

## CHAPTER 1

### INTRODUCTION

#### 1.1 INTRODUCTION AND OVERVIEW

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

#### 1.2 THE SIGNIFICANCE OF AUTOMOTIVE TRADE IN WORLD TRADE

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

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

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

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

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

Source: WTO (2008), International Trade Statistics

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

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

### **1.3 BACKGROUND OF THE SOUTH AFRICAN AUTOMOBILE INDUSTRY**

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

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

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<sup>2</sup> In the industrial organisation literature, the term ‘international production sharing’ is used interchangeably with the terms ‘fragmentation’, ‘vertical specialisation’, ‘outsourcing’, and ‘intra-product specialisation’, among others.

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

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

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

Source: NAAMSA (2007)

Note: \*2000 figure

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

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

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<sup>3</sup> The automobile sector here comprises vehicle assembly, component manufacturing, tyres, and motor trade, which includes retailing, distribution, servicing and maintenance (NAAMSA, 2007).

<sup>4</sup> Domestic production of vehicles includes cars, and light, medium and heavy commercial vehicles (NAAMSA, 2007).

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

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

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

#### **1.4 STATEMENT OF THE RESEARCH PROBLEM**

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

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

## **1.5 HYPOTHESES OF THE THESIS**

### **1.5.1 Hypothesis (I)**

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

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

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

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

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

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

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

- Hypothesis (v):* To investigate the effects of regional integration on IIT patterns in the automobile industry.
- Hypothesis (vi):* To examine whether foreign direct investment promotes IIT patterns in the automobile industry.
- Hypothesis (vii):* To investigate whether trade openness influences IIT patterns in the South African automobile industry.
- Hypothesis (viii):* To ascertain whether tariffs applied to the automobile industry have significant effects on IIT patterns.
- Hypothesis (ix):* To investigate the way automotive assistance applied to the automobile industry may affect IIT patterns.
- Hypothesis (x):* To ascertain whether economies of scale is a determinant of IIT patterns in the automobile industry.
- Hypothesis (xi):* To analyse the impact of product differentiation on IIT patterns in the automobile industry.
- Hypothesis (xii):* To assess the impact of the exchange rate on the intensity of IIT patterns in the automobile industry.
- Hypothesis (xiii)* To examine the impact of the trade imbalance on IIT patterns.

## **1.6 JUSTIFICATION OF THE THESIS**

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

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

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

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



industry. Although policy reforms and their likely impact on the domestic industry is discussed in Chapter 4, the evaluation of the impact of automotive policy on South Africa is beyond the scope of this thesis and does not form part of the objectives outlined in Section 1.7.

## **1.7 OBJECTIVES OF THE RESEARCH**

- (i) To empirically measure the intensity and composition of bilateral IIT levels in the South African automobile sector
- (ii) To segregate total IIT into VIIT and HIIT patterns in the South African automobile industry
- (iii) To identify and investigate country- and industry-specific determinants of bilateral total IIT, VIIT and HIIT in the automobile industry
- (iv) To assess whether VIIT and HIIT patterns are affected differently by country and industry determinants.
- (v) To contribute to the debate and make recommendations for future automotive trade and industry policy derived from the preceding objectives.

## **1.8 RESEARCH METHODOLOGY**

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

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

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

## **1.9 SCOPE OF THE THESIS**

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

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

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

## **1.10 CHAPTER OUTLINES OF THE THESIS**

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

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

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

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

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

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

*Chapter 5:* This chapter adopts the following format: Section 5.2 revisits the theoretical motivation for measuring and investigating IIT patterns. In Section 5.3, the methodology for empirically measuring and separating bilateral IIT into shares of VIIT and HIIT patterns is discussed. Section 5.4 discusses the data used in the empirical analysis. In Section 5.5, the empirical results of the patterns of IIT between South Africa and 20 selected bilateral trading

partners in the automobile industry over eight years (2000–2007) are discussed. Section 5.6 concludes with a summary of this chapter.

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

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

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

## **1.11 CONCLUDING REMARKS**

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

## CHAPTER 2

### THEORETICAL REVIEW OF THE INTRA-INDUSTRY TRADE LITERATURE

#### 2.1 INTRODUCTION

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

#### 2.2 REVIEW OF THE THEORETICAL INTRA-INDUSTRY TRADE LITERATURE

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

New trade theories of IIT refer to the simultaneous trading of a product within a specific industry and exist under imperfect competition, EoS and product differentiation. This trade theory of IIT does not necessarily require comparative advantage since it stems from

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

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

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

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

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

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

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

### 2.2.1.1 Final products

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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



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

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

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

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

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

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

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

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

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

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

$$x_i = Lc_i, \quad L = \sum_{i=1}^n l_i \quad (2.10)$$

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

$$P = \frac{\alpha}{Lc} + \beta \quad (2.11)$$

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

$$L = \sum_{i=1}^n [\alpha + \beta x_i] \quad (2.12)$$

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

Then,

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

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

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

$$U = \sum_{i=1}^n v(c_i) + \sum_{i=n+1}^{n+n^f} v(c_i) \quad (2.14)$$

where products 1, ...,  $n$  will be produced at home and products  $n + 1, \dots, n + n^f$  will be produced in the foreign country. With the introduction of the foreign country when trade is allowed, the size of the joint or average market, and consequently the size of the labour force ( $L$ ), increases thereby increasing the number of product varieties available for consumption to

both nations. From Equation (2.15), each country will produce ( $n$ ) number of variety products proportional to its labour force ( $L$ ) as given by:

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

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

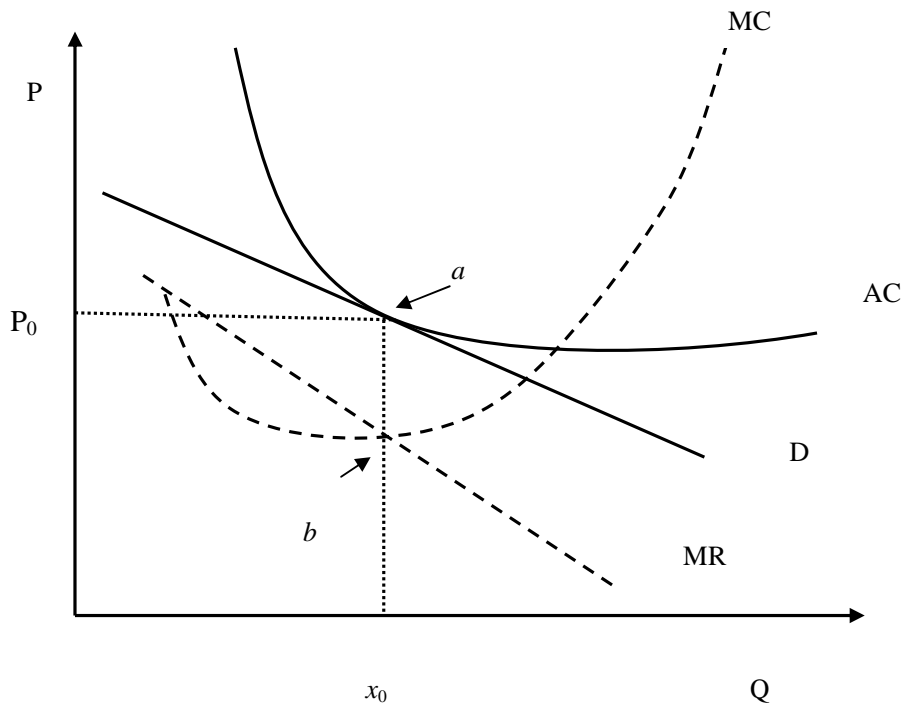
$$n_T = \frac{(L + L^f)}{l_i} = n + n^f \quad (2.16)$$

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

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

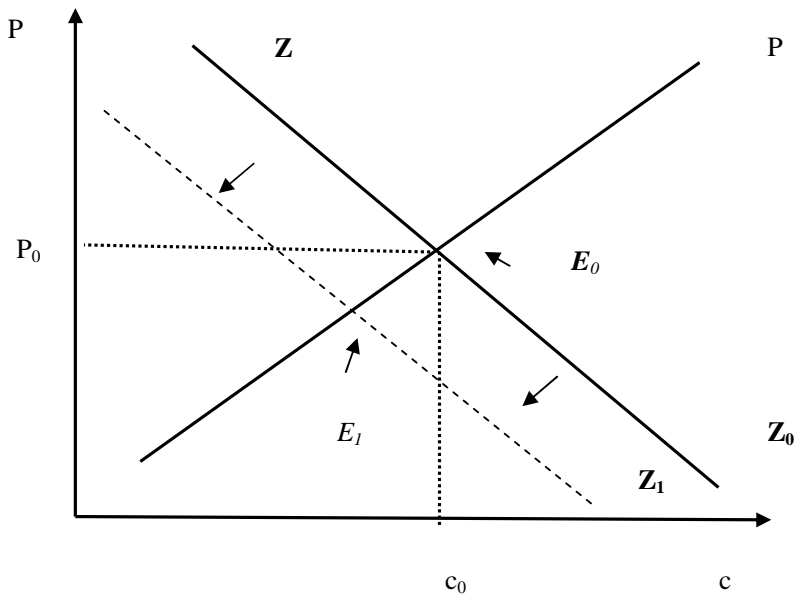
In Schmidt & Yu (2000), a theoretical model is derived from Helpman & Krugman (1985) that allows for firm heterogeneity in export markets and proves that EoS are positively related to the volume of IIT and the share of industry trade in production. In this model, the exporting firm (traded products)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

**Figure 2.1 The firm's output solution under IIT**



Source: Salvatore (2007)

**Figure 2.2 Market equilibrium in Krugman's model**



Source: Krugman (1979)

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

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

### 2.2.1.2 Intermediate products

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

$$n_{\theta} = n + n^f \frac{(1-\Psi)}{\gamma} (s + s^f) \quad (2.23)$$

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

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

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

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

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



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

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

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

### 2.2.2.1 Final products

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

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

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

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

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

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

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

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

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

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

Comparative advantage in the home country occurs when:

$$[c(\alpha_m) - c^f(\alpha_m)] < 0 \quad (2.28)$$

and

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

According to Equations (2.28) and (2.29), the home (foreign) country has a comparative advantage in producing product quality types that requires capital-intensive (labour-intensive)

procedures exceeding the marginal quality ( $\alpha_m$ ). On the other hand, the home (foreign) country experiences comparative disadvantage in product qualities requiring greater capital-saving (labour-saving) techniques.

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

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

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

Consequently,

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

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

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

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

model assumes large price (unit value) differences to distinguish between different quality varieties.

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

#### 2.2.2.2 Intermediate products

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

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

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

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

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

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

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

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

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

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

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

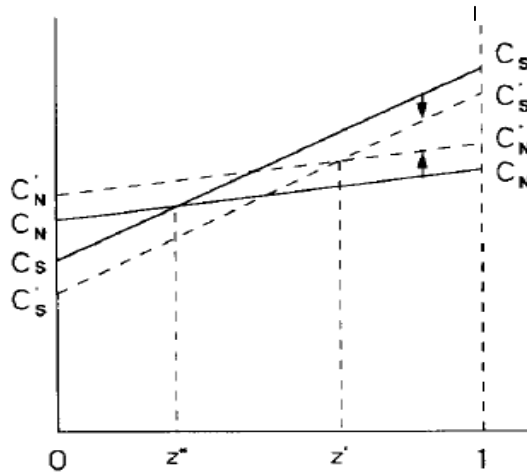
In Equation (2.38),  $z^*$  defines the equilibrium of trading intermediates between the two countries where the minimum cost loci are equated where:

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

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

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

**Figure 2.3 Outsourcing and capital movements from North to South**



Source: Feenstra & Hanson (1997)

Suppose capital flows (such as FDI) from North to South or outsourcing activities are increased,  $C_S C_S$  shifts downward whereas  $C_N C_N$  shifts upward (as indicated by the direction of the arrows) causing  $z^*$  to increase to  $z'$  as shown in Figure 2.3. The increase in  $z^*$  implies

that an increase in the relative capital accumulation in the South will in turn result in an increase in the relative demand for skilled labour ( $H$ ) in both countries with a positive impact on relative wages of skilled labour in both countries. This model also implies that both nations are better off, although wage inequality may rise.

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

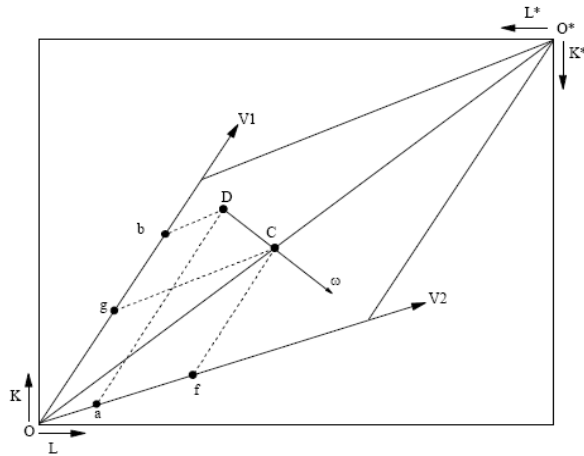
### 2.3 WORLD INTEGRATED EQUILIBRIUM (IE) APPROACH TO IIT

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

In Figure 2.4 the popular Edgeworth box is used to depict the production outcomes of two goods ( $j = 1,2$ ) and two factors of production ( $L, K$ ) for each country ( $k = 1,2$ ). The world endowment of  $L$  and  $K$  are depicted along the width and height of the box, respectively. The slope of the ray from connecting each country's origin denotes the capital-labour ( $K/L$ ) ratios. The domestic endowment of  $L$  is measured by the horizontal distance from  $O$  and the vertical distance measures the  $K$  endowment. In the same way, the foreign endowment of  $L^*$  is measured by the horizontal distance  $O^*$  and the endowment of  $K^*$  is measured by the vertical distance. In the Edgeworth box, the domestic country is capital abundant whilst the foreign country is labour abundant. The net factor content of trade is the difference between the net

factor content of consumption and the net factor content of production. In Figure 2.4, the net factor content of trade is illustrated by subtracting the factor content of the imported good ( $V_2$ ) from that of the exported good ( $V_1$ ). Within the world  $IE$  a set of allocations (factor price equalisation) of factor endowments can be constructed that will allow countries to attain all of the benefits of the fully integrated world by trading in goods alone.

**Figure 2.4 Economic distance and HIIT**



Source: Fontagné and Freudenberg (1997)

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

$$Y_k = rK_k + wL_k \quad (2.39)$$

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

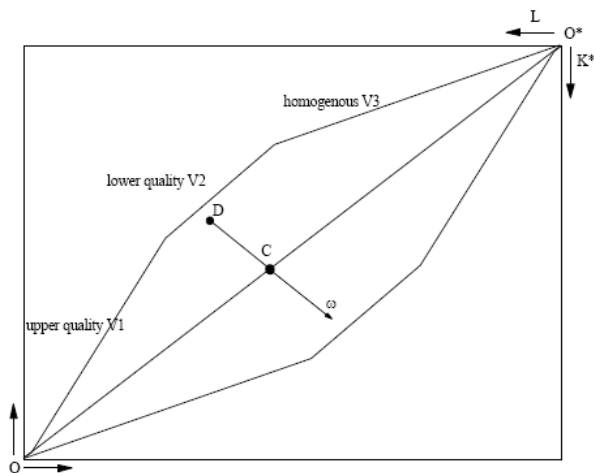
$$v_j = [a_{Kj}(r), a_{Lj}(w)] \quad (2.40)$$

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



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

**Figure 2.5 Economic distance and VIIT**



Source: Fontagné and Freudenberg (1997)

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

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

In Figure 2.5, OWT is now associated with non-zero net factor content of balanced trade, whereas IIT under vertical differentiation reflects different factor contents corresponding to different qualities traded as a result of the experience of internal redistributive pressures. In Figure 2.5, vectors  $V1$ ,  $V2$  and  $V3$  represent high and low qualities of differentiated goods and

homogenous goods respectively. Further, Figure 2.5 illustrates that greater relative economic distance is now positively associated with VIIT.

## **2.4 FRAGMENTATION THEORY OF INTERNATIONAL PRODUCTION**

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

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

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

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

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

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

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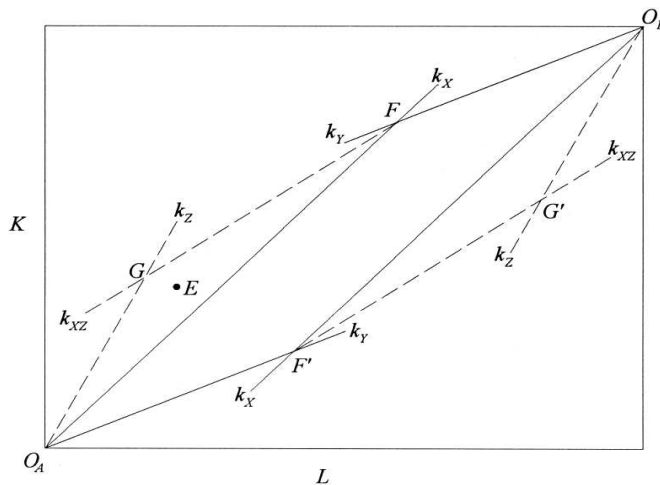
7 Ando (2006), Aturokulo (2007), Kimura (2006); Kimura *et al.*, (2006); 2007), Wakasugi (2007) examined trade in intermediate products in East Asia trade and Chung & Deardorff (2008) consider the case of manufacturing in Chile's manufacturing sector.

8 The expression "fragmentation" was initiated by Jones & Kierzkowski (1990; 2001).

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

- (i) If the prices of goods remain unchanged, then fragmentation must necessarily increase the value of output of any country where it occurs as well as that of world trade.
- (ii) If fragmentation causes price adjustments, then such fragmentation can lead to the deterioration of a country's terms of trade and in turn lower its welfare.
- (iii) In the presence of fragmentation of production, it is possible, although not necessary, that the ownership of some factors may lose even if the country gains as a whole.
- (iv) In the absence of fragmentation, if factor prices are not equalised, then the subsequent occurrence of fragmentation will enhance the opportunity for factor prices to become equalised across countries.

**Figure 2.6 Fragmentation-based trade models**



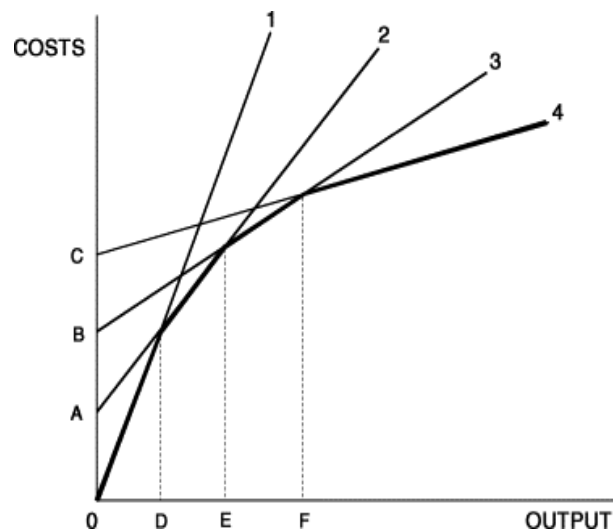
Source: Deardorff (2001)

In Jones & Kierzkowski's (1990; 2001; 2005) fragmentation model, they emphasise that the production process hinges on the idea of using service links to connect vertically integrated production processes into separate fragments (production blocks) that can be produced in different parts of the world. Importantly, it is crucial to distinguish between *production blocks* and *service linkages* (Jones & Kierzkowski, 1990). In Jones & Kierzkowski (2005), constant returns to scale (CRS) occur inside production blocks whilst increasing returns to scale associated with fixed costs and higher output can be found *within* service links (transport, communication and other coordinating activities), thereby reducing the service costs of connecting the fragments of the production process and thus encouraging

international fragmentation of the production process to be carried out in various geographical locations. Thus, the model postulates that increased outsourcing contributes to lower total production costs attributable mainly to the costs of services connecting production fragments that do not rise in equal proportion to the level of output. Further, reduced service link costs tend to discourage national agglomeration production activities.

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

**Figure 2.7 Fragmentation and the costs of production**



Source: Jones & Kierzkowski (2005)

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

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

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

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

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

## 2.5 SUMMARY AND CONCLUDING REMARKS

This chapter summarised theoretical models of HIIT and VIIT in the context of final products and intermediate products. In summary, HIIT trade is largely caused by monopolistic competitive practices and EoS. The ineffectiveness of HIIT theory from the viewpoint of FDI and outsourcing and production networks (Okubo, 2004) has led to the extensive use of VIIT

models for this purpose. On the other hand, VIIT is formulated on the basis of perfectly competitive markets where the presence of EoS in production is not a necessary condition. In the case of VIIT, countries with larger differences in factor intensities, endowments, technologies and per capita income levels tend to exchange VIIT flows while the opposite is true for HIIT. VIIT largely explains trade between the North (developed countries) and South (developing and emerging economies) which tend to exchange products (final products and intermediate products) that are vertically differentiated by quality.

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