attributable to government financial assistance.[27] A positive sign indicates that greater AA serves to stimulate all IIT types. Conversely, a negative sign reveals that lower AA is expected to have a positive influence on IIT patterns. Thus, the predicted sign for AA is indeterminate.

6.5.7 Tariffs (TAR)

Hypothesis (7): The lower the level of tariffs, the greater the shares of VIIT, HIIT and TIIT.

Typically, a negative relationship between trade barriers and the share of IIT is predicted. Most studies use the level of tariffs as a proxy for trade barriers, despite other forms of trade barriers (quotas, quantitative restrictions, NTBs, etc.) and find that a reduction in trade barriers (tariffs) increases IIT (Sharma, 2004; Veeramani, 2009; Zhang *et al*., 2005). As a result of trade agreements with specific automotive provisions, preferential lower tariffs are applied to the automobile industry. Thus, trade agreements serve to reduce trade barriers thereby resulting in trade-creating effects between trading countries and the likelihood of rising IIT levels in the automobile industry. On the other hand, two studies reveal a positive relationship between trade barriers and IIT (Kind & Hathcote, 2004; Al-Mawali, 2005). In this thesis, the tariff variable used is calculated as the bilateral average level of applied MFN automotive tariff rates using HS 6-digit level data (WTO, 2009).

6.5.8 Exchange rate (EXR)

Hypothesis (8): There is no a priori for the impact of the exchange rate on the shares of VIIT, HIIT and TIIT.

The impact of the exchange rate on IIT patterns is not evidently described by IIT theory. Nevertheless, depreciation (appreciation) of the exchange rate is expected to stimulate exports (imports) and thus influence all IIT patterns. For instance, an increase (decrease) in the value of South African rand–US dollar exchange rate implies depreciation (appreciation) of the domestic currency which is expected to increase IIT levels in the automobile industry.

27 For example, in Alabama (USA), US$ 300 million was given to Mercedes-Benz for the creation of 1,500 jobs (subsidy per job = US$ 200 thousand). Further, in Setubal (Portugal), US$ 484 million was given to Ford, creating 1,900 jobs (subsidy per job = US$ 254 thousand) (Kumar & Gallagher, 2007).

6.5.9 Product differentiation (PD)

Hypothesis (9): The greater the degree of product differentiation, the larger the share of VIIT and the lower the share of HIIT.

According to theoretical and empirical studies of IIT, the degree of product differentiation (PD) is an important determinant of IIT (Byun & Lee, 2005; Chang, 2009; Faustino & Leitão, 2007). As in previous studies, this thesis distinguishes between vertical product differentiation and horizontal product differentiation (Bernhofen & Hafeez, 2001; Faustino & Leitão, 2007). Balassa & Bauwens (1987) and Hu & Ma (1999) use the Hufbauer (1970) index as a proxy for the degree of PD and have been modified by Fontágne *et al.* (1997) as follows:

$$PD_{ij,kt} = \sum_{i \in j} \left[\frac{XV_{it}}{\sum_{i \in j} XV_{it}} \times \frac{\max(UV^{X}_{ij,kt}, UV^{X}_{i..t})}{\min(UV^{X}_{ij,kt}, UV^{X}_{i..t})} \right] \qquad (6.19)$$

Where $PD_{ij,kt}$ = the degree of product differentiation, XV_i = the export value of the host country, UV^X= the unit value of exports and $UV_{i.t}$ = the average unit value of XV_i to all trading partners.

The computed degree of the PD measure is equal to or greater than 1, where values close to 1 indicate low degrees of product differentiation and values further away from 1 are conversant with higher degrees of vertical product differentiation. According to Fontágne *et al.* (1997), the index provides an average unit value dispersion of export unit values for a given product *k* aggregated over the sum of all products in a given industry and is a measure of the vertical differentiation of a product. The PD variable is expected to be positively related to VIIT, negatively related to HIIT and ambiguous for TIIT in the automobile industry.

In addition, after visual observation that the PD variable appears to be non-linear in profile, a quadratic transformation of the PD variable is included as an explanatory variable in the regression models in order to capture the non-linear effect of the explanatory variable. Therefore, a positive (negative) relationship is expected over some unspecified range for VIIT (HIIT) while the opposite relationship is expected beyond that scope. A similar transformation of the PD variable is done in Veeramani (2009), although advertising expenditure as a percentage of sales is used as a proxy for the degree of product differentiation in his study.

6.5.10 Trade imbalance (TIMB)

Hypothesis (10): The smaller the trade imbalance, the larger all IIT patterns.

As in Byun & Lee (2005), Clark (2005) and Thorpe & Zhang (2005) this thesis includes a trade imbalance (TIMB) control variable equal to net trade as a proportion of total trade, as shown in Equation (6.15). Hence, if there is balanced trade, then TIMB = 0, otherwise TIMB = 1.

$$\text{TIMB}_{ij,kt} = \frac{\left| X_{j,kt} - M_{j,kt} \right|}{(X_{j,kt} + M_{j,kt})} \quad (6.20)$$

This control variable has typically been used in regression models of IIT where the Grubel & Lloyd index (1975) is used as a dependent variable, although it has not yet been used as a dependent variable in a regression model using the trade overlap index and threshold methodology to measure VIIT and HIIT patterns (Fontagné & Fredenberg, 1997). The expected sign is negative implying that the *IIT(z)* index is biased in the presence of trade imbalances and that the estimation results should be interpreted cautiously with this in mind.

The gravity model is estimated in the form of Equation (6.2) and is given as:

$$IIT(z)_{ijt} = \alpha_0 + \alpha_1 RDGDP_{ijt} + \alpha_2 WDIST_{ijt} + \alpha_3 TO_{ijt} + \alpha_4 FDI_{ijt} + \alpha_5 EoS_{ijt} + \alpha_6 AA_{ijt} + \alpha_7 TAR_{ijt} + \alpha_8 EXR_{ijt} + \alpha_9 PD_{ijt} + \alpha_{10} TIMB_{ijt} + \varepsilon_{ijt} \quad (6.21)$$

The expected signs for the VIIT regression equation are:

$$\alpha_1 > 0, \alpha_2 < 0, \alpha_3 > 0, \alpha_4 > 0, 0 < \alpha_5 < 0, 0 < \alpha_6 < 0, \alpha_7 < 0, 0 < \alpha_8 < 0, \alpha_9 > 0, \alpha_{10} < 0$$

The expected signs for the HIIT regression equation are:

$$\alpha_1 < 0, \alpha_2 < 0, \alpha_3 > 0, \alpha_4 < 0, \alpha_5 > 0, 0 < \alpha_6 < 0, \alpha_7 < 0, 0 < \alpha_8 < 0, \alpha_9 < 0, \alpha_{10} < 0$$

Finally, the expected signs for TIIT will depend on the strength of the impacts of VIIT and HIIT.

Table 6.2 Definitions and proxies of explanatory variables and expected signs

Explanatory variable	Variable	Proxy	TIIT	HIIT	VIIT
Relative difference in economic size	RDGDP	Factor endowment and technology differences between *i* and *j*	+/–	–	+
Geographic distance	WDIST	Weighted distance between capital cities of *i* and *j*	–	–	–
Trade openness	TO	Degree of trade openness	+	+	+
Foreign direct investment	FDI1	Actual inward FDI as a% of gross fixed capital formation (GFCF)	+/–	–	+
	FDI2	Absolute difference of FDI1 between *i* and *j*	+/–	–	+
Economies of scale	EoS1	Bilateral average of total vehicle production (units) between *i* and *j*	+/–	+	+/–
	EoS2	Absolute difference of total vehicle production (units) between *i* and *j*	+/–	+	+/–
Automotive assistance	AA	Average number of paid automobile industry workers between *i* and *j*	+/–	+/–	+/–
Tariffs	TAR	Average MFN automotive tariff rates of *i* and *j*	–	–	–
Exchange rate	EXR1	Nominal effective exchange rate index	+/–	+/–	+/–
	EXR2	Bilateral South African cents per USA dollar exchange rate	+/–	+/–	+/–
Product differentiation	PD	Revised Hufbauer index as a measure of degree of product differentiation	+/–	–	+
	PD^2	Quadratic of PD	+/–	+	–
Trade imbalance	TIMB	Control variable	–	–	–

6.6 SUMMARY AND CONCLUSION

In this chapter, the econometric procedure employed in the empirical investigation of this thesis was sketched out. Secondly, a discussion on the empirical hypotheses of the determinants of bilateral VIIT and HIIT patterns in the South African automobile industry was provided.

The econometric technique used in this investigation comprised panel data econometrics (gravity model). A key advantage of panel data estimation is that it allows for unobservable effects to be controlled, which could otherwise lead to variable bias being omitted. Three model specifications were discussed, namely the pooled model, the fixed effects model and the random effects model. The choice between the pooled and the fixed effects models is determined by the F-test (Baltagi, 2005) and the appropriateness of the fixed effects model can be assessed using the Hausman Test (Verbeek, 2008), which compares a more efficient model with a less efficient model but ensures that the most efficient model is also consistent. These econometric investigations will be conducted in the next chapter (Chapter 7) to ascertain the most suitable econometric model to investigate the determinants of bilateral IIT patterns in the South African automobile industry.

The hypotheses of the country- and industry-specific empirical determinants (explanatory variables) were discussed in the latter part of this chapter. The hypotheses of the empirical determinants for explaining vertical IIT and horizontal IIT patterns proffered and discussed here have been informed by the theoretical and empirical IIT literature and will be estimated and the results discussed in the next chapter.

CHAPTER 7

GRAVITY MODEL ESTIMATION AND DISCUSSION OF RESULTS

7.1 INTRODUCTION

The primary goal of this chapter is to develop a model of IIT patterns in order to test the empirical hypotheses of the determinants of VIIT and HIIT in the South African automotive industry and to present the estimation results of the econometric specifications conducted. In particular, the thesis estimates the statistical significance of the determinants of bilateral VIIT, HIIT and TIIT using pooled, fixed effects and random effects models. Thus, this chapter estimates a gravity model according to Equation (6.21) and provides the estimation results for the pooled, fixed effects and random effects models for all IIT types.

This chapter is organised as follows. Section 7.2 provides the univariate properties of the variables used in the regression analysis by conducting panel unit root tests, while Section 7.3 presents the econometric results of the pooled, fixed effects and random effects models estimated. In Section 7.4, discussions of the econometric results are provided, and finally, Section 7.5 summarises and concludes the research.

7.2 UNIVARIATE CHARACTERISTICS OF VARIABLES

Panel unit root tests of the variables were conducted using at least three unit root tests to investigate the univariate characteristics of all series in the panel. Unit root tests are conducted to test whether potential cointegrating relationships exist among the variables used in the regression analysis. In other words, unit root tests assist in determining whether variables are stationary or nonstationary. If, according to the unit root tests, the variables are identified as being stationary, then normal estimation procedures can be employed to estimate the relationships between variables. The three unit root tests include the Augmented Dickey Fuller (ADF)-Fischer and the Philips Perron-Fischer (Madala & Wu, 1999) tests as well as the Levin, Lin & Chu (LLC) (Choi, 2001) test. Table 7.1 reports the panel unit root tests rejecting the null of a unit root and concluding that the panel is stationary. This implies that OLS methods can now be used to estimate Equation (6.21).

Table 7.1 Panel unit root tests

Variable	Levin, Lin and Chu Test	ADF-Fischer Test	PP-Fischer Test
H_0: All series in the panel contains a unit root			
$VIIT_{ijt}$	–7.3449 (0.0000)***	40.71351 (0.0332)**	47.3692 (0.0064)***
$HIIT_{ijt}$	–3.4346 (0.0003)***	55.9610 (0.0006)***	49.3032 (0.0038)***
$TIIT_{ijt}$	–4.0128 (0.0000)***	40.8811(0.0006)***	42.4172 (0.0222)**
$RDGDP_{ijt}$	–14.1415 (0.0000)***	45.7353 (0.0098)***	37.8855 (0.0621)*
$WDIST_{ijt}$	–2.5607 (0.0052)***	48.7620 (0.0044)***	27.5211 (0.3824)
TO_{ijt}	–15.5316 (0.0000)***	68.3376 (0.0000)***	49.5996 (0.0035)***
FDI_{ijt}	–27.4389 (0.0000)***	34.9699 (0.1123)	44.0924 (0.0148)***
EoS_{ijt}	–5.6752 (0.0000)***	25.1905 (0.5082)	36.5531 (0.0820)*
AA_{ijt}	–1.9025 (0.0286)**	35.5728 (0.0998)*	42.5551 (0.0215)**
TAR_{ijt}	–9.5557 (0.0000)***	40.4394 (0.0353)**	47.1166 (0.0068)***
EXR_{ijt}	–13.3046 (0.000)***	70.3818 (0.0000)***	46.9240 (0.0072)***
PD_{ijt}	–13.0180 (0.000)***	42.0161 (0.0245)**	38.4100 (0.0555)**
PD^2_{ijt}	–9.7850 (0.0000)***	36.0867 (0.0901)*	35.8471 (0.0945)*
$TIMB_{ijt}$	–13.2311 (0.0000)***	57.8477 (0.0003)***	85.6323 (0.0000)***

*Notes: Asterisks indicate (1%)***, (5%)** and (10%)* levels of statistical significance.*
Probabilities are reported in parenthesis.

7.3 ECONOMTRIC ESTIMATION RESULTS

The econometric estimation results of pooled, fixed effects and random effects models of VIIT, HIIT and TIIT will be reported and discussed at this point. To overcome potential problems associated with heteroscedasticity, White's cross-section robust variance-covariance matrix is used to produce the corrected standard errors and t-statistics that are reported for pooled, fixed effects and random effects models of IIT patterns in Appendix H, Table 7.2 and Appendix J, respectively.

7.3.1 Pooled models

As explained in Chapter 6.3, of the three specifications employed in this thesis, the pooled model is the most restrictive and implies the inexistence of heterogeneity between individual countries within the panel. The empirical results of the pooled models for VIIT, HIIT and TIIT are presented in Appendix H. Accordingly, the Adjusted R^2 of 0.44, 0.09 and 0.48 are weak for VIIT, HIIT and TIIT, respectively.

The Chow test (*F*-test) (Baltagi, 2005) is conducted to determine if the pooled model is appropriate for this study. According to the *F*-test, the null of no country effects (or poolability) is tested using $H_0 : \mu_1 = \mu_2 = ...\mu_{N\text{-}1} = 0$ (no individual effects; same intercept across all cross-sections) and $H_A : \mu's \neq 0$ (not all are equal to 0).

$$F = \frac{(RRSS - URSS)/(N-1)}{URSS/(NT-N-K)} \sim F_{(N-1),(NT-N-K)} \qquad (7.1)$$

where RRSS = the restricted residual sum of squares and URSS = the unrestricted residual sum of squares.

If the computed *F*-test statistic is greater than the *F* distribution with (*N–1*) and (*NT–N–K*) degrees of freedom for the numerator and denominator respectively, the null hypothesis that the pooled estimators are efficient is rejected. Hence, the fixed effects model is most appropriate model suggesting that countries are heterogeneous. Accordingly, the null of no country effects (or poolability) is rejected since the critical $F_{12,90}$ (= 1.83) < F_{stat} (= 18.28, 4.04 and 5.75) for VIIT, HIIT and TIIT, correspondingly. Thus, the pooled models for all IIT patterns are unsatisfactory for explaining the determinants between South Africa and its bilateral trading partners. Therefore, the rest of the empirical results for the pooled model will not be discussed.

7.3.2 Fixed effects models

In the fixed effects models, heterogeneity across cross-sections is assumed by acknowledging different intercepts for every country in the panel. Fixed effects can have two dimensions, cross-section effects and time effects. According to the fixed effects estimations, all three regression models for bilateral shares of VIIT, HIIT and TIIT appear to be well explained, since the Adjusted R^2 is equal to 0.69, 0.32 and 0.74 respectively[28].

It is expected that the fixed effects model will be the most appropriate model for investigating the determinants of IIT for several reasons. Firstly, according to Baltagi (2005), random effects are inappropriate specifications if the number of cross-sections (*N*) are small, as is the

28 The Adjusted R^2 is explained in the context of variances in the shares of IIT and not the values of IIT, indicating that the Adjusted R^2 is high and exhibits very good explanatory power of the models of IIT patterns.

case with this study (*N* = 13). Secondly, the selection of the fixed effects model for this study is supported by Egger (2000), who argues in favour of fixed effects estimates of gravity models when estimating trade flows between predetermined countries. Thirdly, according to the Hausman (1978) test statistic (χ^2), which tests for misspecification for orthogonality of the random effects estimates (Egger, 2000), the null for the all estimated models is rejected. The Hausman test (ξ_H) is illustrated next.

The Hausman test according to Verbeek (2008) assesses the appropriateness of the random effects estimates against the fixed effects estimates according to the following equation:

$$\xi_H = \left(\hat{\beta}_{FE} - \hat{\beta}_{RE}\right)\left[\hat{V}'\left\{\hat{\beta}_{FE}\right\} - \hat{V}\left\{\hat{\beta}_{RE}\right\}\right]^{-1}\left(\hat{\beta}_{FE} - \hat{\beta}_{RE}\right) \qquad (7.2)$$

Under the H_0: Regressors are uncorrelated with individual effects against the H_A: Regressors, which are correlated with individual effects. In other words, the null hypothesis is that the random effects specification is true (Egger 2000; Metha & Parikh, 2005).

In Equation (7.2), $\hat{\beta}_{FE}$ and $\hat{\beta}_{RE}$ are the estimated coefficients and the $\widehat{V}'s$ represent the covariance matrices from the fixed and random effects models respectively. Now, if the computed Hausman test statistic is larger than the Chi-squared (χ^2) distribution with *k* degrees of freedom (explanatory variables), the null of no correlation of the individual effects (with explanatory variables) is rejected, indicating that the fixed effects model is the preferred model and the random effects estimates are significantly inconsistent (Hsiao, 1986).

Thus, according to the computed Hausman test (Verbeek, 2008), the correctness of fixed effects model is verified and indicated by the Hausman test statistics reported in Table 7.2. The computed Hausman test statistics for the VIIT, HIIT and TIIT models are $\chi^2(7)_{stat}$ = 112.31, 55.94 and 129.69 > $\chi^2(7)_{crit}$ = 18.48 at the 1 per cent significance level respectively confirming that the fixed effects model is preferred for empirically investigating the determinants of VIIT, HIIT and TIIT in the South African automobile industry.

Table 7.2 Fixed effects estimation results for VIIT, HIIT and TIIT

Explanatory variables	Dependent variables		
	VIIT	HIIT	TIIT
Constant	4.0742 (7.5037)***	0.2772 (0.8472)	4.2710 (11.2468)***
$RDGDP_{ijt}$	0.2874 (2.9457)***	–0.2170 (–2.5098)***	0.2203 (3.0603)***
$WDIST_{ij}$	–0.1349 (–3.3463)***	0.03359 (1.1831)	–0.1904 (–12.007)***
TO_{ijt}	0.4736 (5.7751)***	0.0558 (2.0592)**	0.4113 (5.1597)***
FDI_{ijt}	0.0239 (4.9152)***	–0.0244 (–2.8123)***	0.0206 (6.9599)***
EoS_{ijt}	–0.0227 (–2.0764)**	–0.0331 (–1.6201)	–0.0225 (–2.2016)**
AA_{ijt}	–0.4429 (–6.5149)***	(–0.0458) (–1.7469)*	–0.4784 (–7.6383)***
TAR_{ijt}	0.2199 (1.92527)**	*n/a*	0.0699 (0.5668)
EXR_{ijt}	*n/a*	0.0527 (2.4269)***	*n/a*
Adjusted R^2 F test Hausman test	0.69 18.28*** 112.31***	0.32 4.04*** 55.94***	0.74 5.75*** 129.69***

Notes: White cross-section t-values are given in parenthesis.
n/a indicates that the variable has been dropped.
*Asterisks indicate (1%)***, (5%)** and (10%)* levels of statistical significance.*

Further, according to the fixed effects model, the country-specific effects imply the existence of unobservable features unique to each country that may hamper or strengthen bilateral IIT levels between South Africa's trading partners. The results of the country-specific coefficients (α's) are presented in Appendix I. Negative signs for over half of the countries included in the sample of this study suggest that there are specific factors relevant to Australia, Brazil, France, Sweden, Spain, Italy, Turkey and India that reduce bilateral VIIT and subsequently TIIT with South Africa in the automobile industry and which may not have been captured in the estimated gravity model. On the other hand, for the rest of the countries, China, Germany, Japan, the UK and the USA, the positive signs for these country-specific effects indicate that VIIT and subsequently TIIT for these trading partners can potentially be explained by other factors not used in the gravity model. For HIIT, and aligned with the same argument, several countries possess negative signs revealing the importance of specific country effects not considered in the HIIT regression estimated in this thesis. These effects potentially reduce bilateral HIIT with South Africa and vice versa. Interestingly, the econometric results confirm that Sweden, Australia, Turkey, India and, to a lesser extent, Italy and Spain are potential "outliers in VIIT" (as illustrated in Chapter 5.5.2) as indicated by the negative signs of the country-specific coefficients (α's) reported in Appendix I.

7.3.3 Random effects models

At this point, it is important to emphasise that the countries under study were predetermined and not randomly chosen from a large population (*N*); they were selected on the basis of their trading status and the intensity of their bilateral IIT levels with South Africa. Therefore, it is not surprising that the estimation results for the random effects model appear to be inefficient, biased and entirely inappropriate for investigating the determinants of IIT patterns in the South African automobile industry. The estimation results of the random effects model for VIIT, HIIT and TIIT are reported in Appendix J. Accordingly, in all three regression models, the explanatory powers are very poor. In addition, most of the coefficients are insignificant and possess the unexpected wrong signs. Therefore, the empirical results of this model will not be discussed.

The following section, Section 7.4, contains a discussion on the econometric results according to the fixed effects models of VIIT, HIIT and TIIT.

7.4 DISCUSSION OF THE ECONOMETRIC RESULTS

The empirical results of the econometric analysis are largely in line with theoretical models of VIIT and HIIT. As expected, the relative difference in economic size (RDGDP) coefficient is positive and statistically significant at the 1 per cent level for VIIT and negative and statistically significant at the 1 per cent level for HIIT *a priori*. This result implies that, as countries differ in relative economic size and in relative factor endowments, the share of VIIT will be larger as the potential gains from trade in quality products are greater. On the other hand, the potential gains from trading variety products are reduced when the relative difference in economic size is large. This result confirms H-O trade type theories for VIIT, including the explanation of the fragmentation theory of international production for intermediate products (Feenstra & Hanson, 1997). Furthermore, the econometric results of the HIIT regression conform to Helpman & Krugman's (1985) theoretical model of HIIT, according to which countries of similar sizes, factor endowments and technologies trade products that are differentiated by variety. In the case of HIIT for intermediate products, the results are also in line with Ethier's model (1982).

The empirical findings also show that weighted geographical distance (WDIST) deters VIIT and TIIT and has no significant impact on HIIT. The coefficients of WDIST for both VIIT and TIIT possess the correct negative signs and are highly statistically significant at the 1 per cent level; however, they are not statistically different from zero for HIIT. Moreover, the influence of distance on bilateral TIIT has implications for fragmentation and international production processes (Jones & Kierzkowski, 1999; 2001) in terms of which service link costs are essential for enhancing vertical trade (Kimaru *et al*., 2007). There is, therefore, a need for further economic development and greater investments and advancements in infrastructural projects relating to ICT and transport (rail, road and freight) technologies in an attempt to effectively lessen the barriers of trade for VIIT and international production processes. This will contribute to reducing the effective distance between countries and regions, thus stimulating IIT in the automobile industry.

The thesis also experimented with the time invariant distance (DIST) variable in the panel estimation. A second stage regression was conducted as recommended by Martinez-Zarzoso & Nowak-Lehman (2001). In this second stage regression model,[29] individual effects are regressed on the time-invariant distance (DIST) variable as well as regional dummies (NAFTA and EU). The results indicate that the coefficient of the distance (DIST) variable had the unexpectedly positive statistically significant sign for all IIT patterns. In the end, the WDIST variable was chosen over the time-invariant DIST variable in the final econometric estimations.

Nevertheless, few authors demonstrate a positive sign on the distance coefficient (Kind & Hathcote, 2004; Zhang, *et al*. 2005; Zhan & Li, 2006) when investigating VIIT and HIIT patterns, indicating that DIST is not important in facilitating IIT. This argument is based on

29 $IE_{ij} = \alpha_0 + \alpha_1 DIST_{ij} + \alpha_2 NAFTA + \alpha_3 EU + \mu_i$ where IE is individual effect, DIST is distance, NAFTA and EU are dummy variables taking the value of 1 when the country is part of or a member of NAFTA or EU, respectively and otherwise zero. The econometric results of the second stage regression models for VIIT, HIIT and TIIT are not reported here. They are discussed in the text.

good communication technologies and infrastructure that make communication across geographical boundaries cost-effective.

Now, turning to the impact of regional integration on IIT patterns in the automobile industry, the coefficient on NAFTA reveals a positive and significant impact at the 1 per cent level of significance for VIIT, HIIT and TIIT. This finding is line with the fact the AGOA established in 2000 may have resulted in trade-creating effects for the automobile industry, thereby causing rising IIT levels between South Africa and the USA. In addition, this finding may provide a case for establishing an FTA with the USA.

Moreover, VIIT and TIIT do not appear to be influenced by the EU, as a positive but insignificant impact on VIIT and TIIT was revealed. On the other hand, HIIT is highly positively correlated to increasing integration efforts with EU trading partners in the automobile industry. This is not surprising as IIT between South Africa and EU countries such as Germany and France are largely explained by HIIT. Further investigation into potential trade diverting effects between South Africa and EU countries for VIIT should be explored.

The sign on the trade openness (TO) coefficient has the correct positive signs as expected for all IIT patterns and is statistically significant at the 1 per cent level for VIIT and TIIT and at the 5 per cent level for HIIT.[30] Thus, the degree of trade openness is important for VIIT, HIIT and TIIT in the South African automobile industry. Clark (2005), Thorpe & Zhang (2005) and Zhang & Li (2006) also found that TO positively influence IIT. Thus, the findings suggest that further trade liberalisation of the South African economy is predicted to encourage IIT levels in the automotive industry.

The results reveal that the FDI coefficient is positive and statistically significant at the 1 per cent level for VIIT and TIIT, while it is not statistically different from zero for HIIT. This

30 The trade openness (TO) variable is a country-specific variable used to capture the impact of trade openness, whereas the tariff (TAR) variable is an industry-specific variable capturing effects of industry trade policy. The inclusion of both variables is justified in the models for two reasons. Firstly, there is no evidence of perfect multicollinearity and dropping any one of the variables reduces the overall fit of the models estimated resulting in several of the explanatory variables becoming insignificant. Secondly, consensus on the harmfulness of the degree of multicollinearity to the estimates for panel data in the literature is ambiguous.

FDI variable is proxied by the absolute difference in inward FDI stocks (FDI2) between South Africa and its trading partners; indicating that a positive sign on the FDI coefficient reflects large differences in inward FDI between trading partners, which is expected to promote VIIT and TIIT. Thus, greater inward FDI for South Africa, *ceterus paribus,* tends to complement trade and consequently encourage VIIT. This finding supports arguments by several authors that FDI strategies and the motives of MNCs driven by efficiency-seeking FDI that increase VIIT (Aturupane *et al.*, 1999; Fukao *et al*., 2003; Zhang *et al*., 2005).

However, in the case of the HIIT regression, FDI is proxied by actual inward FDI stock values (FDI1). The coefficient on this FDI proxy becomes significant at the 1 per cent level and possesses a negative sign, indicating that this variable negatively affects HIIT by displacing trade.[31] This implies that FDI influences VIIT and HIIT in different ways. In other words, market-seeking FDI by MNCs enjoys the benefits associated with growing emerging markets, location advantages and substantial trade barriers. Similar findings of such market-seeking FDI motives by MNCs as a determinant of IIT patterns have been reported by Byun & Lee (2005), Chang (2009) and Veeramani (2009). Moreover, the results of this study suggest that intensive FDI activities by MNCs are a substitute for trade, thereby reducing HIIT and, as a result, potentially resulting in agglomeration effects. This is not surprising as high trade barriers provide incentives for multinational firms to engage in market-seeking FDI activities.

Next, the sign for the EoS variable is negative and statistically significant at the 5 per cent level of significance for both VIIT and TIIT. The EoS variable (EoS2) is defined as the absolute difference in total average vehicle production between South Africa and its bilateral trading partners and is some measure of EoS.[32] Thus, the negative sign on the EoS coefficient implies that large EoS are negatively correlated to VIIT and TIIT. Similar findings of negative statistically significant signs on the EoS (proxied by MES) coefficient for VIIT have been reported by Clark & Stanley (1999), confirming the argument of the existence of large

31 In the VIIT and TIIT regression models, the coefficients and t-statistics for FDI2 are reported, while for the HIIT regression the coefficients and t-statistics for FDI1 are reported (see Table 6.2).
32 The measure of EoS is applicable to the industry (external EoS) and may not necessarily be appropriate as a measure of firm-level (or internal) EoS.

EoS and a small number of firms. On the other hand, some authors interpret the negative coefficient as confirming the paradigm of a large number of firms and the competitive structure of the industry (Faustino & Leitão, 2007; Byun & Lee, 2005). These results imply that the number of firms (consolidation) in the industry should be reduced and production volumes increased accompanied by lower unit costs. Thus, greater EoS would be achieved, which could subsequently encourage VIIT. In addition, a negative sign on the EoS coefficient in the context of fragmentation theory and outsourcing reveals that the existence of EoS deters domestic firms from outsourcing activities and thus reducing trade (Clark & Stanley, 1999; Türkan, 2005). In the HIIT regression model, the EoS variable is proxied by the bilateral average of total average vehicle production (EoS1) between South Africa and its trading partners. The EoS (EoS1) coefficient is negative and not significantly different from zero, indicating that EoS are not important in explaining HIIT in the South African automobile industry. Analogous findings of the non-significance of EoS in explaining HIIT have been reported by Clark (2005), Faustino & Leitão (2007) and Türkan (2005).

The coefficient of the automotive assistance (AA) variable is negative and statistically significant at the 1 per cent and 10 per cent levels of significance for VIIT (and TIIT) and HIIT respectively. Thus, lower AA is expected to positively influence IIT patterns in the automobile industry. This result implies that by reducing government support to inefficient firms, they will be forced to leave the industry thus reducing the number of firms and plants (potentially increasing EoS and specialisation activities). This development is likely to result in larger output and trade outcomes contributing to rising IIT. On the demand side, consumers are expected to benefit from lower prices and differentiated automotive products. Although, the potential labour adjustment costs in the short run is expected, as the industry becomes more competitive and efficient trade opportunities are likely to be created in the medium–to–long term. This finding is in accordance with the WTO Agreement on Subsidies and Countervailing Measures (SCM), which is to be phased out. In addition, the study experimented with interactions between tariffs and automotive assistance (TAR×AA) in an attempt to capture the industrial trade policy impact on IIT patterns in the automobile industry. The findings indicate a positive but insignificant impact on VIIT and TIIT, but a negative and statistically significant impact on HIIT.[33] This result indicates that protection policies serve to weaken HIIT levels in the automobile industry.

Several studies reveal that trade barriers such as tariffs (TAR) impact negatively on IIT (Lee, 1992; Sharma, 2004; Veeramani, 2009). Unexpectedly, the TAR coefficient in this study is positive and statistically significant at the 5 per cent level of significance, suggesting that protection such as tariffs positively influence VIIT in the South African automobile industry. This result corroborates findings by Al-Mawali (2005) and Kind & Hathcote (2004) whereby positive signs on the coefficient of the trade barrier variable were found, indicating that trade barriers positively influence IIT because protection stimulates multinational activities and encourages the intensity of IIT. Although the TAR coefficient possessed a highly negative statistically significant sign for the HIIT model, the inclusion of the TAR variable in this model rendered several other regressors insignificant and imposed misspecification problems on the model. Thus, the TAR variable was removed from the HIIT regression. This could have happened as a result of very low and sometimes zero observations for the HIIT indices between South Africa and several of its bilateral trading partners, such as Japan and others. Part of the future government policy (APDP), which is expected to commence in 2013 when the MIDP expires, tariffs applied to CBUs and CKDs are expected to remain fixed at 25 and 20 per cent respectively until 2020. Although not conclusively, this study proposes reducing tariffs applied to the automobile industry aligned with South Africa's main automotive trading partners. This proposition supports the Competition Commission's (CompCom, 2005) recommendation to reduce tariffs in line with trading partners that was derived from their investigation into high vehicle prices in the domestic industry.

In order to capture the effect of the exchange rate on bilateral IIT levels in the South African automobile industry, several proxies for the exchange rate (EXR) were considered in the regression models[34]. In the VIIT model, the coefficient of the exchange rate variable revealed a statistically significant positive sign, implying that depreciation (appreciation) encourages

33 The interaction between (TAR×AA) reduces the Adjusted R^2 to 0.32, 0.63 and 0.66 for HIIT, VIIT and TIIT models respectively.
34 These include the nominal and real effective exchange rate indices, the bilateral SA rand-US$ exchange rate and the SA rand-US$ exchange rate index.

(discourages) VIIT. However, the inclusion of this variable caused the insignificance of several explanatory variables in the VIIT model and was subsequently dropped from the regression. On the other hand, for the HIIT model, the bilateral exchange rate (EXR2) variable acquires a positive sign at the 1 per cent level of significance and improved the overall fit of the regression model.[35] In comparison, a depreciation of the bilateral exchange rate promotes IIT and confirms the findings by Montout *et al.* (2002), Sichei *et al*. (2007) and Thorpe & Zhang (2005).

The inclusion of the product differentiation (PD) variable was found to possess the correct signs for VIIT and HIIT, although insignificant. As greater differentiation of quality products in the automobile industry stimulates VIIT and non-standardisation of product variety stimulates HIIT, a positive sign for VIIT and a negative sign for HIIT on the PD coefficient are expected. In studies by Byun & Lee (2005) and Chang (2009), positive signs for VIIT and negative signs for HIIT on the PD coefficient are reported. The study then proceeded to experiment by incorporating the PD^2 variable. As already mentioned, in the absence of the PD^2 variable, the coefficient of PD has the correct sign for VIIT and HIIT, but is not significantly different from zero. Consequently, the inclusion of the coefficient of PD^2 revealed the opposing statistically significant negative and positive signs at the 1 per cent level for VIIT and HIIT patterns respectively. Moreover, the Adjusted R^2 decreased to 0.67 for VIIT and increased to 0.36 for HIIT. However, the inclusion of coefficients of PD and PD^2 contributed to problems associated with loss of degrees of freedom and altered the significance and signs of some of the other explanatory variables. In the end, they were dropped from the final estimation.

The trade imbalance (TIMB) control variable was also subsequently removed from the estimation of the final models of VIIT, HIIT and TIIT. Although negative and statistically significant signs for all patterns of IIT were found on the TIMB coefficient, its inclusion resulted in the misspecification of the estimated models. This result implies that the

35 The coefficient on the nominal effective exchange rate index (EXR1) in the HIIT also yielded the correct sign and was statistically significant. However, the use of the bilateral SA-US dollar exchange rate (EXR2) variable resulted in the overall better performance of the HIIT model.

methodologies (see Appendix C) used to measure the intensity of TIIT and to separate patterns of VIIT and HIIT are appropriate and valid for this study.

7.5 SUMMARY AND CONCLUSIONS

In this chapter, an empirical investigation of the country- and industry-specific determinants of bilateral IIT in the South African automobile industry, spanning the period 2000 to 2007, was undertaken. More specifically, several country- and industry-specific hypotheses concerning VIIT, HIIT and TIIT were estimated and tested using a gravity model of trade.

The gravity models of IIT patterns were estimated using three different econometric procedures, namely, pooled, fixed effects and random effects models. The econometric results of the gravity models of IIT patterns, namely VIIT and HIIT, were found to be statistically and economically significant in the context of the fixed effects method of estimation and in accordance with new trade theory. The empirical results reveal that relative difference in economic size, trade openness, FDI and tariffs stimulate VIIT, whilst distance, EoS and automotive assistance negatively affect it. On the other hand, relative difference in economic size, FDI, and automotive assistance negatively affect HIIT, whereas trade openness and the depreciation of the exchange rate positively influence it. Moreover, the findings assert that the FDI strategies and motives of multinational firms in the automobile industry are market-seeking for HIIT and efficiency-seeking for VIIT.

The thesis also showed that the regression model for HIIT in the automobile industry exhibited weaker explanatory power compared to the VIIT model. This is not surprising since South Africa’s bilateral IIT is largely dominated by VIIT. The econometric results of the research also revealed that country and industry determinants affect VIIT and HIIT in different ways indicating the importance of decomposing TIIT into patterns of VIIT and HIIT. The overall findings of the thesis propose further trade liberalisation and deregulation of the South African automobile industry in an effort to attract greater efficiency-seeking FDI and, in doing so, enhance IIT levels.

CHAPTER 8

SUMMARY AND CONCLUSIONS

8.1 INTRODUCTION

The thesis set out to measure the empirical significance of IIT in the automobile industry and to analyse IIT patterns, namely VIIT and HIIT, between South Africa and its main trading partners. Next, the thesis developed a model of IIT to empirically identify and investigate potential country- and industry-specific determinants of bilateral IIT patterns in the South African automobile industry. More specifically, the study developed an empirical model to investigate the determinants of VIIT and HIIT patterns in the South African automobile industry using panel data econometric techniques.

This thesis is a first attempt to conduct such an empirical investigation of IIT patterns between South Africa and selected bilateral trading partners in the automobile industry.

At this time it is important to re-emphasise the objectives of this thesis. It is well known that the impact of government policy on the automobile industry is a critical one and this will be left to be explored by future research. Notwithstanding, emanating from the empirical findings, this thesis presents several important implications for government policy. Moreover, the empirical findings of this study are expected to provide valuable information for trade analysts, policy makers and the manufacturers of automotive products to add to their understanding of the global trade flows of automotive products.

Section 8.2 presents the main findings of the thesis. In the following section, Section 8.3, policy recommendations inferred from the findings of the thesis are offered. Section 8.4 presents some of the limitations of the thesis and also offers some insights for areas of future research arising from the limitations.

8.2 MAIN FINDINGS OF THE THESIS

The purpose of this study was to investigate country- and industry-specific determinants of IIT patterns in the South African automobile industry. The study used South Africa's HS 6-digit level bilateral trade data for selected countries in the automobile industry, spanning the period 2000 to 2007, to test several hypotheses. Importantly, the hypotheses presented and tested in this thesis were extracted from theoretical models of IIT theories, namely VIIT and

HIIT theory, and also considered some issues of the fragmentation theory of international production.

Firstly, the presence and intensity of bilateral IIT in the South African automobile industry has been empirically measured and can largely be explained by North–South trade or trade between unequal nations. This is not surprising as automotive trade between South Africa and its top three bilateral trading partners (USA, Germany and Japan) accounts for over 50 per cent of total automotive trade. The dominance of VIIT over HIIT in the South African automobile industry can largely be explained by H-O type trade theories whereby countries of difference in economic size reflecting factor endowment and technology differences tend to trade products that are differentiated by quality. By contrast, HIIT is very low in the South African automobile industry and is largely supported by the theoretical models of Helpman & Krugman (1985) and Markusen & Venables (2000). These models predict that countries that are similar in terms of economic size tend to trade in goods that are differentiated by variety. In addition, MNCs and market-seeking FDI strategies and trade protection are important factors influencing HIIT.

The proposal that South Africa has a comparative advantage in producing and exporting high-quality VIIT products is in contrast to theoretical predictions by Falvey & Kierzkowski (1987) and can in some ways be explained by the vertical specialisation and fragmented production chains occurring in the same product category (Ando, 2006). This occurrence may be indirectly linked to the MIDP which encourages MNC and FDI activities in the domestic market, including the facilitation of transfer of production technologies used to manufacture better quality automotive products. Notwithstanding, South Africa is eminent in possessing a comparative advantage in capital-intensive techniques despite its apparent labour abundance (Alleyne & Subramanian, 2001).

Secondly, the econometric results reveal that difference in relative economic size, trade openness, FDI and tariffs stimulate VIIT, whilst distance, EoS and automotive assistance negatively affect it. On the hand, differences in relative economic size, FDI and automotive assistance negatively influence HIIT, whereas trade openness and depreciation of the exchange rate positively affect it. Furthermore, the presence of MNCs and FDI strategies appear to displace HIIT (market-seeking FDI) thereby encouraging agglomeration activities in the domestic industry whilst FDI motives by MNCs are complementary to trade and tend to promote VIIT (efficiency-seeking FDI).

Thirdly, the findings of this thesis related to the impact of market size (as proxied by the bilateral average of GDP) and average standard of living (as proxied by bilateral average of GDP per capita) on IIT patterns are inconclusive, as the coefficients of these explanatory variables possessed the incorrect signs and were sometimes not significantly different from zero in the econometric estimation when combined with other explanatory variables indicating the presence of multicollinearity. They were subsequently removed from the estimation of the final models of VIIT, HIIT and TIIT. In addition, when including explanatory variables of product differentiation and the trade imbalance, although the correct signs were revealed, misspecification of the regression models occurred and consequently they were also dropped from the final econometric analysis. In the case of the potential effects of the regional integration on IIT patterns estimated in a secondary regression (see Footnote 29), the sign on the coefficients reveal mixed results. Accordingly, the EU dummy revealed insignificant impacts on VIIT and TIIT, while the impact on HIIT was significantly positive. In addition, the NAFTA dummy displayed statistically significant positive impacts on all IIT patterns in the automobile industry. Thus, there may be some merit in favour of South Africa potentially upgrading AGOA to establish a US-FTA, which may be expected to provide trade-creating effects and to benefit the domestic automobile industry.

Fourthly, the results reveal that VIIT and HIIT can largely be explained differently by the factors. The findings suggest that difference in economic size and FDI impose differing impacts on VIIT and HIIT patterns. In particular, efficiency-seeking FDI strategies by MNCs influence VIIT, whereas market-seeking FDI strategies determine HIIT. Although trade openness and automotive assistance tend to influence VIIT and HIIT in the same way, distance, tariffs and EoS affect VIIT negatively with no impact on HIIT. Additionally, HIIT is influenced by depreciation of the exchange rate.

Last of all, several policy recommendations arise from the findings of this thesis and will be discussed in the next section of this chapter. Policy implications and recommendations for future automotive policy will be discussed at this juncture.

8.3 POLICY RECOMMENDATIONS

Several policy implications arise from the findings of this thesis that will be valuable for trade policy analysts, policy makers and manufacturers of automotive products.

Firstly, the thesis argues in favour of further trade liberalisation and deregulation of the South African automobile industry, as greater trade openness and deregulation are expected to attract greater efficiency-seeking FDI so as to increase VIIT and consequently TIIT in the automobile industry. The results of the thesis offer support for the argument that market-seeking FDI is encouraged by protectionist policies and contribute to the deterioration of balance of payments and causes terms of trade problems in the long run through the repatriation of funds (Nunnencamp & Spatz, 2004).

Secondly, trade barriers (tariffs and automotive assistance) as part of automotive policy should be reduced and geared to more unbiased competitive practices that can contribute to increased domestic manufacturing output and stimulate IIT. In the domestic automobile industry, under the new APDP, tariffs are expected to remain fixed at 25 per cent and 20 per cent for CBUs and CKDs respectively from 2013 until 2020. Thus, this thesis offers support for further tariff liberalisation, which could attract efficiency-seeking FDI, reduce domestic prices and result in inefficient producers exiting the industry.

More specifically, the thesis also argues in favour of reducing automotive assistance to the industry in an attempt to increase IIT levels. It is well known from trade theory that production subsidies are less distorting compared to export subsidies. Under the new APDP, the IEC scheme (export subsidy) is expected to be terminated whilst the introduction of production subsidies is expected. This indicates that the government's policy is somewhat geared to the correct policy direction. Another concern is that the government's automotive policy incentives are largely biased against component manufacturers while largely benefiting OEMs. These incentives should be redesigned as more neutral by reducing support to OEMs and in some way include incentives for component manufacturers, especially in areas that can contribute to increasing their manufacturing capacity. The automotive investment incentive scheme as part of the future APDP that largely favours OEMs is expected to contribute positively to increasing manufacturing capacity and technology innovations and processes. However, it is also expected to contribute to reducing welfare costs. This is argument is supported by the findings of a study conducted by the Productivity

Commission (2005) in Australia, which revealed that automotive assistance contributes positively to large-scale capital investments while distorting prices and displacing resources away from efficient productive uses, thereby reducing the international competitiveness of the domestic industry.

Thirdly, related to the explanations above, perhaps some consolidation in the domestic industry is necessary. Such a development could contribute to efficient production and the achievement of greater EoS in production and the profitability of industry stakeholders in the long run that could outweigh some of short-term adjustment costs (e.g. reduction in labour) that are likely to be associated with firms exiting the industry. However, it has been argued that increasing IIT levels in the domestic industry is typically associated with lower adjustment costs compared to increasing inter-industry trade in total trade.

Fourthly, the study is of the opinion that greater investments should be directed to ICT and physical infrastructure (roads, rail, shipping and freight) in order to improve the trade costs associated with geographical distance and the service links and connections necessary for effectively increasing VIIT and fragmentation and international production processes.

Finally, R&D by OEMs and component manufactures is regarded as being inadequate compared to international competitors. The thesis recommends that OEMs reduce capital expenditure on support mechanisms (local content and export incentives) and increase the share of capital expenditure on R&D to at least 5 per cent. Although, the industry has experienced export success in recent years, this expansion is observed as having occurred at the cost of industry employment (Flatters, 2003) and has contributed to reduced domestic production, especially in component manufacturing. In this case, greater investment in engineering technology and education and training could improve manufacturing capacity and productivity levels, which could in turn facilitate competition and trade in component manufacturing.

8.4 LIMITATIONS OF THE THESIS AND FUTURE RESEARCH

First, the methodology used to separate TIIT into VIIT and HIIT rests on the positive relationship between price (or unit value) and quality. Further, the assumption that large price (unit value) differences imply differentiation by quality is adopted. However, in this thesis, the assumption that high prices (or unit values) reflect high quality may not necessarily be accurate. Aiginger (1997) argues that trade deficits combined with high unit costs potentially imply high costs instead of high quality. The approaches to quality developed by Greenaway *et al*. (1994, 1995) and Fontagné & Freudenberg (1997) are typically based on thresholds of 15 and 25 per cent and may lead to possible distortions in the measurement of product quality in IIT and hence to inaccurate measures of the extent of VIIT and HIIT patterns (Azhar & Elliott, 2006). This is an obvious shortcoming of the threshold methodology based on relative unit value differences between exports and imports as is adopted in this thesis. However, this method has merit and is widely used in the international trade literature whereby most studies use 10, 15 and 25 per cent thresholds. Importantly, this thesis improved on past studies by employing a more stringent threshold of 35 per cent for robustness and sensitivity analysis. In the end, the overall findings were not altered and the dominance of VIIT in the South African automobile industry is confirmed. Nevertheless, further research is required to investigate whether high prices or relative export unit values are conclusively associated with high quality or high costs and refinement of the methodologies to decompose TIIT into its patterns.

Second, it is commonly accepted in the empirical literature that the gravity methodology does not allow for the evaluation of welfare implications of IIT, which is an obvious caveat of this study. At best, the findings of this thesis argue in favour of reducing protectionist policies and further deregulation of the industry, which indirectly infers efficiency concerns and positive welfare implications in the automobile industry. It is important to point out that some welfare implications can be inferred from gravity models of IIT. For example, consumer welfare increases as a result of greater variety and higher quality of goods at lower prices. On the supply side, more efficient producers remain in the industry as a result of lower unit costs of production (EoS), the adoption of improved technology and higher output. Further research is warranted to investigate welfare and efficiency concerns using different methodologies such as computable general equilibrium (CGE) modelling, as the gravity model is not necessarily appropriate for such an investigation. Thus, future research proposes the adoption of CGE analysis to investigate the welfare and efficiency effects of trade policy on the South African automobile industry.

Lastly, a potential shortcoming of the panel data econometric specification employed in the thesis is the relatively small sample of countries used in the econometric investigation. This shortcoming is related to the availability of reliable and consistent data for all the initial countries ($N = 20$) used in this thesis. Several countries were dropped from the regression model for those reasons. In addition, alternate more sophisticated panel data, econometric procedures and estimation methods should be explored. For example, to deal with the small sample bias, future research recommends adopting the dynamic modelling of panel data using GMM approach in a gravity model specification.

Other ways to improve the econometric analysis include testing other explanatory variables and develop better proxies – *industry* and *firm-level data* – such as wage rates for unskilled, skilled and professional workers, automotive MNC-specific FDI activities and EoS, R&D, human capital, productivity and ICT, among others as superior data becomes available. This is especially true for developing countries. The lack of reliable data for developing countries, especially for sectoral and industry data, has meant that certain important factors could not be investigated as determinants of IIT that might have been critical. However, it should be pointed out that the research in this thesis introduced a new industry-specific proxy for the EoS variable and a new industry explanatory variable and proxy (automotive assistance) in the econometric investigation. Consequently, both industry determinants yield satisfactory impacts on IIT patterns. Another challenge is the inability of international trade data to reflect the whole structure of international production (cross-border) distribution and production networks requires the availability and use firm-level data (Kimaru, 2006). Nevertheless, the use of trade data, especially *product level* data as was used in this thesis, provides valuable information. The thesis recommends developing databases of firm-level data for advanced empirical investigations.

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APPENDIX A

Commodity description of harmonised system (HS) coding system: automotives and related products at the 6-digit level

Number	HS-6 digit code of product descriptions
	Final products (Automobiles)
	Motor vehicles and other vehicles for transport of persons
1	H870210: Diesel powered buses with a seating capacity of > nine persons
2	H870290: Buses except diesel powered
3	H870310: Snowmobiles, golf cars, similar vehicles
4	H870321: Automobiles, spark ignition engine of <1000 cc
5	H870322: Automobiles, spark ignition engine of 1000-1500 cc
6	H870323: Automobiles, spark ignition engine of 1500-3000 cc
7	H870324: Automobiles, spark ignition engine of >3000 cc
8	H870331: Automobiles, diesel engine of <1500 cc
9	H870332: Automobiles, diesel engine of 1500-2500 cc
10	H870333: Automobiles, diesel engine of >2500 cc
11	H870390: Automobiles nes including gas turbine powered
12	H870399: Motor cars and other motor vehicles, including station wagons and racing cars
	Motor vehicles for transport of goods
13	H870410: Dump trucks designed for off-highway use
14	H870421: Diesel powered trucks weighing < 5 tonnes
15	H870422: Diesel powered trucks weighing 5-20 tonnes
16	H870423: Diesel powered trucks weighing > 20 tonnes
17	H870431: Spark ignition engine trucks weighing < 5 tonnes
18	H870432: Spark ignition engine trucks weighing > 5 tonnes
19	H870490: Trucks nes
20	H870499: Motor vehicles for the transport of goods - other
21	H870510: Mobile cranes
22	H870520: Mobile drilling derricks
23	H870530: Fire fighting vehicles
24	H870540: Mobile concrete mixers
25	H870590: Special purpose motor vehicles nes
26	H870600: Motor vehicle chassis fitted with engine
27	H870699: Chassis fitted with engines, for the motor vehicles of headings nos. 87.01 to 87.05
	Intermediate products (Automotive and related components)
	Vehicle bodies
28	H870710: Bodies for passenger carrying vehicles
29	H870790: Bodies for tractors, buses, trucks etc
	Vehicle parts
30	H870810: Bumpers and parts thereof for motor vehicles
31	H870821: Safety seat belts for motor vehicles

32	H870829: Parts and accessories of bodies nes for motor vehicles
33	H870830: Brakes and servo-brakes and parts thereof
34	H870831: Mounted brake linings for motor vehicles
35	H870839: Brake system parts except linings for motor vehicles
	Transmissions
36	H870840: Transmissions for motor vehicles
37	H870850: Drive axles with differential for motor vehicles
38	H870860: Non-driving axles/parts for motor vehicles
39	H870870: Wheels including parts/accessories for motor vehicles
40	H870880: Shock absorbers for motor vehicles
41	H870890: Other parts and accessories
42	H870891: Radiators for motor vehicles
43	H870892: Mufflers and exhaust pipes for motor vehicles
44	H870893: Clutches and parts thereof for motor vehicles
45	H870894: Steering wheels, columns & boxes for motor vehicles
46	H870895: Safety airbags with inflater system; parts thereof
47	H870899: Motor vehicle parts, nes
	Metal parts
48	H830120: Locks of a kind used for motor vehicles of base metal
49	H830230: Motor vehicle mountings, fittings, of base metal, nes
	Engine and engine parts
50	H840731: Engines, spark-ignition reciprocating, <50 cc
51	H840732: Engines, spark-ignition reciprocating, 50-250 cc
52	H840733: Engines, spark-ignition reciprocating, 250-1000 cc
53	H840734: Engines, spark-ignition reciprocating, over 1000 cc
54	H840790: Engines, spark-ignition type nes
55	H840820: Engines, diesel, for motor vehicles
56	H840991: Parts for spark-ignition engines except aircraft
57	H840999: Parts for diesel and semi-diesel engines
58	H841330: Fuel, lubricating and cooling pumps for motor engines
59	H841520: Air cond used in vehicle
60	H842123: Oil/petrol filters for internal combustion engines
61	H842131: Intake air filters for internal combustion engines
62	H842542: Hydraulic jacks/hoists except for garages
	Machinery parts
63	H848310: Transmission shafts and cranks, cam and crank shafts
64	H848320: Bearing housings etc incorporating ball/roller bearing
65	H848330: Bearing housings, shafts, without ball/roller bearings
66	H848340: Gearing, ball screws, speed changers, torque converter
67	H848350: Flywheels and pulleys including pulley blocks
68	H848360: Clutches, shaft couplings, universal joints
69	H848390: Parts of power transmission etc equipment
70	H848410: Gaskets of metal sheeting, including sandwich type
71	H848420: Mechanical seals

72	H848490: Gasket sets, other joints of similar composition
	Electric parts
73	H850710: Lead-acid electric accumulators (vehicle)
74	H850720: Lead-acid electric accumulators except for vehicles
75	H850730: Nickel-cadmium electric accumulators
76	H850780: Electric accumulators, nes
77	H851110: Spark plugs
78	H851120: Ignition magnetos, magneto-generators and flywheels
79	H851130: Distributors and ignition coils
80	H851140: Starter motors
81	H851150: Generators and alternators
82	H851180: Glow plugs & other ignition or starting equipment nes
83	H851190: Parts of electrical ignition or starting equipment
84	H851220: Lighting/visual signalling equipment nes
85	H851230: Sound signalling equipment
86	H851240: Windscreen wipers/defrosters/demisters
87	H851290: Parts of cycle & vehicle light, signal, etc equipment
88	H851829: Loudspeakers, nes
89	H852721: Radio receivers, external power, sound reproduce/record
90	H852729: Radio receivers, external power, not sound reproducer
91	H853921: Filament lamps, tungsten halogen
92	H853922: Filament lamps, of a power <= 200 Watt, > 100 volts
93	H853929: Filament lamps, except ultraviolet or infra-red, nes
94	H854430: Ignition/other wiring sets for vehicles/aircraft/ship
	Other parts
95	H902519: Thermometers, except liquid filled
96	H902610: Equipment to measure or check liquid flow or level
97	H902620: Equipment to measure or check pressure
98	H902680: Equipment to measure, check gas/liquid properties nes
99	H902910: Revolution counters/taximeters/mileometers/pedometers
100	H902920: Speed indicators, tachometers, stroboscopes
101	H903033: Other, without a recording device
102	H903039: Ammeters, voltmeters, ohm meters, etc, non-recording
103	H903210: Thermostats
104	H903281: Hydraulic and pneumatic automatic controls
105	H903289: Automatic regulating/controlling equipment nes
106	H910400: Instrument panel clocks etc for vehicles/aircraft etc
107	H940120: Seats, motor vehicles
108	H940190: Parts of seats
109	H980100: Original equipment components
111	H700711: Safety glass (tempered) for vehicles, aircraft, etc
112	H700721: Safety glass (laminated) for vehicles, aircraft, etc
113	H700910: Rear-view mirrors for vehicles
114	H401110: Pneumatic tyres new of rubber for motor cars

115	H401120: Pneumatic tyres new of rubber for buses or lorries
116	H401220: Pneumatic tyres used
117	H401290: Solid or cushioned tyres, interchangeable treads
111	H401310: Inner tubes of rubber for motor vehicles
118	H401390: Inner tubes of rubber except bicycle or motor vehicle

Source: Compiled from Quantec database

APPENDIX B

List of countries used in the regression analysis

Region	Countries
EU and Other Europe	United Kingdom (UK), Germany (DEU), Spain (ESP), France (FRA) Sweden (SWE), Italy (ITA) and Turkey (TUR).
NAFTA	United States of America (USA)
Africa	Zambia (ZAM), Mozambique (MOZ), Angola (AGO)
Asia-Pacific	Hong Kong (HK), China (CHN), Japan (JAP), Rep Korea (KOR), Taiwan (TAW), India (IND), Thailand (THA) and Australia (AUS)
MERCOSUR	Brazil (BRA)

APPENDIX C

Summary of classification of trade patterns

Trade Pattern	Formula of index/ degree of trade overlap	Description
Two-way trade or intra-industry trade (IIT)	$GL_{ij,kt} = \frac{\left(X_{ij,kt} + M_{ij,kt}\right) - \left\|X_{ij,kt} - M_{ij,kt}\right\|}{\left(X_{ij,kt} + M_{ij,kt}\right)}$	Index lies between 0 and 1, equal to share of IIT in total trade.
One-way trade (OWT) or inter-industry trade	$FF_{ij,kt} = \frac{Min(X_{ij,kt}, M_{ij,kt})}{Max(X_{ij,kt}, M_{ij,kt})} \geq 10\%$	No significant overlap ≤10 per cent reflects OWT.
Horizontal intra-industry trade (HIIT)	$1 - \alpha \leq \frac{UV^X_{ij,kt}}{UV^M_{ij,kt}} \leq 1 + \alpha$	Overlap/IIT with small unit value differential where α=0.25 (0.15; 0.35)
Vertical intra-industry trade (VIIT)	$\frac{UV^X_{ij,kt}}{UV^M_{ij,kt}} < 1 - \alpha$ or $\frac{UV^X_{ij,kt}}{UV^M_{ij,kt}} > 1 + \alpha$	Overlap/IIT with large value unit value differentials where α=0.25 (0.15; 0.35)

Source: Author's compilation

APPENDIX D

List of selected empirical studies of determinants of IIT patterns

Author(s)	Model specification(s)	Determinants (Explanatory variables)	TIIT	VIIT	HIIT
Al-Mawali (2005)	Pooled, FE, Between and RE	Joint market size (GDP×GDP*j*)(+), distance (DIST)(-), technology gap(+/-), human capital differences (DHUM)(ns), landlockedness (LAND)(ns), political risk (POL)(ns), intellectual property rights(ns/-), trade barriers (TB)(tariffs)(+), trade intensity (TI)(+) & regional dummies (REG)(ns).	√	√	√
Aturupane, *et al.* (1999)	Non-linear least squares	Foreign direct investment (FDI)(+), economies of scale (EoS)(+/-), product differentiation (PD)(+/-), concentration (CONC)(ns/+) & labour intensity (L)(+/-) .	√	√	√
Byun & Lee (2005)	Tobit model	DGNIPC(+), DHUM(+/ns), EoS(-), market structure (MS)(+), FDI(-ns), trade imbalance (TIMB)(-), (REG)(+), economic development (+), factor endowment difference (CAPLAB)(+/-), PD(+/-) & DIST(-).	√	√	√
Clark (2005)	Tobit model	Size of trading partner (GDP*j*)(+), DGDPC(-), PD (+), EoS(ns), technology intensity (TECH)(+), MS(ns), vertical specialisation (VS)(+), TIMB(-), TO(+) & international transport charges (-).	√	×	×
Chemsripong *et al.* (2005)	Pool–SUR (Lin-log) and Logistic model	Average GDP of *i* and *j* (SIZE)(+), DGDPC(+), DIST(-), culture (CUL)(+) & TO(+).	√	×	×
Chang (2009)	RE (Linear)	GDPC(-/+), FDI(-), R&D/GDP(+/-), EDU/GDP(+/-), PD(+/-), RCA(+/-) & REG(+/-).	√	√	√
Fontagné *et al.* (1997)	FE (Log-log)	SIZE(+), DGDP(+/-), GDPC(+), DGDPC(+/-) DIST(-), NTB(+), FDI(+), PD(+/-), EoS(+) & EXR(+).	√	√	√
Fukao *et al.* (2003)	OLS & Instrumental variable (IV) approach	DGDPC(+), DIST(-), FDI(+), INDSIZE(+), DHUM & RDUM(+/-). IV (various).	×	√	×
Faustino & Leitão (2007)	Pooled, FE and RE. Dynamic panel data (GMM estimators)*	EoS(*na*/ns), (CONC)(+/-), PD(ns), capital/labour ratio (K/L) (+/-), intensity of human capital (HCS/L)(+/-), labour (L)(-/+), human capital (HC)(+/-), productivity (PROD)(ns) & FDI(ns).	×	√	√
Hirchberg *et al.* (1994)	Tobit model	DGDP(ns), INEQGDPC (-/+), $GDPC_i$(+), border(BOR)(+), DIST(-), (EXR)(-) & REG(+).	√	√	√
Hu & Ma (1999)	OLS (linear) and Tobit model	DGDPC(+) enrolment ratio of degree students(ns), EDU/GDP(+), share of manufactured X/total X(+), income distribution(-), FDI(*na*/+), MES(+) & (R&D)(+) & PD)(+/*na*).	√	√	√

Kind & Hathcote (2004)	Non-linear least squares	DGNIPC(-) DGDP(-), DIST(+), TB (tariffs)(+) & trade deficit (TD)(-) .	√	×	×
Montout *et al.* (2002)	FE (log-log)	SIZE(+), RDGDP(-), PCI(+), DPCI(-), DIST(-), MES(*na*/-), EXR(-) & REG(+).	√	√	√
Sharma (2004)	FE, RE (VIIT and TIIT) and Tobit model (HIIT)	EoS(-ns/+), MS(-/ns), PD(ns), effective rate of assistance (ERA)(-) & R&D(ns/-).	√	√	√
Sichei *et al.* (2005)	Logit model (GLM, wild bootstrapping)	RDGDP(-), DGDPC(-), EXR(+), degree of economic freedom(+), trade openness (ns) & FDI(+).	√	×	×
Thorpe & Zhang (2005)	OLS (Linear)	SIZE(+/-), RDGDP(+/-), GDPPC(+/-), DGDPC(-/-), DIST(ns), EoS(+/-), EXR(+) & TIMB(-) & TO(+).	√	√	√
Türkan (2005)	Pooled, FE and RE (Linear)	SIZE(+), RDGDP(+/-), weighted distance (WDIST)(-), DHUM(-) & EoS(ns).	√	√	√
Türkan (2009)	Pooled, FE, FGLS and Logit	SIZE(+), DGDP(ns), DGDPC(+), WDIST(-), FDI(+), EXR(ns) & REG(-).	×	√	×
Veeramani (2009)	FE & RE*	TAR(-), quantitative restrictions (QR)(-), FDI(+), (FDI×TAR)(-), (FDI×QR)(-), MES(-) & PD(-ns).	√	×	×
Umemoto (2005)	Pooled & FE*	SIZE(-), DGDP(+), GDPC(ns), DGDPC(ns) & DIST(-).	×	√	×
Zhang *et al.* (2005)	Factor analysis and GLS (cross section weights).	SIZE(+/-), DIST(+), BOR(+), CUL(+/-), public education expenditures (EDU)(+/-), school enrolments (EDU(+/-), difference in electric power consumption per capita (ELECONS)(+/-), GINI(+/-), FDI(-/+) & TAR(-).	√	√	√
Zhang & Li (2006)	Pooled and FE (log-log)	SIZE(+), RDGDP(-/ns), DGDPC(+/-), FDI(-/+), TO(+) & DIST(+ns).	√	√	√

Source: Author's compilation

Notes: ns=not significant, (+)=positive, (-)=negative, If (+/-) indicate correct sign for VIIT and HIIT, respectively, otherwise correct sign applies to all IIT patterns, (√)=yes, (×)=no, (*) denotes the preferred model. RE=random effects and FE=fixed effects.

APPENDIX E

Grubel & Lloyd (G-L) indices of IIT shares for automotive products, 2000-2007

Region/Country	2000	2001	2002	2003	2004	2005	2006	2007
ROW	0.701	0.741	0.755	0.762	0.708	0.647	0.627	0.612
NAFTA								
USA	0.811	0.865	0.825	0.851	0.979	0.703	0.947	0.815
Europe								
Sweden	0.126	0.128	0.141	0.138	0.096	0.098	0.410	0.254
Turkey	0.238	0.186	0.112	0.209	0.164	0.042	0.546	0.388
Spain	0.351	0.390	0.530	0.506	0.433	0.460	0.412	0.525
Italy	0.434	0.357	0.344	0.364	0.260	0.215	0.369	0.254
France	0.170	0.123	0.340	0.317	0.171	0.158	0.363	0.677
United Kingdom	0.977	0.671	0.724	0.766	0.626	0.759	0.951	0.435
Germany	0.841	0.597	0.548	0.457	0.462	0.240	0.386	0.467
Asia-Pacific								
Japan	0.186	0.382	0.470	0.762	0.640	0.670	0.568	0.812
China, Hong Kong	0.735	0.363	0.507	0.708	0.652	0.537	0.513	0.612
China, Taiwan	0.870	0.931	0.727	0.739	0.583	0.571	0.445	0.420
Australia	0.137	0.238	0.248	0.233	0.157	0.248	0.157	0.188
India	0.743	0.472	0.533	0.616	0.430	0.082	0.052	0.061
China	0.506	0.173	0.097	0.603	0.375	0.181	0.102	0.059
Thailand	0.067	0.053	0.066	0.031	0.018	0.008	0.009	0.015
Rep Korea	0.216	0.206	0.463	0.305	0.083	0.079	0.050	0.034
MERCOSUR and Africa								
Brazil	0.117	0.165	0.089	0.117	0.106	0.114	0.119	0.162
Mozambique	0.278	0.156	0.038	0.119	0.074	0.012	0.021	0.026
Zambia	0.098	0.010	0.036	0.047	0.009	0.022	0.013	0.006
Angola	0.009	0.002	0.003	0.004	0.010	0.011	0.005	0.007

Source: Authors' own calculations, Quantec data

APPENDIX F

Trade patterns of automotive products, 2000 and 2007

Country	2000						2007					
NAFTA												
USA	IIT	0.506	HIIT	0.005			IIT	0.571	HIIT	0.090		
			VIIT	0.501	HQ VIIT	0.449			VIIT	0.481	HQ VIIT	0.831
					LQ VIIT	0.551					LQ VIIT	0.169
	OWT	0.494					OWT	0.429				
Asia-Pacific												
Japan	IIT	0.116	HIIT	0.000			IIT	0.749	HIIT	0.000		
			VIIT	0.116	HQ VIIT	0.959			VIIT	0.749	HQ VIIT	1.000
					LQ VIIT	0.041					LQ VIIT	0.000
	OWT	0.884					OWT	0.251				
China	IIT	0.022	HIIT	0.000			IIT	0.065	HIIT	0.000		
			VIIT	0.022	HQ VIIT	0.966			VIIT	0.065	HQ VIIT	1.000
					LQ VIIT	0.034					LQ VIIT	0.000
	OWT	0.978					OWT	0.935				
India	IIT	0.095	HIIT	0.001			IIT	0.080	HIIT	0.033		
			VIIT	0.094	HQ VIIT	0.863			VIIT	0.047	HQ VIIT	0.702
					LQ VIIT	0.137					LQ VIIT	0.298
	OWT	0.905					OWT	0.920				
Australia	IIT	0.054	HIIT	0.000			IIT	0.148	HIIT	0.063		
			VIIT	0.054	HQ VIIT	0.024			VIIT	0.085	HQ VIIT	0.089
					LQ VIIT	0.976					LQ VIIT	0.911
	OWT	0.946					OWT	0.852				
Europe												
Germany	IIT	0.531	HIIT	0.050			IIT	0.309	HIIT	0.023		
			VIIT	0.481	HQ VIIT	0.861			VIIT	0.286	HQ VIIT	0.659
					LQ VIIT	0.139					LQ VIIT	0.341
	OWT	0.469					OWT	0.691				
UK	IIT	0.558	HIIT	0.025			IIT	0.454	HIIT	0.017		
			VIIT	0.533	HQ VIIT	0.146			VIIT	0.437	HQ	0.336
					LQ VIIT	0.854					LQ	0.664
	OWT	0.442					OWT	0.546				
Spain	IIT	0.128	HIIT	0.039			IIT	0.387	HIIT	0.239		
			VIIT	0.089	HQ VIIT	0.094			VIIT	0.148	HQ VIIT	0.608
					LQ VIIT	0.906					LQ VIIT	0.392
	OWT	0.872					OWT	0.613				
France	IIT	0.177	HIIT	0.001			IIT	0.456	HIIT	0.270		
			VIIT	0.176	HQ	0.125			VIIT	0.186	HQ VIIT	0.113
					LQ	0.875					LQ VIIT	0.887
	OWT	0.823					OWT	0.544				
Sweden	IIT	0.006	HIIT	0.000			IIT	0.136	HIIT	0.000		
			VIIT	0.006	HQ	0.918			VIIT	0.136	HQ VIIT	0.886
					LQ	0.082					LQ VIIT	0.114
	OWT	0.994					OWT	0.864				

Italy	IIT	0.174	HIIT	0.015			IIT	0.214	HIIT	0.058		
			VIIT	0.159	HQ VIIT	0.512			VIIT	0.156	HQ VIIT	0.863
					LQ VIIT	0.488					LQ VIIT	0.137
	OWT	0.826					OWT	0.786				
Turkey	IIT	0.156	HIIT	0.041			IIT	0.055	HIIT	0.000		
			VIIT	0.115	HQ VIIT	0.963			VIIT	0.055	HQ VIIT	0.972
					LQ VIIT	0.036					LQ VIIT	0.028
	OWT	0.844					OWT	0.945				
MERCOSUR												
Brazil	IIT	0.216	HIIT	0.045			IIT	0.084	HIIT	0.007		
			VIIT	0.171	HQ VIIT	0.137			VIIT	0.077	HQ VIIT	0.532
					LQ VIIT	0.863					LQ VIIT	0.468
	OWT	0.784					OWT	0.916				

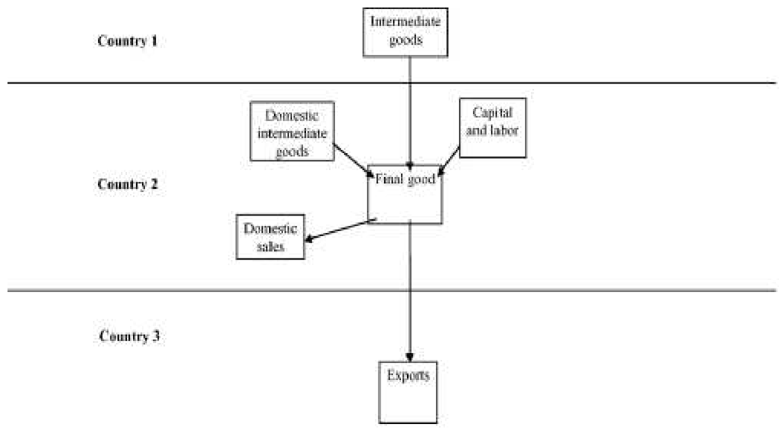
Source: Authors' own calculations, Quantec data

*Notes: *Estimates reported here are based on α=0.25. Thus, HQ VIIT and LQ VIIT shares are determined according to Equation (5.4); if* RUV^{XM} *> (1+α)=1.25 and* RUV^{XM} *< (1-α)=0.75, respectively.*

***Shares of HQ VIIT + LQ VIIT = VIIT (=1)*

APPENDIX G

A simple illustration of vertical specialisation



Source: Chen *et al*. (2005)

APPENDIX H

Pooled estimation results of VIIT, HIIT and TIIT

Explanatory variables	Dependent variables		
	VIIT	HIIT	TIIT
Constant	0.1979 (1.3990)	–0.4978 (–0.7743)	0.2508 (1.7335)*
$RDGDP_{ijt}$	0.2859 (3.6954)***	–0.0278 (–0.2933)	0.2279 (2.6995)***
$WDIST_{ij}$	–0.0315 (–1.4218)	0.0139 (0.4811)	0.0028 (0.1302)
TO_{ijt}	–0.0333 (–2.2654)**	–0.0295 (–1.3452)	–0.0303 (–1.4376)
FDI_{ijt}	0.0274 (4.0674)***	0.0248 (3.1867)***	0.0219 (4.3786)**
EoS_{ijt}	–0.0002 (–0.0375)	0.0238 (1.8882)**	0.0309 (1.7667)*
AA_{ijt}	0.0069 (0.5805)	–0.0034 (–0.1828)	–0.0427 (–2.2809)**
TAR_{ijt}	–0.0833 (–2.9648)***	*n/a*	–0.0589 (–1.6710)*
EXR_{ijt}	*n/a*	0.0029 (0.0477)	*n/a*
Adjusted R^2	0.44	0.09	0.48

*Notes: White cross-section t-values are given in parenthesis. n/a denotes variables dropped. Asterisks indicate (1%)***, (5%)** and (10%)* levels of statistical significance.*

APPENDIX I

Country-fixed effects of VIIT, HIIT and TIIT

Country	VIIT	HIIT	TIIT
	Dependent variables		
α Australia	–0.4637	–0.1267	–0.6206
α Brazil	–0.0687	0.0266#	–0.0713
α China	0.2534#	0.0268#	0.4433#
α France	–0.1191	0.0791#	–0.0751
α Germany	0.3197#	0.0770#	0.4127#
α India	–0.4057	–0.0930	–0.3595
α Italy	–0.2874	–0.0379	–0.3322
α Japan	1.0648#	0.0483#	1.0511#
α Spain	–0.2941	0.0275#	–0.3224
α Sweden	–0.7509	–0.1727	–0.9252
α Turkey	–0.4413	–0.1296	–0.6222
α United Kingdom	0.1035#	0.0408#	0.1100#
α United States	1.0896#	0.2336#	1.3115#

Notes: # indicates a positive sign.

APPENDIX J

Random effects estimation results of VIIT, HIIT and TIIT

Explanatory variables	Dependent variables		
	VIIT	HIIT	TIIT
Constant	0.8470 (1.8328)*	–0.4651 (–0.6822)	0.5731 (1.3315)
$RDGDP_{ijt}$	0.4733 (3.3995)***	–0.0285 (–0.2733)	0.3989 (2.6413)***
$WDIST_{ij}$	–0.0949 (–2.4971)***	0.0151 (0.4749)	–0.0527 (–1.2470)
TO_{ijt}	0.0425 (0.4232)	–0.0303 (–1.2760)	0.0063 (0.0832)
FDI_{ijt}	0.0315 (1.8005)*	0.0244 (2.8716)***	0.0260 (1.4038)
EoS_{ijt}	0.0085 (0.6795)	0.0210 (1.6803)*	0.0060 (0.4380)
AA_{ijt}	–0.0213 (–0.3039)	–0.0020 (–0.1014)	–0.0238 (–0.5335)
TAR_{ijt}	–0.0588 (–0.4377)	*n/a*	–0.0819 (–0.6679)
EXR_{ijt}	*n/a*	0.0020 (0.0326)	*n/a*
Adjusted R^2	0.02	0.06	0.02

Notes: White cross-section t-values are given in parenthesis. n/a denotes variables dropped.
*Asterisks indicate (1%)***, (5%)** and (10%)* levels of statistical significance*
Random country effects are not reported.