CHAPTER 7

GRAVITY MODEL ESTIMATION AND DISCUSSION OF RESULTS

7.1 INTRODUCTION

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

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

7.2 UNIVARIATE CHARACTERISTICS OF VARIABLES

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

Table 7.1 Panel unit root tests

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

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

7.3 ECONOMTRIC ESTIMATION RESULTS

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

7.3.1 Pooled models

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

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

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

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

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

7.3.2 Fixed effects models

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

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

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

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

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

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

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

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

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

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

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

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

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

7.3.3 Random effects models

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

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

7.4 DISCUSSION OF THE ECONOMETRIC RESULTS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

31 In the VIIT and TIIT regression models, the coefficients and t-statistics for FDI2 are reported, while for the HIIT regression the coefficients and t-statistics for FDI1 are reported (see Table 6.2).

32 The measure of EoS is applicable to the industry (external EoS) and may not necessarily be appropriate as a measure of firm-level (or internal) EoS.

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

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

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

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

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33 The interaction between (TAR×AA) reduces the Adjusted R^2 to 0.32, 0.63 and 0.66 for HIIT, VIIT and TIIT models respectively.

34 These include the nominal and real effective exchange rate indices, the bilateral SA rand-US$ exchange rate and the SA rand-US$ exchange rate index.

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

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

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

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

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

7.5 SUMMARY AND CONCLUSIONS

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

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

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

CHAPTER 8

SUMMARY AND CONCLUSIONS

8.1 INTRODUCTION

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

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

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

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

8.2 MAIN FINDINGS OF THE THESIS

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

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

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

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

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

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

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

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

8.3 POLICY RECOMMENDATIONS

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

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

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

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

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

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

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

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

8.4 LIMITATIONS OF THE THESIS AND FUTURE RESEARCH

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

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

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

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