

**ESSAYS IN DOMESTIC TRANSPORT COSTS AND
EXPORT REGIONS IN SOUTH AFRICA**

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NOTE

This thesis has been written in article format. Please take note of the following aspects:

- The format, structure, layout and manner of referencing sources of each article contained in the chapters are not set to the guidelines and stipulations of the journal to which the articles were submitted. The reason is that the articles form part of a thesis and need to be uniform and standardised.
- Each article contains its own problem statement, theoretical and empirical study, conclusions, recommendations and reference list. Abstracts, key terminology and JEL (Journal of Economic Literature) codes are supplied for each article.
- Chapter 2 was not written in article format, but as a thesis chapter that serves as background to the three submitted articles. It reviews relevant international trade theories.
- Chapter 1 and 2 each contains its own reference list.

The three articles bound in this thesis have been submitted to different accredited international journals:

Article 1, titled *Domestic transport costs and the location of export-oriented manufacturing firms in South Africa: a cubic-spline density function approach* has been submitted for possible publication to the Journal of Economic Geography.

Article 2 titled *Determinants of regional manufactured exports from a developing country* has been submitted for possible publication to the International Regional Science Review.

Article 3, titled *Export diversity and regional growth in a developing country context: empirical evidence* has been submitted for possible publication to the Journal of Regional Science.

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SUMMARY

This thesis investigates the impact of domestic transport costs and location on exports originating from exporting regions within a developing country. It is presented in the form of three articles, each addressing a different aspect. These articles are accompanied by a literature review of the background and impact of domestic transport costs on trade.

The first article provides empirical evidence for the significance of domestic transport costs in exports and the spatial location of manufacturing exporters. Cubic-spline density functions are used and the results indicate (a) the proximity to a port is an important consideration in most export-oriented manufacturing firms' location, with more than 70% of manufactured exports in South Africa originating from a band of 100 km from an export hub; and (b) there appears to be a second band of these firms at a distance of between 200 and 400 km from the hub. Between 1996 and 2004, manufactured exports in the band between 200 km and 400 km from the nearest hub increased, suggesting either an increase in manufactured exports that depend on natural resources due to demand factors, and/or a decrease in domestic transport costs, amongst others.

The second article investigates the question of the location of exporters of manufactured goods within a country. Based on insights from new trade theory, the new economic geography (NEG) and gravity-equation modelling, an empirical model is specified with agglomeration and increasing returns (the home-market effect) and transport costs (proxied by distance) as major determinants of the location decision of exporters. Data from 354 magisterial districts in South Africa are used with a variety of estimators (OLS, Tobit, RE-Tobit) and allowances for data shortcomings (bootstrapped standard errors and analytical weights) to identify the determinants of regional manufactured exports. It is found that the home-market effect (measured by the size of local GDP) and distance (measured as the distance in km to the nearest port) are significant determinants of regional manufactured exports. This article contributes to the literature by using developing country data, and by adding to the small literature on this topic. This article complements the work of Nicolini (2003) on the determinants of exports from European regions and finds that the home-market effect is relatively more important in the developing country context (South Africa), a finding consistent with theoretical NEG models such as those of Puga (1998).

The third article is an empirical study of the relationship between export diversity and economic growth in a developing country context. Using export data from 19 sectors within 354 sub-national (magisterial) districts of South Africa, various measures of sub-national export diversity are constructed. It is found that it is not only important how much is exported, but that it is also important what it is that is exported. Regions with less specialisation and more diversified exports generally experienced higher economic growth rates, and contributed more to overall exports from South Africa. It is also found that distance (and thus domestic transport costs) from a port is inversely related to the degree of export diversity. Estimating a cubic-spline density function for the Herfindahl index measure of export diversity, it is found that export diversity declines as the distance from a port (export hub) increases. Most magisterial districts with high export diversity values are located within 100 km of the nearest port. Furthermore, comparing the cubic-spline density functions for 2004 with those of 1996 shows that distance (domestic transport costs) has become more important since 1996 (under greater openness) with magisterial districts located further than 100 km from the ports being less diverse in 2004 than in 1996. One may speculate that a possible explanation for this changing pattern of export diversity may be the impact of greater foreign direct investment (FDI) in South Africa since 1996.

Key words: domestic transport costs, distance, exports, South Africa

OPSOMMING

Hierdie proefskrif ondersoek die impak van binnelandse vervoerkoste en ligging op uitvoere vanaf uitvoerstreke in 'n ontwikkelende land. Dit word voorgelê in die vorm van drie artikels, en elke artikel bespreek 'n verskillende aspek. Die artikels word voorafgegaan deur 'n literatuuroorsig oor die agtergrond en impak van binnelandse vervoerkostes op handel.

Die eerste artikel verskaf empiriese bewyse vir die belangrikheid van binnelandse vervoerkostes in die uitvoer en ruimtelike ligging van vervaardigde uitvoere. Polinoom digtheidsfunksies word gebruik en die resultate dui aan dat (a) die nabyheid aan 'n hawe is 'n belangrike oorweging in die ligging van die meeste uitvoer-georiënteerde firmas, aangesien meer as 70% van vervaardigde uitvoere in Suid-Afrika binne 'n band van 100 km vanaf 'n uitvoerspil geproduseer word; en (b) dit wil voorkom asof daar 'n tweede band van hierdie firmas is met 'n afstand tussen 200 km en 400 km vanaf die naaste spil. Tussen 1996 en 2004, het die aantal vervaardigde uitvoere in die band tussen 200 km en 400 km vanaf die naaste spil toegeneem. Dit dui aan dat daar óf 'n toename in vervaardigde uitvoere wat staatmaak op natuurlike hulpbronne is a.g.v. vraag, en/óf 'n daling in binnelandse vervoerkostes, onder andere.

Die tweede artikel ondersoek die vraag rondom die ligging van uitvoerders van vervaardigde goedere in 'n land. Gebaseer op die insigte van die nuwe handelsteorie, die nuwe ekonomiese geografie (NEG) en gravitasie-vergelyking modellering, word 'n empiriese model gespesifiseer met agglomerasie en toenemende skaalopbrengs (die tuismark-effek) en binnelandse vervoerkoste (soos gemeet deur afstand) as belangrike determinante van die liggingsbesluit van uitvoerders. Data van 354 landdrosdistrikte word gebruik met 'n verskeidenheid beramers (OLS, Tobit en RE-Tobit). Daar word ook voorsiening gemaak vir tekortkominge in die data deur die gebruik van herstreekproefneming standaardfoute. Bogenoemde is gebruik om die determinante van vervaardigde goedere vir streke te bepaal. Daar is gevind dat die tuismark-effek (soos gemeet deur die plaaslike BBP) en afstand (soos gemeet in afstand in kilometer van die naaste hawe) beduidende determinante van vervaardigde uitvoere uit streke is. Hierdie artikel dra by tot die literatuur deur gebruik te maak van data uit 'n ontwikkelende land en om die klein bestaande literatuur oor hierdie onderwerp aan te vul. Die artikel vul die werk van Nicolini (2003) aan oor die determinante van uitvoere vanaf streke in Europa en bevind dat die tuismark-effek relatief meer belangrik is in die konteks van 'n

ontwikkelende land (Suid-Afrika); 'n bevinding wat ooreenstem met teoretiese NEG modelle soos dié van Puga (1998).

Die derde artikel is 'n empiriese studie oor die verhouding tussen uitvoerdiversiteit en ekonomiese groei in die konteks van 'n ontwikkelende land. Deur gebruik te maak van uitvoerdata van 19 sektore van die 354 sub-nasionale distrikte is verskeie maatstawwe van hierdie distrikte saamgestel. Daar is bevind dat nie slegs die hoeveelhede wat uitgevoer word belangrik is nie, maar ook wat uitgevoer word. Streke met minder gespesialiseerde en meer gediversifiseerde uitvoere ervaar oor die algemeen hoër ekonomiese groei, en dra ook by tot die totale uitvoer vanaf Suid-Afrika. Daar is ook bevind dat afstand (en dus binnelandse vervoerkoste) vanaf 'n hawe omgekeerd verwant is aan die graad van uitvoerdiversiteit. 'n Beraming van 'n polinoom digtheidsfunksie van die Herfindahl-indeks dui op 'n daling in uitvoerdiversiteit soos wat afstand van 'n hawe (uitvoerspil) toeneem. Die meeste landdrosdistrikte met hoë waardes van uitvoerdiversiteit is binne 'n 100 km radius vanaf die naaste hawe. Deur die polinoom digtheidsfunksie van 2004 te vergelyk met dié van 1996, word dit duidelik dat afstand (binnelandse vervoerkoste) belangriker geword het sedert 1996 (a.g.v. groter openheid), met landdrosdistrikte wat verder as 100 km van die hawens geleë is, minder gediversifiseerd in 2004 is as in 1996. Dit is moontlik om te spekuleer dat 'n verduideliking vir hierdie veranderde patroon van uitvoerdiversiteit die impak van groter direkte buitelandse investering in Suid-Afrika sedert 1996 is.

Sleutelwoorde: binnelandse vervoerkoste, afstand, uitvoer, Suid-Afrika

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CHAPTER 1: INTRODUCTION

1.1 Introduction

“Movements of people, goods and information have always been fundamental components of human societies. Contemporary economic processes have been accompanied by a significant increase in mobility and higher levels of accessibility.”

Rodrigue, Comtois and Slack (2006: 1)

The development of transport has linked the economic activities of regions and countries and made international trade possible. Movement or trade between countries became beneficial as it encouraged specialisation and increased welfare and income levels of countries (Du Plessis, Smit & McCarthy, 1987; Frankel & Romer, 1996). Over time, especially in the last decades, the movement of people, goods and information has accelerated. Reasons for this acceleration include the establishment of economic blocs and trade organisations, trade liberalisation, and more effective use of international resources brought on by globalisation (Rodrigue *et al.*, 2006). New international trade policies reduced or eliminated tariff and non-tariff barriers between countries (Micco & Pérez, 2001). These policies changed the manner in which trade takes place, as trade costs (i.e. the transport and other costs of conducting business on an international level) are now more important than before. Indeed, where income levels of countries were previously protected by trade policies, they no longer are. The success of exports, and of profitable international participation in the world economy, now depends on the competitiveness of a country's trade costs (Limão & Venables, 2001). Egger (2005) emphasises this by pointing out that successful trade lies in the reduction of trade frictions.

This study determines the impact of trade costs on exports, with specific focus on transport costs¹. Porto (2005) finds that transport costs are the most important trade barrier for developing countries. It is for this reason that numerous studies have emerged to analyse the impact of transport costs on both trade patterns and globalised production (Hoffmann, 2002).

¹ Transport costs can be defined as all costs included in the transfer of physical goods from the exporter to the importer, such as the cost of handling, freight, insurance and tariffs (Brakman, Garretsen and Van Marrewijk, 2001; Chasomeris, 2005).

1.2. Background

This section provides a background to better understanding of the problem statement. Firstly, the impact of transport costs on trade as well as on economic growth is discussed. A synopsis on the measurement of transport costs is provided, and the relevance of measuring domestic transport costs is discussed. Secondly, as the context of South Africa is used in this study, it is useful to provide background information of why this is such a relevant topic.

1.2.1 The Impact of Transport Costs

Countries need to be sensitive to their levels of transport costs if they want to improve their integration into the global economy (Micco & Pérez, 2001). The general consensus in literature, from both theoretical and empirical work, is that transport costs affect both trade and economic development. Exports and economic growth are inextricably linked, if transport costs affect one, the other is also affected.

Henderson, Shalizi and Venables (2001) consider transport costs to be real costs that exhaust scarce resources and choke off trade. According to Hoffmann (2002), transport costs have an impact on trade similar to customs tariffs or exchange rates in that they have the ability to make imports and exports competitive or not. To illustrate this point, evidence from Limão and Venables (2001) indicates that if transport costs increased by 10%, trade volume would be reduced by 20%. Globally, transport costs represent around 5% of the trade value. This figure may seem low, but is mainly the case for developed countries. Developed countries account for approximately 70% of world imports and their proximity to one another ensure low freight rates (Micco & Pérez, 2001). Developing countries, on the other hand, are affected much more severely by transport costs, especially if they are located far from the import markets. Limão and Venables (2001) conclude that geography is paramount to successful trade and find that landlocked developing countries tend to have higher transport costs (approximately 50%) and lower trade volumes (around 60%) than coastal countries.

The reason for this is that transport costs are influenced by geographical factors such as distance to markets and access to ports which, in turn, have an effect on manufactured exports and long-term economic growth. Countries with lower transport costs have experienced more rapid growth in manufactured exports as well as in overall

economic growth during the past three decades, compared with countries with higher transport costs. High transport costs elevate the cost of producing manufactures by increasing the price of imported intermediate and capital goods (again this effect is more severe for developing countries as they tend to import the majority of their intermediate products). These elevated production costs, together with high transport costs, impede the price competitiveness of manufactured exports and ultimately economic growth (Radelet & Sachs, 1998; Gallup, Sachs & Mellinger, 1999; Hoffmann, 2002; Rodrigue *et al.*, 2006). High transport costs also increase the price of imported capital goods. This leads to a decline in foreign and local investment in economic activities, thereby reducing the rate of technological transfer and ultimately economic growth (Chasomeris, 2003). Radelet and Sachs (1998) empirically find that doubling transport costs is associated with a decrease in Gross Domestic Product (GDP) growth (i.e. economic growth) of slightly more than one and a half percentage points.

Therefore, compared to tariffs, transport costs have risen in relative importance for export competitiveness (Hoffmann, 2002). Transport costs are becoming a major component of GDP and, although transport costs have declined as a percentage of the value of trade, trade itself has expanded. This increases the share of transport costs in GDP (UNCTAD Secretariat, 2003). Spending on transport in logistics² has also increased, as “just-in-time” delivery is taking precedence over keeping inventories. Apart from spending on transport in logistics, the incidence of transport costs is also increasing. Nowadays, imports and exports consist of intermediate goods and inputs, as opposed to only final goods (Hoffmann, 2002).

In the measurement of transport costs, one needs to distinguish between two categories of transport costs. The first category is international transport costs. International transport costs are those costs involved in moving goods between countries. The second category is internal or domestic transport costs and includes those costs involved in moving goods within a country (UNCTAD Secretariat, 1999).

Numerous studies and various methods have been used to measure the impact of international transport costs on trade (see for example, Hummels, 1999b; Limão & Venables, 2001; Martínez-Zarzoso, Menéndez, & Suárez-Burguet, 2003). The measurement of domestic transport costs has not been as popular a topic, with no commonly used method. In most cases, a proxy for domestic transport costs is applied

² Logistics is considered to be that part of the supply chain that takes control over transport, warehousing, inventory carrying and administration and management of physical products between the point of origin and the point of delivery to the final consumer (CSIR, 2004).

(Elbadawi, Mengistae & Zeufack, 2001; Limão & Venables, 2001; Combes & Lafourcade, 2005). Overall, it is estimated that domestic transport costs may have a much stronger effect on exports than international transport costs. Despite this, the majority of studies have focused on international transport costs, with only a few studies (as cited above) focusing on domestic transport costs. Even fewer studies are available that investigate the importance of domestic transport costs in an African country.

1.2.2 The Context of South Africa

The South African economy has, in the last decades, transformed itself from one driven by agriculture and mining to an industry-based economy with a focus on the export of high-cost goods and services (Mitchell, 2006). For example, during the period between 1988 and 1998, manufacturing exports increased from 5% to 20% of total exports, whereas gold and primary products decreased from 65% to 45% (DOT, 1998). The change in South Africa's economic dynamics was accompanied by increased levels of economic growth. Unfortunately, the country is still classified as a dual economy. The increasing gap between the formal and informal economies was one of the factors that prompted the development of ASGISA (Accelerated and Shared Growth Initiative – South Africa) and its 6% target economic growth rate (Mlambo-Ngcuka, 2006; DFID, 2006).

A binding constraint to the achievement of ASGISA's aims is the national logistic system (Mlambo-Ngcuka, 2006). Economic growth is limited to the extent to which freight, people and information can be moved (Mitchell, 2006). Clearly, economic growth is hampered by South Africa's spatial problem, as movement occurs over longer distances and at higher transport costs (Mlambo-Ngcuka, 2006). Around 70% of the country's GDP is produced in only 19 of the urban areas and the majority of these are located in inland in Gauteng (Naudé & Krugell, 2005). Location is therefore highly relevant in South Africa.

1.3 Problem Statement

During the past twelve democratic years, South Africa has become more integrated into the international economy. South Africa's reintegration into the world was accompanied by a new economic structure evidenced by trade liberalisation, a contrast to the high

tariffs and subsidies levied during the Apartheid era. South Africa's imported-weighted average tariff rate decreased from more than 20% in 1994 to 7% in 2002 (Bureau of African Affairs, 2006). The result was that domestic industries, previously protected, had to become more competitive to remain profitable in this global arena. The successful participation of these industries in the international market is imperative, since economic growth (government has a target of 6% GDP growth) is to be fuelled by exports of value-added manufacturing goods (Chasomeris, 2003; DFID, 2006).

With consideration to South Africa's geographical location, transport costs are becoming a more important determinant of the country's trade. Both South Africa's external and internal geographical locations warrant low transport costs. The country is situated far from its major markets and the majority of economic activity takes place within 600 km from the nearest sea port. South Africa's transport costs are however, not low. South Africa's transport costs accounted for around 13% of GDP in 2003, which is high in comparison with other emerging markets. Brazil's transport costs, for example, are only 8% of their GDP (Ramos, 2005). The largest part of South Africa's total logistics cost³ (75%) is attributed to transport costs. Transport costs make up 78% of the secondary sector's total logistics costs and 60% of the primary sector's (CSIR, 2004; Chasomeris, 2005).

Therefore, transport costs - especially domestic transport costs - are a relevant issue in South Africa, since transport is the key facilitator in international trade and international trade is the key to economic growth. South Africa's regions do not all produce exports, and if they develop their potential to do so, government may easily achieve its target economic growth rate.

1.4 Research Questions

The primary research question is as follows: "What are the influences of domestic transport costs and location on exports originating from exporting regions within a developing country?"

The secondary research questions are:

³ Logistics costs include throughput (i.e. the total amount of goods that are transported and stored), transport costs, warehousing costs, inventory costs and management and administration costs (CSIR, 2004).

- “Do domestic transport costs influence the location of export-oriented manufacturing exporters located in the various regions in South Africa?”
- “South Africa faces high economic inequality between regions and not all regions generate exports. What are the determinants of regional exports in a developing country such as South Africa?”
- “Export facilitates economic growth. Is the composition of a country’s exports a reason why some regions prosper and others not?”

1.5 Objectives

The objectives of this study, structured to answer the research questions, are to determine:

- the role played by transport costs, specifically domestic transport costs, in trade literature;
- the effect of domestic transport costs on manufactured exports and the location of exporting firms in South Africa;
- the determinants of regional exports from a developing country, with specific focus on domestic transport costs and
- the relationship between exports, in particular export diversity, and spatial inequality in a developing country context.

1.6 Hypothesis

Domestic transport costs and location have an impact on exports originating from exporting regions within a developing country.

1.7 Research Methodology

The research method includes a literature study and various empirical studies in the format of three articles.

The literature study serves as a background and reviews international trade theories, with specific focus on how the role of transport costs as a determinant of trade evolved. It also provides a survey of all empirical research conducted on both international and domestic transport costs.

Article 1 provides empirical evidence for the significance of domestic transport costs in exports and the spatial location of manufacturing exporters. Cubic-spline density functions are used and the results indicate that proximity to a port is an important consideration in most export-oriented manufacturing firms' location decisions.

Article 2 investigates the question of the location of exporters of manufactured goods within a country. Data from 354 magisterial districts in South Africa were used with a variety of estimators (Ordinary Least Squares model, Tobit model and the Random Effects Tobit model). The results indicated that the home-market effect (measured by the size of local GDP) and distance (measured as the distance in km to the nearest port) are significant determinants of regional manufactured exports.

Article 3 provides empirical evidence on the relationship between exports, and in particular export diversity, and spatial inequality in a developing country context. Using export data from 19 sectors within 354 sub-national (magisterial) districts of South Africa, various measures of sub-national export diversity are constructed. It is found that it is not only important how much is exported, but that it is also important what it is that is exported. Regions with less specialisation and more diversified exports generally experienced higher economic growth rates. It is also found that distance (and thus domestic transport costs) may matter for export diversity.

1.8 Demarcation

The demarcation of the study is as follows:

- Chapter two provides an overview of international trade theory and transport costs.
- Chapter three consists of the first article, i.e. the use of cubic-spline density functions to determine the effect of domestic transport costs on manufactured exports and the location of exporting firms in South Africa.
- Chapter four consists of the second article, i.e. the use of various estimators to determine what the determinants of regional manufactured exports are.
- Chapter five consists of the third article, i.e. the relationship between exports and spatial inequality in developing countries.
- Chapter six summarises, concludes and makes recommendations for further research.

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CHAPTER 2: THEORETICAL AND EMPIRICAL EVIDENCE ON TRANSPORT COSTS

2.1 Introduction

Countries trade because it allows for specialisation and improvement in welfare (Du Plessis, Smit & McCarthy, 1987). The explanation and consequences of trade has been the focus of many researchers throughout time, from Smith in the 18th century to Krugman in the 20th century. Traditionally, trade theory has explained trade between countries. More modern theories, however, focus on trade between regions and industries. The basic question that trade theories seek to answer is: why do countries, regions or localities trade?

Section 2.2 provides an overview of literature and consists of international trade theories, with specific focus on how the role of transport costs as a determinant of trade evolved. Section 2.3 provides a survey of all empirical research conducted on both international and domestic transport costs. This section describes the decline in transport costs (section 2.3.1), the significance of transport costs (section 2.3.2), the measurement of transport costs (international transport costs are explained in subsection 2.3.3.1 and domestic transport costs in subsection 2.3.3.2), the differences in transport costs (section 2.3.4) and finally factors influencing transport costs (section 2.3.5). The chapter summarises and concludes in section 2.4.

2.2 Literature Overview of Transport Costs

2.2.1 Neo-classical Trade Theories

The classical school of thought presented the first explanation of trade between countries (that involve both imports and exports, in contrast to the Mercantilists) and how it contributes to national wealth. Among these economists was David Ricardo, who formulated the theory of comparative advantage. His theory provides the basis of the neo-classical trade theories such as the Heckscher-Ohlin theory (Armstrong & Taylor, 2000).

2.2.1.1 Hecksher-Ohlin Model

The theory of comparative advantage explains why a country still has an incentive to trade, even if it can produce the relevant commodities more efficiently than its trading partner (Du Plessis *et al.*, 1987). Trade between two countries can benefit both, if each produces and exports that commodity in which it has a comparative advantage. The Ricardian model is based on the following assumptions: there are 2 countries, producing 2 commodities. These commodities are homogeneous and can be shipped without cost - *transport costs have no influence whatsoever on international trade*. Labour is homogeneous, but may have different productivities across the countries. Labour is also fully mobile within a country, but cannot move across countries (Suranovic, 2003).

The foundation of the Ricardian model is that the cause of international trade lies in the differences in their respective pre-trade price ratios. These prices reflect only the labour cost ratios (Du Plessis *et al.*, 1987). In other words, international trade exist only because of differences in the countries' labour productivity (Krugman & Obstfeld, 2000). However, labour productivity is not the only difference between countries. The Hecksher-Ohlin model extends the Ricardian model by including differences in countries' resources (factor endowments) to the differences in their labour as the variables in the model (Krugman & Obstfeld, 2000). This model is also referred to as the factor-proportions or factor endowment model, as it involves the interplay between the proportions in which different production factors are available in different countries and the proportions in which they are used to produce different commodities (Krugman & Obstfeld, 2000).

According to Du Plessis *et al.* (1987), the basic version of the Hecksher-Ohlin model includes the following assumptions: the model is used for 2 countries (1 and 2), 2 commodities (X and Y) and 2 production factors (capital and labour). Commodity X is labour-intensive and commodity Y is capital-intensive. There is perfect competition in all markets; full employment of all production factors; full mobility of each production factor within the country, but complete immobility across countries and no impediments to trade such as government intervention or transport costs - *transport costs have no influence whatsoever on international trade*⁴. Demand conditions and technology are similar in the two countries and constant returns to scale exist.

⁴ The assumption that there are no transport costs implies that specialisation in production proceeds until relative (and absolute) product prices are identical in both nations with trade. If one allows for transport

Given these assumptions, the Heckscher-Ohlin model states that the country with an abundance of labour will produce and export the labour-intensive commodity. In the country with ample labour, capital is the scarce production factor, which makes the price of capital high relative to the price of labour. Less capital and more labour will be used to produce the relevant commodity cost-effectively, and the country becomes labour-intensive. This commodity is exported to the country with the capital-intensive industry (Du Plessis *et al.*, 1987; Armstrong & Taylor, 2000). The opposite is true for the country with an abundance of capital.

2.2.1.2 Heckscher-Ohlin-Samuelson Model

In the Heckscher-Ohlin-Samuelson model, the reason for trade is somewhat different than in the Ricardian model. In the Ricardian model, trade is driven by technological differences between countries, whereas in the Heckscher-Ohlin-Samuelson model, countries have identical technology. Here, the reason for trade lays in the differences in countries' factor (i.e. resources) endowments (Pomfret, 1991). The factor-price equalisation theory, developed by Paul Samuelson, stems from the Heckscher-Ohlin model and only holds if the latter's assumptions holds. Salvatore (1998: 124) states the Heckscher-Ohlin-Samuelson theorem as follows:

"International trade will bring about equalisation in the relative and absolute returns to homogeneous factors across nations. As such, international trade is a substitute for the international mobility of factors."

The same assumptions as stipulated in section 2.1.1 holds. Country 1 is a low wage nation that is labour-intensive. It increases the production of the labour-intensive product (X) and subsequently decreases the production of the capital-intensive product (Y). The relative demand for labour rises and wages increase. The relative demand for capital decreases, which causes interest rates to fall. The opposite occurs in country 2, the high wage country (wages fall and interest rates rise). Therefore, international trade reduces pre-trade differences in wages and interest rates (Salvatore, 1998).

The Heckscher-Ohlin-Samuelson model further explains that trade does not only reduce differences in returns to identical factors, but also equalise relative factor prices

costs and tariffs, specialisation would only proceed until relative (and absolute) product prices differed by no more than the costs of transport and tariffs on each unit of the product traded (Salvatore, 1998).

(provided that the assumptions hold). In country 1, the demand for labour increases relative to the demand for capital. Therefore, w/r increases and P_x/P_y also increases. In country 2, the opposite occurs and r/w increases and P_y/P_x increases. This process continues until P_x/P_y becomes equal as a result of trade. P_x/P_y only becomes equal if w/r has become equal in the two countries (provided that they continue to produce the two products) (Salvatore, 1998). Salvatore (1998) concludes that as long as relative factor prices differ, relative product prices differ and trade continues to expand. Trade expands until relative product prices are equal. In other words, until relative factor prices are equal.

2.2.1.3 Skills and Natural Resources in the Hecksher-Ohlin Model

In a modified version of the Hecksher-Ohlin model, Wood and Berge (1997) further investigate the reason for differences in countries' composition of exports. Using the Hecksher-Ohlin model as their basis, they replace the two factors of production, capital and labour, with land and skills. Their argument is that the production of exports, namely manufactured and agricultural goods, requires different land and skills ratios. For example, manufacturing requires less land and more skill than agricultural production does. The contribution made by Wood and Berge (1997) to the theories of trade is that the compositions of countries' exports differ because of the differences in the relative availability of human skills and natural resources or land. Countries with high skill/land ratios have a comparative advantage in manufacturing and the opposite is true for agriculture. Countries that export manufactured goods grow at a faster rate than exporters of primary goods. They prove that the availability of both skills and land influence a country's share of manufactured exports.

In an earlier version of their model, Wood and Berge (1994) find that the ratio of skills/land determines success in exports of manufactures. Their model however, does not include transport costs. Jansen van Rensburg (2000) argues that the skill/land ratio may be used as a proxy for transport costs. If a country's skill/land ratio is low, then they would have high domestic transport costs. If this were the case, then the model would illustrate the relationship between manufactured exports and transport costs. Jansen van Rensburg (2000) motivates her argument through the research of Gallup, Sachs and Mellinger (1999) where they find that large developing countries tend to have large inland populations where skills levels are relatively low.

2.2.2 New Trade Theory

In the neo-classical or traditional explanations of trade between countries, the commodities traded between countries depend on factors such as natural resources, skills and factors of production. In each it is assumed that trade takes place in a frictionless (pinpoint) world. However, the simplifying assumptions of these theories do not hold in the real world. Countries do not have the same level of technology, and trade barriers and transport costs do exist. The latter prevent the equalisation of relative commodity prices in different countries. Also, many industries do not operate in conditions of perfect competition, nor do they achieve constant returns to scale (Salvatore, 1998).

Only in the new trade theories initiated by Krugman (1979 & 1980), has the role of transport costs as a determinant of international trade been recognised. The new trade theory challenges the building blocks of neo-classical trade theories by proving that the actual pattern of trade does not depend on comparative advantage (Krugman, 1980; Brakman, Garretsen & Van Marrewijk, 2001). Krugman (1979 & 1980) developed a model where countries improve their welfare through trade in the absence of comparative advantage. The workhorse in the new trade theory is the model of monopolistic competition developed by Dixit and Stiglitz (1977). The new trade theory developed around the fact that the majority of international trade takes place between countries with comparable factor endowments, and that similar products are traded (i.e. intra-industry trade, as opposed to inter-industry trade, takes place) (Brakman *et al.*, 2001). In the new trade theory, Krugman (1979) introduces increasing returns to scale⁵, which implies imperfect (i.e. monopolistic) competition.

As all trade theories, Krugman's model (1979) has several assumptions. Brakman *et al.* (2001) list them as follows: there are two countries (1 and 2) with equal market size. These countries have similar factor endowments and technologies. The firms in the countries produce the same product (say, cars), but different varieties. For example, country 1 produces varieties A, B and C and country 2 produces X, Y and Z. Further assumptions are that the workers (consumers) in each country are immobile and evenly

⁵ For clarification purposes, increasing returns to scale or economies of scale can be either internal or external. Internal economies to scale occur when the cost per unit depends on the size of an individual firm, not on the industry (Krugman & Obstfeld, 2000). In other words, the decrease in average costs is due to an increase in the production level in the firm itself. With external economies, the opposite is true. The reduction in average costs is brought on by an increase in industry-wide level of production (Brakman *et al.*, 2001).

distributed. They have identical preferences and prefer more varieties than less (known as the love-of-variety effect). Finally, all of the varieties are imperfect substitutes.

The core of Krugman's model is that a country's welfare is improved through two effects, namely internal increasing returns to scale (this depends on the market size) and the love-of-variety effect (Krugman, 1979). Brakman *et al.* (2001) explain these two effects. Assume that the two countries' markets open up, which expands the market size. The fact that the firms now produce for a larger market enables them to boost their production levels and achieve increasing returns to scale. Production per variety increases and the price of each variety subsequently falls. Note that factor endowments and the total market size are fixed. Therefore, fewer varieties can be produced due to limited capacity. As a result, say only four varieties can be produced. How is welfare improved? Firstly, due to the increasing returns to scale – prices of the varieties have fallen, which increases real wages. Secondly, due to the love-of-variety effect – consumers now have a choice of four and not three varieties of cars.

The main shortcomings of Krugman's trade model (1979), which has led to his improved model (1980), were that the location of economic activity did not matter and that trade costs (including transport costs) were zero (Brakman *et al.*, 2001). Brakman *et al.* (2001) explain the key differences between the earlier and later models. The first difference is that in the 1979 version, improvements in welfare, due to trade between countries, occur solely because of the love-of-variety effect. The fact that the markets have opened up does not bring about increased levels in the scale of production (despite individual firms' achieving increasing returns to scale). The second difference is that the market sizes of the countries differ. Finally, in the 1980 model transport costs between countries are incorporated through the "iceberg" effect.

"Iceberg" transport costs were first introduced by Samuelson (1952). Transport costs explained in this manner are unique, as it allows for the incorporation of a transport sector into a model, without having to deal with costs or spending from that sector (Brakman *et al.*, 2001; McCann, 2005). Goods can be shipped freely, but only a fraction of goods (g) arrive at the relevant destination, with $(1 - g)$ lost in transit (i.e. it "melts" away). The fraction lost in transit equals the incurred transport cost (Krugman, 1980; Fujita & Krugman, 2004). Brakman *et al.* (2001) describe the concept by means of an example. Assume that T is a parameter that denotes the number of goods that need to be transported to ensure that one unit arrives per unit of distance. Say that one unit of distance is equal to the distance from Naaldwijk to Paris. 107 flowers are transported

from the Netherlands to Paris, but only 100 arrive in perfect condition than can be sold. $T = 1.07$ and the flowers that did not arrive in Paris “melted” away. According to Fujita and Krugman (2004), using “iceberg” transport costs has two advantages. Firstly, it eliminates the need to analyse the transport sector as another industry. Secondly, it simplifies the description of how monopolistic firms set their prices (i.e. it erases the incentive to absorb transport costs, charging a lower FOB price for exports than for domestic sales).

The contribution of the Krugman (1980) model to the patterns of trade is made by the “home-market” effect. Krugman (1980) states that if firms experience increasing returns to scale and face transport costs, then they will locate in the vicinity of the largest market. The concentration of production enables increasing returns to scale, while locating near the largest market minimises transport costs. The “home-market” effect implies that firms will export those products for which there is a large domestic demand.

In an attempt to further understand the geographical clustering of industries, the “home-market” effect was extended into a theory named new economic geography (Armstrong & Taylor, 2000).

2.2.3 New Economic Geography

In an attempt to further understand the geographical clustering of industries, the “home-market” effect was extended into a theory named new economic geography (Armstrong & Taylor, 2000). The theory of new economic geography (NEG) contributes to trade theory by explaining why similar regions have different economic activities (Ottaviano & Puga, 1997) and describing the formation of economic agglomeration in geographical space (Fujita & Krugman, 2004). The goal of NEG is to provide a picture of the spatial economy as a whole (i.e. the general equilibrium) by explaining (through modelling) the interaction between the forces that shape the geographical structure of an economy (Fujita & Krugman, 2004). These forces are either centripetal forces that pull economic activity together or centrifugal forces that achieve the opposite (Armstrong & Taylor, 2000; Fujita & Krugman, 2004). In addition to explaining agglomeration of economic activity, NEG models also incorporate transport costs. Transport costs play a major role in the formation of spatial balances and the development of agglomeration or dispersion of economic activities and regional growth (Lopes, 2003).

The core-periphery model provides the basic introductory framework for NEG. It was introduced by Krugman (1991) and is a variant of the Dixit-Stiglitz (1977) model. The core-periphery model illustrates how interaction among increasing returns to scale at firm-level, transport costs⁶ and factor mobility can cause a spatial economic structure to materialise and change (Fujita & Krugman, 2004). The model consists of two regions (1 and 2), two production sectors (agriculture and manufacturing) and two types of labour (farmers and workers). Table 2.1 outlines the assumptions that hold for this model.

Table 2.1: Assumptions of the Core-periphery Model

Agriculture	Manufacturing
<ul style="list-style-type: none"> • Products are homogenous • Located in only in one region • Constant returns to scale • Farmers are immobile (farmers are equally distributed throughout both regions) • Agricultural goods are moved without cost between regions 	<ul style="list-style-type: none"> • Products are differentiated (each firm produces a different variety) • Located in both regions • Increasing returns to scale • Workers are mobile • Positive transport costs (in “iceberg” form) are incurred in moving manufactured goods between regions

Sources: Krugman, 1991; Fujita and Krugman, 2004

How does this model explain the geographical structure of an economy? In particular, how is the geographical clustering or concentration of manufactured exports in a relatively new location explained? The immobility of the farmers is considered as the centrifugal force, as they consume both products. The centripetal force is more complex and involves a process named circular or cumulative causation. Circular causation consists of backward and forward linkages. Backward linkages occur where workers locate near production and forward linkages where producers locate near the larger market. Now, assume that for some reason a large number of firms locate near each other in region 1. In this region, a wider range of product varieties is produced. The workers (consumers) in region 1 are better off in terms of their product choices than those situated in region 2. The workers in region 1 receive a larger income, due to the increasing returns to scale achieved by the firms. No transport costs are incurred, as the products are produced locally. Region 1’s higher wages act as an incentive for workers in region 2 to migrate to region 1. The market size in region 1 expands (i.e. expenditure shifting) and becomes larger than the market in region 2. Thus, the “home-market”

⁶ Transport costs are included into the New Economic Geography models by means of an adapted form of Samuelson’s “iceberg” transport model. Krugman (1991) redefined the “iceberg” cost function as an explicit geographical distance-related function (McCann, 2005).

effect occurs. More manufacturing firms locate in region 1 because it is more profitable. Also, a greater number of varieties are produced than before. These different product varieties are then shipped (exported) to region 2 (Krugman, 1991; Armstrong & Taylor, 2000; Brakman *et al.*, 2001; Krugman & Fujita, 2004).

Transport costs are the determining factor for the “home-market” effect. By locating near the larger market, firms are able to achieve increasing returns to scale and at the same time minimise their transport costs. This increases the real wage of workers in that region and makes it a more attractive place to live (Brakman *et al.*, 2001). According to Brakman *et al.* (2001), transport costs are the main identifying characteristic of regions in the core-periphery model. In the model, transport costs are assumed zero within a region and positive between two regions. They broadly define transport costs as the various elements that hamper trade such as tariffs, language, cultural barriers as well as the actual costs incurred in moving goods from one place to another. The question, however, is to what extent do transport costs influence agglomeration in this model? The way that the model is set up creates a propensity for agglomeration. Internal economies of scale in manufacturing mean that producing more at a single plant would lower cost. That, however, implies that the manufacturer would incur transport costs to also sell his output in the other region. The manufacturer would thus try to choose a location that maximises the cost saving from large-scale production and minimises production cost (Krugman, 1991; Brakman *et al.*, 2001; Fujita, Krugman & Venables, 2001).

If transport costs were high, trade would not take place, as it is too costly – exports and imports are so expensive that only home production is possible. Production will be spread out to be close to where demand is. If transport costs were low, there would also be no trade or agglomeration since the two regions would be *ex ante* identical and neither would have the forces, such as a thick labour market or inter-industry linkages, which create the propensity for agglomeration. Thus, it is in an intermediate range that transport costs matter for trade and agglomeration. Below this threshold level of transport costs, manufacturers choose the location with large local demand. Local demand will be large precisely where the majority of manufacturers choose to locate. The result is agglomeration at the core and trade with the periphery (Krugman, 1991; Brakman *et al.*, 2001; Fujita, Krugman & Venables, 2001).

In conclusion, what determines exports from a specific location? According to the theory of new economic geography, distance (transport costs) and the “home-market” effect act as incentives for trade.

2.2.3.1 Further New Economic Geography Models

Krugman's work (1991) led to further developments of NEG models where transport costs were the critical element in explaining the location of economic activity (Alonso-Villar, 2005). This section explains some of these models.

Krugman (1995) focuses on increasing returns, imperfect markets, and the theory of international trade. In his model, there are three driving forces. The first is the centrifugal force, which stems from firms wanting to move away from their competitors when selling to an evenly spread out population. The second and third forces are both centripetal. Firms want to locate near their input markets and also closer to their customers (the customers locate near the industry that achieves increasing returns to scale). A degree of concentration occurs. The concentration of production is higher when transport costs are low. When transport costs are high, production is spread out. Transport costs may prohibit trade if it reaches a certain level. This level depends on two factors. Firstly, it depends on the degree of increasing returns to scale in production and, secondly, on the size of these economies of scale. If both values are high, then transport costs have no influence on trade. However, if both are low, then even low transport costs may be prohibitive. Therefore, transport costs are instrumental to trade in this model. Transport costs create trade whenever the values move it below its prohibiting level (Steininger, 2001).

Krugman and Venables (1995) examine the impact of declining transport costs on international trade. Their model consists of two regions (North and South) and two products (agriculture and manufacture, which includes intermediates). If high transport costs prevail, then each region has to be self-sufficient (each region produces both products). Assume now that transport costs gradually reduce. This results in two-way trade in manufactures between the regions and in specialisation (high transport costs prevent specialisation). If, for some reason, the North gains a larger share in the production of manufactures, production would shift to the North. Firms producing intermediates would locate closer to the market (i.e. a backward linkage). Production costs would decrease and demand would increase (i.e. a forward linkage). Thus, a circular process creates an industrialised North. Transport costs below a certain point generate an industrialised core and a de-industrialised periphery. If transport costs continue to fall, it becomes less important to be located near the market. Firms now relocate in the region (the de-industrialised periphery) where there are low wages. Production of manufactures

shifts to the South and reduces in the North. Therefore, the long-term decline in transport costs is the single cause of the shift in the location of production.

In the model developed by Venables (1996), the focus is on how two imperfectly competitive vertically linked industries' location decisions influence each other. The industries (one upstream, the other downstream) are linked through an input-output structure. In this model, labour is immobile. The upstream industry forms the market for the downstream industry. Firms in the upstream industry locate where there are a relatively large number of downstream firms (this is known as the demand linkage). Firms in the downstream industry locate where there are relatively many upstream firms in order to save costs in delivering intermediates (i.e. cost linkage). These two linkages create forces for agglomeration in a single location. However, the location of the immobile workers and consumers create forces for dispersion. The balance between these forces depends on the strength of the industries' vertical integration and the transport costs between locations. According to Alonso-Villar (2005), the relationship between transport costs and agglomeration in this model is not monotonic. If transport costs were high, consumers' demand would create spatial configuration. At the same time, the scattered population would lead to dispersion of economic activity. For intermediate transport costs, vertical linkages make up spatial distribution, causing agglomeration of production. If transport costs were low, economic activity would once again disperse, which is brought on by the high level of wages associated with industrialisation.

Puga (1999) offers a broad framework that combines Krugman (1991) and Krugman and Venables (1995) (Alonso-Villar, 2005). Puga (1999) finds that the mobility or immobility of labour in response to wage differentials provides the reason for either agglomeration or convergence. When transport costs are high, industry is scattered across regions to meet final consumer demand. If transport costs fall, costs and demand linkages lead to the agglomeration of increasing returns activities. At low transport costs, labour immobility creates dispersion, while labour mobility leads to full agglomeration in one location (Alonso-Villar, 2005).

Alonso-Villar (2005) contributes to the explanations of the non-monotonic behaviour of agglomeration. She examines the impact of transport costs of both final and intermediate goods on the spatial distribution of production by analysing each sector separately. The effects of lower transport costs of final goods differ from those of intermediate goods. Divergence is caused by high transport costs of intermediaries.

Regional convergence is the result of improvements in transportation between upstream and downstream firms. It is not, however, transport that facilitates trade between firms and consumers.

Thus, in the NEG models that have been developed, the impact of transport costs on trade and the location of production was clearly identified. In conclusion, transport costs are an obstacle to trade in the sense that they diminish the volume traded and deteriorate the terms of trade (Du Plessis *et al.*, 1987; Krugman & Obstfeld, 2000). Therefore, from literature, it can be concluded that transport costs are a determinant of trade that cannot be ignored. The following section examines the empirical evidence of the significance of transport costs for trade.

2.3 Empirical Evidence on Transport Costs

Empirical evidence has emerged that examines the extent to which the decline in transport costs has influenced economic growth (through increased exports) in economies in the post-war era. It was found that the decline in transport costs was only one of the elements that contributed to growth. The other contributors were reductions in trade barriers, improvement in the quality of transport, the modal shift from ocean to air transport, and the ease with which goods are moved through the development of containerisation (Radelet & Sachs, 1998; Hummels, 1999a; Rietveld & Vickerman, 2004). Transport costs are, however, not completely exogenous. They can be influenced by, for example, government policies and the quality of transport infrastructure (i.e. roads, ports and railways) (Radelet & Sachs, 1998).

This section investigates the empirical evidence as to whether or not transport costs are a determinant of exports from countries, regions or localities.

2.3.1 The Decline in Transport Costs

Busse (2003) states that globalisation is the result of, among other things, lower trade barriers, reductions in transport, and communication costs as well as the development of information and communication technologies. In literature, the general consensus is that transport costs associated with distance have declined considerably over the years (Rietveld & Vickerman, 2004). The cost of moving goods fell approximately 90% during the 20th century (Gleaser & Kohlhase, 2004). More specifically, the real costs of ocean

shipping have decreased by 83% between 1750 and 1990 (Crafts & Venables, 2001), airfreight costs have declined by 63% between 1950 and 1990 (Dollar, 2001) and the real cost per ton in road transport has fallen by 80% over the last century (McConsult, cited in Rietveld & Vickerman, 2004). The reasons for the improvements in transport cost can be attributed to advances in technology and transport infrastructure (Radelet & Sachs, 1998; Rietveld & Vickerman, 2004).

Hummels (1999a), however, contradicts this consensus by finding that transport costs have not declined uniformly. He finds that the cost of ocean transport has, in fact, risen, whereas the costs of air transport have fallen. According to Kumar and Hoffmann (2002), although unit transport costs have fallen, the incidence of shipping costs in the final value of commodities has increased, since many components are purchased internationally.

2.3.2 Significance of Transport Costs

Radelet and Sachs (1998) provide a comprehensive study on the impact of transport costs on a country's international competitiveness. They find that transport costs are influenced by geographical factors such as distance to markets and access to ports which, in turn, have an effect on manufactured exports and long-run economic growth. Countries with lower transport costs have had faster manufactured export growth and overall economic growth during the past three decades than countries with higher transport costs. Their results imply that, if transport costs double, a country's annual growth would increase at a slower rate of slightly more than one and a half percentage points.

In essence, trade is deterred by higher transport costs (Martínez-Zarzoso & Suárez-Burguet, 2004). According to Egger (2005), a decrease in transport costs of 1%, would lead to an increase in bilateral trade openness of 0.6%. Limão and Venables (2001) estimate that a doubling of transport costs would reduce trade volumes (imports and exports) by 45%.

High transport costs elevate production costs by increasing the price of imported intermediate and capital goods. These elevated production costs, together with high transport costs, impede the price competitiveness of manufactured exports and lead to high levels of inflation (Radelet & Sachs, 1998; Hoffmann, 2002). In order to compensate for the effect of higher transport costs, workers have to receive lower wages

and capital-owners have to accept smaller returns (Radelet & Sachs, 1998; UNCTAD Secretariat, 2003). This is very difficult, especially in developing countries, since wages are already close to subsistence level (UNCTAD Secretariat, 1999). Table 2.2 illustrates the impact of transport costs (i.e. freight/shipping costs) on imports.

Table 2.2: Estimates of Total Freight Costs on Imports

Country group	Estimate of freight costs of imports	Value of imports (CIF)	Freight costs as % of import value
World total	364 008	5 960 595	6.11
Developed market-economy countries	221 248	4 320 511	5.12
Developing countries	142 760	1 640 084	8.70
Africa's share (excl. South Africa)	13 806	109 125	12.65

Source: UNCTAD Secretariat, 2003.

Note the difference between the freight costs paid by developed countries and those paid by developing countries. Amjadi and Yeats (1995) find that Africa's high transport costs may be the reason for the deterioration of their share of global exports (Africa's share fell from 3.1% to under 1.2% from the mid-1950s to 1990). East Asian countries' real exports have risen by 800% since the 1970s, whereas those of Sub-Saharan Africa have increased by only 70% (Redding & Venables, 2003). Elbadawi, Mengistae and Zeufack (2001) estimate that transport costs in Africa affect the level of exports more through their effect on domestic prices of imported inputs than through their influence on the CIF (Cost, Insurance, Freight) prices of exports.

Exports are also affected negatively by transport costs. If transport costs increase, the result is a loss of foreign earnings for the exporting country, as well as a loss of markets (this depends on the elasticity of demand and the availability of substitutes) (UNCTAD Secretariat, 2003). In appendix 2.1, articles are listed on the incidence of transport costs (table 2.4) and on the effect of transport costs on trade (table 2.5).

2.3.3 Measurement of Transport Costs

This section describes the various methods available to measure transport costs, both international and national. Table 2.6 in appendix 2.1 lists all studies that measure transport costs.

2.3.3.1 International Transport Costs

In general, it is difficult to obtain data to accurately measure transport costs and several problems exist. Hummels (1999a) points out that there is no single source of data that provides a single indication of transport costs. Transport costs can be observed either directly or indirectly. Direct international transport costs include freight charges and insurance, which is usually added to the freight charge. Indirect transport costs include holding costs for products in transit, inventory costs (to ensure stock in times of uncertainty) and preparation costs associated with shipment size (The Round Table, 2004). According to Anderson and van Wincoop (2003), data for international transport costs can be obtained from two major sources.

The first source is to obtain quotes directly from a shipping firm or industry. Hummels (1999b) makes use of this method by gathering index numbers for prices of ocean and airfreight from trade journals and existing survey data. Limão and Venables (2001) also use this method by obtaining a quote from a single freight forwarding company. Their results are based on the costs of shipping a standard 40-foot container from Baltimore in the United States into various destinations. In their estimations, the journeys are broken down in compartments in order to differentiate between the effect of carriage on land and sea. Martínez-Zarzoso, Gracia-Menéndez and Suárez-Burguet (2003) adapt the quote method slightly by conducting interviews with 15 logistic operators (5 are overland transport operators and 10 are maritime transport operators) in Spain.

The second source is national customs data. Two types of analyses can be conducted with this data to determine international transport costs. The first method is to divide the CIF value of imports by the FOB value of exports, which provides an indication of the bilateral transport costs (Anderson & van Wincoop, 2003). Hummels (1999b) implements this method for the United States and New Zealand. The second method, which has been widely applied, is to use the aggregate bilateral CIF/FOB ratios produced by the International Monetary Fund (IMF). Baier and Bergstrand (2001) and Evenett, Djankov and Yeung (cited in Hummels, 1999a) use IMF data to determine the role of transport costs in international trade. Hummels (1999a), however, criticises the IMF data by discussing three major problems. Firstly, small discrepancies in the information supplied by importers and exporters may result in large changes in the CIF/FOB ratios. Secondly, trade flows reported by importers and exporters may vary for

reasons, such as differences in the quality of data, other than transport (shipping) costs. Thirdly, the IMF does not receive reports from all countries. It may be that if two countries trade with each other, only one of the two countries reports its trade data, forcing the IMF to construct the CIF/FOB ratio based on that one report. This brings the accuracy of the data into question. Nevertheless, IMF data is still used in empirical research due to the difficulty in obtaining better estimates for such a wide range of countries and years (Anderson & van Wincoop, 2003). Other sources of data that can be used in calculations of international transport costs are the US Import Waterborne Databank used by Micco and Pérez (2001) and the International Transport Database used by Sánchez, Hoffmann, Micco, Pizzolitto, Sgut and Wilmsmeier (2003).

Chasomeris (2005) provides an overview of South Africa's international transport costs in terms of its import CIF/FOB ratios, port charges and Europe-South Africa liner shipping freight rates. He observes changes in international transport costs in both the pre- and post- sanction periods. In his three methods to assess South Africa's international transport costs, Chasomeris (2005) finds conflicting results. Whereas the import CIF/FOB ratios indicate that South Africa's international transport costs were high during the period of imposed sanctions (Chasomeris, 2003), the liner freight rates state the opposite. Casomeris (2005) cautions against using import CIF/FOB ratios as a measure for international transport costs, as the composition of imports influences the value of the ratio (high value imports per weight have high CIF/FOB ratio and vice versa). For South Africa, Chasomeris (2005) indicates that the other methods in his study provide more accurate indicators of South Africa's international transport costs. However, port pricing is not without shortcomings and data from shipping lines may be difficult to obtain.

Naudé (2001) finds that international (i.e. shipping) costs in South Africa make up 60% of transport costs for exports. Further, South Africa's import CIF/FOB ratios compare unfavourably to the rest of the world – international transport costs to and from South Africa are approximately 50% higher than the average for developing countries. Jansen van Rensburg (2000), through an analysis of South Africa's import CIF/FOB ratios, finds that international transport costs, rather than domestic transport costs, pose a threat to the competitiveness of South Africa's exports.

2.3.3.2 Domestic Transport Costs

From an overview of the literature, it seems as though little or no attention has been paid to the measurement of domestic transport costs. Several empirical studies include domestic transport costs in the estimation of international transport costs. Elbadawi *et al.* (2001) include domestic transport costs in an index that measures supplier and market access. The variables they use to measure domestic transport costs are the density of the road network (kilometres of roads), the quality of roads (the number of paved roads) and the total land territory of a country. They find that domestic transport costs have a stronger constraint on exports than international transport costs (see section 2.3.3). Limão and Venables (2001) use similar indicators to measure the costs of travel in and through a country. They add the density of the rail network, as well as the main telephone lines per person. Limão and Venables (2001) estimate that overland distance is seven times more expensive than sea distance. Martínez-Zarzoso *et al.* (2003) also find that transporting a product by road increases transport costs. Lopes (2003) examines transport costs in Portugal by observing the distance that products travel inland. He finds that distance influences product flows. Products with a low ratio of value are transported over short distances and the opposite occurs for high value products. Carrere and Schiff (2004) examine the impact of distance of trade (see section 2.3.4) on domestic transport costs. If domestic transport costs increase proportionally more or proportionally less than distance costs, then the distance of trade decreases. Dalal and Katz (2003) measure the impact of both domestic and international transport costs on sales. They state that variations in quantities of products lead to variations in transport costs. Combes and Lafourcade (2002) show how domestic transport costs, intermediate inputs and real geography play an important role in the spatial concentration of French activities. In their findings, they indicate that a decrease in domestic transport costs counterbalances the process of spatial concentration at a country level.

Combes and Lafourcade (2005) extend existing research by developing a methodology to accurately measure domestic transport costs. They compute a measure of generalised transport costs by determining distance costs (fuel, price and fuel consumption, costs due to tolls that have to be paid on highways and maintenance operating costs) and time costs (labour costs, insurance charges, depreciation costs and general charges such as taxes).

Naudé and Gries (2004) include domestic transport costs in modified versions of the Hecksher-Ohlin model that examines the determinants of trade in South Africa. Here, the role of geography and its effect on manufactured exports from different regions in South Africa is taken into account. Naudé and Gries (2004) use the distance (in kilometres) of a region from an international port as a proxy for the domestic transport costs of exports. They test their data from the 354 magisterial districts in South Africa with the Static Tobit Maximum Likelihood Regression, as well as the Random Effects Tobit Regression. In each regression, domestic transport costs are highly significant and negative. In other words, they have a negative effect on manufactured exports. Their results confirm that the existence of domestic transport costs will lead to increasing returns to scale for those manufactured export industries that locate in a way that minimises transport costs.

2.3.4 Differences in Transport Costs

Transport costs differ among countries and this may be the reason for the variations in their ability to compete in international markets (Bougheas, Demetriades, & Morgenroth, 1999). These differences are explained by the geographical locations of countries, as well as the countries' geography. Landlocked countries tend to have higher transport costs (approximately 50%) and lower trade volumes (around 60%) than coastal countries (Radelet & Sachs, 1998; Limão & Venables, 2001). Martínez-Zarzoso *et al.* (2003) argue that landlocked countries' exporters incur extra costs since products transported have to switch between more modes of transport than coastal countries. Landlocked countries also seem to have higher *ad valorem* rates than coastal countries and this exacerbates the effect of the high transport costs. Martínez-Zarzoso and Suárez-Burguet (2004) find that among the countries in their study, Bolivia, which is landlocked, has the highest *ad valorem* rates. The shipping costs are calculations by Limão and Venables (2001), updated for 2002 by Busse (2003). Busse (2003) finds that, as distance increases, the price of shipping a 40-foot container increases (for example, the cost to ship the container from Baltimore to China is \$13 000, whereas the cost to Rotterdam is only \$2 000). Busse (2003) concludes that, even with technological developments in transport, many developing countries continue to be challenged by geography in terms of being remote from major markets or being landlocked.

Countries located further from the major markets also tend to have higher transport costs. Radelet and Sachs (1998) use the CIF/FOB ratio⁷ as a measure of international transport costs to prove this for selected countries. For example, Australia's CIF/FOB ratio is 10.3, whereas Switzerland has a ratio of only 1.7. Coughlin (2004) suggests that declining transport costs can reduce the cost disadvantage of trading with these distant countries and subsequently increase trade with them.

Redding and Venables (2003) examine how a country's geography can affect its transport costs. Countries' export performances differ due to variations in their internal (access to ports) and external geography (proximity to rapidly growing export markets). For example, Sub-Saharan Africa's (SSA) export performance can be attributed to both poor internal and external geography. Many Sub-Saharan African countries are landlocked and have poor transport infrastructure, making access to ports and to foreign markets difficult. Venables (2005) argues that a country's remoteness from markets can be attributed to its geography. Again, SSA is the focus. SSA's geographical disadvantage is evidenced by its poor economic development compared with countries that are not geographically disadvantaged. Venables (2005) states that the effect of transport costs is revealed through a country's trade performance. He uses market access (demand for exports) and supplier access (supply of imports) as measures of remoteness. SSA's poor export performance is due to poor market access (external geography), poor internal geography and inadequate institutions (risk of expropriation). Venables (2005) shows that SSA experiences low supplier access, because the price of capital goods is much higher than other countries. For example, capital equipment in South Africa is twice as expensive as in the UK. Thus, geography (remoteness from sources of supply) is a major determinant of the price of capital goods. Therefore, geography has a negative effect on the level of exports, the level of investment and on per capita income (Elbadawi, Mengistae & Zeufack, 2006).

Several other studies also provide reasons why transport costs among countries differ. One such a reason is economies of scale or, rather, decreasing average costs in shipping. Larger importers tend to have lower shipping costs for comparable commodities (The Round Table, 2004). If a country were able to expand its trade volume, the unit volume of transport would decrease (Martínez-Zarzoso & Suárez-

⁷ CIF (Cost, Insurance and Freight) measures the value of imports, from the point in which it enters a country. This value includes cost, insurance and freight. FOB (Free on Board) measures the value of exports from the point when the merchandise is placed on the carrier. The difference between the values of these two incoterms is a measure of the cost of transporting an item from the exporting country to the importing country (Hummels, 1999a; Brakman *et al.*, 2003).

Burguet, 2004; Kumar & Hoffmann, 2002); more specifically, Hummels and Skiba (2004) find that doubling bilateral trade quantities leads to a 12% reduction in shipping costs.

According to Martínez-Zarzoso *et al.* (2003), transport costs differ because of variations in unit values of exports, which are, in turn, influenced by insurance costs, modal transfers and discrimination between shipping cartels. Fink, Mattoo and Neagu (2002) find that countries' various trade policies cause different transport costs, especially those with restrictive trade policies, as well as private anticompetitive practices regarding the price of transport.

2.3.5 Factors Influencing Transport Costs

Distance is important for international trade relations. Around half of the world's trade takes place between countries located within 3 000 km of each other (The Round Table, 2004). Limão and Venables (2002) find that exports and imports of both final and intermediate goods carry transport costs that increase with distance. Martínez-Zarzoso *et al.* (2003) use distance as a proxy for transport costs since lengthy distances imply longer journeys and an increase in accompanying costs. They estimate that a 1% increase in distance increases transport costs by approximately 0.25%.

The use of distance as a proxy for transport costs is, however, problematic. Coughlin (2004) explains various reasons. Firstly, actual distances are not used. Distance is calculated by the "great circle" formulae in which distance is measured directly (in other words, "as the crow flies"). Secondly, only one route and one transport mode between trading regions are used. Trade between two regions, however, is conducted over many routes, using more than one transport mode. Thirdly, many transport costs do not vary with distance. Dwell costs (including the cost of loading and unloading a ship and the cost of queuing outside a port), for instance, is a cost no matter the distance. Finally, distance is only one of the elements in actual freight rates.

Numerous studies have emerged that estimate the relationship between distance and international trade flows. Coughlin (2004) explains that these studies use the distance elasticity of trade, in other words, the percentage change in the trade flows associated with a given percentage increase in the distance that separates trading partners. These studies conclude that trade flows decrease as distance increase. For example, Venables (2001) finds that trade volumes decrease with distance, as shown in table 2.3. Table 2.3 conveys elasticities of trade volumes at different distances, relative to their value at 1 000

km. If, for instance, θ (distance) = -1.25, trade volumes are down by 82% at 4 000 km and 93% at 8 000 km.

Table 2.3: *Economic Interactions and Distance (Flows Relative to their Magnitude at 1 000 Km)*

Km	Trade ($\theta = -1.25$)
1 000	1
2 000	0.42
4 000	0.18
8 000	0.07

Source: Venables, 2001

Carrere and Schiff (2004) study how countries' distance of trade (DOT)⁸ has evolved from 1962 to 2000. They find that distance of trade has declined over time for the average country in the world. In other words, distance has become more important over time for a large number of countries. In contrast to these findings, Hummels (1999a) observes that the cost of transporting over longer distances has become cheaper than transport over proximate distances.

The fact that the cost of shipping over long distances decreased has had little effect on the distance of trade. Grossman (cited in The Round Table, 2004) indicates that regions that are located 500 miles apart, tend to trade 2.67 times more with each other than regions that are located 1 000 miles apart. A possible reason is that distance is costly. It directly increases transaction costs in terms of additional transport costs of shipping goods, time costs of shipping date-sensitive goods, the costs of contracting at a distance (search costs), costs of obtaining information on remote economies and costs of communicating with distant locations (Overman, Redding & Venables, 2001; Venables, 2001).

Apart from distance, several factors (infrastructure and port efficiency) can indirectly affect transport costs and subsequently a country's export performance and competitiveness. According to Bougheas *et al.* (1999), transport costs depend inversely on the level of a country's infrastructure (i.e. communication and transport infrastructure⁹), whereas a positive relationship between infrastructure and the volume of trade exist. Infrastructure has a positive impact on the volume of trade in that it reduces transport costs. An improvement of 1% in the infrastructure in the destination country lowers

⁸ Distance of trade can be defined as the average distance that a country's international trade is transported. If a country's DOT is decreasing over time, trade with proximate countries increases relative to trade with distant countries. The opposite occurs if DOT is increasing over time (Coughlin, 2004).

⁹ Transport infrastructure includes bridges, tunnels, railroads, airports, harbours and roads (Matsuyama, 1999).

transport costs by 0.14%. In other words, in bilateral trade, if the partner country's infrastructure is poor, transport costs increase. Limão and Venables (2001) further find that poor infrastructure accounts for 40% of transport costs for coastal economies and 60% for landlocked countries. Martínez-Zarzoso *et al.* (2003) prove that the impact of infrastructure on transport costs necessitates investment in new port infrastructures as a way of fostering trade and income. For example, an improvement in airport infrastructure from the 25th to the 75th percentiles reduces transport costs by 15% (Micco & Serebrisky, 2004).

According to Wilson, Mann and Otsuki (2004), port (air and sea) efficiency, as part of trade facilitation, can increase trade flow in manufactured goods, with gains for both importers and exporters. More specifically, Clark, Dollar and Micco (2004) observe that transport (in this case shipping) costs can be reduced by 12% if a seaport's operating efficiency increases from the 25th percentile to the 75th percentile. This would lead to an increase in bilateral trade of roughly 25%.

Time also impacts on transport costs. International trade occurs in physical space and transporting products requires time. Lengthy shipping times impose costs on shippers in the form of inventory-holding and depreciation (Hummels, 2001). Time in transit has become increasingly important, as firms are adapting their management strategies from keeping inventories to "just-in-time" purchasing. "Just-in-time" management allows firms to save costs from holding inventories and to be able to postpone production in times of uncertainty (for example, when demand for a product fluctuates) (Venables, 2005). Empirical evidence has emerged that determines the magnitude of time costs. Hummels (2001) highlights the importance of the costs of time in transit. He examines fast, expensive air transport as well as slow, inexpensive ocean shipping by observing around 25 million shipments into the USA. Hummels (2001) identifies the willingness-to-pay for time savings in shipment in the relative price/speed trade-off between these modes. This is translated into a direct measure of the *ad valorem* barrier equivalent of an extra day in transit. The costs of an additional day in transit for manufactured goods are, on average, 0.8% of the value per good per day. This is equal to a 16% tariff for the average shipping length of 20 days. A decline in air transport costs is equal to a reduction in tariffs on manufactured goods from 32% to 9% *ad valorem*. The increased share of imports into the US, as well as the fact that containerisation doubled the speed of ocean shipping, have led to an average reduction in shipping time of 26

days (equal to a fall in shipping costs worth 12% to 13% of the value of goods traded) (Hummels, 2001; Venables, 2005).

Delays arise in both transit and the processing and handling of products in ports (Venables, 2005). Delays cause uncertainty for a production plant. For example, production cannot be completed unless all components have arrived. A delay in the delivery of components can be costly if production is held up (Harrigan & Venables, 2004). Harrigan and Venables (2004) examine the impact of time (delivery) costs on agglomeration. They argue that if delays or uncertainty in delivery are detrimental to plants' production lines, component plants and assembly plants agglomerate in one location. Therefore, timeliness is both quantitatively and qualitatively important. It is an important aspect of proximity and creates an incentive for clustering of activities. Evans and Harrigan (2003) also find that timely deliveries are only possible from nearby locations.

2.4 Summary and Conclusion

In the global world today, trade liberalisation has led to the reduction of trade barriers amongst countries. Trade barriers no longer protect a country's industries, thus increasing the level of competition for many. This is where non-tariff barriers level the playing field. If a country is plagued by non-tariff barriers, its industries' ability to compete is reduced. Among these non-tariff barriers, trade costs are the most important. Trade costs involve all aspects in conducting business at an international level. One aspect of trade costs is transport costs. Studies have shown that transport costs are the most important non-tariff barrier to trade.

The gradual reduction of transport costs over the last century is said to be one of the drivers of globalisation. However, transport costs have not declined uniformly. The cost of ocean shipping has increased, whereas the cost of air transport has fallen. High transport costs are detrimental to a country's trade levels and economic growth. It is in this area where numerous empirical studies have been conducted.

In the neo-classical trade theories transport costs are acknowledged, but have no influence on trade. In the real world this is untrue, as transport costs influence trade. Consequently, the new trade theory emerged. This theory includes transport costs in an "iceberg" form. Development of the new trade theory has led to the theory of new economic geography. Here, transport costs play a central role as the cause of

agglomeration or dispersion of economic activity. Thus, where trade theories previously neglected transport costs, they have recently begun to acknowledge the impact of transport costs on trade.

Empirical studies support theory by providing the relevant evidence for the significance of transport costs for trade. The general consensus is that international transport costs negatively affect a country's trade volumes. High international transport costs reduce foreign earnings from exports and increase the price of imports, which elevates production costs. These empirical studies measure international transport costs either directly or indirectly. Methods to obtain results include the CIF/FOB ratio, quotes from freight forwarders and interviews with transport operators. All concur with the above-mentioned result. The measurement of domestic transport costs has not been as popular as a field of study, with no commonly used method. The method largely depends on the aim of the study. Mixed results have been found on the influence of domestic transport costs on trade.

The impact of distance on transport costs has been widely documented. As distance increases, trade volumes decrease. Countries tend to trade with proximate partners, even if transport costs over distance have fallen. The distance of trade for the typical countries in the world has decreased, implying that distance matters. Other factors also affect transport costs. They are: infrastructure (investment in infrastructure decreases transport costs), port efficiency (more efficient ports tend to have lower transport costs) and time (delays increase transport costs).

Why do transport costs vary among countries? Firstly, location matters. If a country is situated far from its trading partners, its CIF/FOB ratio is higher than a country located close to its foreign markets. Therefore, remoteness from economic activity increases transport costs. The fact that a country is landlocked or coastal has a large impact on its transport costs. Landlocked countries have higher transport costs than coastal countries. Landlocked countries also tend to have poor internal geography (access to ports), which negatively correlates with transport costs. Secondly, economies of scale reduce the cost of shipping per unit. Countries that are able to produce large volumes for shipment can obtain more favourable prices. Thirdly, different trade policies, competition practices in the transport industry, and insurance rates have varying effects on transport costs.

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APPENDIX 2.1

Table 2.4: Incidence of Transport Costs

Author(s) and date	Title	What it is about	Findings
Carrere, C. & Schiff, M. (2004)	On the geography of trade: distance is alive and well.	This paper examines the evolution of countries' distance of trade in 1962 – 2000.	The distance of trade falls over time for the typical country in the world. Distance has become more important over time for the majority of countries.
Crafts, N. & Venables, A.J. (2001)	Globalisation in history: a geographical perspective.	This paper argues that that a geographical perspective is fundamental to understanding comparative economic development in the context of globalisation.	Documents the fall in costs of moving goods, people and information.
Dollar, D. (2004)	Globalisation, inequality and poverty since 1980.	This paper documents five trends in the modern era of globalisation.	Documentation of the decline in both sea freight and air transport.
Gleaser, E.L. & Kolhase, J.E. (2004)	Cities, regions and the decline of transport costs	This paper documents the decline in the cost of moving goods and explores several implication of a world where it is essentially free to move goods, but expensive to move people.	There has been a remarkable decline in transport costs in the shipment of goods. The cost of moving people within has increased due to increases in road delays.
Hummels, D. (1999a)	Have international transport costs declined?	This paper examines a detailed accounting of the time-series pattern of shipping costs.	Ocean freight rates have increased, while airfreight rates have declined rapidly. The cost of overland transport has declined relative to ocean transport.
Rietveld, P. & Vickerman, R. (2004)	Transport in regional science: the “death of distance” is premature.	This paper discusses the long-term trends in transport costs and the potential spatial consequences.	Although in terms of money and time, the performance of transport has improved significantly, many economic activities have not become footloose to the extent as expressed by the notion of “death of distance”.

Table 2.5: *Effect of Transport Costs on Trade*

Author(s) & date	Title	What it is about	Findings
Anderson, J.E. & van Wincoop, E. (2003)	Trade costs.	This paper surveys trade costs.	The tariff equivalent for trade costs for industrialised countries is 170% (21% is due to transport costs). For developing countries, this figure is much higher.
Bougheas, S., Demetriades, P.O. & Morgenroth, E.L.W. (1999)	Infrastructure, transport costs and trade.	This paper examines the role of infrastructure in a bilateral trade model with transport costs.	For pairs of countries for which investment in infrastructure is optimal, a positive relationship exists between the level of infrastructure and the volume of trade.
Busse, M. (2003)	Tariffs, transport costs and the WTO Doha round: the case of developing countries.	This paper concentrates on the different forms of transport costs and their relative levels in developing countries.	In addition to trade barriers, other trade costs such as transport and communication costs have to be taken into account when looking at the trade performance of developing countries.
Chasomeris, M.G. (2003)	South Africa's sea transport costs and port policy in a global context.	This paper analyses South Africa's maritime policies and transport costs and determines their effect on trade.	South Africa has high rates of sea transport costs and is undertaking steps to privatise ports.
Clark, X., Dollar, D. & Micco, A. (2004)	Port efficiency, maritime transport costs and bilateral trade.	This paper investigates the determinants of shipping costs to the United States.	Port efficiency is a major determinant of shipping costs. Improving port efficiency from the 25 th to the 75 th percentile reduces shipping costs by 12%.
Coughlin, C.C. (2004)	The increasing importance of proximity for exports from U.S. states.	This paper examines how the geographic distributions of USA exports have changed.	Overall in the USA, the geographic distribution of exports has changed so that trade has become relatively more intensive with nearby as opposed to distant countries.
Dalal, A.J. & Katz, E. (2003)	The multi-market firm, transportation costs, and the separation of the output and allocation decisions.	This paper analyses the effects of transport costs for a risk averse, competitive firm selling a single good in a domestic (certain) and a foreign (uncertain) market.	A firm's activity can be insulated from foreign uncertainties by government policies that focus on the shape of the domestic transport function.
Egger, P. (2005)	On the impact of transport costs on trade in a multilateral world.	This paper proposes to account for the differences in the importance of transport costs, depending on the characteristics of trading partners.	A reduction in transport costs is positively related to the level of trade and has an impact on trade openness (a decrease in transport costs of 1%, would lead to an increase in bilateral trade openness of 0.6%).
Evans, C. & Harrigan, J. (2003)	Distance, time and specialisation.	This paper shows the implications for global specialisation and trade where time is money and distance matters.	Products where timely delivery is important are produced near the source of final demand or imported from nearby countries.

Table 2.5: Effect of Transport Costs on Trade (continued)

Fink, C., Mattoo, A. & Neagu, I.C. (2002)	Trade in international maritime services: how much does policy matter?	This paper examines why maritime transport costs are so high in some countries.	Restrictive trade policies and private anticompetitive practices are the reasons for differences in maritime transport costs between countries.
Gallup, J.L., Sachs, J.D. & Mellinger, A.D. (1999)	Geography and economic development	This paper addresses the complex relationship between geography and macroeconomic growth.	Location and climate have large effects on income levels and income growth, through their effects on transport costs, among others.
Harrigan, J. & Venables, A.J. (2004)	Timeliness, trade and agglomeration.	This paper focuses on the costs associated with delivery times.	Timeliness is not only a quantitatively important aspect of proximity, but also matters qualitatively, creating an incentive for the clustering of activities.
Hummels, D. & Skiba, A. (2004)	Shipping the good apples out? An empirical confirmation of the Alchian-Allen conjecture.	This paper extends the Alchian-Allen theory by deriving a relationship between per unit and <i>ad valorem</i> trade costs and the quality composition of trade.	Doubling bilateral trade quantities leads to a 12% reduction in shipping costs.
Hummels, D. (1999b)	Towards a geography of trade costs.	This paper offers direct and indirect evidence on trade barriers, to establish a comprehensive geography of trade costs.	New data on freight rates indicate that import choices are made so as to minimise transport costs.
Hummels, D. (2001)	Time as a trade barrier.	This paper examines the importance of time as a trade barrier by estimating the magnitude of time costs.	Each day saved in shipping time is worth 0.8% <i>ad valorem</i> for manufactured goods.
Limão, N. & Venables, A.J. (2001)	Infrastructure, geographical disadvantage, transport costs and trade.	This paper investigates the dependence of transport costs on geography and infrastructure.	A deterioration of infrastructure from the median to the 75 th percentile increases transport costs by 12% points and reduces traded volumes by 28%.
Limão, N. & Venables, A.J. (2002)	Geographical disadvantage: a Heckscher-Ohlin-von Thünen model of international specialisation.	This paper analyses trade and production patterns of countries located at varying distances from an economic centre.	Exports and imports of final and intermediate goods carry transport costs, which increase with distance.
Matsuyama, K. (1999)	Geography of the world economy.	This paper shows how a change in transport and other trade costs affects the distribution of industries.	Smaller transport costs makes an industry “footloose”.
Micco, A. & Serebrisky, T. (2004)	Infrastructure, competition regimes and air transport costs: cross country evidence.	The aim of this paper is to estimate the effects of infrastructure, quality of regulation and changes in the competition regime on air transport costs.	An improvement in airport infrastructure from the 25 th to the 75 th percentiles reduces transport costs by 15%.
Overman, H.G., Redding, S. & Venables, A.J. 2001.	The economic geography of trade, production and income: a survey of empirics.	This paper surveys the empirical literature on the economic geography of trade flows, factor prices and production.	Geography is a major determinant of factor prices, and access to foreign markets alone explains around 35% of the cross-country variation in <i>per capita</i> income.

Table 2.5: Effect of Transport Costs on Trade (continued)

Porto, G.G. (2005)	Informal export barriers and poverty.	This paper investigates the poverty impacts of informal export barriers such as transport costs, unwieldy customs practices, costly regulations and bribes.	For low-income countries (in this case Moldova), transport costs are the most important trade facilitation barrier.
Redding, A. & Venables, A.J. (2003)	Geography and export performance: external market access and internal supply capacity.	This paper investigates the determinants of countries' export performance looking in particular at the role of international product market linkages.	Poor external geography, poor internal geography and poor institutional inequality contribute in approximately equal measure to explaining Sub-Saharan Africa's poor export performance.
Redding, S.J. & Venables, A.J. (2004)	Economic geography and international inequality.	This paper estimates a structural model of economic geography using cross-country data on <i>per capita</i> income, bilateral trade and the relative price of manufactured goods.	The geography of access to markets and sources of supply is statistically significant and quantitatively important in explaining cross-country variation in <i>per capita</i> income.
Venables, A.J. (2001)	Geography and international inequalities: the impact of new technologies.	This paper evaluates the claim of whether or not new technologies mean the "death of distance".	New technologies will not mean the death of distance, but the contribution of these technologies to economic development will not cease to be important.
Venables, A.J. (2005)	Geographical economics: notes on Africa.	This paper focuses on the economic remoteness of Sub-Saharan Africa from the rest of the world.	Sub-saharan Africa's remoteness has a negative impact on the level of exports, the prices of investment goods and on <i>per capita</i> income.
Wilson, J.S., Mann, C.L. & Otsuki, T. (2004)	Assessing the potential benefit of trade facilitation: a global perspective.	This paper measures and estimates the relationship between trade facilitation and trade flows in manufactured goods in 2000-2001.	Improvement in port efficiency (one of the aspects of trade facilitation) leads to an increase in trade flows.

Table 2.6: Modelling of Transport Costs

Author(s) & date	Title	What it is about	Findings
Amjadi, A. & Yeats, A.J. (1995)	Have transport costs contributed to the relative decline of Sub-saharan Africa's exports?	This paper determines whether relative differences in freight costs between Africa and other countries contributed to the latter's relatively poor export performance and what influence these costs currently have on the location of industrial activity in Africa.	Freight rates for African exports are considerably higher than on similar goods originating in other countries. Payments for transport have increased, reducing the share of foreign earnings that can be used for investment.
Baier, S.L. & Bergstrand, J.H. (2001)	The growth of world trade: tariffs, transport costs and income similarity.	This paper examines the relative effects of transport cost reductions, tariff liberalisation and income convergence on the growth of world trade among several OECD countries.	The average world trade growth since World War 2 can be explained by income growth (67%), tariff-rate reductions 25% and transport cost declines 8%.
Chasomeris, M.G. (2005)	Assessing South Africa's shipping costs.	This paper quantifies the extent of South Africa's international shipping costs using CIF/FOB ratios.	There has been a slowdown in the percentage rate of increase in SA's port charges from 1999 - 2005 and nominal rates have declined by 52.5% from 1991 - 2001.
Combes, P. & Lafourcade, M. (2002)	Transport costs, geography and regional inequalities.	This paper empirically investigates the predictions of economic geography models regarding the role of transport costs on regional inequalities.	Transport costs play a critical role in the spatial concentration of French activities. Short-term decreasing transport costs may counterbalance the process of spatial concentration at the country level.
Combes, P. & Lafourcade, M. (2005)	Transport costs: measures, determinants and regional policy implications for France.	This paper develops a methodology to accurately compute transport costs.	Their proxies for transport costs capture transport costs well in a cross-section analysis. Policies that most impact transport costs are identified.
Elbadawi, I., Mengistae, T. & Zeufack, A. (2001)	Geography, supplier access, foreign market potential and manufacturing exports in developing countries: an analysis of firm level data.	This paper determines the importance of geography relative to trade policy or institutional or physical infrastructure in Sub-saharan Africa in determining the growth potential of manufactured exports.	Geography is as significant a determinant of manufactured export growth as trade policy and institutional infrastructure. Domestic transport costs are a stronger influence on the level of exports than int. transport costs.

Table 2.6: *Modelling of Transport Costs (continued)*

Hoffmann, J. (2002)	The cost of international transport and integration and competitiveness in Latin America and the Caribbean.	This paper seeks to examine the causal links between trade and the cost of international transport services.	Transport costs can be reduced if economies of scale are reached in transport systems and if competition in these systems is promoted.
Lopes, L.P. (2003)	Border effect and effective transport cost.	This paper makes a first effort to estimate the effective transport cost on the Portuguese economy, using regional data on trade volumes, as well as to estimate the border effect.	A relatively high transport cost exists together with a relatively low border effect.
Martínez-Zarzoso, I. & Suárez-Burguet, C. (2004)	Transport costs and trade: empirical evidence for Latino-American imports from the European Union.	This paper aims to investigate the relationship between trade and transport costs by applying a gravity model.	Higher distance and poor importer's infrastructure notably increase transport costs. A higher volume of trade has the opposite effect, as it lowers transport costs.
Martínez-Zarzoso, I., Gracia-Menéndez, L. & Suárez-Burguet, C. (2003)	Impact of transport costs on international trade: the case of Spanish ceramic exports	This paper aims to investigate the determinants of maritime and overland transport costs and the role they play in deterring trade across countries using interviews with transport operators and a gravity model.	Higher distance and poor partner infrastructure lead to an increase in transport costs. Importer income has a positive impact on bilateral trade flows.
Micco, A. & Pérez, N. (2001)	Ports and transport.	This paper shows the importance of transport costs and ways that economic policies at the national level can reduce them.	An improvement in port efficiency from the 75 th percentile to the 25 th percentile in the world rankings reduces shipping costs by the equivalent of 9 000 km.
Naudé, W.A. (2001)	Shipping costs and South Africa's export potential: an econometric analysis.	This paper investigates shipping costs for South Africa.	Shipping costs to and from South Africa are almost 50% higher than the average for developing countries.
Naudé, W.A. & Gries, T. (2004)	Economic geography or Hecksher-Ohlin? The case of manufactured exports from South Africa.	This paper investigates the role of geography in explaining trade.	The magisterial districts in SA that will contribute to manufactured exports are those larger in terms of economic size, having good foreign market access, information on foreign markets, competitive transport costs and good local institutional support framework.
Radelet, S. & Sachs, J.D. (1998)	Shipping costs, manufactured exports and economic growth.	This paper investigates whether or not geography plays a role in the promotion of manufactured exports from developing countries.	Geographic isolation and higher shipping costs may make it more difficult, if not impossible, for relatively isolated developing countries to succeed in the promotion of manufactured exports.

CHAPTER 3: ARTICLE 1

DOMESTIC TRANSPORT COSTS AND THE LOCATION OF EXPORT-ORIENTED MANUFACTURING FIRMS IN SOUTH AFRICA: A CUBIC-SPLINE DENSITY FUNCTION APPROACH

ABSTRACT

Empirical evidence for the significance of domestic transport costs in exports and the spatial location of manufacturing exporters is provided. It is found that (a) the proximity to a port is an important consideration in most export-oriented manufacturing firms' location, with more than 70% of manufactured exports in South Africa originating from within 100 km from an export hub; and (b) there appears to be a second band of location of these firms at a distance of between 200 and 400 km from the hub. Between 1996 and 2004, manufactured exports in the band between 200 km and 400 km from the nearest hub increased, suggesting either an increase in manufactured exports that depend on natural resources due to demand factors, and/or a decrease in domestic transport costs.

Keywords: geographical economics, manufactured exports, domestic transport costs, South Africa

JEL Classification Codes: R0, R4 and F14

3.1 Introduction

In the geographical economics literature, transport costs influence international trade patterns and volumes. In recent years, a growing number of studies have focused on establishing the empirical relevance of international transport costs. This literature is accumulating evidence that international transport costs have a significant impact on a country's trade volumes, especially if that country is landlocked or remote from its trading partners. As far as the effects of domestic transport costs are concerned, there have been fewer empirical studies despite the fact that the geographical economic literature emphasises that domestic transport costs may influence the spatial location of exporters within a particular country or region. This article attempts to provide empirical evidence for the significance of domestic transport costs in exports and the spatial location of exporters. Spatially disaggregated data on exports and manufacturing from

South Africa are used to estimate a modified cubic-spline density function for manufactured exports from 354 magisterial districts between 1996 and 2004.

The article is structured as follows. Section 3.2 presents a brief overview of the state of the economics literature on the relationship between transport costs, distance and exports. Section 3.3 discusses the spatial patterns of economic activity in South Africa. Section 3.4 presents the various cubic-spline density functions that will be used to model the impact of distance on exports (and indirectly the impact of transport costs). Section 3.5 reports the results from the estimated cubic-spline density functions. Section 3.6 provides a discussion of the results and section 3.7 concludes.

3.2 Transport Costs, Distance and Exports

In this article, transport costs are defined as the costs incurred in moving freight¹⁰. These freight costs comprise direct and indirect elements. Direct elements include freight charges and insurance on the freight, whereas indirect elements include all costs incurred by the transport operator. Indirect elements vary with the shipment's characteristics. Examples include: holding costs for the products in transit, inventory costs (in the case of late deliveries) and costs incurred during preparation for transit (which depends on the shipment size) (Anderson & Van Wincoop, 2003).

In recent years, transport costs have been recognised as having important and significant impacts on trade patterns and globalised production (Hoffmann, 2002). Limão and Venables (2001) state that transport and other costs of conducting business on an international level are key determinants of a country's ability to participate fully in the world economy, and especially to grow exports. Porto (2005) finds that for low-income countries, transport costs are amongst the most important of trade barriers.

Empirical studies support theoretical views by providing the relevant evidence of the significance of transport costs for trade. The general consensus is that international transport costs negatively affect a country's trade volumes. Evidence from Limão and Venables (2001) indicate that if transport costs increased by 10%, trade volume would be reduced by 20%. High transport costs reduce foreign earnings from exports (UNCTAD Secretariat, 2003) and increase the price of imports, which elevates production costs and subsequently inflation (Radelet & Sachs, 1998; Hoffmann, 2002).

¹⁰ In a broader sense, transport costs could also include any number of costs that impede trade such as policy-induced trade barriers, and cultural or sociological barriers (Brakman, Garretsen & Van Marrewijk, 2001).

For countries located far from markets, the effect of transport costs on trade is more severe. Distance is an important part of international trade relations and the impact of distance on transport costs has been widely documented. As distance increases, trade volumes decrease (Venables, 2001). Countries tend to trade with proximate partners (Grossman, cited in The Round Table, 2004), even if transport costs over distance have fallen (Hummels, 1999a). Approximately half of the world's trade takes place between countries located within 3 000 km of each other (The Round Table, 2004). The average distance of trade between countries around the world has decreased, implying that distance matters (Carrere & Schiff, 2004). A possible reason for this occurrence is that increased distance increases costs. It directly increases transaction costs in terms of additional transport costs of shipping goods, time costs of shipping date-sensitive goods, the costs of contracting at a distance (search costs), costs of obtaining information on remote economies and costs of communicating with distant locations (Overman, Redding & Venables, 2001; Venables, 2001).

Limão and Venables (2002) demonstrate that exports and imports of both final and intermediate goods carry transport costs that increase with distance. If a country is situated far from its trading partners, its CIF/FOB ratio¹¹ is higher than a country located close to its foreign markets. For example, Australia's CIF/FOB ratio is 10.3, whereas Switzerland has a ratio of only 1.7 (Radelet & Sachs, 1998). Busse (2003) illustrates this point through another example. The cost to ship a 40-foot container from Baltimore to China is around US\$13 000, whereas the cost to Rotterdam is only US\$2 000 (he follows the same method as Limão and Venables (2001), using 2002 data). Venables (2005) argues that remoteness from economic activity increases transport costs and accounts for the poor export performance of many developing countries situated far from the major markets.

Apart from a country's external geography, its internal geography (whether it is landlocked or coastal) also affects its transport costs. Landlocked countries also tend to have poor internal geography (access to ports), which correlates negatively with transport costs (Redding & Venables, 2003). Therefore, landlocked countries' transport costs are higher (approximately 50%) and have lower trade volumes (around 60%) than coastal countries (Radelet & Sachs, 1998; Limão & Venables, 2001). Martínez-Zarzoso, Gracia-

¹¹ CIF (Cost, Insurance and Freight) measures the value of imports, from the point at which they enter a country. This value includes cost, insurance and freight. FOB (Free on Board) measures the value of exports from the point at which the merchandise is placed on the carrier. The difference between the values of these two incoterms is a measure of the cost of transporting an item from the exporting country to the importing country (Hummels, 1999a, 1999b; Brakman *et al.*, 2003).

Menéndez and Suárez-Burguet (2003) support this argument by proving that exporters situated in landlocked countries incur extra costs since products transported have to switch between more modes of transport than is the case for coastal countries. These landlocked countries also seem to experience higher *ad valorem* rates than coastal countries and this exacerbates the effect of the higher transport costs. Busse (2003) concludes that even with technological developments in transport, many developing countries continue to be challenged by geography due to being remote from major markets or being landlocked.

Various methods have been used to measure the impact of transport costs on trade. The most popular measure of international transport costs is to calculate the CIF/FOB ratio (see footnote 2). Other methods are more direct, such as obtaining quotes from freight forwarders (Hummels, 1999b; Limão & Venables, 2001) and conducting interviews with transport operators (Martínez-Zarzoso *et al.*, 2003). The measurement of domestic transport costs has not been as popular a topic, with no commonly used method. In most cases, a proxy for domestic transport costs is applied. Elbadawi, Mengistae and Zeufack (2001) include domestic transport costs in an index that measures supplier and market access. The variables they use to measure domestic transport costs are the density of the road network (kilometres of roads), the quality of roads (the number of paved roads) and the total land territory of a country. They found that domestic transport costs act as a stronger constraint on exports than international transport costs. Limão and Venables (2001) use similar indicators to measure the costs of travel in and through a country. They add the density of the rail network, as well as the main telephone lines per person. Limão and Venables (2001) estimate that overland distance is seven times more expensive than sea distance. Combes and Lafourcade (2005) extend existing research by developing a methodology to measure domestic transport costs accurately. They compute a measure of generalised transport costs by determining distance costs (fuel, price and fuel consumption, costs due to tolls that have to be paid on highways and maintenance operating costs) and time costs (labour costs, insurance charges, depreciation costs and general charges such as taxes).

From the above discussion it can be concluded that both international and domestic transport costs have significant effects on international trade, and that domestic transport costs may have a much stronger effect on exports than international transport costs. Despite this, the majority of studies have focused on international transport costs, with only a few studies (as cited above) focusing on domestic transport costs. Even fewer

studies are available that investigate the importance of domestic transport costs in an African country. Arguably, following recent contributions by Venables (2005) and Artadi and Sala-i-Martin (2003), Africa is the one continent in the world that faces the most significant challenges in terms of growth, development, exports and integration into the world economy, and is also one of the continents facing the most adverse physical geography (Bloom & Sachs, 1998). The effect of domestic transport costs on manufactured exports and the location of exporting firms in Africa are therefore highly relevant. This article attempts to fill this vacuum by studying the case of domestic transport costs and exports in South Africa.

3.3 The Context of South Africa

The structure or spatial distribution of South Africa's inland economic activity was caused by the discovery of diamonds in Kimberley in 1867 and the discovery of gold in the Witwatersrand in 1886. Johannesburg and the surrounding areas subsequently experienced rapid urbanisation. The role of ports became important as they handled exports of diamonds and gold. During the decades that followed, several factors led to changes in the political situation that caused the exclusion of South Africa from the international community. This was the result of Apartheid (Naudé *et al.*, 2000; Naudé & Krugell, 2005).

Apartheid was a territorial, social and political segregation between different race groups (Naudé *et al.*, 2000). While economic activity during the 19th century was clustered, the Apartheid era had the opposite effect by causing unequal development of economic activity through various policies. Inefficient land use, high transport costs, and under-investment in transport infrastructure, telecommunications and electric power fuelled this inequality (Naudé & Krugell, 2005).

The economy first thrived under the Apartheid rule, then it slowly began to deteriorate. This continued until 1990 when liberalisation began to take place, which led to the lifting of sanctions against South Africa. This transition from a closed to an open economy again changed the spatial structure of economic activity within South Africa (Naudé *et al.*, 2000). South African industries were now exposed to international competition. Subsequently, industries that could not cope with increased levels of competition closed down (for example, the textile industries in the Western Cape). Other

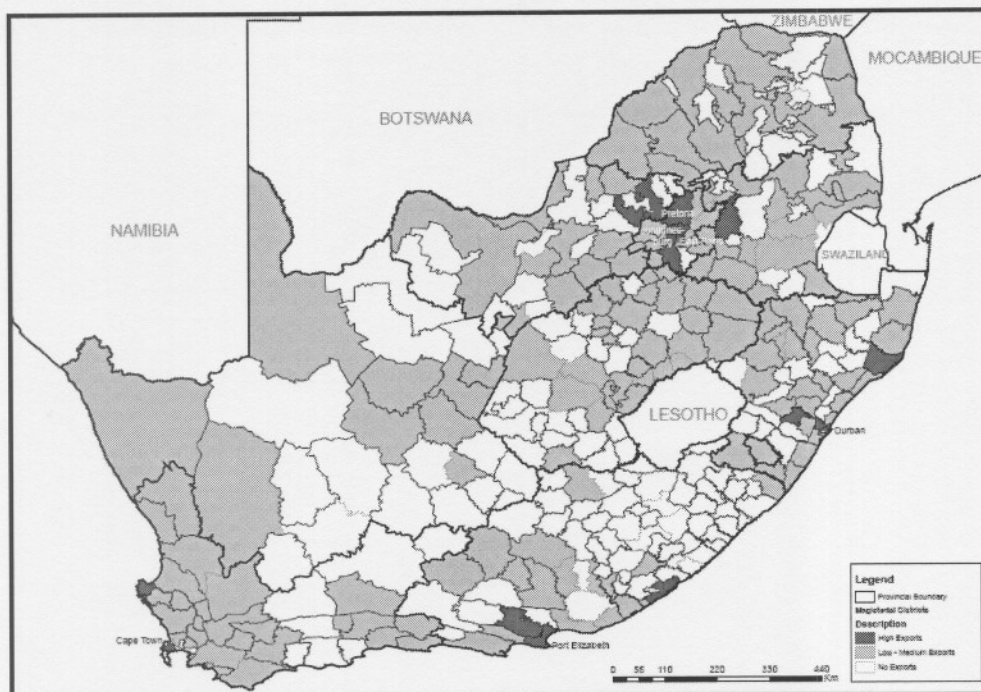
industries that were able to move into new markets thrived (for example, the motor industry in the Eastern Cape) (Naudé *et al.*, 2000).

The current situation is that South Africa's spatial distribution of economic activity is still highly skewed. Around 70% of the country's GDP is produced in only 19 of the urban areas (Naudé & Krugell, 2005). Around 22 of the 354 magisterial districts produced 84% of the total manufacturing exports in 2002. South Africa's skew spatial distribution is clearly evident here, as Gauteng (Johannesburg, Randburg, Boksburg, Germiston and Kempton Park) produce 32.7 of that percentage. The other large agglomerations that export manufactures are Durban-Pietermaritzburg (11.32%), Pretoria-Brits (7.9%) and Cape Town-Belville (5.98%) (Naudé & Gries, 2004; Naudé & Krugell, 2005). Economic activity is also skewed in the sense that the cities located near ports are smaller than those situated inland (Krugell, 2005). This contrasts with theory that argues that exporters will locate closer to ports in order to minimise transport costs. The reason is that distance creates transport costs which, in turn, influence the location decisions of firms that produce manufactures for the export market (Naudé & Gries, 2004). Therefore, domestic transport costs are a relevant issue in South Africa, especially as the major sources of manufactured exports are located inland¹². The shaded districts in figure 3.1 are those that have positive manufactured exports. The relative volume of exports are indicated according to the percentage of exports from a particular district. For instance, the areas shaded black are areas where the district contributes more than 1% of total manufactured exports and the areas shaded grey between 0.1% and 0.99%. It is evident that the majority of manufactured exports originate in the vicinity of one of the major export hubs, namely City Deep (situated in Gauteng), Durban harbour (situated in KwaZulu-Natal), Port Elizabeth (situated in the Eastern Cape) and Cape Town harbour (situated in the Western Cape). City Deep is an inland container port situated in Johannesburg constructed to cope with container traffic originating from Gauteng. Durban is the largest general cargo port in South Africa and also the best-equipped container terminal. Port Elizabeth is situated midway between the ports of Durban and Cape Town. This port specialises in cargoes for the vehicle manufacturing and vehicle

¹² South Africa's transport costs accounted for around 13% of GDP in 2003, which is high in comparison with other emerging markets. Brazil's transport costs, for example, are only 8% of their GDP (Ramos, 2005). The largest part of South Africa's total logistics cost is attributed to transport costs. Logistics costs include throughput (i.e. the total amount of goods that are transported and stored), transport costs, warehousing costs, inventory costs and management and administration costs (CSIR, 2004). Transport costs make up 78% of the secondary sector's total logistics costs and 60% of the primary sector's (CSIR, 2004; Chasomeris, 2005).

components industries. Cape Town's container terminal is a well-located hub for exports and handles high value and time sensitive cargoes (ITRISA, 2005; Transnet, 2006).

Figure 3.1: Exports per Magisterial District



Source: Author's own calculations (MAP drawn by GISCOE)

3.4 Empirical Results

3.4.1 Methodology

Cubic splines are piecewise functions whose "pieces" are polynomials of degree less than or equal to three, joined together to form a smooth function (Poirier, 1973). The reason for the development of spline functions was to overcome the problems experienced with piecewise linear regression functions (Suits, Mason & Chan, 1978). Piecewise linear regression functions suffer from discontinuity in their derivatives. This discontinuity at the kinks of the linear regression makes it difficult to analyse, for example, shifts in elasticities and marginals, (Suits *et al.*, 1978).

Cubic spline functions have been applied to various study disciplines, one of which is urban studies. Anderson (1982, 1985) applies the spline function empirically to

study urban population densities in order to determine the urban population density (or spatial structure) of a metropolitan area (Alperovich, 1995).

Assume that there is a central business district in the metropolitan area, and any location in this area can be expressed as a distance from the centre. For this purpose, census tract data is used to determine the density of the population at various distances from the city centre (Zheng, 1991). The density-distance relationship is estimated by using piecewise, continuous polynomials (Zheng, 1991). Suits *et al.* (1978) initially developed a spline density function where the density variable regresses into three polynomial expressions of the distance variable (Skaburskis, 1989). The function is as follows:

$$\begin{aligned} T = & [\alpha_1 + \beta_1(K - K_0) + \chi_1(K - K_0)^2 + \delta_1(K - K_0)^3]Y_1 + \\ & [\alpha_2 + \beta_2(K - K_1) + \chi_2(K - K_1)^2 + \delta_2(K - K_1)^3]Y_2 + \\ & [\alpha_3 + \beta_3(K - K_2) + \chi_3(K - K_2)^2 + \delta_3(K - K_2)^3]Y_3 + v \end{aligned} \quad (3.1)$$

K is the distance from the tract to the city centre, K_0 is the distance of the closest tract, K_1 is the first interior knot and K_2 is the second interior knot. Y_1 , Y_2 and Y_3 are dummy variables defined on the various intervals on the X-axis. In other words they locate each tract in its segment along the distance variable (Y_i , where $i = 1, 2, 3, \dots$). The parameters α , β , χ and δ describe the spline and v is a normally distributed disturbance term with a zero mean and constant variance (Anderson, 1982; Skaburskis, 1989). In equation (3.1), there is, however, no guarantee that the function is continuous at knots K_0 , K_1 and K_2 . A further problem is that the derivatives are also discontinuous at these knots. It is for this reason that Suits *et al.* (1978) improved their function by adding constraints to the coefficients. The constraints make the function continuous and guarantee continuity of the first and second derivatives. The improved density function can be written as:

$$\begin{aligned} T = & \alpha_1 + \beta_1(K - K_0) + \chi(K - K_0)^2 + \delta_1(K - K_0)^3 + \\ & (\delta_2 - \delta_1)(K - K_1)^3 Y_1^* + (\delta_3 - \delta_2)(K - K_2)^3 Y_2^* \end{aligned} \quad (3.2)$$

$Y_i^* = 1$ if, and only if, $K \geq K_i$. That is, $Y_i^* = 0$ until K reaches K_i , then $Y_i^* = 1$ thereafter (Anderson, 1982). Zheng (1991) has modified the spline density function by omitting the second dummy term and adding an error term. His version of the spline density function (used in this article) is written as:

$$\begin{aligned}
M_r &= \alpha + \beta(K_r - K_0) + \chi(K_r - K_0)^2 + \delta_i(K_r - K_0)^3 + \\
&\sum_{i=1}^{n-1} (\delta_{i+1} - \delta_i)(K_r - K_i)^3 Y_i + \mu_r, \\
Y_i &= 0 \quad \text{if } K_r \geq K_i, \\
Y_i &= 0 \quad \text{otherwise.}
\end{aligned} \tag{3.3}$$

As far as the author is aware, there has not been any study that uses the cubic-spline density function to estimate the impact of distance/domestic transport costs on trade.

3.4.2 Data

Data on exports of manufactured goods were obtained from Global Insight's Southern Africa's Regional Economic Focus database. This database is compiled from data supplied by the South African Revenue Services and the Department of Customs and Excise. The documentation required from exporters by the department of Customs and Excise captures their postal codes or street addresses. This data per postal code is mapped to one of the 354 magisterial districts to provide information on exports from each magisterial district. The magisterial allocations are then compared to the national totals as contained in the South African Reserve Bank Quarterly Bulletin. The data is, however, not flawless as exports are measured at current world prices. In other words, taxes and subsidies are not included in value added. This causes a peculiarity in the export share measure, as some of the magisterial districts have an export share greater than 100% (Naudé & Gries, 2004). Data from two of the dependent variables are used, namely manufactured exports and gross value added.

The only other variable for which data were obtained is distance. In urban spline density studies, actual distances are not used. Distance is calculated by the "great circle" formula in which distance is measured directly (in other words, "as the crow flies"). In this paper, actual road distances are used. The Internet service Shell Geostar (www.shellgeostar.co.za) was used to obtain the shortest route from each of the magisterial districts to each of the major export hubs in South Africa. The hubs used were Cape Town harbour, Port Elizabeth harbour, Durban harbour and City Deep¹³. The shortest distance to one of these hubs were chosen as the actual distance, as it is assumed that exporters strive to minimise their transport costs.

¹³ Other export hubs in South Africa were excluded, because the use of these hubs would lessen the degrees of freedom in the cubic-spline density functions.

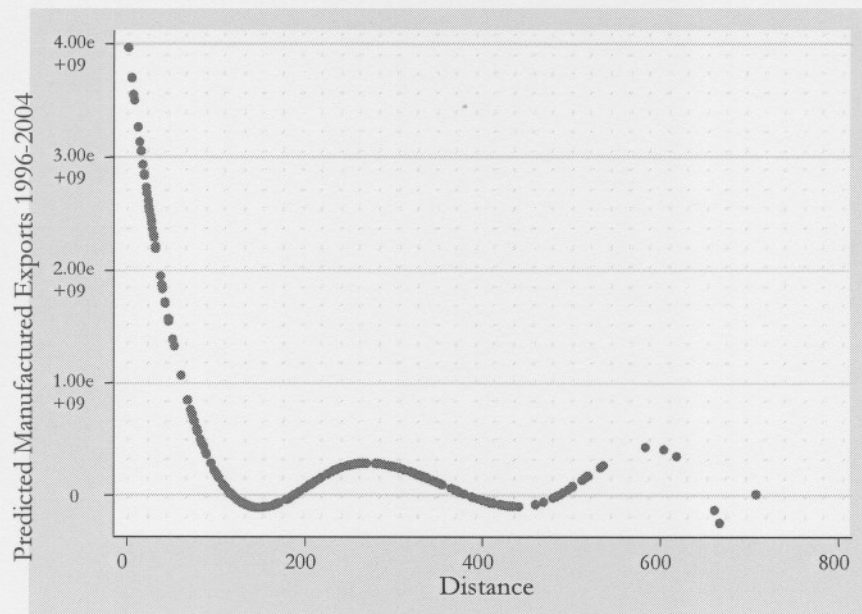
3.4.3 Results

Cubic-spline density functions were applied to different sets of data, using STATA 9 and its OLS (Ordinary Least Squares) estimator. The data sets included the average of manufactured exports between 1996 and 2004 and manufactured exports in 1996 and 2004 respectively. In the cubic-spline density functions, the furthest distance from a hub was used to calculate the knots. Cubic-spline density functions were developed for three, four and five knots for each of the data sets. The results indicated that three knots seemed to provide the best fit to the data. Appendix 3.1 contains the results of the cubic-spline density functions for all of the data sets using three knots. Appendix 3.2 contains the results of the cubic-spline density functions for all of the data sets using four knots and Appendix 3.3 illustrates the results using five knots.

3.4.4 Location of Manufacturers

In order to provide an overview of the relevance of domestic transport costs to the location of manufactured exports in South Africa, cubic-spline density functions were applied to the average of manufactured exports over the period 1996 to 2004. The number of magisterial districts that exported manufactures during this period is 267. Figure 3.2 illustrates the results. From figure 3.2, it is clear that the largest volumes of exports are generated within 100 km of the export hub. This suggests that proximity to a port (hub) is an important consideration in most export-oriented manufacturing firms' location, and that domestic transport costs therefore matter.

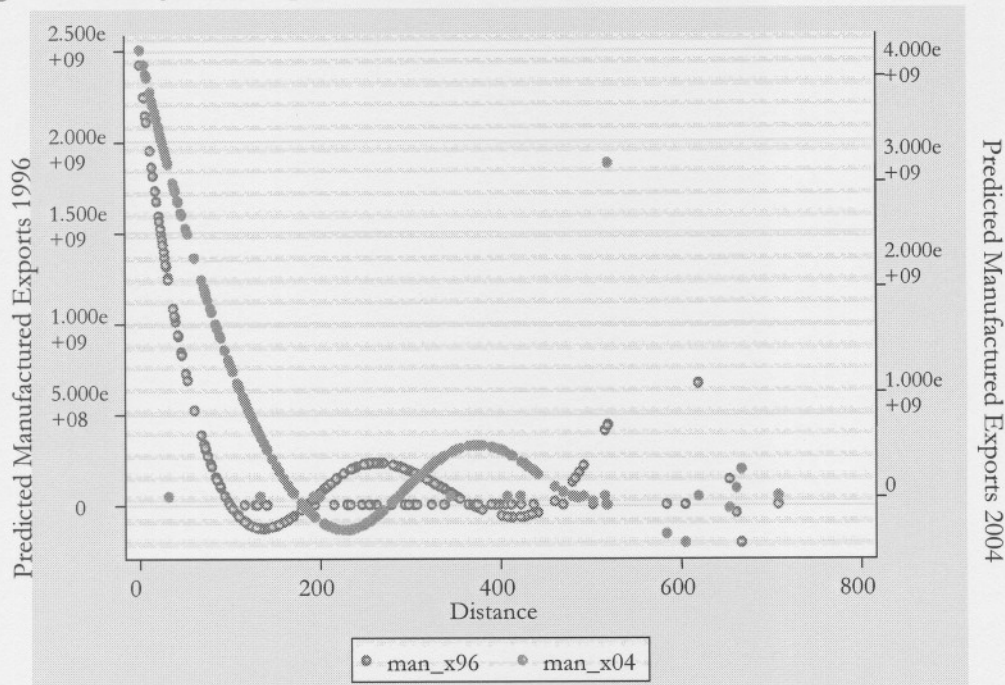
Figure 3.2: Average Manufactured Exports from 1996 to 2004



It is also noticeable from figure 3.2 that there is not a unidirectional decrease in export-orientation as the distance from the port/hub increases. In fact, in South Africa, there appears to be a second band of location of export-oriented manufacturing firms at a distance of between 200 and 400 km from the nearest hub. Several large manufacturing exporters are situated in this band. A third band occurs at around 600 km from the nearest hub. However, the manufactured exports that originate from this band are resource based.

Figure 3.3 compares the density functions for the value of manufacturing exports in 1996 and 2004. In 1996 only 193 of the 354 magisterial districts hosted exported manufactures, whilst in 2004 the number rose to 223 – a 15% increase. The general increase in manufacturing exports from all locations is evident in the rightward shift of the density function in figure 3.3.

Figure 3.3: *Manufactured Exports in 1996 and 2004*



It can also be seen that the amplitude of the 2004 density function in the band between 200 km and 400 km from the hub increased, suggesting greater exports from locations rather further away from the hub. This could suggest an increase in manufactured exports that depend on natural resources due to demand factors and/or a decrease in domestic transport costs over the period.

If the three spline density functions in figures 3.2 and 3.3 are compared, it seems that distance provides, on the average, a better explanation for the level of exports, since the adjusted R-squared is 20% (the adjusted R-squared for 1996 is 17% and for 2004 14%).

3.5 Discussion

In all instances where cubic spline density functions were applied to the various data sets, the results indicated that distance is negatively related to the level of manufactured exports (see appendix 3.1, 3.2 and 3.3). The results obtained are in line with those of Zheng (1991) for the case of metropolitan spatial structures. The majority of exporters of manufactured goods are located within 100 km of the nearest export hub. A second “zone” of export density occurs between 200 and 400 km of the nearest export hub.

Table 3.1 provides information on the location of the manufacturers of the nine sectors of manufactured exports.

Table 3.1: Percentage Exports per Manufacturing Sub-sector by Distance

Sector	Distance in km from nearest export hub							Total % of manufactured exports
	0-100	101-200	201-300	301-400	401-500	501-600	601+	
Food, beverages and tobacco products	84.28	8.14	4.25	2.76	0.50	0.05	0.02	100
Textiles, clothing and leather goods	79.15	1.50	12.50	6.59	0.25	0.01	0.00	100
Wood and wood products	82.39	16.62	0.47	0.39	0.12	0.00	0.00	100
Fuel, petroleum, chemical and rubber products	78.60	14.34	1.38	2.12	3.56	0.01	0.00	100
Other non-metallic mineral products	94.21	2.74	2.19	0.74	0.09	0.02	0.00	100
Metal products, machinery and household appliances	75.75	20.12	0.84	2.43	0.52	0.01	0.33	100
Electrical machinery and apparatus	92.74	0.97	6.05	0.12	0.08	0.02	0.01	100
Electronic, sound/vision, medical and other appliances	98.79	0.64	0.32	0.10	0.13	0.01	0.00	100
Transport equipment	81.28	3.92	14.36	0.26	0.11	0.06	0.00	100
Furniture and other items NEC and recycling	71.53	2.47	1.94	0.82	23.23	0.00	0.01	100

Source: Author's own calculations using Global Insight's Regional Economic Focus database

The majority (in excess of 70%) of manufactured exports are produced within 100 km of the nearest export hub. For certain goods, such as electronics, about 98% of manufacturing takes place within 100 km of an export hub. Further away from an export hub in South Africa (in excess of 100 km) one tends to find furniture, textiles, and metal products. These goods tend to be produced largely for the domestic market, which is relatively more intensive in natural resources. Thus, the patterns and evolution of the location of manufacturing exporters in South Africa tend to support the idea that domestic transport costs matter for exports.

If one compares the location of manufacturing exporters over time, i.e. compare the level and location of manufactured exports in 1996 and in 2004, two structures are evident (see figure 3.3). Firstly, exporters seem to have located further away from the hub within the first 100 km. Secondly, the level of manufactured exports in the second "band" (originating around 400 km from the hub) has increased significantly from 1996 to 2004. Domestic transport costs might have declined, manufacturers might have obtained ways by which they are able to overcome the incidence of these costs, or the

demand for these types of manufactured goods may have made their export more profitable.

3.6 Conclusions and Recommendations

In the geographical economics literature, transport costs influence international trade patterns and volumes. In recent years, growing numbers of studies have focused on establishing the empirical relevance of international transport costs. This literature is accumulating evidence that international transport costs have a significant impact on a country's trade volumes, especially if that country is landlocked or remote from its trading partners.

This article concludes that both international and domestic transport costs have significant effects on international trade, and that domestic transport costs may have a much stronger effect on exports than international transport costs. Despite this, the majority of studies have focused on international transport costs, with only a few studies (as cited above) focusing on domestic transport costs. Even fewer studies are available that investigate the importance of domestic transport costs in an African country. Given that Africa is the one continent in the world that faces the most significant challenges in terms of growth, development, exports and integration into the world economy, and is also one of the continents facing the most adverse physical geography. The effect of domestic transport costs on manufactured exports and the location of exporting firms in Africa are therefore highly relevant. This article attempts to fill this vacuum by studying the case of domestic transport costs and exports in South Africa.

South Africa's spatial distribution of economic activity is, like those in many other countries, highly skewed. Around 70% of the country's GDP is produced in only 19 of the urban areas. In terms of exports, around 22 of the 354 magisterial districts produced 84% of the total manufacturing exports in 2002. Economic activity is also skewed in the sense that the cities located near ports are smaller than those situated inland. Therefore, domestic transport costs are a relevant issue in South Africa, especially as the major sources of manufactured exports are located inland.

In determining whether distance and transport costs from a particular location to an export hub matters for export-oriented manufacturing firms in South Africa, this article estimates a number of cubic spline density functions for manufactured exports in 1996 and 2004 and for average manufactured exports over the period 1996-2004.

Cubic splines are piecewise functions whose “pieces” are polynomials of degree less than or equal to three, joined together to form a smooth function. These have been applied to various study disciplines, especially urban studies. As far as the author is aware there has not been any study that uses the cubic-spline density function to estimate the impact of domestic transport costs on trade.

From the cubic-spline density functions it was found that in South Africa the largest volumes of exports are generated within 100 km of an export hub. In particular between 70% and 98% of manufactured exports are produced within 100 km of the nearest export hub. For certain goods, such as electronics, about 98% of manufacturing takes place within 100 km of an export hub. Further away from an export hub in South Africa (in excess of 100 km) one tends to find furniture, textiles, and metal products. These goods tend to be produced largely for the domestic market, which is relatively more intensive in natural resources.

The above suggests that, barring some important exceptions, the proximity to a port (hub) is an important consideration in the location of most export-oriented manufacturing firms. However, it was also found that the relationship between exports and distance from an export hub is not unidirectionally negative. In South Africa, there appears to be a second band of location of export-oriented manufacturing firms at a distance of between 200 and 400 km from the nearest hub. Several large manufacturing exporters are situated in this band. A third band occurs at around 600 km. However, the manufactured exports that originate from this band are resource based.

Comparison over time showed that the number of locations from which manufacturing exports occur in South Africa increased by 15% between 1996 and 2004 and that manufactured increased in the band between 200 km and 400 km from the nearest hub. This could suggest an increase in manufactured exports that depend on natural resources due to demand factors and/or a decrease in domestic transport costs over the period. Although further research could clarify whether or not the increase in manufacturing exports in the band further away from the export hub was due to increases in demand and/or decreases in transport costs, it remains that transport costs are an important and significant determinant of the location of export-oriented manufacturing firms in South Africa, and the location near to an export hub is important. It also suggests that improving the efficiency of export hubs, and even creating additional export hubs (e.g. through dry ports) would contribute positively towards increasing the

volume of manufactured exports from South Africa. The South African government is currently planning the creation of such hubs.

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APPENDIX 3.1

3 knots Parameter	Total Hubs		
	Average	1996	2004
a	4.10e+09 (9.03)**	2.51e+09 (7.44)**	4.33e+09 (7.60)**
b	-6.96e+07 (-6.05)**	-4.66e+07 (-5.13)**	-3.79e+07 (-5.11)**
c	366691.1 (4.75)**	260066.1 (4.13)**	73710.2 (3.39)**
d ₁	-598.3 (-4.09)**	-440.5 (-3.60)**	1.10e-06 (0.63)
d ₂ - d ₁	756.2 (3.20)**	606.2 (2.88)**	-1143.5 (-0.83)
d ₃ - d ₄	-539.4 (-1.08)	-684.1 (-1.36)	-2318.6 (-0.42)
d ₄ - d ₅	1.36e+09 (0.44)	1.81e+09 (0.77)	-2.72e+09 (-0.53)
SE	1.7e+09	1.2e+09	2.8e+09
Adj. R-bar squared	0.21	0.17	0.14
No. observations	267	193	223

(t-ratios in brackets:

* significant at the 10% level

** significant at the 5% level)

APPENDIX 3.2

4 knots	Total Hubs		
	Parameter	Average	1996
a	3.58e+08 (0.69)	2.55e+09 (7.50)**	5.72e+09 (7.73)**
b	-1651511 (-0.12)	-4.89e+07 (-5.21)**	-8.25e+07 (-4.86)**
c	23881.5 (0.25)	283058.6 (4.20)**	303994.4 (3.76)**
d ₁	-52.7 (-0.28)	-500.05 (-3.67)**	-0.00 (-2.73)**
d ₂ - d ₁	.10 (0.15)	1.45 (2.89)**	20.22 (2.62)**
d ₃ - d ₄	.57 (0.27)	-3.77 (-2.21)**	27.15 (3.07)**
d ₄ - d ₅	-16.93 (-0.95)	15.04 (1.02)	71.88 (1.57)
d ₆ - d ₅	8.90e+09 (1.12)	-2.67e+10 (-1.79)*	-6.66e+09 (-0.48)
d ₇ - d ₆	—	—	—
SE	1.9e+09	1.2e+09	2.8e+09
Adj. R-bar squared	-0.02	0.18	0.18
No. observations	267	193	223

(t-ratios in brackets:

* significant at the 10% level

** significant at the 5% level)

APPENDIX 3.3

5 knots Parameter	Total Hubs		
	Average	1996	2004
a	2.22e+08 (0.42)	2.63e+09 (7.63)**	5.50e+09 (7.71)**
b	4708666 (0.33)	-5.28e+07 (-5.36)**	-7.41e+07 (-4.87)**
c	-34865.98 (-0.34)	320769.2 (4.36)**	252400.8 (3.70)**
d ₁	88.07821 (0.41)	-593.79 (-3.83)**	-.0000113 (-2.38)**
d ₂ - d ₁	-.0018079 (-0.85)	.00 (2.91)**	.0262125 (2.16)**
d ₃ - d ₄	.0128365 (1.18)	-.02 (-2.38)**	-.0211681 (-1.18)
d ₄ - d ₅	-.0736356 (-1.40)	.07 (1.66)*	.0696358 (0.84)
d ₆ - d ₅	1.217318 (1.11)	-.86 (-1.11)	-.5000189 (-0.31)
d ₇ - d ₆	-2.84e+10 (-0.84)	1.95e+10 (0.88)	1.13e+10 (0.22)
SE	1.9e+09	1.2e+09	2.8e+09
Adj. R-bar squared	-0.02	0.18	0.17
No. observations	267	193	223

(t-ratios in brackets:

* significant at the 10% level

** significant at the 5% level)

CHAPTER 4: ARTICLE 2

DETERMINANTS OF REGIONAL MANUFACTURED EXPORTS FROM A DEVELOPING COUNTRY

ABSTRACT

In this article, the question of the location of exporters of manufactured goods within a country is investigated. Based on insights from new trade theory, the new economic geography (NEG) and gravity-equation modelling, an empirical model is specified with agglomeration and increasing returns (the home-market effect) and transport costs (proxied by distance) as major determinants of the location decision of exporters. Data from 354 magisterial districts in South Africa are used with a variety of estimators (OLS, Tobit, RE-Tobit) and allowances for data shortcomings (bootstrapped standard errors and analytical weights) to identify the determinants of regional manufactured exports. It is found that the home-market effect (measured by the size of local GDP) and distance (measured as the distance in km to the nearest port) are significant determinants of regional manufactured exports. This article contributes to the literature by using developing country data, and by adding to the small literature on this topic. This article complements the work of Nicolini (2003) on the determinants of exports from European regions and finds that the home-market effect is relatively more important in the developing country context (South Africa), a finding consistent with theoretical NEG models such as those of Puga (1998).

Keywords: developing country, manufactured exports, home-market effect, domestic transport costs

JEL Classification Codes: R12, R49, F12 and F14

4.1 Introduction

Theoretical and empirical work in international trade has, with a few exceptions, predominantly focused on trade between countries, as opposed to focusing on where exports originate within a country. International trade theory, until fairly recently, assumed away all elements that might make consideration of the geography of exports possible. For instance, transport costs, distance, market size, scale economies and agglomeration were only recently incorporated into trade models. In this respect, important initial contributions on the integration of regional science and international

trade theory were made by Krugman (1979, 1980, 1991), Venables (2001), Fujita, Krugman and Venables (2001) and Fujita and Krugman (2004).

Despite these advances, relatively little evidence has been forthcoming as to the appropriateness of these theoretical models (Brakman, Garretsen & Van Marrewijk, 2001; Venables, 2005; Naudé & Krugell, 2006; Gries & Naudé, 2007). Moreover, where transport costs in international trade are concerned, empirical work has so far tended to focus on international shipping costs (Radelet & Sachs, 1998; Hummels, 1999; Clark, Dollar & Micco, 2004). This article's contribution is to present empirical evidence on the geographical location and determinants of exports from a developing country. Understanding these determinants may be important given the wide consensus that exists on the positive impact of export growth on economic growth and development (see Foster, 2006; Hausman, Hwang & Rodrik, 2006) and on the potential for differential export performance to contribute to spatial inequality (see Kanbur & Venables, 2005). Existing studies on this topic focus only on developed countries (for example Nicolini, 2003). A developing country perspective is given in this article using data from South Africa's 354 magisterial districts. The focal point is manufactured exports, as manufacturing firms tend to be more footloose than, for example, firms in mining or agriculture. It is found that local demand (or economic growth) positively influences exports, whereas distance from a port decreases exports. The further that exporters are located from an export hub (such as a port), the less their manufactured exports. Distance (i.e. domestic transport costs) therefore matters.

The article continues in section 4.2 by describing the modelling approach from the framework of theoretical contributions on the topic. Thereafter, in section 4.3 the data and estimators used are discussed. Before the results are discussed in section 4.5, the profile and patterns of manufactured exports in South Africa are described in section 4.4. The article concludes with a summary and suggestions for further research in section 4.6.

4.2 Modelling Approach

4.2.1 Theoretical Background

In traditional explanations of trade (such as the Heckscher-Ohlin model) patterns of trade between countries depend on natural resources, skills and factors of production. It is assumed that trade takes place in a perfectly competitive and frictionless (pinpoint) world without transport costs (Salvatore, 1998).

Only relatively recently, in the new trade theories, has the role of transport costs as a determinant of trade in international trade been recognised (see e.g. initial contributions by Krugman, 1979; 1980). Herein, Samuelson's (1952) concept of iceberg transport costs is frequently used. With "iceberg" transport costs, goods can be shipped freely, but only a fraction of goods (g) arrive at the relevant destination, with $(1 - g)$ being lost in transit (i.e. it melts away). The fraction lost in transit is seen as the transport cost incurred (Krugman, 1980; Fujita & Krugman, 2004). According to Fujita and Krugman (2004), using iceberg transport costs has two advantages. Firstly, it eliminates the need to analyse the transport sector as another industry. Secondly, it simplifies the description of how monopolistic firms set their prices (i.e. it erases the incentive to absorb transport costs, charging a lower FOB (Free on Board) price for exports than for domestic sales). Krugman (1991) redefined the iceberg cost function as an explicit geographical distance-related function (McCann, 2005).

Both international and domestic transport costs can be distinguished, and have significant effects on trade. As far as international transport costs are concerned, Radelet and Sachs (1998) analyse the impact of international transport costs on the international competitiveness of developing countries. They find that transport costs are influenced by geographical factors such as distance to markets and access to ports which, in turn, have an effect on manufactured exports and long-term economic growth. Countries with lower transport costs have experienced more rapid growth in manufactured exports as well as in overall economic growth during the past three decades, than countries with higher transport costs. High transport costs elevate the cost of producing manufactures by increasing the price of imported intermediate and capital goods. These elevated production costs, together with high transport costs, impede the price competitiveness of manufactured exports (Radelet & Sachs, 1998; Hoffmann, 2002). Limão and Venables (2001) find that landlocked developing countries tend to have higher transport costs

(approximately 50%) and lower trade volumes (around 60%) than coastal countries. Clark *et al.* (2004:417) find that transport costs are a significant determinant of bilateral trade between Latin America and the USA, and that port efficiency is an important determinant of international shipping costs (improving port efficiency from the 25th to the 75th percentile can reduce shipping costs by up to 12%).

As far as domestic transport costs and the relationship between transport costs and firm location are concerned, the so-called home-market effect has been offered to explain the observed spatial concentration of industries. Krugman (1980) explains that if manufacturing firms experience increasing returns to scale in the face of positive transport costs, they will locate in the vicinity of the largest market. This implies that one can expect the concentration of production to enable increasing returns to scale, while locating near the largest market minimises transport costs. As a determinant of regional manufacturing exports, the home-market effect implies that manufacturing firms will export those products for which there is a large domestic (local) demand (Amstrong & Taylor, 2000).

Transport costs are the determining factor for the home-market effect. By locating near the larger market, firms are able to achieve increasing returns to scale and at the same time minimise their transport costs. This increases the real wage of workers in that region and makes it a more attractive place to live (Brakman *et al.*, 2001). According to Brakman *et al.* (2001), transport costs are the main identifying characteristic of regions in the core-periphery model of the new economic geography (NEG) theory. In the model, transport costs are assumed zero within a region and positive between two regions. Transport costs comprise various elements that hamper trade, such as tariffs, language, and cultural barriers as well as the actual costs incurred in moving goods from one place to another (Krugman, 1991; Brakman *et al.*, 2001; Fujita, Krugman & Venables, 2001).

If transport costs were high, trade would not take place, as it would be too costly - exports and imports are so expensive that only home production is possible. Production will be spread out to be close to demand. If transport costs were low, there would also be no trade or agglomeration since the two regions would be *ex ante* identical and neither would have the forces, such as a thick labour market or inter-industry linkages, that create the propensity for agglomeration. Thus, it is in an intermediate range that transport costs matter for trade and agglomeration. Below this threshold level of transport costs, manufacturers choose the location with large local demand. Local

demand will be large precisely where the majority of manufacturers choose to locate. The result is agglomeration at the core and trade with the periphery (Krugman, 1991; Brakman *et al.*, 2001; Fujita, Krugman & Venables, 2001).

From the above, the main determinants of exports from a specific location are distance (transport costs) and the home-market effect. Empirical evidence supports these conclusions (Venables, 2001; see also Crafts & Mulatu, 2005 for a discussion of the location of industry in Britain). For instance, countries tend to trade with proximate partners (Grossman, cited in The Round Table, 2004), even if transport costs over distance have fallen (Hummels, 1999). Approximately half of the world's trade takes place between countries located within 3 000 km of each other (The Round Table, 2004). The distance of trade for the average countries in the world has decreased, implying that distance matters (Carrere & Schiff, 2004). A possible reason for this occurrence is that distance is costly. It directly increases transaction costs in terms of additional transport costs of shipping goods, time costs of shipping date-sensitive goods, the costs of contracting at a distance (search costs), costs of obtaining information on remote economies and costs of communicating with distant locations (Overman, Redding & Venables, 2001; Venables, 2001). Redding and Schott (2003:516) also show that firms that are located at some distance from final markets face transport costs on both their sales as well as on their inputs, and as a consequence will have less value added available to remunerate labour, which in turn will reduce incentives for investment in human capital. This is an additional channel through which distance from markets can reduce a region's growth and explain spatial economic inequality.

4.2.2 Regional Trade Model

In the previous section, trade, as a result of agglomeration, was explained. Various other models (for example the gravity model of trade and the price elasticity model of supply and demand) have been developed to explain trade and, more specifically, the determinants of the exports of countries. What distinguishes the gravity model of trade from other models is that it incorporates a spatial element, namely distance, to the explanation of trade. As indicated space, in the form of distance, is highly relevant as one of the determinants of trade in the NEG theory. The gravity model states that bilateral trade flows between countries are determined by their respective incomes, the distance between them and other country-specific factors such as language, geographical

continuity, trade agreements and colonial ties (Deardorff, 1995; Head, 2003). The general conclusion from the existing empirical studies is that the further the countries are located from one another, the lower are the trade flows due to increasing transport costs (Brakman *et al.*, 2001; Nicolini, 2003).

The gravity model is, however, not without shortcomings and has been widely criticised for not having a solid theoretical foundation. The theoretical foundation underlying this model has been the subject of research for more than three decades (Anderson, 1979; Bergstrand, 1985, 1989, 1990; Deardorff, 1995, Evenett & Keller, 2001). Deardorff (1995) shows that the gravity equation can be derived from any of the trade theories, as it characterises many of their attributes. Indeed, the gravity equation has also been derived from the new trade theory. For example, Feenstra, Markusen and Rose (2001) employ the gravity equation in conditions of monopolistic competition to test for the home-market effect. They use the incomes of the country pairs as proxies for the home-market effect and find that it exists for differentiated goods, but not for homogeneous goods (domestic income elasticity exceeds the partner income elasticity). Therefore, with subtle differences in the parameter values, Feenstra *et al.* (2001) found that the gravity equation is supportive of an increasing returns model as embodied in new trade theory.

It is only in the work of Nicolini (2003) that the focus is no longer on countries but on regions within countries. Up to this point, no other study has engaged in such an approach. Nicolini (2003) adapts the gravity model to develop and test a theoretical model (based on NEG theory) of the determinants of singular (export) flows from regions. Her study finds that factors that determine a country's exports differ from the factors that determine where those exports originate within a country. Nicolini's (2003) theoretical framework assumes (a) a utility function of consumers that consume both local and imported goods and (b) a production function of local and foreign firms. Exporting the goods incurs transport costs (in the form of iceberg transport costs). As her model only considers singular trade flows, she derives the home-market effect from the assumption that the demand for local goods exceeds that of imported goods. The reasoning behind this assumption is as follows: when local firms agglomerate due to the effect of circular causation, they are able to specialise and achieve increasing returns to scale. This lowers their production costs and subsequently prices. Consumers demand local firms' goods as they are cheaper than imported goods. As demand increases, firms

are able to expand and eventually export their goods. Export is therefore the result of increased demand that originates from circular causation (i.e. the home-market effect).

In the following section, Nicolini's (2003) empirical model is tested with developing country data (from South Africa) in order to compare and contrast results between developed and developing country regions. Whilst Nicolini's (2003) empirical models are tested for a developing country, more sophisticated estimators are used in this article since not all regions within a developing country export, in contrast to Nicolini's developed country sample where all regions had positive exports.

4.3 Empirical Model

4.3.1 Estimating Equation

The estimating equation follows that of Nicolini (2003) and implies that exports (EXP_R) from a region are determined by a geographical component (Geo_R) particular to each region, the "home-market" effect (HM_R) of each region and specific regional features (SE_R). The equation as developed by Nicolini (2003) is:

$$\text{Log}(EXP_R) = c + \beta_1 \text{Log}(Geo_R) + \beta_2 \text{Log}(HM_R) + \beta_3 \text{Log}(SE_R) \quad (4.1)$$

Nicolini (2003) measures the home-market effect by using the GDP per region corrected by the geographical surface area of the region (GDP per km²) in order to account for the size of the local market. She finds that the home-market effect explains the export intensity of the regions. The geographical component captures transport costs. Transport costs are proxied by using two different measures, the surface area of a region (i.e. the geographic area in km²) and the transport intensity (the local transport infrastructure or network) of each region. Nicolini (2003) finds that the surface of a region affects the density of exports negatively (and concludes that distance matters, also see section 4.2.1) and increased transport intensity facilitates trade flows (infrastructure is positively correlated with trade volume, also see Bougheas, Demetriades & Morgenroth, 1999). She adds dummies in her test for whether or not a region is adjacent to a foreign country.

Due to data constraints, the estimating equation for this article has to be modified slightly, but still follows Nicolini's (2003) approach. The equation is as follows:

$$\text{Log}(EXP_M) = c + \beta_1 \text{Log}(Dist_M) + \beta_2 \text{Log}(HM_M) + \beta_3 \text{Log}(SE_M) \quad (4.2)$$

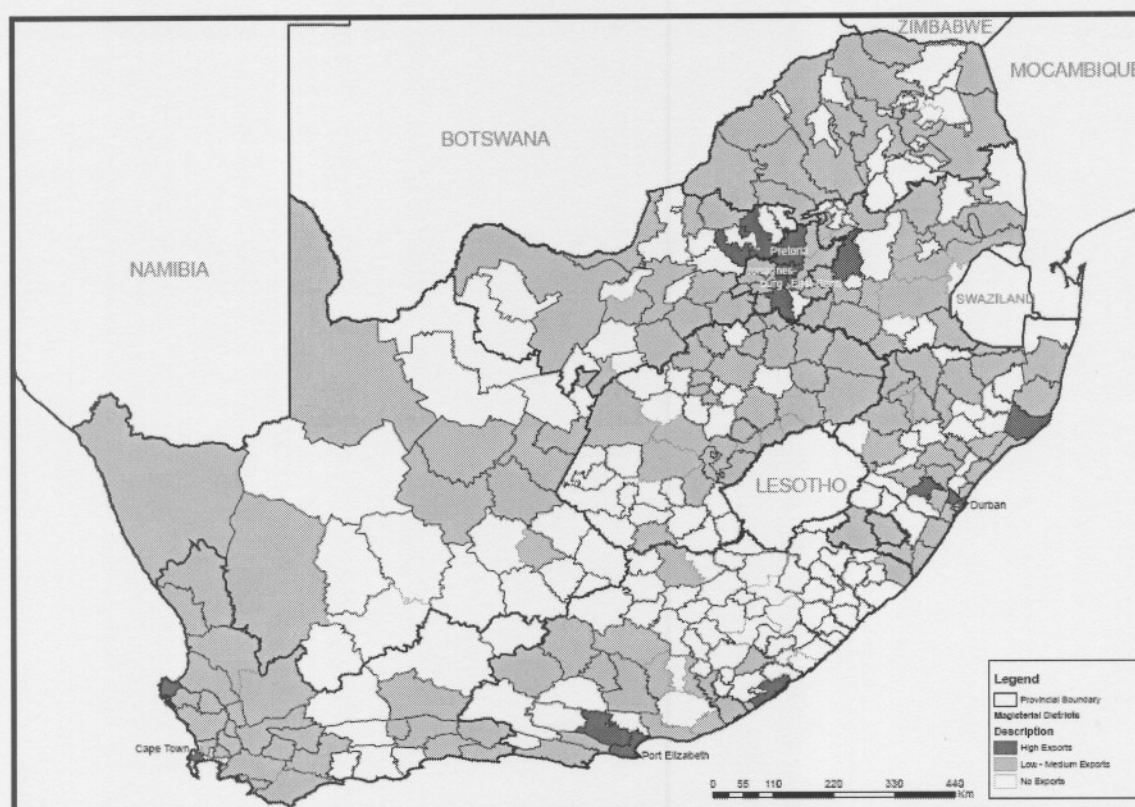
The home-market effect (HM_M) is captured by the GDP per magisterial district¹⁴. The geographical component ($Dist_M$) here is also measured using two proxies, namely the distance from each magisterial district to its nearest export hub (also see section 4.3.2) and the surface area of each magisterial district. The influence of domestic transport costs on regional exports is captured through the implementation of these proxies. The use of dummies for adjacency is not relevant.

4.3.2 Data

The discussion on the data used in this article needs to be preceded by a short description of the magisterial districts in South Africa (which constitute the regions in this article). South Africa has nine provinces, each with a number of magisterial districts. The Western Cape has 42 magisterial districts, the Eastern Cape 78, the Northern Cape 26, the Free State 52, KwaZulu Natal 51, the North West 19, Gauteng 24, Mpumalanga 31 and the Limpopo province has 31 magisterial districts. The number of magisterial districts total 354 (Global Insight Southern Africa, 2006). Each magisterial district is unique in the sense that their sizes, levels of income, numbers of exports, climate conditions and even cultural backgrounds differ (Gries & Naudé, 2007). In addition to their different attributes, the districts' economic development has not been on par since 1994, with some regions growing fast and others shrinking in per capita income terms (Bosker & Krugell, 2006). South Africa's magisterial districts therefore provide valuable insight into why some regions or locations export and others do not. Figure 4.1 provides a graphical illustration of South Africa's magisterial districts. The shaded districts are those that have positive manufactured exports. The relative volumes of exports are indicated according to the percentage of total exports originating from a particular district. For instance, the areas shaded black are areas where the district contributes more than 1% of total manufactured exports and the areas shaded grey between 0.1% and 0.99%.

¹⁴ In this section, the concept of a "region" corresponds to a magisterial district (an area governed by a local authority) in the South African case. There are 354 magisterial districts (see also section 4.3.2), which formed the basis for the country's 1996 and 2001 censuses. The 354 magisterial districts are depicted in figure 4.1. The 354 magisterial districts, which acted as borders for local authorities, were changed after 2000 to 283 municipal areas. However, for present purposes, it is more useful to use the 354 regions since it provides a finer geographical spread due to the higher number of separate regions.

Figure 4.1: Exports per Magisterial District



Source: Author's own calculations (MAP drawn by GISCOE)

Panel data on manufactured exports was obtained from Global Insight Southern Africa's Regional Economic Focus database (Global Insight, 2006). This database is compiled from data supplied by the South African Revenue Services and the Department of Customs and Excise. The documentation required from exporters by the Department of Customs and Excise captures their postal codes or street addresses. This data per postal code was mapped to the 354 magisterial districts (the cross-section units) to provide information on each magisterial district. The magisterial allocations were then compared to the national totals contained in the South African Reserve Bank Quarterly Bulletin (Gries & Naudé, 2007). Data for exports, Gross Domestic Product (GDP) per magisterial district was obtained from this database. The Regional Economic Focus Database also provides geographical data of each magisterial district (data on the surface area (in km²) was used as one of the proxies for domestic transport costs).

The only other variable, for which data was obtained, is distance. In gravity models, distances from city centre to city centre is calculated. In this article, actual distances in South Africa between the magisterial districts and the major export hubs are used. The export hubs are: City Deep (a dry port for containers situated in Gauteng),

Durban harbour (in KwaZulu-Natal), Port Elizabeth harbour (in the Eastern Cape) and Cape Town harbour (situated in the Western Cape). The reason for including only these ports is that that majority of manufactured exports move through them as they are equipped to handle containers and higher value products. These hubs are also situated on one or more of the three main freight corridors namely Gauteng to Durban, Gauteng to Cape Town and Gauteng to Port Elizabeth. Around 62% of all South Africa's imports and exports are moved through one or more of these corridors (DOT, 2005). In terms of the data, the shortest distance from each magisterial district to one of these hubs was chosen as the distance variable, as it is assumed that exporters strive to minimise their transport costs. The internet service Shell Geostar (www.shellgeostar.co.za) was used to obtain these distances. Shell Geostar is a mapping service that provides detailed maps and distances between any two locations in South Africa. Table 4.1 provides the list of variables:

Table 4.1: List of Variables¹⁵

Variable	Description
• Log Export	• Logarithm of magisterial exports (in actual value)
• Log GDP	• Logarithm of magisterial GDP (in actual value)
• Log Distance	• Logarithm of distances (in km)
• Log Surface	• Logarithm of regional surface area (in km ²)

4.3.3 Estimators

In this article, various estimators are applied with STATA 9. The following paragraphs provide descriptions of the estimators. Section 4.5 discusses the results.

4.3.3.1 Tobit Model

The Tobit model, or censored regression method, was developed by Tobin (1958) in a study on household expenditure. He introduced the concept of censoring the dependent variable, where it has an upper or lower limit, or both. A censored variable implies that the values of that variable in a certain range are transformed to a single value, which creates a mass point (Green, 2003; Smith, 2006). The Tobit analysis is useful when analysing dependent variables that cannot take values lower or higher than a particular

¹⁵ In each instance the logarithm of the variables is used as it removes non-linearities, limits changes of the variance of the variables and allows for interpretation of the coefficients as elasticities (Vogelvang, 2005).

limit (Roneck, 1992). In many instances the dependent variable is zero for a large part of the observations (as is the case of the dependent variable in this article) (Green, 2003).

The Tobit model is estimated using maximum likelihood methods (Smith, 2006). The pooled Tobit model is specified as:

$$y_i^* = x_i\beta + u_i \tag{4.3}$$

$$\text{with } y_i = y_i^* \text{ if } y_i^* > 0 \text{ and } y_i = 0 \text{ if } y_i^* \leq 0 \tag{4.4}$$

where the residuals, u_i , are assumed to be independently and normally distributed, with mean zero and constant variance σ^2 . It is assumed that y_i and x_i are observed for $i = 1, 2, \dots, n$. The new random variable, or the latent variable y_i^* , is unobserved if $y_i^* \leq 0$ (Amemiya, 1984; Roneck, 1992; LeClere, 1994; Sigelman & Zheng, 1999; Nicholson, Thornton & Muinga, 2004; Green, 2003; Hou, Wang & Duncombe, 2005). Equation (4.3) and the corresponding constraints in equation (4.4) are implemented using *tobit* in STATA 9.

Green (2003) points out that when the dependent variable is censored, it is better to apply a censored regression method to a conventional regression method, as the latter fails to differentiate between limit (zero or censored) observations and non-limit (continuous or uncensored) observations. It is for this reason that the interpretation of the coefficients of the Tobit model differs considerably from that of an OLS regression model. In an OLS regression model, the coefficients represent the impact of the independent variable on the dependent variable, whereas in a Tobit model, the coefficient represents the effect of an independent variable on the latent dependent variable (LeClere, 1994). In order to extract as much information as possible from the Tobit coefficients, McDonald and Moffitt (1980) suggest a decomposition of the coefficients to better the understanding of the effects of the explanatory variables on the dependent variable. The total marginal effect, $\delta E(y) / \delta X_i$, has to be disaggregated into the weighted sum of two types of marginal effects. The first type is the change in y of those values above zero, weighted by the expected value of y if above zero. The second type is the change in the probability of y being above zero, again weighted by the

expected value of y if above zero (McDonald & Moffitt, 1980; Hou *et al.*, 2005)¹⁶. If one refrains from using marginal effects, one can only report the significance of the coefficients and compare the sizes of the variables. Doing so will possibly lead to misinterpretation of the coefficients (Roneck, 1992). The marginal effects after the Tobit estimation are reported in section 4.5.

4.3.3.2 *Random Effects Tobit Model*

A panel data set is one that provides multiple observations on each individual in a sample over time (Baltagi, 1995; Hsiao, 2003). This type of data set has several advantages over conventional cross-sectional or time-series data sets, as it adds another dimension to the empirical analyses. McPherson, Redfern and Tieslau (1998) list these advantages. Firstly, panel data models are able to capture both cross-section and time-series variation of the dependent variable. Secondly, the models can also measure observable and unobservable effects that variables have on the dependent variables. Hsiao (2003) adds to the list a larger number of data points than other data sets, more degrees of freedom, and reduced collinearity among explanatory variables. Panel data sets are, however, not without shortcomings. Panel data tend to suffer from both heterogeneity and selectivity bias (Hsiao, 2003) According to Baltagi (1995), panel data is also limited in the sense that there tend to be design and data collection problems, distortions of measurement errors and the data sets usually cover only short time spans.

Panel data takes into account the heterogeneity between individuals and of individuals over time through the use of variable intercept models. These models consist of three types of variables, individual time-invariant (here the variable remains constant for a given individual over time, e.g. distance), period individual-invariant (the variable is the same for all individuals, but changes over time, e.g. interest rates) and individual time-varying variables (here the variable varies across individuals as well as across time, e.g. GDP or exports per magisterial district (Hsiao, 2003). Baltagi (1995) states that most of the panel data model applications make use of a one-way error component model that captures the unobservable individual specific effects of these variables.

The observed and unobserved effects of the variables (whether or not they vary or remain constant) are absorbed into the intercept term (Hsiao, 2003). These unit or time-specific variables are included in one of the two basic panel data models, namely

¹⁶ For a detailed theoretical derivation of marginal effects, refer to McDonald and Moffitt (1980), Roneck (1992), LeClere (1994), Green (1999 & 2003) and Hou *et al.* (2005).

Fixed-Effect models or Random-Effects models. In Fixed-Effects models, the effects of the omitted variables are considered to be constant (Baltagi, 1995; Hsiao, 2003). In this article, it is assumed that the unobserved heterogeneity is best characterised as randomly distributed variables, which makes the application of a Random-Effects estimator appropriate. A Random-Effects model takes into account not only effects of observable variables on the dependent variable (in this case exports), but also effects due to unobserved heterogeneity between the individuals (i.e. the magisterial districts). The reason for this assumption is that the magisterial districts in South Africa vary considerably in their culture, climate, ethnic background and distance from one another. Therefore, it is believed to be reasonable to assume that the unobserved differences between them are randomly distributed (McPherson *et al.*, 1998; Gries & Naudé, 2007).

The theoretically derived equation based on that of Nicolini (2003) stipulated in section 4.3.1 (see equation (4.2)) can be rewritten as a Random-Effects panel data model. Baltagi (1995) and Verbeek (2004) specify the linear regression model with panel-level random effects as follows:

$$y_{it}^* = x_{it}\beta + \mu_i + \varepsilon_{it} \quad (4.5)$$

The dependent variable y_{it}^* is a latent variable that represents an unobservable index of ability or desire in a magisterial district (i) (the cross-sectional unit) to export a positive quantity of manufactured goods in period (t) (the time-series unit). The variable x_{it} is a matrix of explanatory variables as discussed in section 4.3.2, μ_i is a vector of time-invariant unobservable factors determining exports and ε_{it} is a vector of stochastic disturbances. Often μ_i and ε_{it} are written as one composite error term, which is assumed to be normally distributed. It is assumed that $E(\mu_i\mu_j) = 0$; $E(\mu_i, \varepsilon_{jt}) = 0$ and $E(\varepsilon_{it}, \varepsilon_{jt}) = 0$ (McPherson *et al.*, 1998; Gries & Naudé, 2007).

Not all magisterial districts exported manufactured goods over the period 1996 to 2004, which changes the nature of the dependent variable. The dependent variable is seen as censored from below (or left-censored), therefore the more appropriate Random-Effects Tobit (or weighted maximum likelihood) estimator has to be used. The latent variable (manufactured exports) takes on a positive value if exports are positive and takes on zero if the magisterial district does not export. In other words:

$$y_{it} = y_{it}^* \quad \text{if} \quad y_{it}^* > 0 \quad \text{and} \quad y_{it} = 0 \quad \text{if} \quad y_{it}^* \leq 0 \quad (4.6)$$

Equation (4.5) and the corresponding constraints in equation (4.6) are implemented using `xttobit` in STATA 9. Marginal effects for this panel data model are reported in section 4.5.

The occurrence of heteroskedasticity is a concern in all empirical work. If heteroskedasticity occurs, misleading conclusions can be drawn. Heteroskedasticity implies that random variables are spread around their mean values with different variances (i.e. the error terms do not have, as they should, a constant variance). Heteroskedasticity tends to be more evident in cross-sectional data (with heterogeneous units) than in time-series data. The reason for is that there may be a scale effect, because the units vary in size (Gujarati, 2006). The data used in this study, as described in section 4.3.2, consist of magisterial districts with varying sizes. Heteroskedasticity might therefore occur. Two methods were used to determine whether or not the data are heteroskedastic. Firstly, a visual inspection was conducted by plotting the residuals against the fitted values. The scatter graph indicated varying variances, which prompted a more formal test. The Breusch-Pagan test was subsequently applied as a post-estimation test of an OLS regression model. The null hypothesis of the Breusch-Pagan test is that there is constant variance, or, no heteroskedasticity. Indeed, the χ^2 results lead to the rejection of the null hypothesis. Therefore, the estimators used in this article have to correct the evident heteroskedasticity.

In STATA 9, most of the empirical estimators are able to correct heteroskedasticity through, for example, the calculation of robust standard errors. However, for certain estimators such as the Tobit model (used in this article), this option is not available. One has to resort to different methods to obtain constant variance. The first method (when using pooled data) is to convert the data and use an integral regression, which allows robust standard errors. The second method is to obtain bootstrapped standard errors. Cribari-Neto and Zarkos (1999) suggest that weighted bootstrap methods can be successfully used to obtain variances of linear parameters under non-normality. Unfortunately for the Tobit model using the panel data, the options are limited to one. To eliminate heteroskedasticity when using the Random Effects Tobit model, the only option is to estimate bootstrapped standard errors where applicable. These are reported in section 4.5 below.

Another problem with cross-section data on units such as regions or districts relates to biases due to the different sizes of the districts. This results in non-random sampling. For instance, the varying sizes of the districts could lead to better point

estimates for certain variables in the large districts, as there are more observations for these districts. Therefore, allocating the same weight for districts with many observations and districts with few observations creates a bias. Weights can be used to correct this bias. In this article, analytical weights are applied. Analytical weights are weights that are inversely proportional to the variance of an observation. The observations are observed means and the weights are the number of elements that give rise to the average (STATA, 2006). Most of the regressions in this article are thus also estimated with two weights, namely the GDP of 1996 and the population in 1996.

4.4 Profile of Manufactured Exports from South Africa

Before setting out the results from the estimations, it is useful to discuss the context. South Africa has become an active competitor in the global market since it opened up its economy in 1994. Trade liberalisation replaced the anti-export bias of the previous policy of import substitution to make way for higher, export-led growth (Coetzee, Gwarada, Naudé & Swanepoel, 1997). Since 1994, policies were adopted and aimed at accelerating the liberalisation process of South Africa's economy, such as the relaxation of exchange rate controls, tariff reduction and controlling the Rand through market interest rates (Naudé, 2001; Heintz, 2003).

Roux (2004) argues out that South Africa's trade liberalisation, through the tariff reforms, had a significant impact on the country's trade with imports and exports rising from 47% in 1996 to approximately 60% of GDP in 2004. A large proportion of this rise in exports can be attributed to the increase in manufactured exports. Manufactured exports have increased from 17% in 1988 to 54% in 1998. Since 1991, the ratio of manufactured exports to GDP has tripled from 3.1% to 9.6% (Rankin, 2001).

The location of the South African manufacturing sector reflects the spatial inequality of economic activity in the country (see Suleman & Naudé, 2003). Naudé and Krugell (2003 & 2006) point out that in 2000, 84% of total manufacturing exports were generated by only 22 of the 354 magisterial districts. The percentage generated by these 22 districts differs by 1% from that of 1996. This, together with the fact that they are located in urban agglomeration areas, suggests that export in manufacturing is mostly an established urban activity. The export behaviour of magisterial districts between 1996 and 2004 is generally erratic, where in some years certain districts export manufactures and in others not. Overall, the number of magisterial districts that export manufactures

increased by 15% from 1996 to 2004. However, there are still many magisterial districts that have zero manufactured exports. Fortunately, this number declined from 158 in 1996 to 129 in 2004 (Regional Economic Focus Database, 2006). Gries and Naudé (2007) examine the varying export and growth performances or patterns of South Africa's magisterial districts. They find that magisterial districts with larger economic activity (measured by gross value added), competitive transport costs (those that are located near ports), foreign market access (measured by the degree of imports into a magisterial district) and good institutional quality (i.e. capital stock necessary for production) are able to export manufactures more successfully than those regions that do not have these qualities. They also tested the impact of a district's population on exports (which, together with the gross value added, proxied the home-market effect) and found that magisterial districts with smaller economies tend to export less. Hence, the home-market effect contributes to a district's export volumes.

As indicated, geography plays an important role in the location and volume of manufactured exports in South Africa. Matthee, Naudé and Krugell (2006) provide empirical evidence (through the application of cubic-spline density functions) on the impact of domestic transport costs on both manufactured exports and the spatial location of such exporters. They observe that the largest volume (between 70% and 98%) of exports from magisterial districts is generated within 100 km from the export hub. For certain goods (mostly skill-intensive goods such as electronics) about 98% of manufacturing takes place within 100 km of an export hub. Further away from an export hub in South Africa (in excess of 100 km) one tends to find fewer skill-intensive goods such as furniture, textiles, and metal products being exported. These goods are largely produced for the domestic market, and make relatively more use of natural resources. Table 4.2 summarises their results per manufacturing sub-sector.

Table 4.2: Percentage Exports per Manufacturing Sub-sector by Distance

Sector	Distance in km from nearest export hub							Total
	0-100	101-200	201-300	301-400	401-500	501-600	601+	
Food, beverages and tobacco products	84.28	8.14	4.25	2.76	0.50	0.05	0.02	100
Textiles, clothing and leather goods	79.15	1.50	12.50	6.59	0.25	0.01	0.00	100
Wood and wood products	82.39	16.62	0.47	0.39	0.12	0.00	0.00	100
Fuel, petroleum, chemical and rubber products	78.60	14.34	1.38	2.12	3.56	0.01	0.00	100
Other non-metallic mineral products	94.21	2.74	2.19	0.74	0.09	0.02	0.00	100
Metal products, machinery and household appliances	75.75	20.12	0.84	2.43	0.52	0.01	0.33	100
Electrical machinery and apparatus	92.74	0.97	6.05	0.12	0.08	0.02	0.01	100
Electronic, sound/vision, medical and other appliances	98.79	0.64	0.32	0.10	0.13	0.01	0.00	100
Transport equipment	81.28	3.92	14.36	0.26	0.11	0.06	0.00	100
Furniture and other items NEC and recycling	71.53	2.47	1.94	0.82	23.23	0.00	0.01	100

Source: Matthee, Naudé and Krugell, 2006

Matthee, Naudé and Krugell (2006) conclude that proximity to an export hub is an important consideration for the location of manufacturers. The patterns and evolution of the location of manufacturing exporters in South Africa support the idea that domestic transport costs matter for exports. However, several exporters are also located 200km to 400 km from the export hub. This suggests that location (i.e. distance from an export hub) is not the only determinant of regional manufactured exports in South Africa. Identifying the determinants of exports, also across the various regions, may be important in South Africa given that its overall growth is fundamentally constrained by its export growth (Hausmann & Klinger, 2006).

4.5 Estimation Results

In section 4.3.3, equations (4.3) and (4.5) were discussed as the basis for estimating the determinants of regional manufactured exports. Using STATA 9, the regression results for these equations are shown in the tables below. In each table the dependent variable is the log of exports from the magisterial districts. This section is structured as follows: section 4.5.1 reports the results from pooled data estimators, namely an Ordinary Least Squares (OLS) regression and the Tobit model. Section 4.5.2 contains the corresponding

estimators (i.e. Generalised Least Squares regression and Random-Effects Tobit model) for panel data. Results from weighted models are reported in section 4.5.3. As indicated in section 4.3.1, two proxies for domestic transport costs are implemented. However, only the results of distance are reported, as the results for the surface area of each magisterial district were not significant.

4.5.1 Pooled Data Regressions

The OLS regression provides an overall indication of the effect on exports of the explanatory variables when using pooled data. GDP seems to contribute positively to exports, whereas distance has the opposite effect. Table 4.3 reports the results. All of the results are significant at the 1% level.

Table 4.3: OLS Regression Results (Dependent Variable Log Exports)

Variable	Coefficient	Standard Error	Robust SE
Log GDP	3.03	0.08 (37.32)***	0.08 (38.87)***
Log Distance	-1.77	0.13 (-13.33)***	0.14 (-12.66)***
Intercept	-42.56	2.14 (-19.86)***	2.16 (-19.68)***
Adj. R ²		0.52	0.52
Root MSE		5.78	5.78

t-ratios in brackets

**** significant at the 1% level, ** at the 5% level * at the 10% level*

The Tobit model implements censoring of the dependent variable (1293 of the 3186 observations are left-censored at 0). Table 4.4 contains the results.

Table 4.4: Tobit Regression Results (Dependent Variable Log Exports)

Variable	Coefficient	Standard Error	Bootstrapped SE	Marginal Effects $\delta E(y^* y^* > 0) / \delta X_i$
Log GDP	4.43	0.14 (31.91)***	0.13 (3.71)***	3.19
Log Distance	-1.90	0.21 (-9.08)***	0.20 (-9.40)***	-1.37
Intercept	-72.96	3.60 (-20.29)***	3.45 (-21.12)***	
LR $\chi^2(2)$		1857.98		
p-value		0.00		
Pseudo R ²		0.11		
Wald $\chi^2(2)$			3283.91	
p-value			0.00	
Pseudo R ²			0.11	

t-ratios in brackets

*** significant at the 1% level ** at the 5% level * at the 10% level

(Note: Pseudo R² calculated using R² between predicted and observed values is 0.52)

Both the p-values of the Tobit model's Likelihood Ratio and Wald chi-squares¹⁷ in table 4.4 indicate that the model is overall statistically significant at the 1% level. The coefficients have the expected signs and are also statistically significant. The pseudo R² reported in table 4.4 is that of McFadden. However, this pseudo R² may not be the best fit. A better fit can be obtained by calculating the R² between the predicted and observed values (UCLA Academic Technology Services, 2006). For this model, the value is 0.52 (this value is also closer to the adjusted R² of the OLS regression). This squared correlation between the observed and predicted values of exports shows that the explanatory variables account for over 50% of the variance of the dependent variable. Compared to the OLS regression results in table 4.3, the signs and sizes of the coefficients are somewhat smaller, with the effects of the home-market and distance somewhat stronger.

The marginal effects, calculated at the mean, provide information on the effect of the explanatory variables on the dependent variable. The marginal effects reported in column five of table 4.4 are those for the unconditional expected value of the dependent variable, $E(y^*)$, where $y^* = \max(a, \min(y, b))$ (a is the lower limit for the left censoring and b is the upper limit for right censoring) (Cong, 2001). According to these effects, when GDP increases by 1%, exports would on average rise with 3.19% when it is already above zero. On the other hand, when distance increases by 1% (i.e. the exporter producing manufactures is situated further away from an export hub), exports would fall

¹⁷The Wald test has a χ^2 distribution under the null hypothesis that all explanatory variables equal zero (Hou *et al.*, 2005).

by 1.37%. These are relatively strong effects that, as indicated by further analysis below, may be robust.

4.5.2 Panel Data Regressions

The GLS regression, similar to the OLS, gives an overall indication of the effect on exports of the explanatory variables when using panel data. Table 4.5 reports the results. The p-values of the Wald test (with varying degrees of freedom) indicate that the model is overall statistically significant at the 1% level. GDP and distance are significant at the 1% level and both have the expected signs. The intercept here is slightly smaller than that of the OLS regression. When considering the results in table 4.5, it can be seen that the coefficients of GDP are somewhat smaller, and those of distance quite large.

Table 4.5: GLS Regression Results (Random Effects) (Dependent Variable Log Exports)

Variable	Coefficient	Standard Error	Robust SE
Log GDP	2.73	0.15 (17.88)***	0.15 (18.34)***
Log Distance	-2.07	0.32 (-6.44)***	0.28 (-7.50)***
Intercept	-34.85	4.17 (-8.36)***	4.14 (-8.42)***
Wald $\chi^2(2)$ p-value		602.15 0.00	
Wald $\chi^2(3)$ p-value			3792.91 0.00

t-ratios in brackets

*** significant at the 1% level * at the 5% level * at the 10% level

The regression results of the Random-Effects Tobit model are reported in table 4.6. The χ^2 values of the Wald test are 1069.21 and 463.67 for the model with standard errors and bootstrapped standard errors respectively. The p-values of the Wald tests are statistically significant at the 1% level, thus the model has a large degree of explanatory power. The sizes of the coefficients, compared to the Tobit model, are smaller. Again, the coefficients have the expected sign and are statistically significant. The coefficients are smaller in size than that of the OLS and Tobit results in tables 4.3 and 4.4.

Table 4.6: Random-Effects Tobit Regression Results (Dependent Variable Log Exports)

Variable	Coefficient	Standard Error	Bootstrapped SE	Marginal Effects $\delta E(y y^* > 0) / \delta X_i$
Log GDP	3.07	0.13 (23.84)***	0.33 (9.43)***	2.62
Log Distance	-1.88	0.23 (-8.20)***	0.49 (-3.82)***	-1.60
Intercept	-41.81	3.37 (-12.40)***	8.75 (-4.78)***	
Wald $\chi^2(2)$		1069.21	463.67	
p-value		0.00	0.00	

z-ratios in brackets

*** significant at the 1% level, * at the 5% level * at the 10% level

The marginal effects are calculated in a similar manner to those of the Tobit model, using panel data. The marginal effects show that when GDP increases by 1%, exports would, on average, rise by 2.62%. Also, when distance increases by 1% (i.e. the exporter producing manufactures is situated further away from an export hub), exports would fall by 1.60% (larger than that found in the Tobit analysis).

4.5.3 Weighted Regressions

As explained in section 4.3.3, weights can be used to prevent the creation of a bias when non-random sampling is used. In this case analytical weights are implemented in two instances: in an OLS regression and in a Tobit model. The regression results are reported for two weights of each magisterial district, the GDP of 1996 (see table 4.7) and the population of 1996 (see table 4.8). The sizes of the coefficients seem to be smaller compared to the results of the above-reported estimators, especially for the distance variable. However, the signs and significance levels are identical.

The marginal effect of distance on exports in the weighted Tobit estimator (using GDP as analytical weight) is considerably smaller than that of the previous results. Here, a 1% increase in distance from an export hub is associated with a decrease in exports of only 0.18%. The marginal effect of GDP on exports is similar (1% increase in GDP creates an increase of 3.27% in exports). Marginal effects are calculated using population as analytical weight with the effect of distance slightly more severe on exports and the contribution of GDP larger.

It should be noted that although most of the results using surface area as a proxy for domestic transport costs are statistically insignificant, the results from the weighted

regressions are not. The results are not reported here, however the sign of surface area is negative and that of GDP is positive.

Table 4.7: Weighted OLS and Tobit Regression Results (Dependent Variable Log Exports; Analytical Weight = GDP of 1996)

Regression Variable	Weighted OLS		Weighted Tobit		
	Coefficient	Standard Error	Coefficient	Standard Error	Marginal Effects $\delta E(y y^* > 0) / \delta X_i$
Log GDP	2.50	0.06 (43.61)***	3.27	0.09 (37.04)***	3.27
Log Distance	-0.36	0.05 (-6.67)***	-0.18	0.08 (-2.26)**	-0.18
Intercept	-37.36	1.47 (-25.42)***	-56.37	2.26 (-24.95)***	
Adjusted R ²		0.59			
Root MSE		3.73			
LR $\chi^2(2)$				2089.62	
p-value				0.0000	
Pseudo R ²				0.119	

t-ratios in brackets

*** significant at the 1% level ** at the 5% level * at the 10% level

Table 4.8: Weighted OLS and Tobit Regression Results (Dependent Variable Log Exports; Analytical Weight = Population of 1996)

Regression Variable	Weighted OLS		Weighted Tobit		
	Coefficient	Standard Error	Coefficient	Standard Error	Marginal Effects $\delta E(y y^* > 0) / \delta X_i$
Log GDP	3.08	0.08 (38.24)***	4.43	0.13 (34.83)***	4.03
Log Distance	-1.32	0.01 (-38.84)***	-1.08	0.14 (-7.62)***	-0.98
Intercept	-47.12	2.07 (-22.75)***	-78.79	3.24 (-24.34)***	
Adjusted R ²		0.59			
Root MSE		5.4888			
LR $\chi^2(2)$				2302.88	
p-value				0.0000	
Pseudo R ²				0.1270	

t-ratios in brackets

*** significant at the 1% level ** at the 5% level * at the 10% level

In conclusion, the various estimators used in this article gave results on the signs for the coefficients, positive for GDP and negative for distance. Therefore, the sign and coefficients can be considered as robust (although the size of the coefficient cannot be deemed robust). The effect of GDP (the home-market effect) was also found to be much stronger in all cases than that of distance. The effect of distance, in particular, was found to be sensitive towards the size of the district. When the latter was controlled using

analytical weights, the effect of an increase of 1% in distance from an export hub would result in a fall in manufactured exports of approximately 0.18%.

4.6 Conclusions and Recommendations

Nicolini (2003:447) recently stated that “one of the principal unsolved dilemmas of trade theory” is “why and where people decide to locate their production”. In this article, the question of where exporters of manufactured goods would be located within a country was investigated. Based on insights from new trade theory, the new economic geography and gravity-equation modelling, an empirical model was specified wherein agglomeration and increasing returns (the home-market effect) and transport costs (proxied by distance) were identified as major determinants of choice of location for exporters.

The main result of this article is that internal distance, and thus domestic transport costs, influences the extent to which different regions in a developing country can be expected to be successful in exporting manufactures. Data from 354 magisterial districts in South Africa were used with a variety of estimators (OLS, Tobit, RE-Tobit) and allowances for data shortcomings (bootstrapped standard errors and analytical weights), to determine that the home-market effect (measured by the size of local GDP) and distance (measured as the distance in km to the nearest port) are significant determinants of regional manufactured exports.

The contribution of this study was to test for these determinants using developing country data, and to generally contribute to the small literature on this topic. In this regard this article complements the article of Nicolini (2003) on the determinants of exports from European regions. In particular, it was found here that home-market effect has a much larger or stronger effect on exports (the marginal effect was calculated as between 3.2 and 4) than distance (the marginal effect, when weighted, was between 0.18 and 0.98) in a developing country setting. In contrast, Nicolini (2003: 459, 460, 461) found the effect of the home-market effect to be significant but smaller in overall size and the effect of transport/distance (which she proxied using surface area and transport infrastructure) to be slightly higher, with sizes of coefficients ranging between 0.7 and 1.3 for the home-market effect (GDP) and -0.36 and -0.58 for distance (surface area). Although direct comparisons between the results in this article and that of Nicolini (2003) for Europe are made difficult due to different estimation methods and different proxies for distance (our measures are more accurate for distance) the overall suggestion

is that the home-market effect is relatively more important in the developing country context (South Africa) with less perfectly competitive firms. This result is consistent with the theoretical model of Puga (1998) wherein developing countries, which urbanise later with better transport technologies (such as South Africa), are spatially more concentrated than present developed regions (such as the EU) (Venables, 2005:16). Further research is recommended to investigate the ways in which geography and historical patterns of location may result in regional differences in the relative importance of increasing returns and transport costs.

4.7 References

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CHAPTER 5: ARTICLE 3

EXPORT DIVERSITY AND REGIONAL GROWTH IN A DEVELOPING COUNTRY CONTEXT: EMPIRICAL EVIDENCE

ABSTRACT

This article provides empirical evidence on the relationship between exports, and in particular export diversity, and spatial inequality in a developing country context. Using export data from 19 sectors within 354 sub-national (magisterial) districts of South Africa, various measures of sub-national export diversity are constructed. It is found that it is not only important how much is exported, but that it is also important what it is that is exported. Regions with less specialisation and more diversified exports generally experienced higher economic growth rates, and contributed more to overall exports from South Africa. It is also found that distance (and thus domestic transport costs) from a port is inversely related to the degree of export diversity. Estimating a cubic-spline density function for the Herfindahl index measure of export diversity, it is found that export diversity declines as the distance from a port (export hub) increases. Most magisterial districts with high export diversity values are located within 100 km of the nearest port. Furthermore, comparing the cubic-spline density functions for 2004 with those of 1996 shows that distance (domestic transport costs) has become more important since 1996 (under greater openness) with magisterial districts located further than 100 km from the ports being less diverse in 2004 than in 1996. One may speculate that a possible explanation for this changing pattern of export diversity may be the impact of greater foreign direct investment (FDI) in South Africa since 1996.

Keywords: exports, export diversification, export variety, regional growth, new economic geography

JEL Classification Codes: F14 and R11

5.1 Introduction

Unequal spatial development is a feature of most countries. Recent years have seen a burgeoning literature focusing on the nature, determinants and consequences of spatial inequality on development. It is recognised that the spatial agglomeration of a country's economic activity is a key determinant of that country's economic development pattern (Puga & Venables, 1999:292). Kanbur and Venables (2005) report on a recent project to analyse spatial inequalities in over 50 developing countries. Despite this surge of interest

in spatial inequality in developing countries, relatively little attention has been focused on trade, and specifically exports, as a determinant of spatial inequality in developing countries. This lack of attention to exports and spatial development is in contrast with some recent work in the growing field of new economic geography (NEG) where the theoretical basis for the relationship between exports and spatial development has been put forward (see e.g. Venables, 2005) and where a small, but growing, literature provides empirical evidence, albeit from developed regions such as the EU, on the role of exports in regional growth and on the determinants of regional exports (see e.g. Nicolini, 2003).

The relative lack of research on the role and determinants of exports in spatial development in developing countries is also in contrast to the rich literature on the general (cross-country) relationship between exports and growth which supports policy reforms aimed at trade liberalisation and the strengthening of a country's export performance as a means of boosting growth and development. Foster (2006:1058-1061) contains a recent summary of the literature on exports and growth and discusses the reasons why exports are good for growth¹⁸ (none which, however, refers to the potential impact on spatial inequality). A number of notable studies find empirical evidence that exports are good for growth, such as Edwards (1997), Sala-i-Martin (1997), Sachs and Warner (1997), Elbadawi (1998) and others.

It is therefore a surprising omission in this literature that the potential role of exports in spatial inequality has not been studied in greater detail. Two possible explanations might be that, firstly, an appropriate theoretical basis has been lacking before the development of models with the NEG framework that could handle issues such as imperfect competition and transport costs¹⁹ and, secondly, that sub-national (spatial) data on exports are generally difficult to come by in a developing country.

The contribution of this article is to provide some empirical evidence on the relationship between exports and spatial inequality in a developing country context. In particular, the author builds on earlier work on the determinants of the location of export-oriented manufacturing firms in a developing country (Mathee, Naudé & Krugell, 2006; Mathee & Naudé, 2007) and focus on the potential importance of export diversity (variety) for spatial economic growth and development. In this respect the

¹⁸The benefits of exports are argued to come from (a) knowledge spillovers and knowledge diffusion, (b) the greater scope for economies of scale, (c) greater competition and efficiency and (d) the loosening of a country's foreign exchange constraint.

¹⁹In traditional explanations of trade patterns of trade between countries and regions depend on natural resources, skills and factors of production. It is assumed that trade takes place in a perfectly competitive and frictionless (pinpoint) world without transport costs.

article will also contribute to the small recent literature that recognises that it is not only important how much is exported, but that it is also important what it is that is exported. For instance Hausmann, Hwang and Rodrik (2005:2) point out that “*not all goods are alike in terms of their consequences for economic performance. Specializing in some products will bring higher growth than specializing in others*”. Using export data from 19 sectors within 354 magisterial districts of South Africa, various methods are employed to measure the “diversity” of exports from a particular region, including the recently proposed EXPY and PRODY measures proposed by Hausman *et al.* (2005). This is the first time, as far as the author is aware, that these latter measures have been used to inform spatial growth issues.

The article is structured as follows. In section 5.2 a brief overview is provided of the literature on exports and spatial development, emphasising the importance of the diversity or composition of exports for spatial growth. In section 5.3 the empirical evidence from South Africa is given. Subsection 5.3.1 discusses the various measures of export diversity, and subsection 5.3.2 describes the data that will be used. Subsection 5.3.3 firstly describes the current patterns of export and export diversity from South Africa’s various regions. Secondly, subsection 5.3.3 describes the relationship between export diversity and transport costs (distance) given that transport costs will influence the location of export firms (as set out in the NEG). Thereafter, subsection 5.3.3 presents regression results on the relationship between regional growth and export diversity, where the different measures of export diversity are used as explanatory variables in a Barro-type growth regression. The article concludes with a summary and recommendations for further research.

5.2 Literature Overview

In traditional trade theories, spatial economic differences are ascribed to differences in factor endowments, technologies and policy regimes. These theories, however, fail to explain why similar regions have different economic activities and subsequently different economic growth rates (Ottaviano & Puga, 1997). The theory of new economic geography fills the gap left by traditional trade theories, as it describes the formation of economic agglomeration in geographical space (Fujita & Krugman, 2004). The rationale behind regional economic imparity is that agglomeration creates growth and certain regions experience forces that encourage agglomeration and others experience forces that achieve the opposite (Armstrong & Taylor, 2000; Fujita & Krugman, 2004). Centripetal

forces include market-size effects, thick labour markets and pure external economies (such as knowledge spillovers). Centrifugal forces, on the other hand, include immobile factors of production, land rents and pure external diseconomies (such as congestion) (Krugman, 1998; Fujita, Krugman & Venables, 2001; Fujita & Krugman, 2004).

Agglomeration is not, however, only influenced by these forces. Transport costs also play a major role in the formation of spatial balances and regional growth in that they affect the development of agglomeration or cause dispersion of economic activities (Lopes, 2003). If transport costs were high, trade between regions would not take place, as it is too costly – exports and imports are so expensive that only home production is possible. Production will be spread out to be close to where demand is. If transport costs were low, there would also be no trade or agglomeration since the regions would be *ex ante* identical and neither would have the forces, such as a thick labour market or inter-industry linkages, which create the propensity for agglomeration. Thus, it is in an intermediate range that transport costs matter for trade and agglomeration. Below this threshold level of transport costs, manufacturers choose the location with large local demand. Local demand will be large precisely where the majority of manufacturers choose to locate. The result is agglomeration at the core and trade with the periphery (Krugman, 1991; Brakman Garretsen & Van Marrewijk 2001; Fujita *et al.*, 2001).

Economies of scale create agglomeration, which in turn leads to growth. The activities in an agglomerated setting generate externalities or spillovers. The externalities or spillovers depend on whether one considers localisation economies or urbanisation economies (Brakman *et al.*, 2001). The former is described as a geographical concentration of the same or similar industries that form an agglomeration (Economic Geography Glossary, 2006). Externalities created here result from specialisation of economic activity, which is advocated by the Marshall-Arrow-Romer theory as well as by Porter (1990). Glaeser, Kallal, Scheinkman and Schleifer (1992) describe these spillovers as knowledge that is transferred between firms in the same industry. Once an industry shares knowledge in specialisation, innovation and growth occur at a faster rate. Lall, Koo and Chakravorty (2003) add that, in addition to knowledge being shared, firms also share sector-specific inputs, skilled labour and technologies which enhance the productivity levels of all firms in that industry. Examples of empirical work on the specialisation of economic activity include Duranton and Puga (1999), Midelfart-Knarvik, Overman, Redding & Venables (2000) and Mukkala (2004). Urbanisation economies describe benefits or spillovers due to the agglomeration of different economic activities

(Economic Geography Glossary, 2006). Jacobs (1969) states that knowledge spillovers have a larger impact on local growth if knowledge is shared between firms of different industries. Lall *et al.* (2003) describe that firms in a diverse area having access to a wide range of services that support their business. Once a variety of output is produced, it leads to external economies of scale for both producers and consumers (Rivera-Batiz, 1988). Bostik, Gans and Stern (1997) conclude that urbanisation is positively related to regional economic growth. Examples of empirical work on the diversification of economic activity include Glaeser *et al.* (1992), Harrison, Kelly and Grant (1996) and Kelley and Helper (1999). Duranton & Puga (2001) observe that diversified agglomerated areas, or so-called nursery cities promote the development of new products, especially in the early stages of the product life cycle. They find, however, that specialisation alongside diversification is important in the efficient functioning of an economic system. For developing countries diversity in economic activity has a stronger impact on regional growth, as they have abundant labour but low skill levels and wages (Lall *et al.*, 2003).

The economic growth of developing countries has been a much discussed topic in recent years. The topic of export growth in these countries been discussed even more (De Piñeres & Ferrantino, 1997). It has been shown that there is a positive link between economic growth and export diversification (or export variety) (Al-Marhubi, 2000; Funke & Ruhwedel, 2005). The pattern of economic development led by export-oriented growth has, in the face of globalisation, experienced restructuring in terms of the composition of exports. For example, there has been a declining trend in the terms of trade in primary products (Athukorola, 2000). Those developing countries that were able to diversify their exports experienced accelerated growth (De Piñeres & Ferrantino, 1997; Herzer & Nowak-Lehmann, 2006). Feenstra and Kee (2005) find that a 10% increase in export variety of a country's industries raises the productivity level of that country by 1.3%. Herzer and Nowak-Lehmann (2006) explain that export diversification can occur either horizontally or vertically. Horizontal export diversification implies that the number of export sectors has increased. This reduces the dependency on a few sectors to lead export-oriented growth. Dependency on a few sectors may, in fact, hamper growth if they experience fluctuations in, say, demand or prices (Al-Marhubi, 2000). Furthermore, if there is instability in these industries, investment may be withdrawn and this negatively affects growth (Dawe, 1996). Horizontal diversification implies stabilisation (Al-Marhubi, 2000). Vertical diversification occurs when the composition of exports shift from primary products to manufactured products. The production of primary exports does

not result in as many spillovers as the production of manufactured exports. In the latter, externalities on, for example, knowledge and new technologies are created. These externalities benefit other economic activities (possibly creating horizontal diversification) and improve the ability of all industries to compete internationally (Chuang, 1998; Al-Marhubi, 2000; Herzer & Nowak-Lehmann, 2006). Hausmann *et al.* (2005) conclude that the composition of a country's exports matter, as countries that produce higher productivity goods experience greater export performance and are subsequently able to benefit more from the gains of globalisation.

Based on the notion that exports are good for economic growth (through the channels mentioned in the introduction - see footnote 1), a large number of countries (including South Africa) have liberalised trade and embarked on outward-oriented development strategies. Whilst the literature has extensively studied the linkages and causality between exports and growth, and noted the various idiosyncrasies in country approaches and experiences (and identified the controversies that remain) (Foster, 2006), the literature is less clear on the impact of trade on spatial inequality. On the one hand, the basic core-periphery model of the NEG predicts that generally, more open economies will have less spatial inequality (Ades & Glaeser, 1995; Krugman & Livas, 1996; Venables, 2005). This is because, in a more open economy with firms being able to export more, local firms become less reliant on the local market with a subsequent reduction in the forces of agglomeration. On the other hand, it is feared that not all regions will share equally from the gains from increasing exports and that geography (locational factors) might determine the export propensity of firms (see Osborne, 1997; Overman *et al.*, 2001; Roper & Love, 2001; Traistaru, Iara & Paura, 2002:2). More pertinently, research on sub-national convergence in per capita incomes has failed so far to find significant evidence of convergence between regions, with one of the world's most successful export-led growth cases, that of China, being characterised by increasing spatial inequality (Kanbur & Zhang, 2005). In Mexico, regional income convergence "broke down" after the country joined NAFTA (North American Free Trade Agreement), with states endowed with higher levels of human and physical capital and better infrastructure growing faster than those without after joining NAFTA (Chiquiar, 2005:257). Also, despite the fact that South Africa has been liberalising its trade since 1994 with substantial export success, there is little evidence of any significant convergence in per capita incomes between the country's regions (Naudé & Krugell, 2003 & 2006).

The above cited literature has focused on the relationship between a country's aggregate exports and spatial development and, as such, does not provide for a wholly satisfactory direct test of the different hypotheses. To do so, one would ideally require disaggregated data on exports to determine whether greater (or lesser) spatial inequality is associated with changes in the exports (such as in level and/or composition) from different sub-national regions.

5.3 Empirical Investigation

In the previous section, it is indicated that the current literature tends to expose the importance of exports for growth, and that greater openness ought to lead to less spatial inequality within a country. However, in practice greater export growth has not generally been accompanied by less spatial inequality. This might imply that different sub-national regions have different characteristics which determine their ability to export. Moreover, it is being recognised that what a sub-national region exports may matter. In this regard, analyses on country levels tend to be in agreement that export diversity and diversification may be important for economic growth. In this section we use data from South African sub-national regions to test whether such a relationship might hold. If so, it might explain why spatial inequality tends to persist despite the fact that the country's overall growth in exports has been significant since the late 1990s.

In this section therefore (subsection 5.3.3) the regression results on the relationship between various measures of export diversity and economic growth across 354 sub-national regions (magisterial districts) in South Africa is reported. First, however, in subsection 5.3.1, the various measures of export diversity used, including the recently proposed PRODY and EXPY measures of Hausmann *et al.* (2005) is explained. Thereafter, in section 5.3.2, the data used is discussed, before setting out the results.

5.3.1 Measures of Export Diversity

The export diversity of the various regions is measured using four types of indices. The first diversity index is the Herfindahl index which examines trends in export revenue or specialisation of the regions. Petersson (2005) defines this measure of specialisation as follows:

$$SPEC_{jt} = \sum_i \left(\frac{E_{jit}}{\sum_j E_{jit}} \right)^2 \quad (5.1)$$

where E_{jit} represents the exports of a region j of a particular industry (or export sector) i in a given year t . An index value approaching 1 indicates a high degree of export concentration (or specialisation), whereas a value approaching 0 signifies a high degree of export diversification (Pettersson, 2005). This index is numbered (1) in the regression results.

The second diversification index was developed by Al-Marhubi (2000). This measure is the absolute deviation of the region's share of the country's total exports. Al-Marhubi (2000) calculates this measure as follows:

$$S_{jt} = \frac{\sum_i |h_{ijt} - h_{it}|}{2} \quad (5.2)$$

where h_{ijt} is the share of industry i in total exports of region j and h_{it} is the share of industry i in total country exports in a given year t . Again this measure ranges from 0 to 1 where 1 represents total concentration and 0 total diversification (Al-Marhubi, 2000). This index is numbered (2) in the regression results.

The third measure is the normalised-Hirschmann index, which is a concentration index. This index also provides values between 0 and 1. According to Al-Marhubi (2000) and Naqvi and Morimune (2005), the normalised-Hirschmann index for a region is defined by the following formula:

$$H_{jt} = \frac{\sqrt{\sum_{i=1}^n \left(\frac{x_{it}}{X_{jt}} \right)^2} - \sqrt{\frac{1}{n}}}{1 - \sqrt{\frac{1}{n}}} \quad (5.3)$$

where x_{it} is the value of exports of industry i located in region j and X_{jt} is the total exports of region j in a given year t . The number of industries is indicated by n . An index value nearer to 1 indicates extreme concentration. Likewise, a value closer to 0 signifies a more diverse combination of exports (Al-Marhubi, 2000; Naqvi & Morimune, 2005). This index is numbered (3) in the regression results.

The fourth measure is an index that ranks exports in terms of their implied productivity: In other words, it shows the quality of the exports (what a region exports, matters). Hausmann *et al.* (2005) developed a formula to generate an income/productivity level for each industry or export sector. This level (called PRODY) reflects the weighted average of the per capita GDP of the regions that host the exporting industries. Using this level, a measure (called EXPY) can be calculated for the productivity level associated with a country's specialisation pattern. EXPY reflects the income/productivity level that corresponds to a region's export basket (this is done by calculating the export-weighted average of the PRODY for that region) (Hausmann *et al.*, 2005). Hausmann *et al.* (2005) define PRODY as follows:

$$PRODY_{it} = \sum_j \frac{x_{jit} / X_{jt}}{\sum_j (x_{jit} / X_{jt})} Y_{jt} \quad (5.4)$$

where x_{jit} / X_{jt} is the share of industry i 's exports located in region j in the region's overall export basket in a given year t . Y_{jt} is the real per capita GDP of region j in year t . EXPY in turn is calculated as:

$$EXPY_{jt} = \sum_i \left(\frac{x_{jit}}{X_{jt}} \right) PRODY_i \quad (5.5)$$

5.3.2 Data

Data on sub-national exports from 19 industries were obtained from South African Revenue Services (Department of Customs and Excise) for the period 1996. Other sub-national data corresponding to the 354 magisterial districts in South Africa, such as data on openness (openness is calculated as the share of total exports to nominal GDP), contribution of manufacturing exports to total exports, population growth, real GDP growth, real GDP per capita and human capital were obtained from Global Insight Southern Africa's Regional Economic Explorer, which is based on a number of official Statistics South Africa sources. Human capital is proxied by education levels higher than grade 12, following Fedderke (2001).

The distance variable used in this study is the actual distance (in kilometres) between the magisterial districts and the major export hubs in South Africa. The export

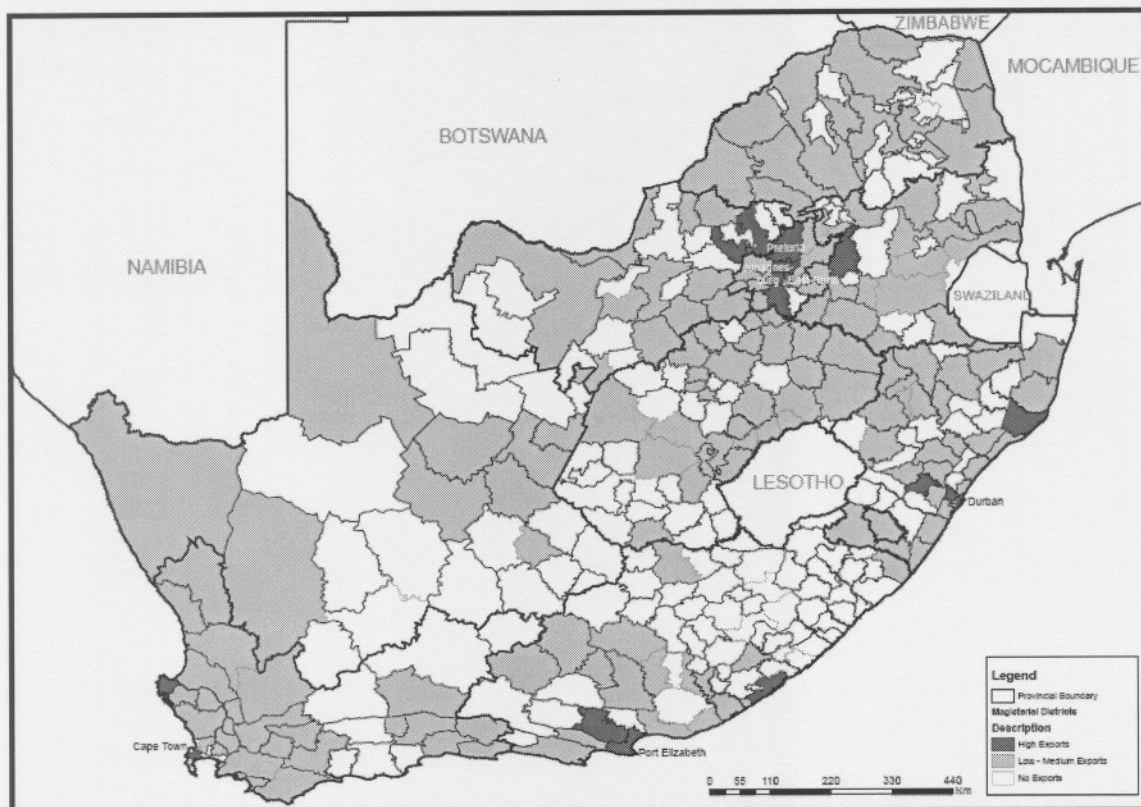
hubs are: City Deep (a dry port for containers situated in Gauteng), Durban harbour (in KwaZulu-Natal), Port Elizabeth harbour (in the Eastern Cape) and Cape Town harbour (situated in the Western Cape). The reason for including only these ports is that that majority of exports move through them as they are equipped to handle containers and higher value products. These hubs are also situated on one or more of the three main freight corridors namely Gauteng to Durban, Gauteng to Cape Town and Gauteng to Port Elizabeth. Around 62% of all imports and exports are moved through one or more of these corridors (DOT, 2005). In terms of the data, the shortest distance from each magisterial district to one of these hubs was chosen as the distance variable, as it is assumed that exporters strive to minimise their transport costs. The internet service Shell Geostar (www.shellgeostar.co.za) was used to obtain these distances. Shell Geostar is a mapping service that provides detailed maps and distances between any two locations in South Africa.

5.3.3 Results

5.3.3.1 *Export Diversity in South Africa*

This section provides a descriptive overview of export diversity in South Africa. Firstly, how much is exported in South African by its regions? Figure 5.1 provides an illustration of the 354 magisterial districts (which comprise the 9 provinces) in South Africa. The shaded districts in figure 5.1 are those that have positive manufactured exports. The relative volume of exports is indicated according to the percentage of exports from a particular district. For instance, the areas shaded black are areas where the district contributes more than 1% of total manufactured exports and the areas shaded grey between 0.1% and 0.99%. The determinants of these sub-national exports are analysed in Matthee and Naudé (2007).

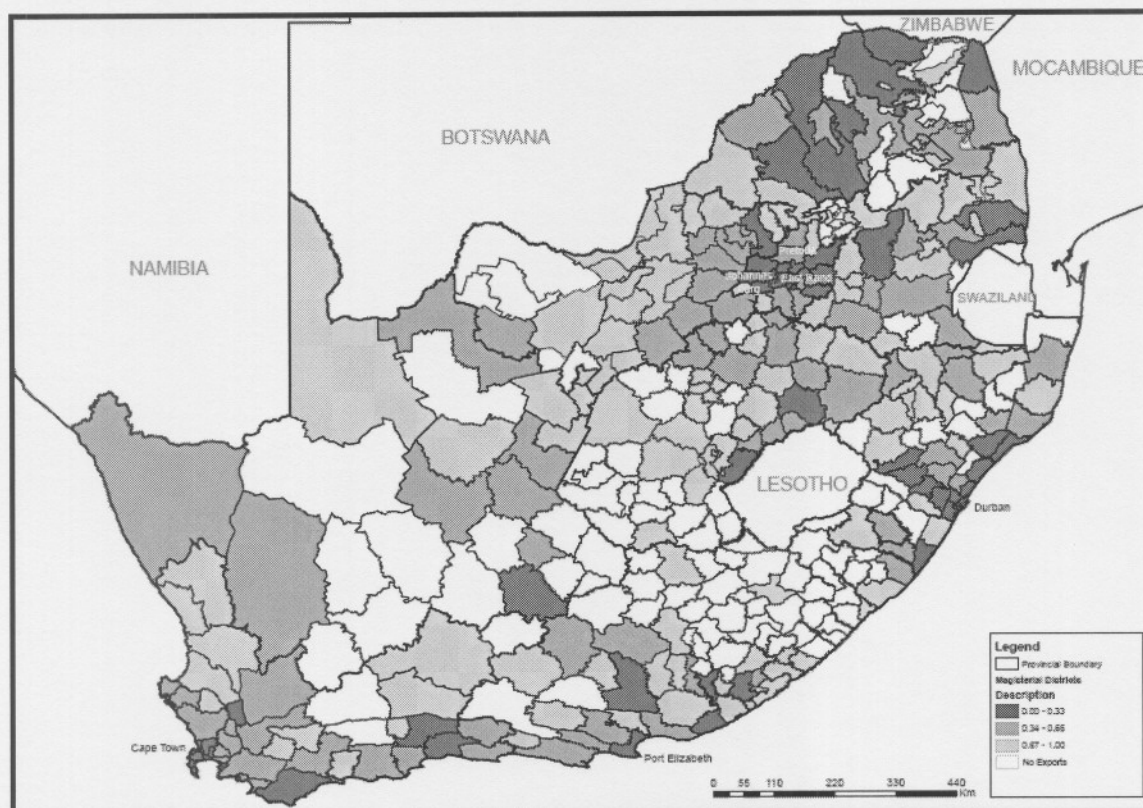
Figure 5.1: Exports per Magisterial District



Source: Author's own calculations (MAP drawn by GISCOE)

Secondly, what is being exported in terms of diversity? Figure 5.2 graphically illustrates the regions' diversity of exports as calculated by the Herfindahl index in 2004. Here total exports are taken into account. The shaded areas reveal whether a region's exports are diversified or concentrated. The black magisterial districts' Herfindahl index is nearer to 0, which indicates diversity. The light grey districts' index value is closer to 1 (i.e. exports are more specialised). The white areas do not export and therefore do not have an index value.

Figure 5.2: Export Diversity or Concentration



Source: Author's own calculations (MAP drawn by GISCOE)

The magisterial districts with an index value greater than 0.90 in 2004 experienced an average annual real GDP per capita growth rate below the average for all exporting magisterial districts in 2004. Moreover, these districts contributed only 1.29% of total exports in 2004. For the magisterial districts with an index value of below 0.20, the opposite is true. Their average annual GDP per capital growth rate is above average (for all exporting magisterial districts in 2004). The contribution made to total exports in 2004 is 32.90%. The calculation of the normalised-Hirschmann index requires the number of export producing sectors of each region. On average (in 2004), the more diversified districts produce exports in 17 of the 19 sectors, whereas the more concentrated districts produce exports only in 3 sectors (with little or no exports in the manufacturing sector).

The type of sector in which a region produces also matters. As explained above, Hausmann *et al.* (2005) construct an index (PRODY) that represents the income level associated with that sector. This index is basically the weighted average of per capita GDP of all regions producing in that export sector. Table 5.1 provides the PRODY values for each of 19 export sectors in South Africa, as well as the increase in the income level in the sectors over the period 1996 to 2004. In contrast to the findings of

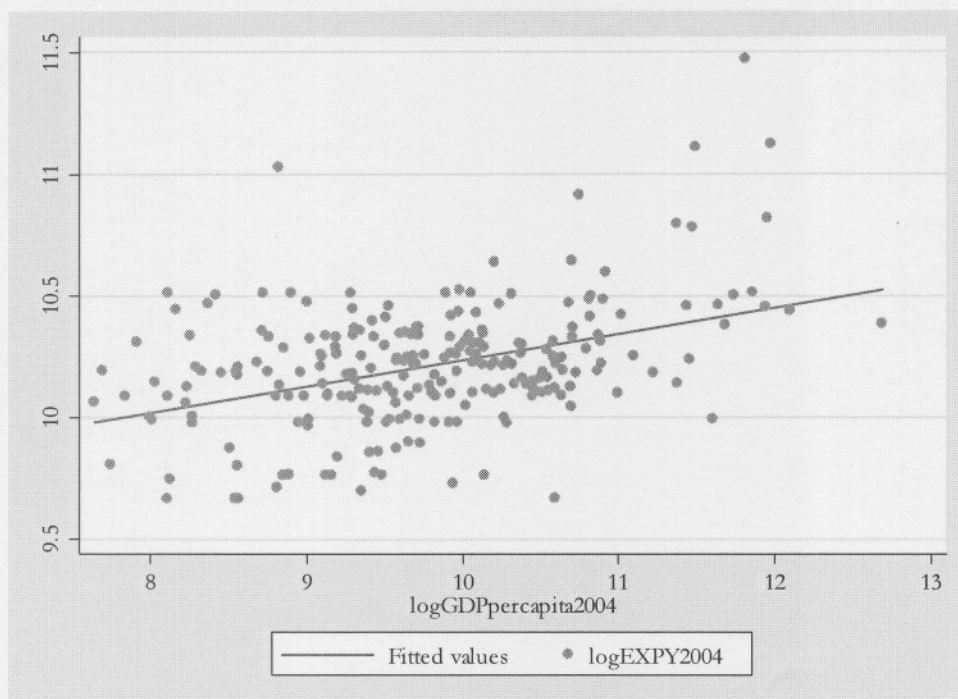
Hausmann *et al.* (2005), the sectors with low PRODY values are not in the primary sector. The forestry and logging sector (classified in the primary sector), wood and wood products sector as well as the furniture sector (classified in the manufacturing sector) have the lowest increase in PRODY values. The sectors with the highest increase in PRODY values are electrical machinery and apparatus and electronic, sound/vision and other appliances. Production in these two sectors mainly takes place in one of the metropolitan areas. This makes sense, as these regions tend to have higher per capita GDPs than the rural regions.

Table 5.1: PRODY Values of Each Export Sector

Export Sector	1996	2004	% increase
Agriculture and hunting	12303	23797	8
Forestry and logging	18413	22853	2
Fishing, operation of fish farms	24440	54552	9
Mining of coal and lignite	26410	69789	11
Mining of gold and uranium ore	56312	134779	10
Mining of metal ores	27027	71823	11
Other mining and quarrying	12390	28555	10
Food, beverages and leather goods	15450	27588	7
Wood and wood products	14071	16842	2
Textiles, clothing and leather goods	9621	15198	5
Fuel, petroleum, chemical and rubber products	19955	37046	7
Other non-metallic mineral products	14828	29150	8
Metal products, machinery and household appliances	18359	30727	6
Electrical machinery and apparatus	10797	37276	15
Electronic, sound/vision, medical and other appliances	17851	69432	16
Transport equipment	14217	26189	7
Furniture and other items NEC and recycling	15294	21264	4
Electricity, gas, steam and hot water supply	35217	84427	10
Other unclassified good	15651	27949	7

Hausmann *et al.* (2005) develop the productivity level further to determine the productivity level associated with a region's export basket (EXPY). Figure 5.3 illustrates the relationship between the fitted values of EXPY in 2004 and the real GDP per capita in that year. There appears to be a positive relationship between these two variables (a piecewise correlation indicates correlation at the 5% significance level). According to Hausmann *et al.* (2005), such a correlation indicates that rich (poor) regions export products that tend to be exported by other rich (poor) regions.

Figure 5.3: Fitted Values of EXPY in 2004



5.3.3.2 Export Diversity and Transport Costs

Transport costs are increasingly recognised as having important and significant impacts on trade patterns and globalised production (Hoffmann, 2002). Referring to the role of transport and transport infrastructure in theories of regional development and the NEG, Bruisma *et al.* (2000:260) remark that “*In this long theoretical debate transport infrastructure has always played a - more or less - eminent significant role*”. Limão and Venables (2001) state that transport and other costs of conducting business on an international level are key determinants of a country’s ability to participate fully in the world economy, and especially to grow exports. Porto (2005) finds that for low-income countries, transport costs are amongst the most important of trade barriers. Empirical studies support theoretical views by providing the relevant evidence of the significance of transport costs for trade. The general consensus is that international transport costs negatively affect a country’s trade volumes. Evidence from Limão and Venables (2001) indicate that if transport costs increased by 10%, trade volume would be reduced by 20%. For developing countries, this effect is much more severe, as they tend to be landlocked. Landlocked countries’ transport costs are higher (approximately 50%) and have lower trade volumes (around 60%) than coastal countries (Radelet & Sachs, 1998; Limão & Venables, 2001). On the matter of domestic transport costs, Elbadawi, Mengistae and

Zeufack (2001) find that domestic transport costs act as an even stronger constraint on exports than international transport costs. Exporting regions' growth is more constrained, as domestic transport costs affect the competitiveness of their exports.

As the focus here is on export diversity, and empirical evidence shows that domestic transport costs matter, one needs to establish the impact of these costs on the level of a region's export diversity. Matthee, Naudé and Krugell (2006) use cubic-spline density functions to determine the significance of domestic transport costs for the spatial location of manufactured exporters. They find that the proximity to a port is an important consideration in most export-oriented manufacturing firms' location decisions. The issue here is whether or not domestic transport costs are important for export diversity. Cubic-spline density functions are used to determine the relationship between domestic transport costs (proxied by distance to the nearest export hub) and the Herfindahl index. Cubic splines are piecewise functions whose pieces are polynomials of degree less than or equal to three, joined together to form a smooth function (Poirier, 1973). Zheng (1991) formulates the cubic-spline density function as:

$$M_r = \alpha + \beta(K_r - K_0) + \chi(K_r - K_0)^2 + \delta_i(K_r - K_0)^3 + \sum_{i=1}^{n-1} (\delta_{i-1} - \delta_i)(K_r - K_i)^3 Y_i + \mu_r$$

$$Y_i = 0 \quad \text{if } K_r \geq K_i$$

$$Y_i = 0 \quad \text{otherwise.} \tag{5.6}$$

Figure 5.4 provides the relationship between distance and the Herfindahl index values for 2004. It appears that those magisterial districts with a diverse range of exports are located within around 100 km from the nearest export hub. Those with high Herfindahl index values are located further at 400 km. The outliers on the right-hand side of the graph specialises in agriculture, with the exceptions of Prieska (whose production lies in food processing), Namaqualand (in metal products) and Hay (in furniture).

Figure 5.4: Cubic-Spline Density Function for Herfindahl-Index Values in 2004

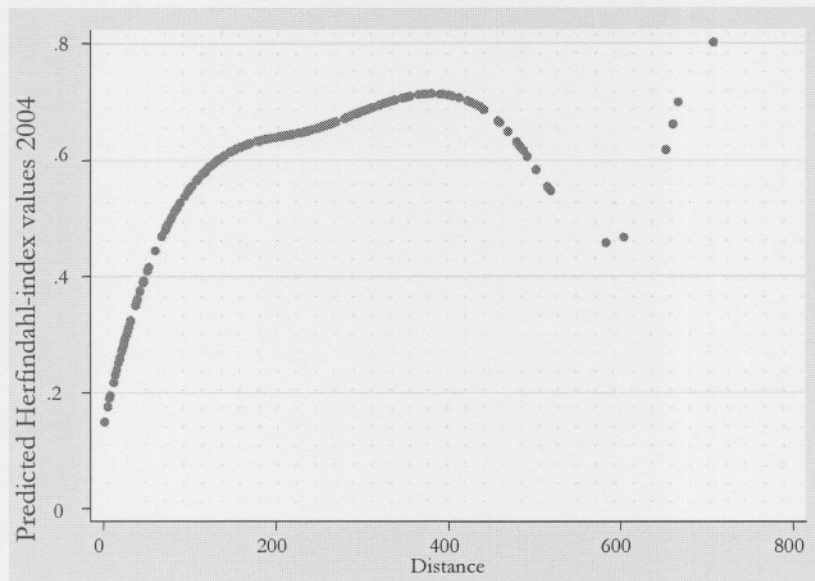
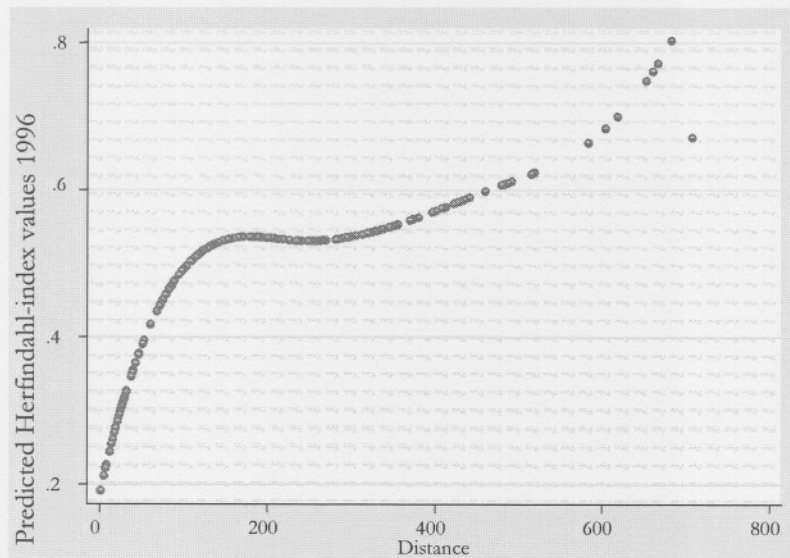


Figure 5.5 provides the same relationship, only with those magisterial districts that had positive exports in 1996. Here it seems that the magisterial districts between 200 and 400 km were more diversified in 1996 than in 2004. The same outliers appear on the right-hand side, with less focus on agriculture. Fewer magisterial districts produced exports in 1996 than in 2004.

Figure 5.5: Cubic-Spline Density Function for Herfindahl-Index Values in 1996



5.3.3.3 Export Diversity and Growth: Regression Results

Before the regression results are illustrated and explained, a detailed explanation of the growth variables is provided. The dependent variable is the average annual growth rate of real GDP over the period 1996 to 2004. Human capital is the average value (between 1996 and 2004) of the proportion of population with an education level higher than grade 12. Openness is the average share of total exports to nominal GDP of 1996 and 2004. The contribution of manufacturing exports is the average share of manufacturing exports to total exports of 1996 and 2004. Population growth is the average annual growth rate of the population over the period 1996 to 2004. The logarithm of the level of real GDP per capita in 1996 is used as the initial GDP per capita. Each index is reported as the average value taken between 1996 and 2004. The regressions run were only for the magisterial districts that had positive exports during the period 1996 to 2004. Table 5.2 provides a summary of all variables used.

Table 5.2: Summary (Dependent Variable Real GDP Growth, 1996-2004)

Variable	Mean	Standard Deviation	Min	Max
Real GDP growth	0.67	0.74	-7.01	3.80
Population growth	1.07	0.38	0.08	2.25
Initial GDP per capita	17773.58	1207.26	1207.56	216178.3
Human Capital	3.80	2.73	0.56	17.79
Openness	0.31	0.24	0	1.98
Distance	304.01	80.51	27.9	684
Total Exports	5480051	385596	32.53	1.21e+07
Index 1	0.86	0.45	0	1.59
Index 2	1.03	0.56	0	1.97
Index 3	0.73	0.38	0	1.34

Table 5.3 reports the results of the various regressions run with the three indices. The results indicate that two of the three indices are significant at the 1% level and the other at the 5% level. None of the other variables are, however, significant. This may be that the manner in which the indices are constructed encompasses the effects of say, human capital, population growth and openness. A piecewise correlation between these variables and the indices revealed that they are significantly correlated at the 5% level. The negative signs of the coefficients are similar to Al-Marhubi's (2000) results. The negativity implies that, with other given factors, larger export diversification and lower concentration or specialisation contributes to real GDP growth. Therefore it matters

what a magisterial district exports. The coefficient of distance, which proxies domestic transport costs, is negative in all three instances, although not significant.

Table 5.3: OLS Regression Results for Index Regressions (Dependent Variable Real GDP Growth, 1996-2004)

Variable	(1)		(2)		(3)	
	Coefficient	Robust SE	Coefficient	Robust SE	Coefficient	Robust SE
Constant	0.43	0.54 (0.79)	0.41	0.54 (0.76)	0.48	0.53 (0.91)
Population growth	0.13	0.10 (1.27)	0.13	0.10 (1.28)	0.12	0.10 (1.25)
Log Initial GDP per capita	0.09	0.06 (1.61)	0.08	0.06 (1.42)	0.08	0.06 (1.50)
Human Capital	0.02	0.02 (0.89)	0.02	0.02 (0.90)	0.12	0.02 (0.90)
Openness	0.11	0.44 (0.26)	0.03	0.51 (0.05)	0.05	0.46 (0.12)
Distance	-0.00	0.00 (-1.24)	-0.00	0.00 (-1.10)	-0.00	0.00 (-1.23)
Index 1	-0.67	0.24 (-2.83)***				
Index 2			-0.47	0.21 (-2.27)**		
Index 3					-0.74	0.28 (-2.66)***
No. observations		281		281		281
R ²		0.0867		0.0743		0.0822
Root MSE		0.71107		0.71588		0.71284

t-ratios in brackets

*** significant at the 1% level ** at the 5% level * at the 10% level

The results in table 5.3 show that export diversity is significantly associated with GDP per capita growth, with all the indices significant at the 1% level. However, which type of diversity, either horizontal or vertical, also matters. Table 5.4 provides the regression results that determine the nature of the magisterial districts' diversity. Two explanatory variables are used. The first variable is the Herfindahl index values of manufacturing exports in terms of total exports and the second variable is primary exports as a percentage of total exports (again the average for 1996-2004 for both variables is used). The Herfindahl index values of manufacturing exports serve as a proxy for horizontal diversity and the changes in the values of primary exports proxies vertical diversity (i.e. diversification of exports from primary to secondary products).

Table 5.4: OLS Regression Results for the Horizontal/Vertical Diversity Regression (Dependent Variable Real GDP Growth, 1996-2004)

Variable	Coefficient	Robust SE
Constant	1.13	0.12 (9.69)***
Herfindahl index for manufactured exports	-7.22e-07	3.66e-08 (-19.73)***
Primary exports as percentage of total exports	0.01	0.00 (1.63)
No. observations		281
R ²		0.00262
Root MSE		1.6528

t-ratios in brackets

*** significant at the 1% level ** at the 5% level * at the 10% level

From table 5.4, it can be concluded that vertical integration in South Africa is not a significant source of economic growth on the local level. Horizontal diversification (in manufacturing), however, is associated with larger growth (the coefficient of the Herfindahl index is significant at the 1% level). Therefore, it is not important to merely diversify exports from primary to secondary products, but the type and diversity of secondary products produced and exported are what matter for growth.

5.4 Summary and Conclusions

There is a widely shared belief that exports are good for economic growth, and that greater openness ought to lead to less spatial inequality within a country. However, in practice, greater export growth has, in general, not been accompanied by less spatial inequality. In this article, one possible explanation for this was investigated, that different sub-national regions tend to export different products, and that it is the type and quality of products that are being exported that matter for economic growth. Research on the level of countries tends to concur that export diversity and diversification may be important for economic growth, but so far very little research has focused on the sub-national or regional level.

The contribution of this article was, therefore, to provide empirical evidence on the relationship between exports and, in particular, export diversity and spatial inequality in a developing country context. Using export data from 19 sectors within 354 sub-national (magisterial) districts of South Africa, various measures of sub-national export diversity were constructed, including the recently proposed EXPY and PRODY measures proposed by Hausman, Hwang and Rodrik (2005). This is the first time, as far

as the author is aware, that these latter measures have been used to inform spatial growth issues.

The results showed that it is not only important how much is exported, but that it is also important what it is that is exported. Regions with less specialisation and more diversified exports generally experienced higher economic growth rates, as well as contributed more to overall exports from South Africa. For instance, in terms of the Herfindahl Index, sub-national regions (magisterial districts) with an index value of higher than 0.9 (high specialisation) experienced below average annual growth in GDP per capita between 1996 and 2004, whilst those with an index value below 0.20 (diversified exports) achieved an above average growth rate in GDP per capita over the period. Moreover, the magisterial districts with index value below 0.20 contributed 33% of South Africa's total exports in 2004. The positive relationship between export diversity and growth on a regional (sub-national) level is similar to the positive relationship Al-Marhubi (2000) found on a cross-country level, and the finding that on a sub-national level export sectors with low PRODY values are in resource-intensive and primary sectors (such as in forestry and related sectors) are consistent with the cross-country evidence of Hausmann *et al.* (2005).

It is also found that distance (and thus transport costs) may matter for export diversity. Estimating a cubic-spline density function for the various measures of export diversity, it is found that export diversity declines as the distance from a port (export hub) increases. Most magisterial districts with high export diversity values are located within 100 km of the nearest port. Furthermore, comparing the cubic-spline density functions for 2004 with that of 1996 allowed an indication of how the distance-export diversity relationship had changed over time (the period in question was characterised by significant trade liberalisation). This showed that distance (transport costs) has become more important since 1996 (under greater openness), with magisterial districts located further than 100 km from the ports being less diverse in 2004 than in 1996. One may speculate that a possible explanation for this changing pattern of export diversity may be the impact of greater foreign direct investment (FDI) in South Africa since 1996, following the opening up of the economy and the transition to democracy. In another context, Bruinsma *et al.* (2000) find that transport infrastructure, and therefore distance, are significant determinants of the locational decisions of "footloose" multinational firms, and that these firms tend to locate in particular high-value added sectors in close proximity to a port (see for example the role of FDI in China's spatial development in

Ma, 2006). In South Africa, tentative indications that may support this hypothesis was found in the fact that it is horizontal diversification and not vertical diversification *per se*, that is associated with higher economic growth, and that high-skill intensive sectors with integrated global markets (such as electronics) tend to be almost exclusively located within a small distance of ports. Further research is needed to clarify the relationship between export diversity, openness and foreign direct investment.

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CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This thesis investigated the impact of domestic transport costs and location on exports originating from exporting regions within a developing country. It is presented in the form of three independent articles, each addressing a different aspect. These articles are accompanied by a literature overview on the background and impact of domestic transport costs on trade.

The first aim of the thesis was to analyse the role that has been played by transport costs, specifically domestic transport costs, in trade literature. By compiling a profile of domestic transport costs and their effect on trade (*cf.* Chapter 2), it was possible to achieve the second aim, determining the impact of domestic transport costs on manufactured exports and the location of exporting firms in South Africa (*cf.* Article 1). Article 1 concluded that domestic transport costs play a role in the location of manufactured exporters. However, domestic transport costs are not the only determinant of trade from regions. The third aim was to investigate all factors that could impact trade from various exporting regions in South Africa (*cf.* Article 2). In South Africa, not all regions export and, by analysing the determinants, one could establish why this is so. Article 2 implied that distance (i.e. domestic transport costs), as well as income (i.e. GDP) are important determinants of regional trade from developing countries. The evidence from Article 2 prompted an investigation which led to the fourth aim (*cf.* Article 3). Trade generates income and economic growth, but the composition of trade could make one region more successful than others. Article 3 examined the relationship between export diversity and economic growth in a developing country context.

6.2 Results and Conclusions of the Study

In chapter 2, the evolution of transport costs in trade theories was explained. It began with the neo-classical trade theories. Here, transport costs are acknowledged, but have no influence on trade. However, as transport costs do influence trade, the new trade theory was developed in which transport costs (in the form of “iceberg” costs) impact trade negatively. The theory of new economic geography stemmed from the new trade theory. In the theory of new economic geography, transport costs play a central role as the cause

of agglomeration or dispersion of economic activity. Therefore, where trade theories previously neglected transport costs, they have recently begun to acknowledge their impact on trade.

Chapter 2 continued by providing an overview of empirical studies on transport costs. Empirical studies support theory by providing the relevant evidence of the significance of transport costs for trade. The general consensus is that international transport costs negatively affect a country's trade volumes. High transport costs reduce foreign earnings from exports and increases the price of imports, which elevates production costs. These empirical studies measure international transport costs either directly or indirectly. Methods to obtain results include the CIF/FOB ratio, quotes from freight forwarders and interviews with transport operators. All concur with the above-mentioned result. The measurement of domestic transport costs has not been as popular, with no commonly used method. The method used largely depends on the aim of the study. Mixed results have been found on the influence of domestic transport costs on trade.

The chapter concluded by explaining why transport costs differ among countries. Firstly, location and distance matter. If a country is situated far from its trading partners, its CIF/FOB ratio is higher than a country located close to its foreign markets. Therefore, remoteness from economic activity increases transport costs. The fact that a country is landlocked or coastal has a large impact on its transport costs. Landlocked countries have higher transport costs than coastal countries. Landlocked countries also tend to have poor internal geography (access to ports), which negatively correlates with transport costs. Secondly, economies of scale reduce per unit cost of shipping. Countries that are able to produce large volumes for shipment can obtain favourable quotes. Finally, different trade policies, competition practices in the transport industry and insurance rates have varying effects on transport costs.

Chapter 3 contains the first article, titled *Domestic transport costs and the location of export-oriented manufacturing firms in South Africa: a cubic-spline density function approach*. This article set out to answer the second secondary research question: "Do domestic transport costs influence the location of export-oriented manufacturing exporters located in the various regions in South Africa?"

In determining whether distance and transport costs from a particular location to an export hub matter for export-oriented manufacturing firms in South Africa, this

article estimated a number of cubic-spline density functions for manufactured exports in 1996 and 2004 and for average manufactured exports over the period 1996-2004. From the cubic-spline density functions it was found that, in South Africa, the largest volumes of exports are generated within 100 km of an export hub. In particular, between 70% and 98% of manufactured exports are produced within 100 km of the nearest export hub. For certain goods, such as electronics, about 98% of manufacturing takes place within 100 km of an export hub. Further away from an export hub in South Africa (in excess of 100 km) one may find furniture, textiles, and metal products. These goods tend to be produced largely for the domestic market, which is relatively more intensive in natural resources.

The above suggests that, barring some important exceptions, the proximity to a port (hub) is an important consideration in the location of most export-oriented manufacturing firms. However, it was also found that the relationship between exports and distance from an export hub is not unidirectionally negative. In South Africa, there appears to be a second band of location of export-oriented manufacturing firms at a distance of between 200 and 400 km from the nearest hub. Several large manufacturing exporters are situated in this band. A third band occurs at around 600 km, but the manufactured exports that originate from this band are resource based.

Comparison over time showed that the number of locations from which manufactured exports occur in South Africa increased by 15% between 1996 and 2004 and that manufactured exports increased in the band between 200 km and 400 km from the nearest hub. This could suggest an increase in manufactured exports that depend on natural resources due to demand factors and/or a decrease in domestic transport costs over the period.

In conclusion, transport costs are an important and significant determinant of the location of export-oriented manufacturing firms in South Africa, and the location near to an export hub is important. Improving the efficiency of export hubs, and creating additional export hubs (e.g. through dry ports) would contribute positively towards increasing the volume of manufactured exports from South Africa. The South African government is currently planning the creation of such hubs.

Chapter 4 contains the second article, titled *Determinants of regional manufactured exports from a developing country*. This article set out to answer the third secondary research question:

“What are the determinants of regional exports in a developing country such as South Africa?”

In this article, the question of where exporters of manufactured goods would be located within a country was investigated. Based on insights from new trade theory, the new economic geography and gravity-equation modelling, an empirical model was specified wherein agglomeration and increasing returns (the home-market effect) and transport costs (proxied by distance) were identified as major determinants of choice of location for exporters.

The main result of this article was that internal distance, and thus domestic transport costs, influence the extent to which different regions in a developing country can be expected to be successful in exporting manufactures. Data from 354 magisterial districts in South Africa were used with a variety of estimators (OLS, Tobit, RE-Tobit) and allowances for data shortcomings (bootstrapped standard errors and analytical weights) were made to determine that the home-market effect (measured by the size of local GDP) and distance (measured as the distance in km to the nearest port) are significant determinants of regional manufactured exports.

In particular, it was found that the home-market effect has a much larger or stronger effect on exports than distance in a developing country setting than in a developed country setting. Therefore, the overall suggestion is that the home-market effect is relatively more important in the developing country context (South Africa) with less perfectly competitive firms. This result is consistent with theoretical models wherein developing countries, which urbanise later with better transport technologies (such as South Africa), are spatially more concentrated than present developed regions (such as the EU).

Chapter 5 contains the third article, titled *Export diversity and regional growth in a developing country context: empirical evidence*. This article set out to answer the final secondary research question: “Is the composition of a country’s exports a reason why some regions prosper and others not?”

Exports generate economic growth. Therefore, greater openness ought to lead to less spatial inequality within a country. However, in practice, greater export growth has, in general, not been accompanied by less spatial inequality. In this article, one possible explanation for this, that different sub-national regions tend to export different products, and that it is the type and quality of products that are being exported that matter for

economic growth, was investigated. Research on country-level tends to concur that export diversity and diversification may be important for economic growth, but so far very little research has focused on the sub-national/regional level.

The results of this article showed that it is not only important how much is exported, but that it is also important what it is that is exported. Regions with less specialisation and more diversified exports generally experienced higher economic growth rates and contributed more to overall exports from South Africa. For instance, in terms of the Herfindahl Index, sub-national regions (magisterial districts) with an index value of higher than 0.9 (high specialisation) experienced below average annual growth in GDP per capita between 1996 and 2004, whilst those with an index value below 0.20 (diversified exports) achieved an above average growth rate in GDP per capita over the period. Moreover, the magisterial districts with index value below 0.20 contributed 33% of South Africa's total exports in 2004. The positive relationship between export diversity and growth on a regional (sub-national) level is similar to the positive relationship of other research on a cross-country level. The finding that on a sub-national level export sectors with low income/productivity levels, are in resource-intensive and primary sectors (such as in forestry and related sectors) are also consistent with the existing cross-country evidence.

It was also found that distance (and thus transport costs) may matter for export diversity. Estimating a cubic-spline density function for the various measures of export diversity, it is concluded that export diversity declines as the distance from a port (export hub) increases. Most magisterial districts with high export diversity values are located within 100 km of the nearest port. Furthermore, comparing the cubic-spline density functions for 2004 with that of 1996 indicated how the distance-export diversity relationship had changed over time (the period in question was characterised by significant trade liberalisation). This showed that distance (transport costs) has become more important since 1996 (under greater openness), with magisterial districts located further than 100 km from the ports being less diverse in 2004 than in 1996. One may speculate that a possible explanation for this changing pattern of export diversity may be the impact of greater foreign direct investment (FDI) in South Africa since 1996, following the opening up of the economy and the transition to democracy. In another context, existing research indicates that transport infrastructure and therefore distance are significant determinants of the locational decisions of "footloose" multinational firms. Also, these firms tend to locate in particularly high value-added sectors in that are

in close proximity to a port. In South Africa, tentative indications that may support this hypothesis were found in the fact that it is horizontal diversification and not vertical diversification *per se*, that is associated with higher economic growth. High-skill intensive sectors with integrated global markets (such as electronics) tend to be almost exclusively located within a small distance of ports.

6.3 Contributions of the Study

Both international and domestic transport costs have significant effects on international trade, and domestic transport costs may have a much stronger effect on exports than international transport costs. Despite this, the majority of studies have focused on international transport costs, with only a few studies focusing on domestic transport costs. Even fewer studies are available that investigate the importance of domestic transport costs in an African country. Given that Africa is the one continent in the world that faces the most significant challenges in terms of growth, development, exports and integration into the world economy, and is also one of the continents facing the most adverse physical geography. The effect of domestic transport costs on manufactured exports and the location of exporting firms in Africa are therefore highly relevant. This study attempts to fill this vacuum by studying the case of domestic transport costs and exports in South Africa.

The contribution of this study was threefold. Firstly, existing empirical methods, namely cubic-spline density functions, were used for the first time to estimate the impact of domestic transport costs on exports. This application provided a visual understanding of the location of export-oriented firms, as well as the impact of domestic transport costs on these firms in South Africa (*cf.* Article 1). Secondly, the study tested for the determinants of regional trade using developing country data. By doing so, the study contributed to the existing small literature on this topic. In this regard the study complements the work of Nicolini (2003) on the determinants of exports from European regions (*cf.* Article 2). The third contribution was to provide empirical evidence on the relationship between exports, and in particular export diversity, and spatial inequality in a developing country context (*cf.* Article 3). There is a wide range of research export diversity on a country-level, but so far very little research has focused on the sub-national/regional level. This article adds to the latter. The empirical evidence here contributes to the overall aims of the South African government, i.e. to achieve higher

levels of economic growth, as it proves that diversification in regional exports contributes to higher levels of economic growth.

6.4 Recommendations for Further Research

As each article focused on a different aspect of domestic transport costs and exports, it is appropriate to explain recommendations for further research with regard to each article:

- From the comparisons over time (i.e. 1996 and 2004) in article 1, further research is required to clarify whether or not the increase in manufacturing exports in the band further away from the export hub was due to increases in demand and/or decreases in transport costs.
- From article 2, further research is recommended to investigate the ways in which geography and historical patterns of location may result in regional differences in the relative importance of increasing returns and transport costs.
- From article 3, further research is needed to clarify the relationship between export diversity, openness and foreign direct investment.

In general, further research has to be conducted to compare South Africa's domestic transport costs with those of similar emerging market countries (such as Brazil).