

CHAPTER 5

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

5.1 INTRODUCTION

The purpose of this chapter is to identify trade patterns in the South African automobile industry by empirically analysing bilateral IIT shares in the industry¹⁴ 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 VIIT³ 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:

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

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:

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

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 IIT⁴, 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 & Kierzkowski (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:

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

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:

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

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

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

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 $\alpha = 0.25$) or fall outside a specified range of $\pm \alpha$. 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 $\pm \alpha$. 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 $\alpha = 15$ and 35 per cent. As suggested by Greenaway *et al.* (1994) and Fontagné 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:

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

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 investigation. 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.

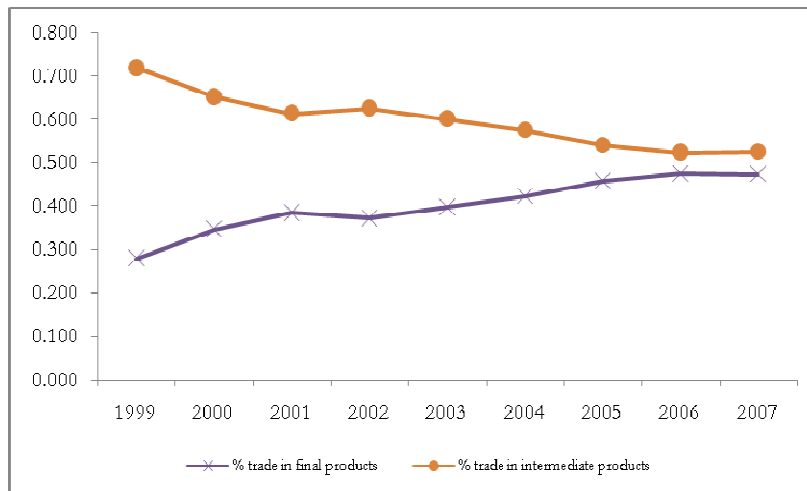
Table 5.1 Illustration of HS87 2-digit, 4-digit and 6-digit coding and descriptions

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



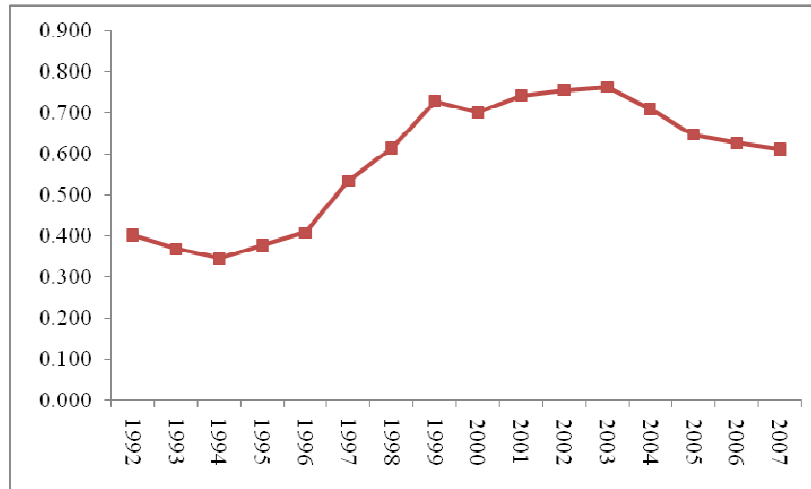
Source: Author's own calculations, Quantec data

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 manufacturers. 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

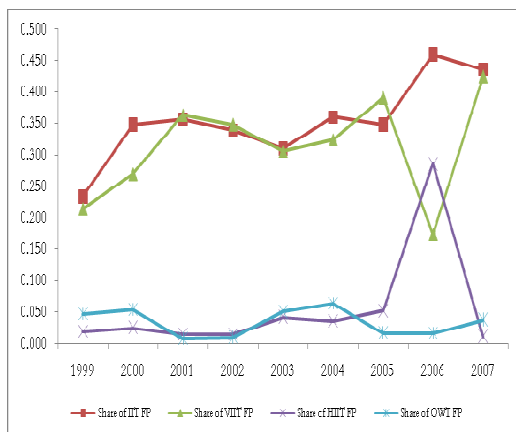
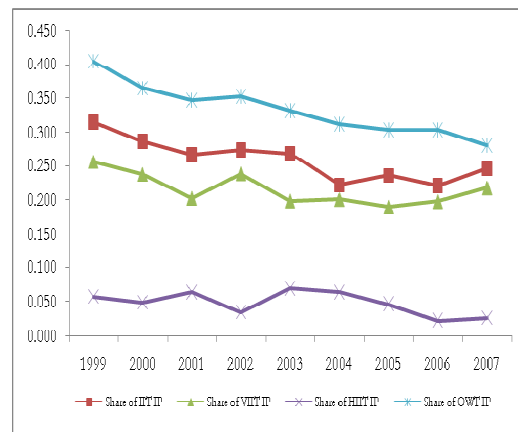


Figure 5.3(ii) Automobile components



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			Country/ region	Trade type	Year		
		2000	2003	2007			2000	2003	2007
NAFTA					Europe				
USA	Share IIT	0.506	0.191	0.571	Germany	Share IIT	0.531	0.379	0.309
	Share OWT	0.494	0.809	0.429		Share OWT	0.469	0.621	0.691
Asia-Pacific					UK	Share IIT	0.558	0.434	0.454
Japan	Share IIT	0.116	0.284	0.749		Share OWT	0.442	0.566	0.546
	India	Share IIT	0.095	0.400	0.080	Spain	Share IIT	0.128	0.108
Share OWT		0.905	0.600	0.920	Share OWT		0.872	0.892	0.613
Taiwan	Share IIT	0.010	0.076	0.056	France	Share IIT	0.177	0.236	0.456
	Share OWT	0.990	0.924	0.944		Share OWT	0.823	0.764	0.544
China	Share IIT	0.022	0.277	0.065	Sweden	Share IIT	0.006	0.073	0.136
	Share OWT	0.978	0.723	0.935		Share OWT	0.994	0.927	0.864
China Hong Kong	Share IIT	0.070	0.064	0.010	Italy	Share IIT	0.174	0.251	0.214
	Share OWT	0.930	0.936	0.990		Share OWT	0.826	0.749	0.786
Thailand	Share IIT	0.010	0.017	0.023	Turkey	Share IIT	0.156	0.193	0.055
	Share OWT	0.990	0.983	0.977		Share OWT	0.844	0.807	0.945
Africa					Zambia	Share IIT	0.249	0.101	0.011
Rep Korea	Share IIT	0.009	0.014	0.007		Share OWT	0.751	0.899	0.989
	Australia	Share IIT	0.054	0.109	0.148	Mozambique	Share IIT	0.160	0.187
Share OWT		0.946	0.891	0.852	Share OWT		0.839	0.813	0.982
MERCOSUR					Angola	Share IIT	0.009	0.003	0.006
Brazil	Share IIT	0.216	0.461	0.084		Share OWT	0.991	0.997	0.994
		Share OWT	0.784	0.539	0.916				

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

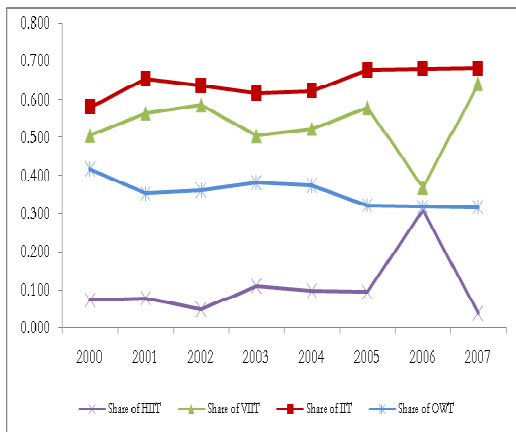


Figure 5.4(ii) South Africa–Japan

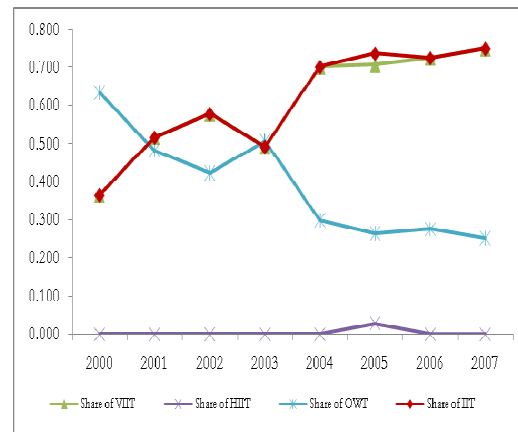


Figure 5.4(iii) South Africa–USA

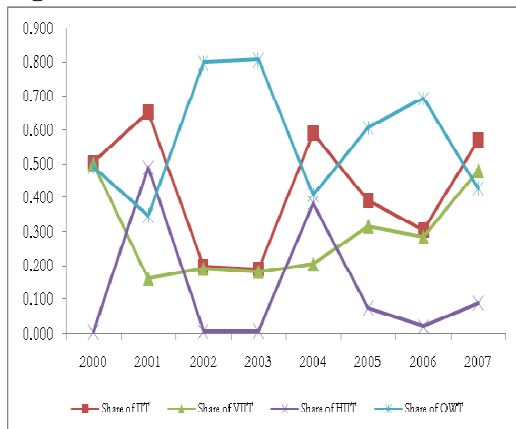


Figure 5.4(iv) South Africa–UK



Figure 5.4(v) South Africa–Germany

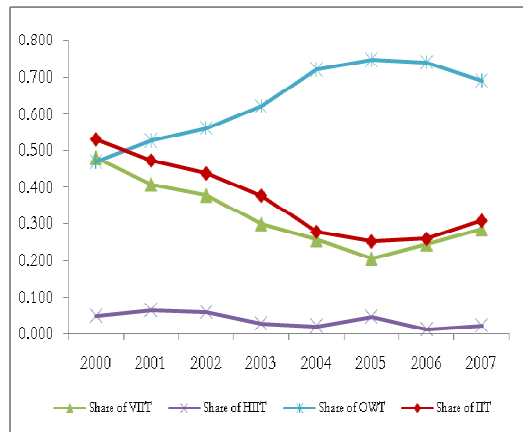
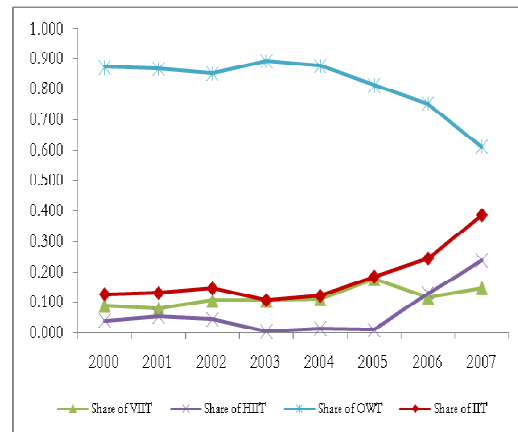


Figure 5.4(vi) South Africa–Spain



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

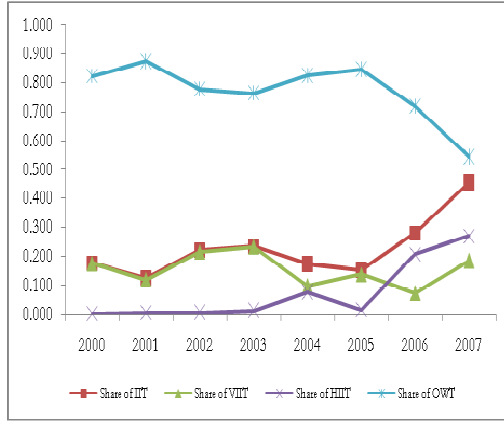


Figure 5.4(viii) South Africa–Italy

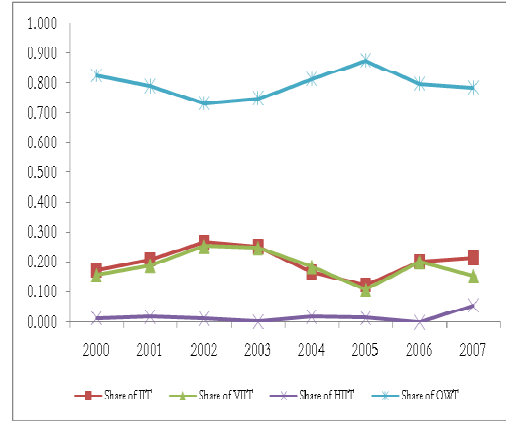


Figure 5.4(ix) South Africa–Sweden

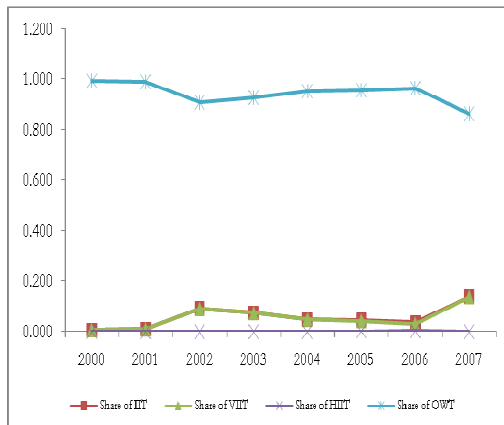


Figure 5.4(x) South Africa–Turkey

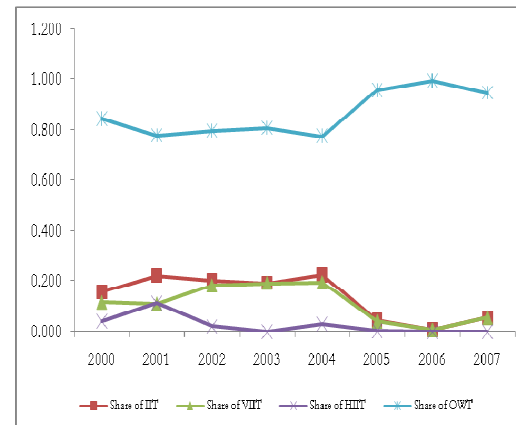


Figure 5.4(xi) South Africa–India

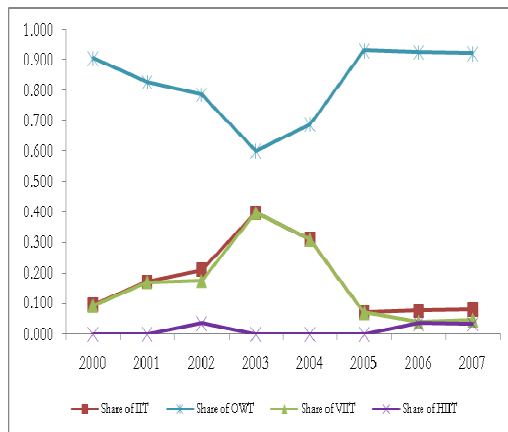
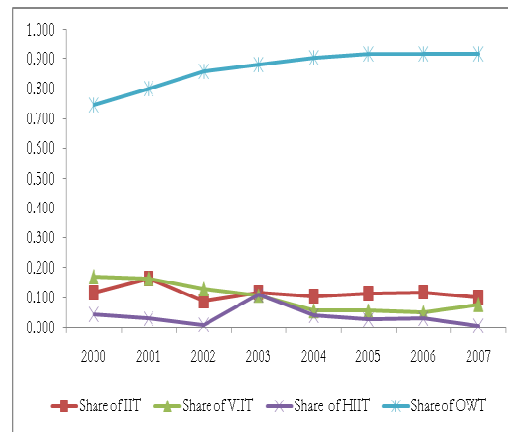


Figure 5.4(xii) South Africa–Brazil



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

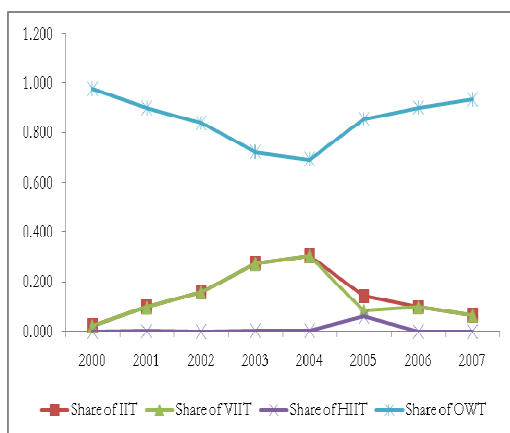
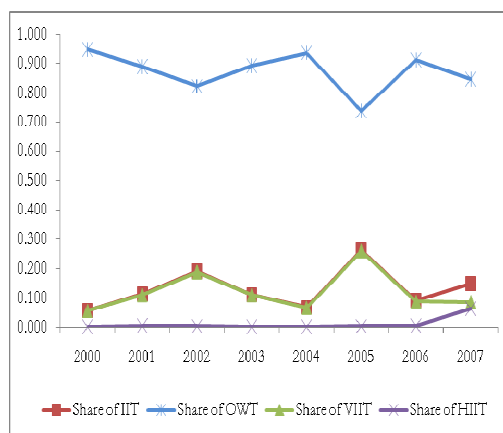


Figure 5.4(xiv) South Africa–Australia

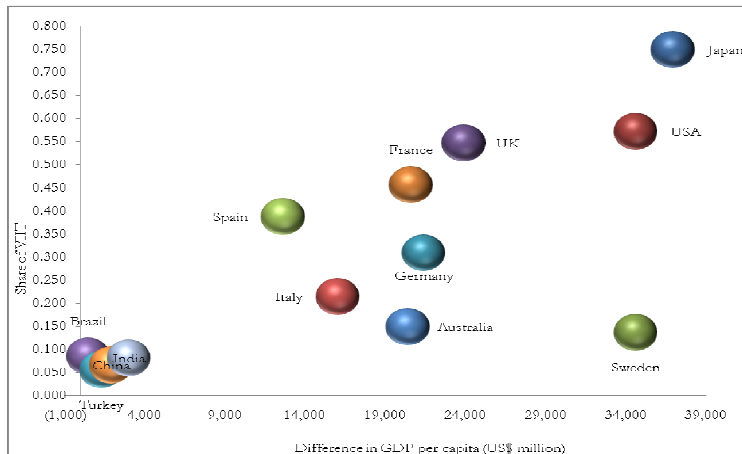


Source: Author’s own calculations, Quantec data

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 as 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 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 nations¹⁶. 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.

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:

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

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:

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

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 $y(z)_{ijt}$ 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, $n = 1 \dots N$, $t = 1 \dots T$ and u_t = white noise disturbance term that is independent and randomly distributed with $(E u_{it}) = 0$; $\text{Var}(u_{it}) = \sigma^2 > 0$. 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.

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

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_{it} 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 $u_{it} \sim IID(0, \sigma_u^2)$ 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 $E\{\bar{x}_i u_i\} = 0$ 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).

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

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:

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

The WITHIN fixed effects model can be expressed as:

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

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, $E\{\bar{x}_i, \alpha_i\} = 0$. 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:

$$\Omega = E(uu') = Z_\mu E(\mu\mu') Z'_\mu + E(vv') = \sigma_\mu^2 (I_N \otimes J_T) + \sigma_v^2 (I_N \otimes I_T) \quad (6.10)$$

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:

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

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:

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

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

$$\Omega^{-1} = (\sigma^2)^{-1} P + (\sigma^2)^{-1} Q \quad (6.13)$$

In Equation (6.13), let r be an arbitrary scalar

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

Thus, GLS can be obtained as weighted least squares by pre-multiplying the original equation (6.2) (in vector form) by Equation (6.14) and performing OLS on the transformed regression that inverts a matrix of dimension $K+I$, which can then be estimated.

Then, $y^* = \sigma_v \Omega^{-1/2} y$ 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):

$$(y_{it} - \theta \bar{y}_i) = \alpha(1 - \theta) + (x_{it} - \theta \bar{x}_i)\beta + v_{it} \quad (6.15)$$

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

In summary and according to Verbeek (2008), the fixed effects model is conditional on the individual (α_i 's): $E\{y_{it} | x_{it}, \alpha_i\} = x_{it}'\beta + \alpha_i$ 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 integrates them out and allows inferences to be made regarding the population, $E\{y_{it} | x_{it}\} = x_{it}'\beta$, 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 to 1 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 <i>et al.</i> (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: ^aValues for China and India are obtained from www.chinaonline.com and www.indiastat.online, respectively.

^bFDI 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 concorderd 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 Brühlhart (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:

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

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

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:

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

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):

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

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 Fontagné *et al.* (1997) as follows:

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

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 Fontagné *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 $TIMB = 1$.

$$TIMB_{ij,kt} = \frac{|X_{j,kt} - M_{j,kt}|}{(X_{j,kt} + M_{j,kt})} \quad (6.20)$$

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:

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

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>i</i> and <i>j</i>	+/-	-	+
Geographic distance	WDIST	Weighted distance between capital cities of <i>i</i> and <i>j</i>	-	-	-
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>i</i> and <i>j</i>	+/-	-	+
Economies of scale	EoS1	Bilateral average of total vehicle production (units) between <i>i</i> and <i>j</i>	+/-	+	+/-
	EoS2	Absolute difference of total vehicle production (units) between <i>i</i> and <i>j</i>	+/-	+	+/-
Automotive assistance	AA	Average number of paid automobile industry workers between <i>i</i> and <i>j</i>	+/-	+/-	+/-
Tariffs	TAR	Average MFN automotive tariff rates of <i>i</i> and <i>j</i>	-	-	-
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.