

# INTRA-INDUSTRY TRADE: A METHODOLOGY TO TEST THE AUTOMOBILE INDUSTRY IN SOUTH AFRICA

Maylene Y Damoense

*Monash University, School of Business and Economics*

André C Jordaan

*University of Pretoria, Department of Economics*

## Abstract

This paper provides a study of the theory and empirical evidence of intra-industry trade (IIT) and relates it specifically to South Africa's automobile industry. The automobile industry in South Africa is a key sector within the national economy and has experienced increased trade and foreign investment in recent years, and thus represents an important case study of IIT. In view of this, the paper proposes a methodology that may be used in future to assess the pattern and determinants of IIT between South Africa and its main trading partners in the automobile industry.

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## 1

### Introduction

Over the last two decades, the South African economy has experienced important economic reforms and increased trade liberalisation, including industrial policy restructuring, for example, in the electricity, agriculture and automobile industries. More specifically, following South Africa's entry into the World Trade Organisation (WTO) during the Uruguay Round in 1994, trade liberalisation of the South African economy intensified. The automotive industry was singled out as a strategic sector in the South Africa economy since it represents an important employer and contributes largely to the nation's gross domestic product (GDP). Presently, the domestic auto industry operates under the Motor Industry Development Programme (MIDP) which was launched in September 1995 and is expected to end in 2012. The policy framework of the MIDP provides important incentives and protection for multinational firms (Black, 2001; Al-Mawali, 2005). This has contributed significantly to increased multinational activity and foreign

direct investment (FDI), including rapid export expansion that has benefited the local auto industry.

Most previous studies examine intra-industry trade (IIT) at a highly aggregate level, covering a wide range of industries and many countries or country groups (Greenaway, Milner & Elliot *et al.*, 1995; Hellvin, 1996; Gullstrand, 2001; Emirhan, 2002; Kandogan, 2003b; Senoglu, 2003; Chemsripong, Lee & Agbola, 2005). Only a few studies have focused primarily on industry-specific intra-industry trade (Tharakan & Kerstens, 1995; Aturupane, Djankov & Hoekman, 1997; Montout, Mucchelli & Zignago, 2002; Kind & Hathcote, 2004; Umemoto, 2005). More specifically, the application of IIT theory to South Africa is as yet limited (Simson, 1987; Parr, 1994; Isemonger, 2000; Al-Mawali, 2005). The local automotive industry particularly has never been studied from this angle, and so this paper is a first attempt in this direction. It is important to highlight that past empirical research referred to in this study may not be directly comparable to the work reported here, due to differences in the data systems employed in applying IIT theory. Many past studies employ Standard International Classifications (SITC)

data, while this study draws on past research that uses Harmonised System (HS) data based on various levels of disaggregation. However, these studies are included in this discussion because it is important to provide a complete survey of the extant literature on IIT. The objective of this paper is to provide a theoretical overview of the important aspects of IIT, and provide empirical support for the structure and determinants of IIT in the automobile industry in South Africa, so that a methodology to test the automobile industry in South Africa can be proposed. The paper is organised as follows: section 2 outlines the theoretical foundations of IIT, and sets out empirical evidence from previous studies into IIT. Section 3 provides a synopsis of South Africa's automobile industry. Section 4 offers an outline of the proposed methodology for analysing the pattern of IIT. Section 5 discusses the determinants of IIT in South Africa's automotive industry. Section 6 concludes the study.

## 2

### IIT: a literature overview

#### 2.1 Theoretical perspective

An early theory of trade, formulated by David Ricardo (1817) and known as the theory of comparative advantage mentions trade between different industries as *inter-industry trade*. This theory highlights differences among countries with respect to factor endowment, technology, climate, etc. and predicts that countries export the products that use their abundant resources intensively and import those products that use their scarce resources intensively (Lindert & Pugel, 1996; Ruffin, 1999). According to the traditional Hecksher-Ohlin (H-O) trade model based on comparative advantages of homogeneous goods in a perfect competition context, trade between two countries is characterised mainly by differences in factor endowment. Several studies have been unsuccessful in finding strong empirical support for the H-O hypothesis for inter-industry trade in world trade. This led to the emergence of *new trade theories* in the 1980s.

The new trade theory of IIT refers to the simultaneous trading of a product within a particular industry and does not necessarily require comparative advantage since it arises from differentiated products and scale economies. In the international trade literature, a distinction is made between vertical and horizontal differentiated IIT. This distinction is important to make because there are different theoretical underpinnings and determinants applicable to each type of IIT (Greenaway *et al.*, 1995). Vertical integration of IIT relates to two-way trade of *different varieties of quality products* (Falvey, 1981; Shaked & Sutton, 1984), whereas horizontal integration of IIT refers to two-way trade of *similar quality products with different attributes* (Lancaster, 1980; Krugman, 1981; Bergstrand, 1990). The models of vertical differentiated IIT can be sub-divided into the neo-Hecksher-Ohlin (H-O) model (Falvey, 1981) and the Shaked and Sutton model (1984). In the H-O model, a perfectly competitive market is assumed and firms do not require increasing returns to scale in production to produce varieties of different qualities. This implies that higher quality products are associated with higher prices since such products tend to have intensive capital requirements. On the demand side, higher income consumers tend to consume high quality products while low income consumers tend to consume lower quality products. An extension of the neo-H-O model by Falvey and Kierzkowski (1987) imply that countries with abundant capital will produce a greater variety of differentiated products and vertically differentiated products that can be distinguished by price and quality. In the Shaked and Sutton model, trade in vertically differentiated products is studied in the context of a natural oligopoly (see Shaked & Sutton, 1984).

According to the extant literature, horizontal differentiated IIT models are based on assumptions of monopolistic competition and increasing returns to scale (Krugman, 1980; Helpman & Krugman, 1985) and imply that intra-industry trade in differentiated products will take place between trading partners who possess similar factor endowments. Thus, the more similar in size trading partners are with

respect to factor endowments and level of income, the larger the horizontal IIT between them will be. In such models of monopolistic competition, the demand side reflects the diverse varieties favoured by consumers while the supply side reflects the existence of economies of scale (EoS) in production (Montout *et al.*, 2002; Senoglu, 2003). Countries with bigger differences in factor endowment and level of income have larger vertical IIT flows. It appears that IIT between developed countries tends to be horizontally differentiated whereas IIT between developing countries tends to be vertically differentiated (Hellvin, 1996; Al-Mawali, 2005). Within horizontal differentiated IIT, a further distinction can be made with respect to two alternate models, namely, the neo-Chamberlinian model, also referred to as the “love for variety approach” (Dixit & Stiglitz, 1977; Krugman 1980, 1982) and the neo-Hotelling model, also known as the “ideal variety approach” (Lancaster; 1980; Helpman, 1981). Although the production sides of the two models are alike, their respective demand sides differ (Senoglu, 2003). In the neo-Chamberlinian model, consumers attempt to consume as many different varieties of a particular product as possible, whereas in the neo-Hotelling model, consumers have diverse preferences for substitutable varieties of a particular product that they regard as ideal (Tharakan & Kerstens, 1995; Al-Mawali, 2005).

Most of the empirical work on IIT has used the unadjusted Grubel and Lloyd (G-L) index (1975), despite its biases and shortcomings. In the literature, a number of variations of the G-L index can be found, yet the unadjusted measure is still widely used and remains the preferred measure to determine the degree of IIT between trading partners. However, it is widely accepted in the empirical literature that the unadjusted G-L index is inappropriate for determining the pattern of IIT, that is, distinguishing between vertically differentiated IIT and horizontally differentiated IIT. Fontagne and Freudenberg (1997) following an original suggestion by Abd-el-Rahman (1991) propose a superior methodology to distinguish between inter- and intra-industry trade (see section 4), and Falvey

(1981) and Falvey and Kierzkowski (1987) put forward a methodology to determine the pattern of IIT using differences in price (unit values) to reflect differences in quality of products (see section 4).

## 2.2 Empirical perspective

There is much empirical evidence for the IIT theory that highlights the key role of country-specific factors; such as *market size, economic distance, geographical distance*, etc. (Greenaway *et al.*, 1995; Hellvin, 1996; Gullstrand, 2001; Montout *et al.*, 2002; Al-Mawali, 2005; Chemsripong *et al.*, 2005; Umemoto, 2005). Hellvin (1996) focuses on IIT between China and OECD countries using SITC 3-digit level data, and find that the share of IIT increased moderately between China and the OECD countries between 1980 and 1992. The main conclusion of this study is that vertical IIT exists between China and OECD countries. The study also found per capita income (Linder’s hypothesis, 1961) and market size to be positively-signed and statistically significant, while trade barriers were found to be negatively-signed and statistically significant.

A study by Gullstrand (2001) focuses on analysing demand patterns and vertical IIT between the North (EU countries) and the South (lower income countries). Employing HS 6-digit level data for 1992, the study reveals that income distribution, per capita income (and their interaction) and average market size are important for vertical IIT. In their study, Chemsripong *et al.* (2005) investigate the determinants of IIT in manufactures between Thailand and APEC countries using SITC 3-digit level data for the period 1980-1999. They consider pre-APEC and post-APEC scenarios. In the pre-APEC period, their results indicate that differences in levels of economic development, transport and information costs (geographical distance) were negatively related to IIT, while similarities in levels of economic development, capital intensity, culture and openness were positively related to IIT. In the post-APEC era, economic size is positively related to IIT. This study does not distinguish between horizontal and vertical IIT.

Intra-industry studies relevant to South Africa include Simson (1987), Parr (1994), Isemonger (2002) and Al-Mawali (2005). Using HS system data, Isemonger (2000) reveals that South Africa exhibits relatively low levels of overall IIT, though higher levels of IIT are observed in the clothing and textiles industries. On a positive note, Isemonger (2000) estimates rising IIT levels for the South African economy for the period 1993 to 1996, in contrast to predictions by Simson (1987) and Parr (1994). A recent South African study by Al-Mawali (2005) analyses the structure of IIT for the South African economy employing SITC data for the period 1994 to 2004. This study employs Kandogan's methodology to decompose total IIT into horizontal IIT and vertical IIT instead of using the traditional G-L index. The methodology proposed by Kandogan may not necessarily be appropriate for this kind of study, however, since his method is mainly concerned with the adjustment cost implications of trade liberalisation that are beyond the scope of the study (see Kandogan, 2003a, 2003b). This problem aside, however, Al-Mawali concludes that market size, geographical distance, trade barriers, trade intensity and regional integration are significant for South Africa's IIT. None of these South African studies focuses on the automotive industry.

Several empirical studies specifically focus on IIT with respect to *specific industries* (Tharakan & Kerstens, 1995; Kind & Hathcote, 2004). However, very limited work has been done, as mentioned above, on IIT specifically in the automobile and automobile parts industries (Montout *et al.*, 2002; Umemoto, 2005). In the available studies, country-specific factors play an important role in influencing the pattern of IIT when country effects are controlled. In the study by Tharakan and Kerstens (1995), bilateral IIT in the European toy industry is found to be horizontally differentiated when toy imports into the European Union (EU) exceed exports. Kind and Hathcote's (2004) fabric industry trade study focuses on the United States' trade with 92 countries in four SITC categories within the fabric industry. Their main findings suggest that levels of economic development, market size and trade deficit are negatively correlated with IIT, while trade barriers and distance are

positively associated with IIT. However, their study does not consider the pattern of IIT in the fabric industry.

Using HS 6-digit level data, Montout *et al.* (2002) examine the structure and determinants of IIT for the automobile and automotive parts industries in NAFTA. They distinguished between horizontally differentiated IIT in goods of varying quality (of different unit values) from trade in varieties of goods (of similar unit values). The key determinants of horizontal IIT between NAFTA's trading auto partners are found to be economic distance and market size, and the key industry-specific variable of *minimum efficient scale* (as a proxy for *economies of scale*) is found to be negatively correlated with horizontal IIT in automobiles. Another study, by Umemoto (2005), explores horizontal IIT and vertical IIT between Japan and Korea also using HS 6-digit level data for automotive parts. The econometric results reveal that smaller differences in market size and transportation costs are major factors positively influencing IIT between Korea and Japan. Thus, the Korea-Japan FTA is likely to stimulate IIT in automobile parts. Furthermore, low levels of horizontal IIT are found but vertical IIT is rising rapidly between the two countries (Umemoto, 2005).

In recent years, advancing globalisation and the rise of international production networks have led to increased intra-firm trade through FDI flows related to multinational activities especially in the world automobile industry. Rising IIT and increasing FDI are associated with increasing multinational activity, as firms locate parts of their production operations across countries (OECD, 2002). The empirical literature suggests a positive relationship between IIT and multinational firm activity but an ambiguous relationship between IIT and FDI (Aturupane *et al.*, 1997; Markusen & Maskas, 2001; Emirhan, 2002). Aturupane *et al.* (1997) investigate the effects of industry-specific factors on IIT between the European Union and eight Central and Eastern countries (CEECs) over the period 1990 to 1995. The key variables of product differentiation (PD), labour intensity, EoS and FDI are found to have a positive impact of vertical IIT. Conversely, two of the variables (PD and FDI) are found to be negatively related

to horizontal IIT. Also, FDI levels have a positive effect on some of Turkey's manufacturing horizontal IIT (Emirhan, 2002). Montout *et al.* (2002) find that the substantial rise of horizontal IIT in NAFTA's automobile industry may reflect the international production strategies of multinational firms. This led to a study by Markusen and Maskus (2001) that proposes a G-L type index called the intra-industry affiliate sales (IIAS) index to determine the pattern of intra-industry foreign affiliate production. IIAS refers to sales by foreign affiliates of multinational firms. The findings of the study show that the IIAS index between the US and partner countries rises relative to the IIT index as countries grow and become similar in size as well as in relative endowment (Markusen & Maskus, 2001).

Another study by Egger, Egger and Greenaway (2004) argues that the standard measure of the GL index, although widely used, is unsuitable for multinational activities because it does not take into account the income flows stimulated by repatriated profits of multinational firms and therefore tends to underestimate the share of IIT. They develop a general equilibrium model to take this trade imbalance into account (see Egger, *et al.*, 2004).

A few studies have revealed that regional integration is associated with increased IIT (Montout *et al.*, 2002; Chemsriping *et al.*, 2005; Umemoto, 2005), and Al-Malwali (2005) reveals a negative association with South Africa's IIT. Montout *et al.* (2002) confirm the significant role of regional integration in NAFTA on IIT for the automobile industry. In the study by Chemsriping *et al.* (2005), the entry of Thailand into APEC stimulated IIT in manufactured goods with other APEC partner countries. Similarly, Umemoto (2005) suggests that the Korea-Japan FTA is likely to contribute to significant growth of IIT in automotive parts between them. The implication for South Africa following the result of Al-Mawali's study is that regional integration may in fact be an important barrier to the expansion of further IIT.

Another important industry-specific factor is the level of trade barriers, which has important implications for the level of IIT. The South African study by Al-Malwali (2005) finds a

positive, statistically significant relationship between levels of trade barriers (tariffs) and all types of IIT. The study specifically relates the result to protection offered by incentives under the present Motor Industry Development Programme (MIDP) to the activities of multinational firms in case of the South African automobile industry. This implies that the average level of tariffs in the South African automobile industry provides an advantage for further expansion of IIT. This is not surprising, since a similar conclusion is arrived at by Kind and Hathcote (2004), who find that the level of tariffs between the US and fabric trading partners has a positive impact on the level of IIT. On the other hand, Hellvin's study (1996) uses tariffs in China as a proxy for trade barriers and finds them negatively correlated with IIT.

### 3

#### **A snapshot of South Africa's automobile industry**

There are eight original equipment manufacturers (OEMs) (Volkswagen SA, Daimler-Chrysler SA, BMW SA, Toyota SA, Nissan SA, Ford Motor Company of SA, General Motors SA and Fiat Auto SA) producing a little more than 400,000 vehicle units per annum in South Africa. In addition, there are about 150 registered component suppliers and some 400 independent component suppliers of automotive parts (NAAMSA, 2005). Under the present MIDP policy framework, tariffs on completely built-up units (CBUs) and completely knocked-down (CKDs) kits are following a phase-down schedule of a reduction of 2 percent per annum until 1 January 2007. At present, import duty rates of 36 percent and 28 percent respectively are applied to imports of CBUs and automotive components (DTI, 2004). Starting from 1 January 2008, tariffs applied to imported light vehicles and components will be phased down by 1 percent per annum to reach a level of 25 percent and 20 percent respectively by 1 January 2012. It is important to highlight that the tariff phase-down programme is proceeding faster than is required by WTO regulations. Other

important incentives under the MIDP include the import-export complementation (IEC) scheme and the productive asset allowance (PAA) scheme.

The automobile sector in South Africa has experienced substantial growth in trade and foreign investment in recent years, and thus represents an important case-study for IIT. Between 1995 and 2004, the automobile industry's exports of components and light vehicles (including both passenger and light commercial vehicles) increased from R4,2 billion to R39,2 billion, while that of automotive imports increased from R16,4 to R58,0 billion (NAAMSA, 2005). Despite the local industry's exceptional growth in automotive exports it remains a net importer of automotive products and experienced an automotive trade deficit of R18, 8 billion in 2004.

South Africa as part of South Africa Customs Union (SACU) has developed important ties with countries of the North American Free Trade Agreement (NAFTA) through the Africa Growth Opportunity Act (AGOA), established in January 2001 and also has significant trade links with the South African Development Community (SADC) and countries of the European Union (EU). South Africa exports a substantial amount of automotive products (both CBUs and CKDs) to member countries

of the EU and NAFTA trade blocs (see table 2). For instance, through the AGOA, BMW SA has been awarded the opportunity to export left-hand drive 3-series models to the USA, and DaimlerChrysler SA is likely to export new C-class models, including left-hand drive models to the USA (DTI, 2004).

Since the mid-1990s, the automotive industry has been one of the most successful recipients of FDI inflows in all of South Africa's manufacturing industries, especially through increased foreign ownership of local OEMs by multinational firms (Toyota Japan, General Motors, DaimlerChrysler, etc.). Local OEMs are now largely integrated into the global production networks of auto multinational firms (Damoense & Simon, 2004). The incentives (import-export complementation, productive asset allowance and tariffs) offered under the MIDP provide protection to multinational firms (Black, 2001; Al-Mawali, 2005), which in turn inject FDI into the industry and contribute to the export expansion and growth of the local industry. As indicated in table 1, South Africa remains a net importer of total automotive products realising a trade deficit of R18,8 billion in 2004. The appreciation of the exchange rate in 2002 and 2004 contributed largely to the widening automotive trade deficit (NAAMSA, 2005).

**Table 1**

South Africa's total automotive industry trade balance (R billion), 1995-2004

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

Source: NAAMSA (2005)

Since automotive CBU imports are greater than automotive CBU exports in South Africa's automotive industry, IIT is likely to occur as a result of vehicle consumers' demanding a greater variety of differentiated products (horizontal IIT). Light vehicle imports (sales) into the South African vehicle market have been rising in late years, from R8,0 billion in 2001 to R16,7 billion in 2004 (NAAMSA, 2005). Tharakan and Kerstens (1995) note a similar trend in IIT in the European toy industry. However, Umetemo (2005) finds that vertical IIT is more likely to be exhibited in automotive parts.

Table 2 shows South Africa's main automotive trading partners for exports of CBUs and

automotive components. Noteworthy are the figures for 2004, when South Africa exported 71.3 percent of the value of total component exports and 24.5 percent of the value of total CBU exports to countries of the EU (United Kingdom, Germany and France). This figure for the share of CBUs from SA to EU in 2004 is a drop from 52,8 percent in 2000; in the same period the share of auto components remained relatively stable. Also, in 2004 South Africa exported 13.9 percent of the value of total component exports and 8.4 percent of the value of total CBU exports to the United States, a member of the North American Free Trade Area (NAFTA).

**Table 2**  
South Africa's automotive exports by region/country, 2000-2004

<b>Automotive exports</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
	(Rm)	(Rm)	(Rm)	(Rm)	(Rm)
<b>South Africa to World</b>	20 040	30 001	40 110	40 732	39 238
Light vehicles	7 400	11 416	17 227	19 436	17 500
Automotive components	12 640	18 586	22 883	21 269	21 738
<b>South Africa to NAFTA</b>	percent	percent	percent	percent	percent
Light vehicles	7.3	17.9	22.6	19.5	13.9
Automotive components	10.1	12.5	11.1	8.9	8.4
<b>South Africa to EU</b>	percent	percent	percent	percent	percent
Light vehicles	52.8	37.6	29.9	19.5	24.5
Automotive components	69.8	70.5	70.85	69.9	71.3
<b>South Africa to SADC</b>	percent	percent	percent	percent	percent
Light vehicles	11.9	9.2	10.2	5.6	3.9
Automotive components	5.6	5.8	6.2	5.8	5.5
<b>South Africa to Other</b>	percent	percent	percent	percent	percent
Light vehicles:					
MERCOSUR (Argentina/Brazil)	-	-	-	-	-
Australia/New Zealand	12	11	12	16	20
Japan/China/Singapore/Taiwan	18	20	22	38	35
Other	-	4.3	3.3	1.4	2.7
Automotive components:					
MERCOSUR (Argentina/Brazil)	0.4	0.5	0.4	0.7	0.3
Australia/Japan/China	-	3.4	4.9	7	6.1
Other		7.3	6.6	7.7	8.4

**Source:** Compiled from NAAMSA (2005)

Table 2 also shows that exports of automotive products to selected countries (Australia, Japan and China) of the Asia Pacific Economic Community (APEC) are steadily increasing.

Overall then, trade of automotive products in the South African automotive industry has been rising over recent years. Thus, it would be useful to understand the pattern of IIT and the determinants of the type (horizontal or vertical) of IIT in this strategic industry. The figures seem to indicate that IIT in the South African automobile industry may be horizontally differentiated (by variety) and IIT in automotive parts vertically differentiated (by quality). This is the main hypothesis presented in this study. Apart from the country-specific determinants of IIT that have been discussed extensively in the literature, the main industry-specific variables to be considered in this paper are FDI, trade barriers (tariffs) and minimum efficient scale (MES).

#### 4

### Proposed methodology of IIT

The G-L index (1975) is the most widely used measure of the intensity of IIT. This index calculates the share of IIT as the part of balanced trade that represents the overlap between exports and imports of total trade between countries  $i$  and  $j$  for a given industry  $k$ . The unadjusted G-L index is given by:

$$GL_{ij,k} = 1 - \frac{|X_{ij,k} - M_{ij,k}|}{X_{ij,k} + M_{ij,k}} \quad (1)$$

where  $X_{ij,k}$  and  $M_{ij,k}$  = exports and imports, respectively, between countries  $i$  and  $j$  in industry  $k$ .

The value of the G-L index varies between 0 and 100, where 0 implies that all trade is complete inter-industry trade and 100 implies that all trade is complete IIT. According to the *new classical view*, the H-O theory can explain the part of trade that is net trade or inter-industry trade associated with comparative advantage but cannot explain the part of trade that is IIT associated with monopolistic competition (Lindert & Pugel, 1996). The part of trade that is IIT can thus be more appropriately described

by *new trade theory*. A key bias of the unadjusted G-L index is its ignoring of trade imbalances. This concern has been well documented in the economic literature. Another empirical bias unavoidable in the unadjusted G-L index comes from having to choose the 'correct' disaggregation level of data (Isemonger, 2000). As a result, Grubel and Lloyd, and Aquino (1978) propose an adjusted G-L index, though many empirical economists prefer and continue to use the unadjusted G-L index despite the biases associated with it.

Also, there is general agreement that the G-L index does not provide information about patterns of trade, that is, whether IIT can be defined as horizontally differentiated or vertically differentiated. This study, to overcome this shortcoming, uses the alternative method proposed by Fontagne and Freudenberg (1997), and originally suggested by Abd-El-Rahman (1991), which distinguishes between inter-industry trade (one-way trade) and IIT (two-way trade). (This method is also adopted by Aturupane *et al.*, 1997; Gullstrand, 2001; Montout *et al.*, 2002; Utemomo, 2005). The method is given by the following equation:

$$\frac{\text{Min}(X_{ij,kt}, M_{ij,kt})}{\text{Max}(X_{ij,kt}, M_{ij,kt})} > 10\% \quad (2)$$

where  $X$  = exports and  $M$  = imports,  $i$  = home country,  $j$  = partner country and  $k$  = product in period  $t$ . This alternative index considers trade as intra-industry when the value of the minority flow represents at least 10 percent of the majority flow. Most past studies use a benchmark of 10 percent, including Utemomo (2005), though Montout *et al.* (2002) use a benchmark of 20 percent. In this study, a benchmark of 10 percent is employed.

After establishing trade flow as intra-industry, this study proceeds to determine the pattern of IIT. Following previous studies, an important presumption advocated by Falvey (1981) and Falvey and Kierzkowski (1987) is that differences in price (unit value) are reflected in differences in quality. An industry is subject to horizontal IIT in industry  $k$  that satisfies the criterion:

$$1 - \alpha \leq \frac{UV_{ij,kt}^X}{UV_{ij,kt}^M} \leq 1 + \alpha \quad (3)$$



where  $UV =$  unit value of (X) exports and (M) imports of the home country =  $i$ ,  $j =$  partner country and  $k =$  product in period  $t$ .

Vertical IIT in industry  $k$  exists when:

$$\frac{UV_{ij,kt}^X}{UV_{ij,kt}^M} < 1 - \alpha \text{ or } \frac{UV_{ij,kt}^X}{UV_{ij,kt}^M} > 1 + \alpha \quad (4)$$

According to the index, products are considered to be vertically differentiated (differing in quality) if relative unit values of exports and imports exceed 15 percent (where  $\alpha = 0.15$ ) or falls outside a specified range of  $\pm\alpha$ . By contrast, products are considered horizontally differentiated (differing in variety) when relative unit values of exports and imports fall within the range of  $\pm\alpha$ . Abd-el-Rahman (1991) and Greenaway *et al.* (1995) use a unit value of 15 percent (where  $\alpha = 0.15$ ), but Aturupane *et al.* (1997), Gullstrand (2001) and Umemoto (2005) use a unit value of 25 percent (where  $\alpha = 0.25$ ) for robustness. In this study, a unit value of 25 percent is employed.

Taken from the literature, the model specification takes the form:

$$IIT(z)_{ij} = \alpha_0 + \sum_m \alpha_{im} Z_{ijm} + \varepsilon_{ijt} \quad (5)$$

where  $IIT_{ijt} =$  IIT index between the home country  $i$  and its trading partner  $j$  for period  $t$ , and  $z$  varies over vertically differentiated and horizontal IIT.  $IIT_{ijt}$  depends on a collection of explanatory variables,  $Z_{ijm}$ , which include country-specific and industry-specific factors influencing the pattern of IIT.

Now, two regression equations for the proposed model with the share of IIT ( $z$ ) in total trade for the automobile industry are estimated separately, that is, equation (1) for CBUs or light vehicles sector and equation (2) for the automobile components sector.

In the regression equations below, IIT ( $z$ ) is the dependent variable taken as the share of IIT in total trade. The superscript  $A$  and  $C$  denote automobiles (CBUs) and components, respectively. A log-log functional form for the two regression models is specified as follows:

$$\begin{aligned} IIT(z)_{ij}^A = & \alpha_1 \left[ \frac{GDP_i + GDP_j}{2} \right] + \alpha_2 DGDP \\ & + \alpha_3 GDPPC + \alpha_4 DGDPPC \\ & + \alpha_5 DIST + \alpha_6 DREG + \alpha_7 FDI \\ & + \alpha_8 TB + \alpha_9 MES + \varepsilon \end{aligned} \quad (6)$$

$$\begin{aligned} IIT(z)_{ij}^C = & \beta_1 \left[ \frac{GDP_i + GDP_j}{2} \right] + \beta_2 DGDP \\ & + \beta_3 GDPPC + \beta_4 DGDPPC \\ & + \beta_5 DIST + \beta_6 DREG + \beta_7 FDI \\ & + \beta_8 TB + \varepsilon \end{aligned} \quad (7)$$

where

GDP = average market size

DGDP = proxy for absolute difference in market size

GDPPC = average of per capita GDP

DGDPPC = proxy for absolute difference in per capita income

DIST = geographical distance

DREG = dummy variable for regional integration

FDI = foreign direct investment

TB = trade barriers

MES = proxy for minimum efficient scale

The expected signs of the regression equations are:

- if  $(\alpha_1 \text{ and } \beta_1) > 0$ , if  $(\alpha_2 \text{ and } \beta_2) < 0$  (horizontal IIT) and if  $(\alpha_2 \text{ and } \beta_2) > 0$  (vertical IIT),
- if  $(\alpha_3 \text{ and } \beta_3) > 0$  (horizontal IIT) and if  $(\alpha_3 \text{ and } \beta_3) < 0$  (vertical IIT),
- if  $(\alpha_4 \text{ and } \beta_4) < 0$  (horizontal IIT) and if  $(\alpha_4 \text{ and } \beta_4) > 0$  (vertical IIT),
- if  $(\alpha_5 \text{ and } \beta_5) < 0$ ,  $(\alpha_6 \text{ and } \beta_6) > 0$ ,  $(\alpha_7 \text{ and } \beta_7) > 0$ ,  $(\alpha_8 \text{ and } \beta_8) < 0$ , if  $\alpha_9 < 0$  (horizontal IIT) and if  $(0 < \alpha_9 < 0)$  (vertical IIT).

As in previous studies, Ordinary Least Squares (OLS) with fixed effects modelling are used (Montout *et al.*, 2002; Al-Malwali, 2005; Umemoto, 2005). Before the calculations as outlined above can be performed, the level of disaggregation of the chosen data must be established. Following Montout *et al.* (2002) and Umemoto (2005), studies that particularly focus on IIT trade in the automobile industry,

this study uses HS data from the automobile industry disaggregated at the 6-digit level. Isemonger (2000) notes that disaggregating further to the HS 8-digit level is likely to succumb to virtually no IIT.

## 5

### Determinants of IIT in South Africa's automobile industry

The literature provides strong empirical evidence regarding country-specific determinants as well as industry-specific determinants of both vertically differentiated (by quality) and horizontal differentiated (by attributes) IIT. In this study, several country-specific and industry-specific determinants of IIT are considered. It has been well established in the literature that country-specific and industry-specific variables affect horizontal and vertical IIT differently. The main question for this study is: does horizontal differentiated IIT or vertical differentiated IIT exist in South Africa's automobile industry? (see Section 4).

In addition, a number of hypothesised relationships between the share of the two types of IIT and various country and industry characteristics can be formulated from the literature. The following are considered in this paper:

- I) Country-specific determinants:
  - i. The higher the average market size (GDP), the larger the share of horizontal, vertical and total IIT ( $\alpha_1$  and  $\beta_1 > 0$ ).
  - ii. The greater the difference in market size (DGDP), the lower the share of horizontal IIT ( $\alpha_2$  and  $\beta_2 < 0$ ), and the higher the share of vertical IIT ( $\alpha_2$  and  $\beta_2 > 0$ ).
  - iii. The higher the average per capita income (GDPPC), the greater the share of horizontal IIT ( $\alpha_3$  and  $\beta_3 > 0$ ), and the smaller the share of vertical IIT ( $\alpha_3$  and  $\beta_3 < 0$ ).
  - iv. The larger the difference in per capita income (DGDPPC), the smaller the share of horizontal IIT ( $\alpha_4$  and  $\beta_4 < 0$ ),

and the larger the share of vertical IIT ( $\alpha_4$  and  $\beta_4 < 0$ ).

- v. The larger the geographical distance (DIST), the lower the share of horizontal, vertical and total IIT ( $\alpha_5$  and  $\beta_5 < 0$ ).
- vi. The higher the degree of regional integration (REG), the greater the share of horizontal, vertical and total IIT ( $\alpha_6$  and  $\beta_6 > 0$ ).

#### II) Industry-specific determinants:

- i. The greater the levels of FDI in the auto industry, the larger the share of horizontal, vertical and total IIT ( $\alpha_7$  and  $\beta_7 > 0$ ).
- ii. The lower the level of trade barriers (TB) in the automobile industry, the greater the share of horizontal, vertical and total IIT ( $\alpha_8$  and  $\beta_8 < 0$ ).
- iii. The smaller the minimum efficient scale in the automobile industry, the larger the share of horizontal IIT ( $\alpha_9 < 0$ ), while the share of vertical IIT is indeterminate ( $0 < \alpha_9 < 0$ ).

### 5.1 Country-specific determinants

#### *Average market size (GDP)*

As in most past studies, the average level of GDP of the two trading partners provides this study with a proxy for the size of the market, since economic size influences the volume of trade. A larger average market size is expected to benefit from the potential EoS in production and trade and as a result increase the variety of differentiated products and the variety of different quality products. In this instance, it is expected to find a positive association between the average size of the market and the share of all types of IIT.

#### *Absolute differences in size of the market (DGDP)*

The majority of empirical studies reveal a statistically significant relationship between the share of IIT and differences in the size of the economies of the trading partners. A common way to measure absolute market size, found in

the literature e.g. Balassa (1986) and Balassa and Bauwens (1987) is proxied as:

$$DGDP_{ij} = 1 + \frac{[w \ln w + (1-w) \ln(1-w)]}{\ln 2} \quad (8)$$

$$\text{where } w \equiv \frac{GDP_i}{GDP_i + GDP_j}$$

It is expected that countries similar in size tend to trade more, which is in accordance with Linder's hypothesis (1961), such that a positive relationship between IIT and absolute differences in economic size can be expected. On the other hand, according to the H-O hypothesis, it is expected that countries with larger differences in factor endowment will trade more, thus a negative relationship between IIT and relative market size is expected.

#### *Average standard of living (GDPPC)*

Most studies use the income per capita of the two trading partners expressed as an average of the trade of the two partners. Countries with high levels of per capita income are associated with high levels of economic development, and thus are expected to increase the share of IIT. The level of per capita income is a proxy for the level of capital-labour ratio (supply side) (Helpman & Krugman, 1985), while the level of per capita income is a proxy for the variety and sophistication of differentiated products (demand side). Capital-intensive production techniques are assumed to be required for supplying the differentiated products demanded by consumers. The predicted sign for this coefficient is positive for horizontal IIT and negative for vertical IIT.

#### *Absolute economic distance (DGDPPC)*

According to the literature, if the absolute difference in per capita income level between countries is large, the share of IIT in total trade is likely to increase and thus a positive sign for this explanatory variable is expected. More specifically, a positive sign is hypothesised for vertical IIT and a negative sign for horizontal IIT. Many studies use the absolute difference in per capita income levels between trading partners as a proxy for levels of economic development (Emirhan, 2005). The larger the gap of per capita income between trading

partners, the larger the level of inequality of development (Chemsripong *et al.*, 2005).

#### *Geographic distance (DIST)*

Geographic distance is typically used as a proxy for transport costs, delivery times and market access barriers. Many studies use kilometres or miles to measure geographic distance between the capital cities of trading partners. Geographical distance is also sometimes used as a trade resistance factor. Since greater distance between trading partners leads to lower IIT, a negative relationship between the share of total IIT (horizontal and vertical) and the distance parameter is expected, according to the literature.

#### *Regional integration (REG)*

Rising regional integration has led to large intra-regional trade and IIT flows of various products, including automotive products. Particularly in the world automotive industry, regional and preferential trade agreements, including specific automotive provisions (rules of origin, tariffs, import-export requirements, etc.) have become widespread in recent years (Damoense, 2005a). Increasing regional integration, by removing or reducing trade barriers between trading partners should increase the volume of trade and the share of IIT in total trade. The inclusion of a dummy variable for regional integration is suggested and assumes a value of 1 if both South Africa and the trading partner are members of any common free trade agreement (FTA) or preferential trade agreement (PTA) with specific automotive provisions (SA-EU FTA, SACU, AGOA, etc), and a value of zero otherwise. Hence, IIT in the South Africa's automobile industry is expected to show a positive association with regional integration.

## **5.2 Industry-specific determinants**

#### *Foreign direct investment (FDI)*

Generally, FDI is hypothesised to be positively correlated with the share of total, horizontal and vertical IIT. Levels of FDI in the automotive industry are typically associated with levels of involvement of multinational firms and greater specialisation in production plants located in

different countries. In their study, Montout *et al.* (2002) find that the incentive agreements of NAFTA's automotive policy framework strongly influence the production and investment strategies of multinational firms. In turn, given the significance of multinationals in the automobile industry, these strategies certainly have a strong impact on the pattern of IIT in the industry. In the South African case, a similar outcome is expected since the involvement of multinational firms in the automotive industry is generally strongly associated with the presence of such firms and since the policy framework of the MIDP encourages multinational activity in the industry.

#### *Trade barriers (TB)*

Typically, a negative relationship between the level of trade barriers and the share of IIT is predicted (Hellvin, 1996). Most studies use the level of tariffs as a proxy for trade barriers, despite other forms of trade barriers (quotas, quantitative restrictions, non-tariff barriers, etc). In this study, the level of tariffs between South Africa and its main trading partners in the automobile industry are used as a proxy for the level of trade barriers. Presently, automotive tariffs are being phased down under the MIDP and preferential lower tariffs are applied as a result of trade agreements with specific automotive provisions, for example in the AGOA. Thus, such agreements to reduce trade barriers between trading countries are likely to result in rising IIT in the automobile industry between South Africa and its trading partners. It is not surprising then that some studies have revealed a positive relationship between trade barriers and IIT (Kind & Hathcote, 2004; Al-Mawali, 2005).

#### *Minimum efficient scale (MES)*

Scale economies represent an important determinant of IIT. In the case of horizontal IIT, they establish a motivation for multinational firms to spread fixed costs of knowledge capital across multiple plants. The larger the minimum efficient scale, the greater the number of firms and the larger the number of differentiated products (by variety), thus the bigger the share of horizontal IIT. The predicted sign showing

the relationship between horizontal IIT and EoS is negative (Greenaway *et al.*, 1999; Montout *et al.*, 2002). On the other hand, in the case of vertical IIT, motives are generated when there are different factor intensities combined with different factor endowments across countries. The expected sign between vertical IIT and EoS is ambiguous (Aturupane *et al.*, 1997; Markusen & Maskus, 2001). In addition, the predicted sign of scale economies for vertical IIT depends largely on the market structure of the industry (Aturupane *et al.*, 1997). The literature proposes a few methods for measuring EoS. A common proxy for EoS in past studies is minimum efficient scale (MES) (Aturupane *et al.*, 1997; Emirhan, 2002; Montout *et al.*, 2002). In particular, Montout *et al.* (2002) consider 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, the method employed by Montout *et al.*, (2002) and initially used by Menon, Greenaway and Milner (1999) is suggested:

$$MES = \frac{OT_i/N_i(4)}{OT_i/N_i(n-4)} \quad (9)$$

where: OT = total output in the home country *i*,  $N_i(4)$  = number of persons employed in the four largest OEM firms in the automobile industry in South Africa, and  $N_i(n-4)$  = number of persons employed for the rest. Thus, a negative relationship is hypothesised between MES and the share of horizontal IIT, whereas there is no *a priori* for vertical IIT.

## 6

### Concluding remarks

This paper theoretically analyses the determinants of horizontal and vertical differentiated IIT with specific reference to the automobile industry in South Africa. Given the vast economic literature on IIT, a methodology is proposed that will provide insights into the pattern of IIT in the automobile industry between South Africa and its main trading partners. In order to analyse the pattern of IIT, the extent of IIT needs to be evaluated first using the G-L index. Next, the pattern of IIT using HS 6-digit disaggregated data from the automobile industry is analysed

using the methodology presented in section 4. In particular, it is important to determine whether IIT can be defined as horizontally differentiated (by variety) or vertically differentiated (by quality). The final step in the methodology is econometric analysis to test the main hypothesis of the presence of horizontal differentiated or vertical differentiated IIT between South Africa and its main trading partners in the automobile industry. Following previous work specifically related to the automotive industry, horizontally differentiated IIT (differentiated by variety) is expected to exist for South African automobiles, while vertical IIT to exist for automotive parts (differentiated by quality). Additional hypotheses to be tested include both country-specific and industry-specific variables as discussed in section 5 of this paper. This allows the identification of explanatory variables (determinants) that are statistically significant in explaining the structure of IIT relevant to the automobile industry in South Africa. In particular, it is expected that market size, differences in per capita income (economic distance) and regional integration influence the share of IIT. In terms of industry-specific variables, trade barriers, EoS and FDI are expected to be statistically significant in influencing the structure of IIT.

Thus, future research could include conducting empirical estimations of the share of IIT and the pattern of IIT in the automobile industry between South Africa and its main trading partners based on the methodology proposed in this study. Such an exercise could provide valuable information to trade analysts and policymakers. Understanding the pattern of IIT in the automotive industry has important implications for trade and industry policy, especially for future trade agreement negotiations with respect to South Africa's automobile industry.

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