Analysing measurements of international transportation costs

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ABSTRACT

Transport costs are commonly used in research when analysing international trade, specifically as one of the determinants of trade flows. Furthermore, transport costs are often used as one of the elements to identify markets with high export potentials. However, quotations for direct transport costs between countries are difficult to obtain for research purposes. Therefore, many researchers use indirect measures such as the CIF/FOB ratios to measure a country`s cost of international transportation. This dissertation contributes to a better understanding of the CIF/FOB ratios as a measure of international transport costs, and aims at highlighting some of the limitations attached to using these ratios as a substitute for direct measures. A correlation analysis is used for investigating whether these ratios are adequate to replace quotations for actual transport costs by comparing their variation with direct freight rates for South Africa. The analysis compensates for some of the limitations of aggregate CIF/FOB ratios by taking into consideration transport mode, product type and partner country. The direct freight rates were obtained from a freight forwarder company located in Johannesburg, South Africa, and includes rates from South Africa to eleven Far East countries and fourteen European countries. The freight rates were collected for general cargo and automotive parts for containerised products. The CIF/FOB data used in this study are sourced from the World Integrated Trade Solution (WITS), United Nations Conference on Trade and Development (UNCTAD), International Monetary Fund`s International Financial Statistics (IFS), Direction of Trade Statistics (DOTS) and the Global Trade Analysis Project (GTAP). The findings of this study show that the CIF/FOB data is severely error-ridden and that researchers should be careful when using CIF/FOB ratios as a source of international maritime transport costs. Even after considering transport mode, product type and partner country, the CIF/FOB ratios calculated for purposes of this study display a very low and mostly insignificant correlation with direct freight rates. Overall, there was an increasing trend in the CIF/FOB ratios and a declining trend in the actual freight rates. Where possible, direct transport costs should rather be used.

Key words: CIF/FOB ratios; international transport costs; trade costs; *ad valorem* shipping costs.

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LIST OF ABBREVIATIONS

CEPII   Centre d'Études Prospectives et d'Informations Internationales

CIF   Cost, Insurance and Freight

BACI   Base pour l'Analyse du Commerce International

DOTS   Direction Of Trade Statistics

DSM   Decision Support Model

FDI   Foreign Direct Investment

FOB   Free on Board

GDP   Gross Domestic Product

GTAP   Global Trade Analysis Project

GVCs   Global Value Chains

HS   Harmonized System

IFS   International Financial Statistics

IMF   International Monetary Fund

JIT   Just-in-Time

LDCs   Least Developed Countries

LLDCs   Landlocked Developing Countries

LPI   Logistics Performance Index

MFN   Most Favoured Nation

NBER   National Bureau of Economic Research

NDP   National Development Plan

NEG   New Economic Geography

OECD   Organisation for Economic Co-operation and Development

SITC   Standard International Trade Classification

TDCA   Trade Development Cooperation Agreement

TEU   Twenty foot equivalent Unit

UN   United Nations

UNCTAD   United Nations Conference on Trade and Development

WITS   World Integrated Trade Solution

CHAPTER 1: INTRODUCTION

1.1 Background

International trade is commonly identified as one of the driving forces behind economic growth and social development (Hummels, 2007). The substantial decrease in trade restrictions as well as the cost of communication and transportation in recent years, have contributed towards an increase in countries' wealth and social wellbeing (Chasomeris, 2006). Likewise, the development of trade blocks and trade organisations, together with the more efficient use of available resources, have increased the movement of individuals and goods between countries (Rodrigues, Comtois & Slack, 2006). This trend has led to a decrease in the barriers that separate nations from one another, and has further contributed towards longer life expectancies and increased standard of living (Stiglitz, 2003: 4). Import protection, which consists of tariffs and non-tariff barriers, has also decreased due to trade liberalisation, diminishing the anti-export bias, and allowing resources to travel to countries benefiting from a comparative advantage (Cassim, Onyango & Seventer, 2004:1).

Although trade liberalisation has benefited many countries, not every nation is able to evenly benefit from the positive effects of globalisation, due to high trade costs (Thompson, 2006). Trade costs are identified as all the costs involved in getting a product from its country of origin to its destination country. It includes all aspects of international business, and are measured to be one of the key elements explaining the volume of goods and services being traded between nations (Chasomeris, 2005b). Trade costs consist of several elements, including tariffs, distance, infrastructure, time, and transport costs (Behar & Venables, 2010). The transport costs element of trade costs has been identified as the most substantial non-tariff barrier to trade (Korinek & Sourdin, 2010). Due to the movement towards freer trade and a reduction in tariffs, the transport costs' effective rate of protection is now relatively higher than the protection provided by tariffs (Porto, 2005). Evidently, transport costs in Ecuador and Chile are 20 times higher than the average tariff they face in the United States market (Clark, Dollar & Micco, 2004). Therefore, transport costs have become, by default, a progressively significant trade performance determinant (Hummels, 2007). To succeed in international markets, a country's competitiveness of transport costs is essential (Limão & Venables, 2001). Due to the intensity of the competition in the global market, companies must continuously improve their efficiency to be able to survive in foreign markets. Therefore, an understanding of the nature and magnitude of international transport costs is essential.

1.1.1 The impact of transport costs on trade flows

Transport costs are an important consideration in international trade as they control the patterns and volumes of foreign trade. The structure of a country's industries, their income and prices are all connected to transport costs (Hummels, 2007). Recently, the world has experienced a movement towards freer trade and trade liberalisation. However, many developing nations still struggle to participate in international trade as a result of the high transport costs they are facing (Radelet & Sachs, 1998). Transport costs can reduce the total revenues of exports, and increased transport costs can result in lower competitiveness in the increasingly globalised markets (Behar & Venables, 2010). Transport costs can largely obstruct international trade as high transport costs function as an anti-export bias which reduces a country's competitiveness (Chasomeris, 2006). However, high transport costs at times can serve as a form of protection to domestic producers, as domestic products will be more competitive due to the higher price of imported goods.

High international transport costs reduce countries' export profits, which again negatively affect income levels and employment. High transport costs increase the price of all imported capital goods which would lead to a reduction in real investments and slow the process of technology transfer through capital imports. A reduction in domestic and foreign investments can be crucial for countries of which production is dependent on intermediate imports, as is the case in most developing nations. The aggregate savings levels available for investments are negatively affected by high international transport costs, which serve as an additional impediment for investments (Radelet & Sachs, 1998). Besides, high international transport costs also negatively affect a country's long-term economic growth levels (Chowdhury, 2003).

Micco and Perez (2001) argue that it is essential for countries to consider their transport costs carefully if they desire to increase their participation in the global markets. Research conducted by Behar and Venables (2010) and Hummels (2001) show that economic development, as well as transport costs affect trade. Therefore, a country's export levels and economic growth are linked. The effect that transport costs have on trade is similar to the effect of exchange rates and tariffs, as it influences the competitiveness of imports and exports (Clemens & Williamson, 2002). Limão and Venables (2001) investigated transport costs with data collected from the World Bank employee`s moving company, in their research on the effects of transport cost on trade. The moving company provided Limão and Venables with the transport costs of moving

one TEU[1] container from Baltimore, United States, to locations where the employees could relocate. The authors found elasticities of transport cost in respect of distance between 0.2 and 0.3. In other words, trade volumes would decrease with between 20% and 30% if transport costs increase with 10%. Transport costs exhaust scarce resources and are a real cost that represents about 5% of trade value on a global basis (Hoffman, 2002). However, developed countries are accountable for approximately 70% of the world's imports (Micco & Perez, 2001). Therefore, this relatively small figure mainly represents the developed nations. Micco and Perez (2001) point out that the proximity of developed countries gives the benefit of low transport costs. Contrarily, the consequences of transport costs on developing nations are more crucial, especially for developing countries which are located far away from their import markets (Limão & Venables, 2001).

Geography is an important factor to take into consideration and could contribute to a country's success in trade (Frankel & Romer, 1999). Evidently, Limão and Venables (2001) found that landlocked countries tend to have approximately 50% higher transport costs and 60% lower volumes of trade compared to coastal countries. Port accessibility and distance to markets are geographical features accountable for the high transport costs seen in landlocked and several developing nations (World Bank, 2010). These geographical factors influence long-run economic growth and manufactured exports.

Research conducted by Radelet and Sachs (1998) proves that lower transport costs have a positive impact on manufactured exports and economic growth. As high transport costs rise, the capital and intermediate goods prices also rise and the cost of producing manufactured goods increases together with an increase in the inflation rate (Hoffman, 2002). Thus, capital-owners must settle for lower returns and employees receive lower wages. Also, such a scenario is challenging in developing countries due to the already low wage levels. Radelet & Sachs (1998) state that high transport costs, and the increasing costs of production obstruct economic growth, as well as the price competitiveness of manufactured exports. This scenario is especially true for developing nations, as they rely on importing most of their intermediate goods (Hoffman, 2002). Hoffman (2002) contends that countries' export competitiveness is affected by transport costs to a higher degree than are tariffs. As trade has expanded in volume, transport costs are now a key component of the Gross Domestic Product (GDP), even though

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[1] TEU stands for Twenty-foot Equivalent Unit which is a measure used to describe the capacity of a container ships and terminals.

transport costs as a percentage of trade value has declined (UNCTAD Secretariat, 2003). GDP growth falls with approximately 1.5% if transport costs double (Radelet and Sachs, 1998).

In today's economies, it is no longer common that one single location fully produces a product or service, and then exports it as a final product to the end consumers. Instead, the production process has become a complex practice which takes place in several different countries. The reason behind the increasing outsourcing of the various production activities is that products or parts of a product can be produced more efficiently and cost effectively in countries that have the required competence and resources (Timmer, Erumban, Los, Stehrer & de Vries, 2014). For this reason, transport costs play an even stronger role in competitiveness for these global value chains[2].

1.1.2 South Africa`s international transport costs

Approximately 90% of international trade for countries located on the African continent occur by means of maritime transportation. Similarly, approximately 85% of trade volumes for most countries in the world are conducted by sea (UNCTAD, 2016). The world`s seaborne trade volumes surpassed 10 billion tons in 2015, which is the highest trade volumes ever documented in the United Nations Conference on Trade and Development`s (UNCTAD) records. South Africa depends heavily on its maritime shipping industry, as 98% of the country's trade volumes are seaborne (SAMSA, 2016). South Africa has an international shipping network and commercial ports that have contributed towards the country's economic growth and serve as a means of trade facilitation. South Africa is geographically situated far away from its main trading partners China, United States and Germany, which places the country in a disadvantageous position compared to its closer located competitors (ITC Trade Map, 2017). To improve South Africa`s connection to its trading partners, extensive hauls are essential. The country is ranked within the international maritime trading nations' top twelve list, as the country is responsible for roughly 6% of the world's tonne-miles[3] (Jones, 2002).

In spite of the increasing importance of its international maritime trade, South Africa used to practice a trade policy directed to import-substitution due to the country's controversial social-economic and political background, until 1994 (Jonsson & Subramanian, 2001). However, post-

[2] Global Value Chains (GVCs) are complex production activities and can be defined as all the activities involved in getting a good or service from its origin to its final use and how these actions are dispersed across intercontinental boundaries and geographical areas (Sydor, 2011).
[3] Tonne-mile refers to a statistical unit of freight transportation equivalent to a ton of freight moved one mile.

apartheid, South Africa has seen a movement away from import-substitution towards more export-oriented trade policies focusing on increasing competitiveness in international markets. Trade liberalisation is now in focus, serving as an incentive towards job creation and economic growth through increased global competitiveness. Thus, the country lowered its average MFN-applied tariffs to 7.7% in 2014, down from 23% in the 1990s (Vickers, 2014).

According to Vickers (2014), as much as 58% of South Africa's imports faced a zero-percentage tariff. As the weighted average tariffs on imported goods saw a drastic decrease after 1994, the domestic firms had to upsurge its levels of competitiveness to keep remain profitable in the global market. A lowering of the country's tariffs is resulting in an increase in non-tariff barriers to trade, with transport costs contributing as one of the primary determinants of the country's trade performance (Chasomeris, 2006). However, compared to other emerging economies, South Africa's transport costs of approximately 13% of GDP in 2003 are high (Seria, 2005). The significance of transport costs further emphasises the importance of lowering transport costs and restructuring the transportation sector, if South Africa is going to succeed in reaching its new trade policy objectives. The National Development Plan (NDP) includes increased exports as a means to achieve the economic growth goals set for the country (National Planning Commission, 2012).

1.2 Motivation

Many studies make use of transport costs when analysing international trade flows. Studies on the determinants of trade between different countries use transport costs, mostly in gravity-type models (for example Hummels & Lugovskyy, 2006; Hummels, 2007; Chasomeris, 2006; Behar & Venables, 2010). Moreover, export potential assessments and international market selection methods such as the Decision Support Model (DSM) make use of transport cost data as part of their analysis for identifying markets with high export potential (South African studies include Steenkamp & Viviers, 2012; Viviers, Cuyvers, Steenkamp, Grater, Matthee & Krugell, 2014; Steenkamp, Grater & Viviers, 2016).

Transport costs can be measured directly by means of quotes obtained from freight forwarders and shipping companies, or indirectly by applying CIF/FOB ratios or the distance between trading partners. A product is declared for customs twice when traded internationally. The exporter of the product declares the goods at a Free on Board (FOB) value, which is the value of the goods at the exporter's border. The importer declares the goods at a Cost Insurance and Freight (CIF) mirror value, which includes the costs of freight as well as insurance and port

handling charges (Hummels, 1999a). When comparing the reported CIF and FOB values, the difference is said to represent the transport cost of the goods (Chasomeris, 2009). This difference is measured as a ratio, also known as the CIF/FOB ratio, and is used to measure countries' transport costs. The distance measure of international transport costs assumes that the transport cost rises as the distance between trading partners increases, and declines as the distance falls (Behar & Venables, 2010). See Chapter 3 for a detailed discussion on CIF/FOB ratios and distance as a measure of international transport costs.

Direct transport cost quotes are difficult and time-consuming to obtain from shipping companies for research purposes, especially if the analyses include many countries (Hummels, 2007). These direct shipping cost data are often seen as commercially sensitive as they are prices which the shipping companies privately negotiate with clients. In the cases where companies are willing to reveal their direct freight rates, the data can be officially set prices that may diverge from the real negotiated prices (Radelet & Sachs, 1998). Consequently, collecting quotations from shipping companies' year on year on a disaggregated product level per destination country can be a significant obstacle when conduction research on the topic (Chasomeris, 2006). The best alternative to direct transport costs therefore is to use CIF/FOB ratios. There are, however, some limitations to these indirect measures. The most important limitations include the dependence on the transport mode, product type and trading partners. The accuracy of aggregated CIF/FOB ratios in estimating transport cost often is questioned because it considers only total trade over all destination countries and products. This does not consider transport mode, product type and partner country which has a huge influence on transport costs (Chasomeris, 2006; Hummels & Lugovskyy, 2003, 2006). Also, aggregated CIF/FOB ratios are implicitly trade-weighted, where the weights are determined by import compositions that vary across countries and over time (Chasomeris, 2005b, 2006; Hummels, 1999a). Furthermore, the quality of a country`s derived CIF/FOB ratios depends on the accuracy of the country`s import CIF and import FOB time series data (Hummels & Lugovskyy, 2003; Yeats, 1995). Inconsistent use of incoterm definitions and terminology also creates confusion and potential misuse of the country's CIF/FOB ratios (Chasomeris, 2006).

Due to the limitation of aggregated CIF/FOB ratios not taking into consideration transport mode, product type and trading partner, this study investigates the correlation over time between actual shipping rates and CIF/FOB ratios for containerised general cargo, and specifically automotive parts, shipped from South Africa via ocean freight to specific trading partners in Europe and the Far East for which data could be obtained. The study focuses solely

on South Africa`s maritime transport costs as sea freight is South Africa`s main mode of transportation (98% of the country's trade volumes are seaborne).

1.3 Problem statement

With a view to fully understand the impact of transport costs on trade, it is necessary to measure transport costs over time. However, direct transport costs are proprietary information of shipping companies and can therefore be challenging to obtain (Hummels & Lugovskyy, 2003; Micco & Perez, 2001). Consequently, researchers in need of transport costs year on year on a disaggregated level per destination country might struggle to find such information. Therefore, they frequently revert to indirect transport cost measures such as the country's import CIF/FOB ratio or use the distance between trading partners as a proxy for direct transport cost (Hummels, 2001).

Existing research on the accuracy of CIF/FOB ratios as a proxy for transport cost in South Africa is dated (Chasomeris, 2003b, 2006) and mostly done on an aggregated level. Little research has been done to further analyse the relationship between CIF/FOB ratios and actual shipping rates by mode of transport, product type and partner country. This study aims to address this gap. The following research question can be formulated based on the above-mentioned description of the research problem:

- If transport mode, product type and partner country are taken into consideration, can the CIF/FOB ratio serve as a more accurate substitute for direct shipping costs for South African seaborne general containerised cargo exports, and automotive parts specifically?

To answer the above research question, a number of research objectives were formulated as set out in section 1.4.

1.4 Research objectives

This dissertation investigates the transport costs element of international trade by identifying various measures of international transport costs. The aim of this study is to determine the best alternative source of transport costs if direct costs are difficult to obtain. The accuracy and reliability of using the CIF/FOB ratio as a proxy for direct transport costs are evaluated to reach a conclusion as to whether the CIF/FOB ratio can serve as a substitute for direct measures, especially when taking into consideration transport mode, product type and partner country. Obtaining quotations from shipping companies on a disaggregated product level per destination country can be a significant obstacle for these types of studies. Hence this study analyses whether international trade data such as CIF/FOB ratios, or information that is much easier to access from the Internet, can serve as a substitute for direct measures.

The research objectives are divided into a general objective and specific objectives.

1.4.1 General objective

The main objective of this research is to analyse whether CIF/FOB ratios can serve as an accurate substitute to replace direct shipping cost in trade analysis of South African seaborne general containerised cargo trade, and specifically automotive parts. This analysis is unique since it takes into consideration transport mode, product type and partner country.

1.4.2 Specific objectives

Specific objectives include to:

- Provide an overview of the literature on transport costs and its impact on trade and economic growth.
- Compare the sources of CIF/FOB ratios and specify limitations where applicable.
- Identify errors in measuring transport costs by using CIF/FOB ratios from the current literature.
- Provide a summary of the existing literature on CIF/FOB ratios, with specific focus on South African studies.
- Compile and compare CIF/FOB ratios from different data sources with direct shipping quotes by means of a correlation analysis over time, to determine whether CIF/FOB ratios from different data sources are related to one another and can be used as a proxy for direct shipping rates

- Determine whether the CIF/FOB ratios can be used as a relatively accurate proxy for direct shipping rates for South African seaborne general containerised cargo or for a specific sector (automotive parts),
- Compare Internet rates with direct shipping quotes to determine whether Internet rates could be used as an alternative to direct shipping rates.

1.5 Demarcation

In the theory of international trade, it is important to differentiate between the terms *transport costs* and *shipping costs*. Transport costs refer to the transportation of goods with the use of any transport mode. However, shipping costs refer to transportation with the use of sea transport only (Hummels, 2001). As sea freight makes up the majority of international transport and is South Africa`s main international transport mode, the empirical part of this dissertation solely focuses on shipping rates. Furthermore, data on the other modes of transport suffer from limited availability and are therefore excluded from this study.

Since the type of product, mode of transport and destination country affect the CIF/FOB ratio (see Section 3.3.2.2), this study will focus on the shipping cost of seaborne cargo, differentiating between general cargo and automotive parts exports from South Africa to fourteen European and eleven Far East countries. The literature study mainly covers transport costs in general, whereas the empirical study focuses on maritime international transport costs specifically. South Africa`s transport costs are under investigation and the rates will be calculated from a South African perspective.

1.6 Research method

This research, pertaining to the specific objectives, consists of two phases, namely a literature review and an empirical study.

1.6.1 Phase 1: Literature review

The literature study reviews past research on international trade theories and literature on the impact of transport costs on international trade. The literature review serves as a background to how transport costs became an important determinant of international trade. Furthermore, it reviews literature conducted on the issue of measurements of transport costs. This dissertation specifically reviews past research on the accuracy of CIF/FOB ratios as a substitute for direct transport cost measures.

1.6.2 Phase 2: Empirical study

The aim of the research is to analyse the accuracy of South Africa`s CIF/FOB ratios with direct transport costs[4]. The study will therefore compare actual quotes obtained for exports from a South African freight forwarder with the indirect CIF/FOB ratios that will be calculated using different data sources. The analysis takes into account transport mode (sea freight), product type (general containerised cargo and specifically automotive parts) and trading partner (fourteen European and eleven Far East countries). In addition, the direct quotes are compared with shipping quotes from Internet sources as another alternative. The reliability of Internet sources is however questionable, and it is not available over a longer time period.

Countries` import (CIF) and export (FOB) figures are available from several online trade data sources. In this study, countries' import (CIF) and export (FOB) values were found by using data from World Integrated Trade Solution (WITS), United Nations Conference on Trade and Development (UNCTAD), International Monetary Fund (IMF)`s Direction of Trade Statistics (DOTS), IMF`s International Financial Statistics (IFS), and Global Trade Analysis Project (GTAP). The data were used to calculate South Africa`s CIF/FOB ratios which represent the transport costs in an indirect form.

A correlation analysis between the direct and indirect measures was conducted to determine whether easier to obtain CIF/FOB ratios or Internet sources are reliable alternatives to direct shipping quotes in the case of South Africa. The analysis was conducted over time (2007-2015) to determine whether the correlation had changed. Data for the shipping cost of general-purpose containers and automotive parts were gathered and compared, as transport costs may differ considerably depending on the type of product exported.

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[4] This dissertation uses the term shipping costs, freight rate and maritime transport costs interchangeably.

1.7 Chapter division

The structure of this dissertation is as follows:

Chapter 1 provides an introduction, research questions and aim of the dissertation.

Chapter 2 consists of a topical literature review of international trade theories and international transport cost studies. Furthermore, the chapter examines the empirical evidence traced in the literature on the determinants of international transport costs as well as the impact of transport costs on economic growth and trade.

Chapter 3 investigates different direct and indirect measures of international transport costs and specifically explains and defines the CIF/FOB ratio and distance as indirect measures of international transport costs. It also investigates the misuse and limitations of these measures. Furthermore, the findings of previous South African studies on CIF/FOB ratios are discussed in Chapter 3.

Chapter 4 explains the methodology behind this research and analyses South Africa's maritime transport costs by comparing direct shipping rates with country import CIF/FOB ratios for different South African export destination countries by means of a correlation analysis.

Finally, Chapter 5 summarises the main conclusions, results, and recommendations shaping this dissertation. This research should promote a better understanding of the use of CIF/FOB ratios as a measure of international transport costs.

CHAPTER 2: LITERATURE REVIEW ON INTERNATIONAL TRANSPORT COSTS

2.1 Introduction

Globalisation has resulted in the impression of a shrinking world (Frankel, Stein & Wei, 1997). Transport costs have declined due to the increased quality and technological advances of communication infrastructure and transportation services. Such improvements have resulted in a reduction in the barrier of transportation time, costs, and distance, which gives an impression of a smaller world (Grammenos, 2010). Moreover, countries' wealth and people's wellbeing has improved as globalisation has resulted in a significant reduction in transport costs and a movement towards trade liberalisation.

Developments around factors involving international trade and technological improvements enhance economic growth, which have had positive impacts on the country's social and economic development (Chasomeris, 2006). Many countries reduce their tariffs as a result of trade liberalisation. Therefore, the effective rate of protection provided by transport costs is now higher than the protective rate of tariffs for several nations (Micco & Perez, 2001). Consequently, transport costs have become one of the primary determinants of countries' international trade performance and are therefore an important non-tariff barrier.

Chapter 2 provides a theoretical and empirical review of past studies on international transport costs. It reviews international trade theories and the theoretical development of transport costs as a determinant of trade performance. Section 2.2 gives an overview of how transport costs were viewed in international trade theories, including classical trade theories, neo-classical theories, and the theory of the new economic geography. Section 2.3 investigates empirical evidence on the impact of transport costs on trade flows. Section 2.4 examines the various determinants of international transport costs, such as distance, geographical location, infrastructure, trade composition, volume and time. Finally, Section 2.5 provides concluding remarks on international shipping costs.

2.2 Transport cost in international trade theories

Transport costs are important determinants of countries' international trade flows and their involvement in international trade. This section revisits the theories on international trade and the development of economic thought regarding the impact of transport costs on trade flow.

Trade theories did not recognise transport cost as a determinant of international trade before Paul Krugman (1979, 1980) introduced transport costs in the new trade theory. For the sake of being thorough, the classical, neo-classical, new trade and new economic geography theories are briefly discussed in the following subsections.

2.2.1 Classical trade theories

In economic thought, international trade theory is one of the oldest divisions, going back to the ancient Greeks. Economists, intellectuals, and government officials have considered the elements of trade between nations for centuries, questioning whether international trade is beneficial or harmful to countries. There has been a divided opinion on trade since its emergence, with one part recognising the many benefits of international trade between countries and another part criticising trade due to its potential threat to domestic industries, culture, and labour. Despite the divided opinions concerning the benefits or harm of international trade in a nation, economists have identified free trade as a driving force behind technological advancement (Hummels, 2007). Therefore, the overall benefits the society gains as a result of international trade are greater than the potential losses connected to imports (Du Plessis, Smit & McCarthy, 1987).

2.2.1.1 Mercantilism

Mercantilism arose in Europe in the seventeenth and the eighteenth century, and is the first methodical thought devoted to international trade. Mercantilism has been specifically extensive in England, and the literature of this period reveals trade-related and economic issues (Magnusson, 1993). While this literature was extensive and involved numerous principles, some central beliefs were frequently repeated and persistent. The fundamental economic objective, as stated by mercantilist authors was to uphold a favourable trade balance, where the price of the exported domestic products surpasses the price of the imported foreign products (Landreth, 1995). If a nation's export value to other countries exceeds the import value, a balance of trade-surplus emerges. A positive trade balance would yield added treasure and a larger stock of precious metals for the country (Maneschi, 2007: 20).

Certainly, the literature of the mercantilists regards imports as unfavourable and exports as favourable for the nation (Magnusson, 1993). Academics have later questioned the thought of mercantilists, as they were confusing an increase in precious metal holdings with a rise in a nation's wealth. Along with the balance of trade, mercantilists were concerned about the

composition of trade. Mercantilists view exports of raw materials as harmful, and the export of manufactured products as beneficial. Similarly, the import of raw material was advantageous for the countries while the import of manufactured products was damaging (Landreth, 1995). Mercantilists thought that the use of raw materials to produce products with added value would upsurge employment opportunities in a higher degree than simply extracting or producing primary products. Adding value to goods was also seen as a means to reinforce the nation's national defense, developing industries, and advance the economy in general.

Mercantilists invigorated government policies to position the trade flow of commerce, thereby supporting these principles. Furthermore, mercantilists desired a highly bureaucratic agenda, where taxes were used to manipulate the trade balance and trade compositions in favour of the country. However, the principles of mercantilism are not applicable in a setting where several countries practice it simultaneously. Not all countries are able to only import raw materials and export manufactured products or have a continual balance of trade surplus (Magnusson, 1993).

2.2.1.2 Free trade and comparative advantage

In the seventeenth century, numerous economists were against mercantilism. Most prominent is Adam Smith and his book *An Inquiry into the Nature and Causes of the Wealth of Nations* (1776). Herein, Smith fortifies completely free trade and highlights its many benefits (Marrewijk, Ottens & Schueller, 2012). His *Wealth of Nations* transformed earlier thoughts concerning international trade with declarations relating to the labour and specialisation divisions, which potentially could boost economic growth (Schaumacher, 2012). Smith believed that a country able to specialise its production will gain better productivity, which is crucial for improved standards of living in the country concerned (Harrison, 2005). However, the market size limits the labour division. In other words, large markets are able to support huge volumes of specialisation, but a smaller market is not able to specialise its production in the same manner. The emergence of international trade serves as an incentive to outspread the size of a nation`s market. Thus, international labour divisions appeared, together with more innovative specialisation and improvements in global productivity and production, which is advantageous for all countries (Smith & Leamer, 1986). Furthermore, Smith is remembered for his perceptive investigation of trade policies as he stipulates the adverse effects of government interventions as well as the benefits of free trade. In the *Wealth of Nations*, Smith criticises mercantilism as its objectives to diminish imports and upsurge exports is reached with the use of export subsidies and import restrictions (Schaumacher, 2012). Smith believed that a few

local industries would benefit from import restrictions. Yet, the consequences would be a monopoly for the manufacturers in the local market, resulting in higher prices and lower competition (Smith & Leamer, 1986). Smith (1776) maintains that trade regulations emerge as a result of the pressure of special interests wanting to lower competition for own advantage, rather than being imposed by independent establishments. Smith believed that trade promotions and government trade restrictions were destructive. Furthermore, Smith emphasised that the best trade policy is free trade unless other observations prevailed that conjecture.

The Wealth of Nations is a response to the mercantilist literature of the seventeenth century which fortified state regulations of trade to increase national wealth and economic growth, protection of the home industry and employment enlargement as well as favourable trade balances (Marrewijk *et al.,* 2012). Smith was studying economic motives underlying free trade policies. However, one issue with Smith's theory of absolute cost advantage remains puzzling to today: "what if there is nothing that a country can produce more cheaply or efficiently than another country, except by constantly cutting labour costs?" (Marrewijk *et al.*, 2012). The point is that developing nations are not competitive in the global market; therefore, they are not able to reap the benefits of international trade (Du Plessis *et al.,* 1987). If a nation cannot produce any products more efficiently than anyone else, it is not able to participate in the global market or benefit from trading goods and services with other countries (Schaumacher, 2012). As the European Union (EU) nations are more effective than Kenya in all sectors with available data, how can then Kenya benefit from trading with the EU? (Marrewijk *et al.*, 2012).

In the beginning of the nineteenth-century, economists supporting free trade were investigating these problems, led by David Ricardo with his book *Principles of Political Economy* (1817). The *classical model* or the *Ricardian model* was the most noteworthy contribution of this period, presenting the theory of comparative advantage (Suranovic, 2010). The Ricardian model is a simplified model where two nations produce two products. The labour and the products are homogeneous, although the level of labour productivity may differ between the two nations. The cost of transportation does not affect international trade in the Ricardian model, and goods are transported to the nations without any costs. The Ricardian model assumes that two nations benefit from trade if both nations manufacture and export goods in which they have a comparative advantage (Feenstra & Taylor, 2008). A nation that can choose between importing products and produce it locally will compare the cost of importing from another country with the cost of producing the same goods locally. If the cost of importing the product is less than the cost of producing it locally, the country will import (Harrison, 2005). The import costs are

subject to the price of the product the country sends in exchange compared to the cost to produce the product if it did not import it, and not on the cost of producing it in the foreign country. In other words, international trade occurs due to variations in countries' labour productivity (Krugman & Obstfeld, 2000). However, countries vary in other ways than their labour productivity only. By investigating at the nation's various resources, the Heckscher-Ohlin model of factor endowment extends the Ricardian model by including countries' factor intensity and abundance (Armstrong & Taylor, 2000).

2.2.2 Neoclassical economics

Eli Heckscher and Bertil Ohlin constructed the basis for the neoclassical model with their Heckscher-Ohlin phenomenon. Their theory attempts to clarify trade actions of different nations and entities (Krugman & Obstfeld, 2000). In the 1920s and 1930s these two Swedish economists from the Stockholm School of Economics laid the foundations for the propositions they believed designed the pure international trade theory. Heckscher is famous for his book *Mercantilist* and is the creator of the factor endowment theory of international trade. Heckscher's pupil Ohlin joined him in his research, and Ohlin received the Nobel Prize in economics in 1977 with his theory of factor abundance and his book *Interregional and International Trade* (1933) which is the most influential literature in the neoclassical model.

Heckscher and Ohlin's factor model is based on the comparative advantage theory, according to which a nation's production patterns of specific products depend on the nation`s input and cost advantages (Krugman & Obstfeld, 2000). Similarly, their theory proposes that countries produce and export products that the countries have in abundance and which factors are cheap. Also, countries import scarcely available products which need costly input resources. The assumptions of the Heckscher-Ohlin model comprise two countries (A and B), two final goods (M and F), and two factors of production, namely capital and labour (K and L). The model is identified as a 2x2x2 model, in which product X is labour intensive and product Y is capital intensive (Du Plessis *et al.,* 1987). Perfect competition is present in all markets, and there is no cost of transportation or other impediments to trade. Capital and labour are completely mobile within a country and between sectors, but immobile between two different nations. Constant return to scale defines the production in both sectors, and the production function in the two nations is identical with comparable technology structures.

The two nations have similar demand structures. However, the number of factors of production may vary between the nations (Krugman & Obstfeld, 2000). These factor abundance variances

are recognised to cause international trade flows. Consequently, a nation produces and exports products which are labour-intensive if the nation is labour abundant (Kwok & Yu, 2005: 1). The labour abundant nation has limited capital, leading to high capital prices and low labour prices. To produce goods cost-effectively, the labour-abundant nation will use more labour and less capital in its production, making the nation labour-intensive. The labour-intensive nation exports its goods to a more capital-intensive nation. Contrarily, a capital-abundant nation will be most cost-effective if it manufactures and exports capital-intensive commodities (Armstrong & Taylor, 2000).

2.2.3 New trade theory

According to traditional trade theories, international trade is subject to the level of skills, factors of production and natural resources of a nation. The assumptions that foreign trade occurs in a perfect world, with constant returns to scale and perfect competition does not hold as transport costs and other barriers to trade do exist and many countries might not have similar levels of technology (Salvatore, 2001). The new trade theory introduced by Paul Krugman (1979, 1980) was the first trade theory to identify transport costs as an international trade determinant. Krugman's new trade theory stated that actual trade patterns do not depend on comparative advantage (Marrewijk *et al*., 2012). With this statement, Krugman questioned the central principles of the neo-classical trade theories. Krugman developed the New Trade Theory in 1980, which is founded on Dixie and Stiglitz`s (1977) model of monopolistic competition. The fundamentals of the new trade theory are that a nation can partake in international trade to advance its welfare, even without having the benefits of a comparative advantage (Brakman, Garretsen & Van Merrewijk, 2001). In fact, most international trade occurs between countries with comparable factor endowments. Hence intra-industry trade takes place where nations trade products that are similar in nature (Brakman *et al*., 2001).

By presenting increasing returns to scales, the new trade theory indicates imperfect competition. Krugman`s model assumes that there exist two nations with similar market size. The factor endowment and technologies of the two nations are identical, and the nations firms produce the same product, although the goods differ in variety. There is an even supply of immobile labours, and identical customer preferences. The principle of love-of-variety effect applies, stating that customers prefer more rather than less product varieties and the product varieties are all imperfect substitutes (Feenstra & Taylor, 2008). The love-of-variety-effect and internal increasing returns to scale both improve a country`s welfare according to the new trade theory.

As the two nations markets expand as they engage in international trade, the market size increases. A larger market allows firms to increase their levels of production and achieve increasing returns to scale. A rise in the manufacture of each product variety emerges, which results in lower product prices for the consumers. Due to fixed market sizes and factor endowments, limited capacity causes less variety to be produced (McCann, 2005). The love-of-variety effect improves a nation's welfare by giving customers more product varieties to choose between. Furthermore, increasing returns to scale provides lower product prices for each variety, raising the customer's real wages (Brakman *et al*., 2001). Brakman *et al*. (2001) explain that the main limitations of Krugman`s (1979) model where the assumptions that transport cost were zero and the location of economic activity were irrelevant. However, Krugman improves the model in 1980 by presenting the cost of transportation between the trading nations through the "iceberg" effect.

Iceberg transport costs were first presented by Samuelson in 1952, who implied that merely a small part of the consignment shipped between two locations arrives at the final destination. The part of the shipment that does not arrive signifies the cost of transportation (Marrewijk *et al*., 2012). The parameter *T* represents the transport costs and defines the number of products that must be transported to ensure that one unit arrives per unit of distance (Fujita & Krugman, 2004). Assuming that the unit of distance is equal to the distance from Oslo, Norway to Milan, Italy. If 107 Norwegian salmons are transported from Norway to Italy, but only 100 salmons arrive, then *T* equals 1.07. The name Iceberg comes from the fact that it is as if some of the goods have melted away during transportation between the two countries (Fujita & Krugman, 2004). Displaying transport costs in this manner is desirable as there is no need to present a transport sector. Krugman's (1980) trade models impact on trade patterns is seen through the "home-market" effect. If firms are confronted with increasing returns to scale and transport costs, a nation will locate close to the largest markets (Krugman, 1980). Transport costs are reduced as the firms are situated closer to the major market, and the concentration of production makes increasing returns to scale possible. The "home-market" effect proposes that firms will export products for which there is a large demand in the home country. The "home-market" effect extended into the new economic geography to further comprehend industries' geographical clustering (Armstrong & Taylor, 2000).

2.2.4 New Economic Geography

The unequal distribution of inhabitants and economic activities across the world is one of the most outstanding features of the global economic system. The distribution of economic activity and countries' residents across space is not only remarkably unequal; it is also remarkably regular regarding pattern across space as well as economic centres' interactions. The question is, however, why these irregularities occur and why economic activities are so unequally distributed (Henderson, 2005). These aspects cannot be explained adequately by applying the neo-classical framework. Imperfect competition and economies of scale relating to some local advantages are particularly vital (Armstrong & Taylor, 2000). Therefore, to endogenously determine the extent of economic activity in various locations in a general equilibrium context is rather challenging. Not surprisingly, this type of general equilibrium determination of economic size was only developed at a later stage, as the right tools for this endeavour in other economics studies were pending on being advanced (Fujita & Krugman, 2004).

Paul Krugman's contribution in 1991 was ground-breaking, and many economists have since published literature on generalisation, applications and refinements in this field of research. The new economic geography (NEG) provides an image of the spatial economy by explaining the collaboration of the forces determining an economy's geographical structure. Armstrong and Taylor (2000) argue that these forces can either push economic activity apart (centrifugal forces) or pull economic activity closer together (centripetal forces).

The NEG model includes transport costs together with descriptions of clustering of economic activity (Fujita & Krugman, 2004). Local growth, economic activity scattering or clustering, as well as the establishment of spatial balances, are all affected by transport costs (Lopes, 2003). The core-periphery model (1991) offers the basic outline for the NEG, as it shows how firm-level increasing returns to scale, factor mobility and transport costs may cause economic structures to materialise and modify (Fujita & Krugman, 2004). The core-periphery model comprises two regions, labelled Region 1 and Region 2. The economy comprises two sectors, namely manufacturing and food. Farmworkers and manufacturing workers form the consumer base for both regions 1 and 2. This model assumes that the farmers are immobile, and the agricultural products are shipped without any transport costs. The agricultural products are homogenous, located in only one of the regions, and constant returns apply.

In contradiction, the manufacturing workers are mobile, the products are heterogeneous through the various forms and located in both regions, the principle of increasing returns to scale apply and transport costs occur through the Iceberg model when moving manufactured products between the two regions (Krugman, 1991). As the farmers consume both food and manufactured goods, they are the centrifugal force due to their immobility. The process of circular or cumulative causation comprises forward and backward linkages and aids in explaining the centripetal forces. The forward linkages occur when the producers are located close to the larger market, and backward linkages occur when the labour is located close to the production site (Fujita & Krugman, 2004).

Krugman (1991) emphasises that a larger number of different products are manufactured if several firms locate close together in Region 1. The increased variety of goods makes the consumers in Region 1 better off than the consumers located in Region 2 when it comes to product choices. Due to the possibility of increasing returns to scale, the labour in Region 1 receives larger wages than the labour in Region 2 (Brakman *et al.*, 2001). The local production of the goods results in no transport costs when moving the goods. As the labour in Region 1 receives higher incomes, the size of the market in Region 1 expands and exceeds Region 2 in size. The higher wages serve as an incentive to migrate to Region 1. Due to higher profitability, a larger number of manufacturing firms are located in Region 1 and the "home-market" effect arises (Armstrong & Taylor, 2000). Region 1 now produces a more significant amount of product varieties, which are exported to Region 2 (Fujita & Krugman, 2004). A firm which is located close to large markets can achieve minimal transport costs as well as increasing returns to scale.

In the core-periphery model, the cost of transportation is positive when transporting between two regions and zero when transporting within a region. Transport costs are the key identifying features of regions (Lopes, 2003). The model defines transport costs as a factor which hinders foreign trade, such as language, culture barriers, tariffs as well as the actual costs involved with shipping a product from one location to another (Armstrong & Taylor, 2000). A tendency for agglomeration characterises the framework of the core-periphery model, and by producing larger volumes of products at one single firm, lower costs occur through internal economies to scale (Fujita, Krugman & Venables, 2001). To be able to export products to the other region, the manufacturer must account for transport costs. Therefore, the manufacturer attempts to locate where the cost of production is minimised and where large-scale production maximise cost savings (Henderson, 2005).

Trade would not exist in a scenario where transport costs are high, as local production is the only option when imports and exports are too expensive (Fujita *et al*., 2001). As a result, production would be scattered to be located where there is demand for the products (Brakman *et al*., 2001). Similarly, there would not be any trade or clustering if the cost of transportation is low (Fujita & Krugman, 2001). The two regions would then be too similar, and none of the areas would have the forces that create inclination for agglomeration such as inter-industry relations (Fujita *et al*., 2001). Transport costs matter for trade and agglomeration in an intermediate range. Manufacturers would locate in an area where there is significant local demand if transport costs are below this threshold level. Exactly at the position where most manufacturers choose to locate, the domestic demand would be large, resulting in trade with the periphery and clustering at the core (Henderson, 2005). The new economic geography concluded that the "home-market" effect and distance between the locations in terms of transport costs serve as incentives to trade, and are, therefore determinants for exports (Krugman, 1991).

2.2.5 Further New Economic Geography Models

The cost of transportation was the critical component when further developments of the NEG attempted to explain the location of economic activity. Krugman developed the NEG model in 1995 and focused on imperfect markets, international trade theory as well as increasing returns to scale. Steininger (2001) explains that Krugman's NEG model consists of three driving forces. The first force, the centrifugal force, is based on firms moving further away from their competitors when they are selling their products to a population which is evenly distributed. The two other forces are centripetal forces which desire a location close to input markets and the customer base. A level of concentration emerges, as production is larger where the cost of transportation is low and spread out where the cost of transportation is high. Trade may be prohibited if the cost of transportation reaches a certain level, where this level is subject to increasing returns to scale and the procedure of these economies of scale. The cost of transportation does not have any impact on trade if these values are large. On the other hand, if the values are low, transport cost might be prohibitive even if the costs are low. For this reason, transport costs influence trade in Krugman's (1995) new economic geography model (Steininger, 2001).

Krugman and Venables developed a model in 1995 that consisted of manufactured and food products in a South and a North region. Their model investigated the effect of falling transport costs on foreign trade. Both regions had to be self-sufficient in scenarios where the cost of transportation was high. Specialisation and two-way trade in manufacturing products occur if the cost of transportation diminishes. Production would move to the North region if the North region increases its share in manufactured production. The intermediate-product manufacturing firms would move closer to the marketplace, and an increase in demand as well as production costs reductions, would emerge. Therefore, an industrialised North region develops due to a circular process. A de-industrialised periphery and an industrialised core develop due to transport costs below a particular level (Krugman & Venables, 1995). If the cost of transportation continues to decline, having a position close to the market turns out to be less vital. Thus, the firms move their location to the low-wage region and manufacturing goods production diminishes in the North region and moves to the South region. Krugman and Venables` model therefore explains that decreasing transport cost is the sole reason for the change in a firm's location in the long-term.

Venables` model, developed in 1996, examined how location influenced imperfect competitive vertically connected manufacturers. In Venables` (1996) model, the workers are immobile, and the industries relate to an input-output framework where one industry is upstream, and the other is downstream (Alonso-Villar, 2005). The demand linkage appears when the upstream industry firms locate in an area where there are large numbers of downstream firms, as the upstream industry develops the downstream industry market. To save costs on the delivery of intermediate goods, downstream industry firms choose to situate close to a large number of firms in the upstream industry (Venables, 1996). The latter link is named the cost linkage, and together with the demand linkage, it creates forces for clustering in one particular location. Forces for dispersion form through the consumer and immobile labourer's locations. The cost of transportation, as well as the vertical integration strength of the firms formed the equilibrium among these forces (Alonso-Villar, 2005). However, there is not a monotonic relationship amongst agglomeration and transport costs in Venables` model. The spatial configuration would occur on the customer's demand, if the cost of transportation were high. Simultaneously, economic activity dispersion would develop due to a spread population. Vertical linkages cause spatial distribution in the cost of transporting intermediate products and results in production agglomeration. Scattering of economic activity would again occur if transport costs were low, due to high incomes related to industrialisation (Alonso-Villar, 2005).

Puga (1999) compiled a comprehensive framework that connects findings from Krugman (1991), Krugman and Venables (1995) and Alonso-Villar (2005). Puga (1999) argued that convergence or agglomeration is caused by either immobility or mobility of workers in response to salary variances. A location experiences full agglomeration if the cost of transportation is low and the labour is mobile. On the other hand, low transport costs together with immobile labour create dispersion. High transport costs provide dispersion through regions to be able to satisfy customer demand. Where transport costs decrease, agglomeration of increasing returns to scale activities emerges due to cost and demand linkages (Alonso-Villar, 2005). Alonso-Villar adds to the clarifications of agglomeration's non-monotonic behaviour. Alonso-Villar (2005) holds that low transport costs affect intermediate and final goods differently. By analysing final and intermediate product industries separately, Alonso-Villar (2005) observed transport costs impact of on both intermediate and final goods on the spatial spreading of production. The high transport cost of intermediate products causes divergence, and transportation improvements between the downstream and upstream firms result in regional convergence. However, trade facilitation between consumers and firms is not a result of transportation. With her findings, Alonso-Villar (2005) contributed to the enlightenment of the non-monotonic behaviour of clustering.

New economic geography theories evidently included firms' location and transport costs in their models. It can be concluded that the cost of transporting goods from one location to another serves as a hindrance to trade as it deteriorates the terms of trade and reduces the trade volume (Du Plessis *et al*., 1987). Transport costs therefore are important determinants of trade that must not be overlooked.

2.3 The effect of international transport costs on trade and growth development

Prior to the introduction of the new trade theory, economists did not consider transport costs, the distance between the trading partners and other geographical aspects to be trade determinants. According to Frankel *et al*. (1997), nations used to be treated as intangible objects without a physical location. The reason for the lack of research on these important geographical aspects might be that the goal of past research was merely to explain the composition and quantities of a country's total trade volumes, irrespective of the country's trading partners (Rietveld & Vickerman, 2004). More recently, research analysing transport costs and its effect on trade and economic growth has emerged. Most research finds that transport cost reductions were only one among several factors responsible for increases in exports, and thus for economic

growth in a country; the contributing factors being the increasing quality of transport, a movement from air transport to ocean transport, trade barrier reductions as well as the introduction of containerisation (Radelet & Sachs, 1998). Evidence on transport costs and its implications as a trade barrier are presented in the following section.

2.3.1 Transport costs as a trade barrier

The classical trade theories did not consider the geographical measurements of trade, and no interest in enlightening bilateral trade was observed (Krugman, 1998). Standard trade theories centre on the assumption of constant returns to scale and perfect competition, which makes it challenging to analyse several geographical impacts. Krugman (1998) recommends that, to be able to model questions regarding where industries decide to locate, assumptions regarding increasing returns to scale and imperfect competition are required. Due to the absence of analytical tools, research conducted before the time of the new trade theory did not investigate the effect of geographical factors on trade (Frankel *et al.*, 1997). However, transport costs form an important barrier to trade and need empirical and theoretical research.

Transportation is about diminishing the natural obstacle of distance by moving products or individuals from one location to another. The cost divergence between domestic and foreign prices due to the cost of transportation explains why some goods are not traded between certain countries. However, reductions in transport costs as a result of technological improvements can turn previously non-traded products into traded products. Also, lower-priced foreign products may serve as substitutes for higher-priced domestic products, provided the transport costs are low. Conversely, local producers are offered a level of protection if the transport costs are high. Either way, it is the final consumer who ultimately bears the price of the transport costs, as is the case with all other production costs (McConville, 1999).

The partial equilibrium analysis has been used in several studies of international trade to evaluate transport costs' impact on global trade. In these studies, it becomes evident that transport costs influence the final import price of a product, and that lower prices make it more likely to be exported to the target market. However, this analysis has shortcomings, as it assumes that the total transport costs are divided equally between the importer and the exporter (Chasomeris, 2006). The party ultimately bearing the cost of transportation does, however, depend on the price elasticity of supply and demand (McConville, 1999). The elasticity of supply and demand is the proportionate ratio of change in quantities supplied or demanded due to a small proportionate change in price. Fixed supplied quantities represent a perfectly inelastic

supply curve in the short run (Figure 2.1b). Presenting transport costs in this scenario would have no effect on the price of the product, and the producer or shipper bears the total cost of transporting the product (Salvatore, 2001). Contrarily, where demand is perfectly inelastic, the quantity demanded will not be affected by an increase in the price of the product (Figure 2.1a) (Coe, Kelly & Yeung, 2012).

a)

b)
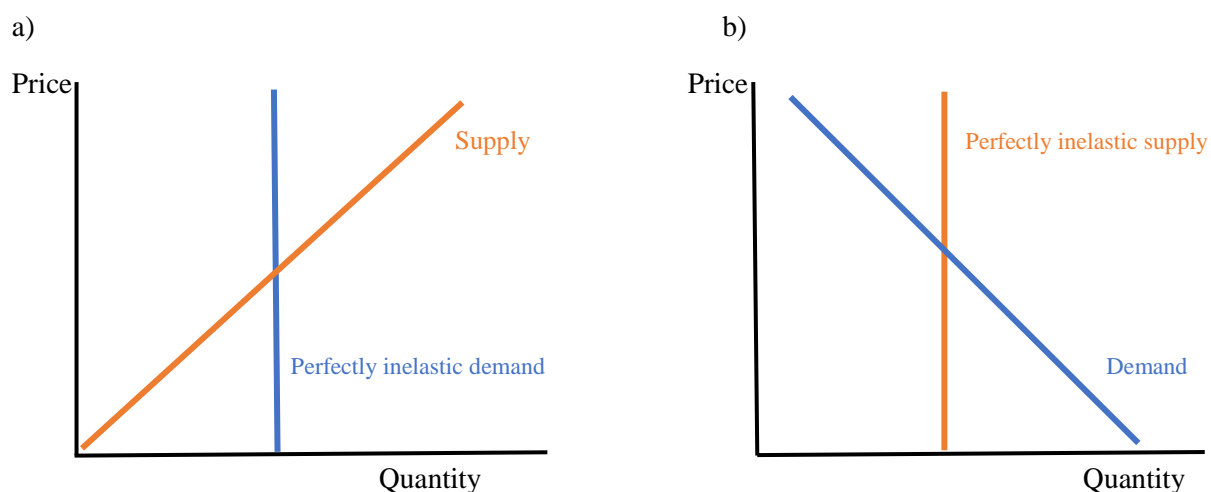
Figure 2.1: Perfectly inelastic supply and demand

Source: Author`s own construction

The price will include the cost of transportation, and the purchaser bears the total cost of transportation. In summary, when the demand for a product is perfectly inelastic, the total transport costs lie on the purchaser of the product. Hence the proportion of the transport costs levied on the purchaser, supplier or shipper of the product depends on the price elasticity of supply and demand (Hornok & Koren, 2015). Trade will take place in cases where the price of a product, including the cost of transportation, is less than the price of the product produced domestically. According to McConville (1999), any changes in the transport costs or price of the product could lead to a considerable alteration of this circumstance. Therefore, the import CIF price must be lower than the domestic price for trade to take place.

Within a free-trade area, modifications in international transport costs can lead to changes in the trade levels in several different ways. Firstly, increases in transport costs might result in an increase in the domestic price of imported goods. Furthermore, an increase in price might result in a decrease in consumption of the product in question. Lastly, import levels may fall as international transport costs encourage the domestic production (Salvatore, 2001). If transport

costs became so high that it eliminates international trade, local suppliers would have to bear the total responsibility of supplying products (McConville, 1999).

International transport costs result in discrepancies between foreign and domestic prices. The economic effects of transport costs are similar to the effects of tariffs and other impediments to trade (Chasomeris, 2006). According to Kindleberger (1968), a decrease in transport costs relative to production costs acts in the same manner as a reduction in tariffs. As a result, trade relative to output expands in already traded items, and products previously traded on a strictly domestic basis turns into internationally traded commerce. Likewise, when domestic prices drop due to a decline in transport costs or tariffs in competitive markets, it serves as an incentive for consumption and a discouragement to produce local products. Import levels increase as it represents the difference between domestic production and consumption (Hornok & Koren, 2015). Simultaneously, export consumption declines and production of exports increases. Thus, total trade increase due to the rise in export volumes (Rose, 1991). Consequently, high transport costs serve as an anti-export bias resulting in decreased international competitiveness (McConville, 1999). A reduction in transport costs might therefore directly stimulate as well as facilitate growth in international trade.

2.3.2 Trends in international transport costs

Transport costs have changed over time. The introduction of containerisation, technological advancement and automatisation has been a positive incentive towards lower costs of transportation (Estevadeordal, Frantz & Taylor, 2003). Larger vessels encourage economies of scale. However, these improvements have resulted in larger differentiations in transport cost between ports, as small ports located far away from major markets benefit to a lesser extent than deep water, automated ports which can host larger ships. Additionally, the evolution in transport costs implies that the effect of distance on trade has changed. The introduction of larger and faster vessels now makes it possible to transport larger volumes of merchandise goods over large distances. The larger vessels must, however, use longer transport routes, as the Suez and Panama canals, for example, restrict access due to vessel size. The transport routes with large trade volumes realise the fullest extent of economies of scale, creating a larger gap between small and large trading nations' transport costs (UNCTAD, 2009).

A relevant question to consider is whether or not transport costs have decreased. Over time, manufactured goods have become less heavy and smaller and lighter products frequently substitute heavy, bulky manufactured goods. The price per weight has increased, as

manufactured goods and processed food represent an increasing share of the traded goods (Korinek, & Sourdin, 2010). Improvements in technology, labour cost variations, and increased efficiency have resulted in a decline in the price of many products. Concurrently, evolutions in production processes have resulted in a significant decline in the price of some goods. However, target branding and increased quality of products result in an upsurge in the price of several products (Korinek, & Sourdin, 2010). Therefore, a country's import basket is a major determinant of transport costs.

The UNCTAD`s *Review of Maritime Transport* stated that maritime transport costs have decreased only marginally between 1980 and 2005. Maritime transport costs accounted for 8% of the final cost of a good in 1980, and just below 6% in 2005 (UNCTAD, 2005). The maritime transport cost of developing countries dropped from 8.5% of the price of goods in 1980 to 7.7% in 2005. Developed countries experienced a slightly larger decline in their maritime transport costs, as the cost of transport was 8% in 1980 and 4.8% in 2005 (UNCTAD, 2005). The economic crisis in 2008 strongly influenced the maritime transport costs, as global consumption and production patterns affect transport costs. Consequently, the overall freight rates dropped drastically in 2008 (UNCTAD, 2009).

Maritime transport costs reached historically low levels in 2015, in most sectors. These low levels were a result of an oversupply of new tonnage and weak demand (UNCTAD, 2016). However, due to the exceptional and lingering decline in the oil price, the tanker sector continued to be strong. A steady decline in the container segment emerged, resulting in record low prices due to low demand and ever-larger container vessels entering the market in 2015. Consequently, 1.7 million TEUs were added to the global fleet (Clarksons Research, 2016). The additional TEUs add significant pressure on the freight rates, and the average spot freight rates on all trade lanes dropped markedly. The Far East-Northern Europe route freight rates were as low as US$ 629 per TEU on average, representing a decline of 46% since 2014 (UNCTAD, 2016). Trade routes which previously experienced strong growth in demand also faced low freight rates in 2015. The Transpacific Shanghai-United States West Coast freight rates were US$ 1 506 on average per 40-foot equivalent unit, representing a fall in the freight rates of 23.55% since 2014 (UNCTAD, 2016).

UNCTAD`s *Review of Maritime Transport* apply IMF data to conduct import CIF/FOB ratios for country groups. Import CIF/FOB ratios per country group for 1970, 1980, 1990 and 1997-2003 were calculated by Chasomeris (2006) (see Section 3.3.2 for a detailed description of CIF/FOB ratios). In all regions, developing countries' maritime transport costs were

considerably higher than the average shipping costs for developed nations. The world`s CIF/FOB ratios were 1.054 in 2003, representing an *ad valorem* transport cost of 5.4%. As developed nations represent 70% of the world's total imports, these relatively low CIF/FOB ratios are mainly a result of the developed nations' low transport costs of 3.9% (Micco & Perez, 2001). When comparing the 2003 CIF/FOB ratios with the 1970 ratios, it becomes evident that maritime transport costs for both developing and developed countries over this period have declined considerably.

As technological improvements reduce transit times and port delays, the cost of shipping is, without a doubt, declining for all nations over time (Busse, 2003). However, as the IMF only updates its CIF/FOB ratios on an infrequent basis, this decline is regrettably not evident in the IMF ratios as they do not display a substantial time trend (Hummels, 2001). Developed nations' maritime transport costs of 3.90% in 2003 are approximately half of the shipping costs for developing nations and other country groups. Latin America had the lowest maritime transport costs of 7.02% in 1997 compared to other developing nations. Oceania and Africa usually represent the highest maritime transport cost, and Africa`s shipping cost was 11.9% of total imports in 2003, and Oceania`s maritime transport cost was 12.3% in the same year. African developing nations faced the highest transport cost among the country groups. An area of concern is the significant increase in CIF/FOB ratios from 11% in 1990 to 12.97% in 2000.

The African Development Report published some interesting results after comparing the transport costs of all the world`s regions in 1980, 1990 and 1994. The report displayed evidence of significant decline in transport costs in all the regions, except from Sub-Saharan Africa (SSA) which saw an increase in transport costs between 1980 and 1994 (African Development Bank, 2004: 172). By 1994, SSA had the highest transport costs in all regions in the world. Approximately 28% of the SSA population lives in landlocked areas, where the CIF/FOB ratio was 13.84% in 2003 (Bloom, Sachs, Collier & Udry, 1998: 239; UNCTAD, 2003). Most regions experienced a moderate reduction in transport costs. However, by 1994 the transport costs were below 10%.

According to Anderson and Van Wincoop (2004) the global trade in high-value-to-weight manufactures has increased at a faster rate than trade in low-value-to-weight primary goods. Airfreight charges have decreased radically, while ocean shipping cost has increased together with the growing use of containerisation. This advances the quality of the shipping facility (Hummels, 2001). Furthermore, Hummels (2001) researched the extensive distribution in the rate of change of air-freight charges through country pairs, since the 1960s. Together with Non-

Tariff Barriers and tariffs, transport costs appear to be equivalent in average magnitude and variability through countries, across commodities as well as time. Transport costs are commonly higher in bulky agricultural goods in the Organisation for Economic Co-operation and Development countries (OECD) where the protection is similarly higher (Anderson & Van Wincoop, 2004). In contrast to Hummels` (2001) findings, Crafts and Venables (2001) concluded in their research that transport costs in ocean-freight, in fact, have declined drastically over time. Glaeser, Porta, Lopez-De-Silanes and Shleifer (2004) notes that international transport costs declined with 90% in the 20th century. Crafts and Venables (2001) found that airfreight costs declined by 63% between 1950 and 1990 and ocean freight declined with 83% between 1750 and 1990 (Dollar, 2001).

2.4 Determinants of international transport costs

Transport costs are an important consideration for all countries involved in international trade (Normizan & Yasunori, 2014). Transport costs connect to several external factors of the nations involved with the transportation of a product from its origin country to its destination country (Venables & Limão, 2007). The combination of distance, deprived infrastructure, and possibly also being a landlocked country surrounded by neighbours with limited infrastructure, can result in the transport costs being considerably higher for some developing nations than for developed nations. This section investigates the different variables influencing a country's transport costs by examining the effect distance, geographical location, infrastructure, trade composition, trade volume and time have on trade flows.

Countries' transport costs vary greatly. With reference to Radelet and Sachs (1998), several reasons for these variations have been established, with the most important being a country's internal and external geographical attributes. The countries that are located farther away from major markets are clearly facing higher transport costs. Secondly, countries that need to cover larger proportions of transport by land are facing higher transport costs as inland transportation charges exceed the cost of sea transport. Thirdly, economies in need of inter-modal transportation methods will experience higher overall transport costs, due to the additional cost of transferring the goods between the different transport modes (Harrigan & Venables, 2006). Lastly, the port infrastructure and quality of port administration have a large impact on a country's shipping costs. Countries with poor infrastructure, cumbersome red tape, and corruption in the customs departments are facing higher levels of total shipping costs, compared

to ports with a superior overall quality and efficiency (Bougheas, Demetriades & Morgenroth, 2003).

Countries' internal geographical attributes affect transport costs since the ease of accessing ports is influenced. Landlocked nations with poor infrastructure will struggle to reach major export markets and are therefore at a competitive disadvantage. Moreover, a country which can increase its trade volumes may benefit from diminishing average costs. Large-scale importers usually experience lower freight costs for similar products, as they face a 12% reduction in shipping costs when trade volumes between two nations are doubled (Hummels & Skiba, 2004). Transport costs tend to be higher in countries that practice trade policies of a restrictive manner. Variations in export unit values might also influence the cost of transportation due to inductance charges, transferring products from one mode of transport to another as well as discrimination among shipping associations (Martínez-Zarzoso & Suarez-Burguet, 2001).

2.4.1 Distance between trading partners

The transportation costs involved in a transaction of a good across borders increase as the distance gets longer (Anderson & Van Wincoop, 2004). Distance therefore is a frequently used explanatory variable in the determination of trade flows. Micco and Perez (2002) found that, if the distance between two trading partners increases with 100%, the transportation costs rise with 20%. Approximately 50% of global trade takes place among nations situated within 3 000 kilometres from one another (European Conference of Ministers of Transport 2004). Martìnez-Zarzoso & Suarez-Burguet (2001) found that transportation costs rise with 0.25% when the distance increases with 1%. The distance elasticities of trade are often used to determine the effect of distance on trade volumes.

Studies by Radelet and Sachs (1998), Hummels (2001) and Coughlin (2004) have concluded that larger distances between trading partners result in lower trade flows. However, more frequent shipments and main routes are occasionally cheaper even if it is further away. Distance is costly due to supplementary costs of transportation, communication costs, search costs and time costs of transporting products that are time-sensitive. Consequently, countries located 500 kilometres away from one another tend to trade 2.57 times more with one another than countries located 1 000 kilometres apart (European Conference of Ministers of Transport, 2004). According to Carrere and Schiff (2004), the distance of trade has declined over time for most countries on average. Put differently, distance has become more important over time for many countries. Contrarily, Hummels (2007) studied the United States` transport costs of

manufactured goods for air and ocean freight between 1951 and 2004, and found that trade over longer distances have turned out to be less costly than trade over adjacent distances.

Exporting countries located far away from their buyers obtain lower prices for their products than do exporting countries that are located closer to its target markets, as the transportation costs will negatively affect the export revenues (Disdier & Head, 2008). Likewise, farther located countries must pay higher prices for their import products because due to higher costs of transporting the goods to the destination country (Fujita, 2012). Limão and Venables (2001) found that when shipping a standard container from Baltimore to various nations worldwide, the transportation costs rise with US$ 380 for every extra 1 000 kilometres. Transporting a shipment using overland transport in addition to sea transport, increases the cost of transport considerably due to the high costs of overland transportation. An additional 1 000 kilometres distance with the use of overland transport increases the transportation costs with US$ 1 380, compared to only US$ 190 per 1000 kilometres for sea transport (Limão & Venables, 2001).

2.4.2 Geographical location

Transportation costs are one of the fundamental explanations on the central role of geography in international trade. The relationship between a nation's geographical location and international trade is highly important and has been in focus since the time of Adam Smith in his book *The Wealth of Nations*. A country that is located closer to the coast and rivers is more likely to develop an extensive labour division, as the transportation costs are lower. With the use of transportation by water, more extensive markets develop for all types of industry (Radelet & Sachs, 1998). The use of sea transport results in development and sub-divisions of all industries at the coasts and navigable riverbanks. These improvements extend shortly into the inland areas of the nations. Contrarily, the lack of navigable rivers leading to inland economies in Africa serves as a disincentive towards economic development and trade. Thus, geographical attributes have a large impact on the elaboration of a country's manufactured exports.

According to Radelet and Sachs (1998), a country with long coastlines relative to its total land area has larger manufactured export growth compared to countries with shorter coastlines. A country with long coastlines has a larger number of ports and easy access to the sea. Therefore, the focus on international trade-related activities tends to be more widespread for nations endowed with longer coastlines (Faye, McArthur, Sachs & Snow, 2004). Redding and Venables (2002), found that economies located in remote areas are experiencing disadvantages as their imports are somewhat expensive due to the high transportation costs involved with trade. These

high import prices also include essential imports such as capital goods and fuel. Remote locations with high transport costs are experiencing large competition on their exports, and they are undesirable to prospective investors who are searching for new locations to produce goods for further exportation (Redding & Venables, 2002).

Landlocked countries suffer from a significant disadvantage compared to coastal countries, as their cost of transportation can be as much as 50% higher (Limão & Venables, 2001). For a landlocked country, the transportation cost can increase with up to US$ 2 170. Put differently, being a landlocked country places the nation 10 000 kilometres farther away from its destination markets than a coastal country (Clark *et al.*, 2004). Approximately one out of five of the world's nations is landlocked (Arvis, Raballand & Marteau, 2007). Twenty out of fifty-four low-income nations are landlocked, with most of these countries located in Sub-Saharan Africa (Yeats & Amjadi, 1999). Contrarily, only three out of thirty-five high-income countries are landlocked (World Bank, 2010). Stimulating trade in landlocked countries is important, as this is one of the reasons for these countries to not be able to take full advantage of international trade (Arvis *et al*., 2007).

Gallup, Sachs and Mellinger (1999) investigated the relations between a nation's economic growth, geographical location and trade, and how this influences the cost of being a landlocked country. On average, a landlocked nation trades 30% less than a coastal country (Behar & Venables, 2010). Landlocked nations are expected to have lengthier IMF aid compared to coastal countries (Arvis *et al.,* 2007). The economic growth patterns of landlocked countries tend to be lower, as being landlocked reduces average growth with roughly 1.5% (Radelet & Sachs, 1998). The import prices increase due to the high customs and handling charges involved in border crossings, which results in a reduced amount of export revenue for the landlocked countries (MacKellar, Wörgötter & Wörz, 2000).

Furthermore, cross-country factors and externalities play an important role in international trade. This is evident in landlocked nations, which depend on their neighbouring nations' infrastructure and policies. The World Trade Organisation (WTO) is working on suppressing these effects. However, when it comes to investments in transportation systems, the WTO has failed to increase the cooperation between nations (Arvis *et al*., 2007). The United Nations (UN) is focusing on aiding the landlocked nations by relieving them from some of the challenges they are facing. The Almaty Programme of Action of 2003 (AMPoA) assists with a view to improve or create regional transport networks, freedom to transit as well as encourage cooperation on an international level (Arvis *et al*., 2007). According to the World Bank (2009),

infrastructure projects on a regional basis will result in a decrease in transport costs and will increase the volumes of trade for many nations and their neighbouring countries.

Landlocked Developing Countries (LLDCs) is the country group with the most severe challenges when it comes to economic growth and development (United Nations, 2013). Their disadvantageous geographical location with the lack of coastlines, high transport costs and remoteness from major markets serves as disincentives for international trade participation (United Nations, 2013). For example, in 2012 an LLDC faced an average total cost to export and import a container of US\$ 2 630 and US\$ 3 252 respectively. These costs are much higher than the costs faced by Least Developed Countries (LDCs), which must pay US\$ 1 860 to export and US\$ 2 294 to import the same container (International Centre for Trade and Sustainable Development, 2014). LLDCs' contribution of merchandise export to the total world exports remains below 1%. LLDCs are found in Africa, Latin America, and Asia, and represent 10% of the developing world`s population. A total of 40% of the world's inhabitants living under one dollar a day is situated in LLDCs. The countries' geographical locations are represented in their levels of economic and social development. Consequently, LLDCs are among the poorest countries in the world, and 16 of the 31 LLDCs classify as Least Developed Countries (LDC) (UNCTAD, 2011).

2.4.3 Infrastructure

A country's infrastructure is another key factor determining transportation costs. High-quality infrastructure can counter-balance a country`s disadvantageous geographical location. Infrastructure plays a crucial role in a nation's economic growth, development, productivity and trade costs (Bougheas *et al.,* 2003). The onshore infrastructure quality is essential for determining countries' transportation costs as it explains 40% of coastal nations' projected transportation costs and 60% of a landlocked nations' transportation costs (Limão & Venables, 2001). The infrastructure quality on the transit route of a country plays an important role in predicting the transportation costs involved in a particular transaction. Limão and Venables (2001) found that if the quality of the infrastructure in the destination country improves with one standard deviation, the cost of transportation will decline by an amount equal to a reduction of 1 000 kilometres of overland distance or 6 500 kilometres by sea. Similarly, if the destination country's infrastructure improves with 1%, transport costs decrease with 0.14%. Put differently, transportation costs are higher if the quality of the infrastructure in the partner country is poor. Also, an increase in a country's seaport operating efficiently from the 25th to the 75th percentile

reduces the ocean transport costs with 12% (Clark *et al*., 2004). As a result, bilateral trade increases with approximately 25%. Evidently, a country's infrastructure quality has an explanatory power in estimating trade volumes. Similarly, a country with poor overall infrastructure can reduce its transportation cost with up to 30% to 50% by increasing its general infrastructure quality from the 25th to the 75th percentile on an international ranking scale (Micco & Serebrisky, 2004). A port which is ranked 75th internationally is comparable with being located sixty kilometres farther away from markets, compared to countries with ports ranked as 25th internationally (Clark *et al*., 2004). Improvements in the quality of infrastructure are crucial for developing nations to take part in globalisation and increasing their participation in international trade. The low quality of infrastructure in large parts of Africa to a large extent explains the poor development and trade patterns in the Africa continent. A cost-benefit analysis is often conducted to calculate the outcome of infrastructure investments. Buys, Deichmann and Wheeler (2010) estimated that an extension of the road network in Africa would raise trade by a value of US$ 250 billion over a 15-year period.

2.4.4 Trade volume and composition of trade

Transport costs are affected by "circular causation", as trade volumes influence the cost of transport. Nations which can produce large shipment volumes might yield the benefits of favourable freight rates, as economies of scale reduce the per unit transportation cost. Research conducted by Clark *et al*. (2004) show that increasing returns to scale are rather common in ocean transport. According to Fuchsluger (2000), the owner of a ship capable of transporting 200 TEU[5] containers to Buenos Aires must pay US$ 70 per container. Conversely, if the ship is of the type 1000 11 TEU, the rate per container will be merely US$ 14 (Clark *et al*., 2004). However, congestion costs increase due to high trade activities, which ultimately increases the total cost of transportation. By investigating import and export variances, Blonigen and Wilson (2007) concluded that the effect of economies of scale is marginally weaker than the effect of congestion.

According to the World Banks` World Development Report (2009), the variation in costs between a Panamax[6] unit of 4 000 TEU and a mega post-Panamax[7] unit of 10 000 TEU are

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[5] TEU: twenty-foot equivalent unit (equal to one container).
[6] Vessels which are classified as Panamax are of the maximum dimensions that will fit through the Panama Canal. These dimensions are 294.1 meter in length, 32.3-meter width and 57.91-meter high. Panamax vessels can transport 5000 TEU.
[7] Post-Panamax: or "over Panamax" refers to ships that are larger than Panamax and do not fit in the Panama Canal.

50% on the trans-Pacific route. Large trade volumes and efficiency are necessary to exploit these cost advantages, as economies of scale are present also in the cost of transportation. In 2009, the cost of transporting a container to the United States from China was approximately US$ 400 and US$ 800 from India and US$ 1300 from Sierra Leone. The large trade volumes from China are most likely the reason behind their low transportation costs (World Bank, 2009). Furthermore, the declining transport costs in China serve as an incentive for other countries to move their production to China. Economies of scale represent a reduction in transport costs, which again supports a further rise in trade volumes (World Bank, 2009).

Furthermore, countries' directional imbalances in trade result in shipping companies having no choice but to return empty containers, leading to an increase in the costs of either exports or imports. Research shows that 72% of the containers being shipped to the United States from the Caribbean in 1998 were empty (Fuchsluger, 2000). Thus, this represented a supply excess in the northbound shipping route which implied that the exporters of the United States were charged an additional 83% for the same products compared to the importers of the country, between Miami (USA) and Port of Spain (Trinidad and Tobago). Based on research conducted by Fuchsluger (2000), exporters located in Asia paid 50% more in transportation charges than European and United States suppliers, due to a surplus of supply on the Asian-European and the Asian-United States shipping routes.

The composition of trade is an additional explanation of variation in nation's transportation costs. A product with a high unit value is facing greater weight unit charges due to the insurance component of shipping costs (Azarnert, 2016). The insurance charges are approximately 15% of the total shipping costs and 2% of the value of the good being traded (Clark *et al.*, 2004). Consequently, countries exporting value-added products are facing a higher weight unit charge, when considering the insurance component. The countries' transportation costs may also differ due to special freight requirements linked to certain goods.

Academics often assume the composition of imports to be constant, although they might agree that changes in import compositions possibly could affect a country's CIF/FOB ratios. According to theory, an increase in the proportion of low-value imports results in an increase in CIF/FOB ratios, and a rise in high-value imports causes the CIF/FOB ratios to decline, *ceteris paribus*. Chasomeris (2006) suggested that Africa's increasing CIF/FOB ratios from 11.36% in 1998 to 12.87% in 2000 is a result of significant changes in the continents' composition of imports. Globally, there has been a decrease in its CIF/FOB ratios the last decades, from 7.75% in 1970, 6.64% in 1980 and 5.22% in 1990. However, in 2000 the world CIF/FOB ratios

increased to 6.21 (Chasomeris, 2006). Please see Chapter 4 for the latest figures on South Africa`s CIF/FOB ratios.

Instead of viewing these trends as changes in direct shipping costs, the changes might be evolving import compositions. The increase in manufactured goods as a proportion of total imports would contribute towards a decline in the world CIF/FOB ratio. Similarly, a decline in oil imports as a proportion of total import would lead to a decline in world CIF/FOB ratios (Chasomeris, 2006). Even if information on the world's actual CIF/FOB ratios was not available, an observation of the evolution of the world's import composition suggests that the ratios might be considerably lower in 1990 than in 1980 (Chasomeris, 2006). However, the world`s CIF/FOB ratios rose in 2000. An investigation into the world`s freight markets supply and demand characteristics explain this increase. The upsurge in sea transport demand in 2000 increased the general freight rates for time-and-trip charters, tankers and containerised routes (UNCTAD, 2001). Contrarily, analysing the world`s import composition shows that the increase in oil (SITC-3) as a proportion of total imports contributed towards the high CIF/FOB ratio in 2000, mainly as a result of the 57% average annual increase in the price of crude oil. Therefore, ignoring or assuming that the composition of imports is constant, seems to be a questionable and intolerable practice.

2.4.5 Trade time

The time it takes to transport a product from the exporting country to the importing country is an important consideration in international trade. Depreciation and the cost of holding inventory are levied on the shipper if the transit time of a shipment is lengthy (Hummels, 2001). When the sea transit time increases with one day, the probability of trade between two countries declines with 1%, or approximately seventy kilometres (Djankov, McLiesh & Ramalho, 2006). According to Hummels and Schaur (2013), there is willingness-to-pay for saved time, which varies between countries. For manufactured goods, a one-day reduction in shipping is worth 0.8% *ad-valorem* (Hummels, 2001, 2006, 2007). In other words, a twenty days' sea voyage is similar to a tariff of 16%. The world saw a thirty-day decline in shipping time on average between 1950 and 1998, as containerisation doubled the speed of sea freight and the share of US imports increased (Hummels, 2001). The reduction in the shipping time equals a reduction in shipping cost valued at 12% to 13% of the price of the good shipped (Hummels, 2001). Time is particularly important for time-sensitive goods. If the transport time increases with 10%, the export of time-sensitive goods declines with 5% (Djankov *et al*., 2006).

Transportation cost reductions coupled with time sensitivity largely affect trade growth and composition. Furthermore, trade volume variations are a result of handling delays. If Uganda could reduce its transit time from fifty-eight days to twenty-seven days, this would be equivalent a 2 200 kilometres reduction of trade distance to the country's trading partners (Djankov *et al.*, 2006). Time savings has become less expensive due to decreasing shipping charges, which can explain the rise in aggregate trade growth and compositional effects. Furthermore, the increase in transportation speed experienced from the year 1950 to 1998 represents a tariff reduction from 32% to 9% on manufactured goods (Hummels & Schaur, 2013). The improvements in the quality of transportation services are now investigated broadly and find transit time to be highly valuable (Djankov, Freund & Pham, 2010). The time it takes to transport a product has decreased over the years which also contributed towards increased trade volumes (Hummels & Schaur, 2013). Due to the rise in transportation speed, more time-sensitive products such as agricultural or fashion items are now traded globally.

The "just-in-time" (JIT) approach is renovating the global production patterns by establishing worldwide cooperation with the use of production networks. JIT purchasing grants firms the possibility of avoiding holding significant amounts of inventory, which results in cost savings (Hummels, 2001). Production can also be deferred in times of uncertainty when using the JIT approach (Nordås, Pinali & Geloso Grosso, 2006).

2.5 Concluding remarks

Chapter 2 provided an overview of past research and findings regarding factors influencing transport costs and their effect on international trade volumes and patterns. The implications of high transport costs are elucidated, emphasising the importance for countries to identify and deal with factors responsible for raising the transport costs. High transport costs are a significant disincentive towards international trade and make a country less competitive in global markets. As the world has moved towards trade liberalisation strategies, barriers to trade have been drastically reduced in the past decades. Trade liberalisation policies have resulted in less protection of domestic firms and increased competitiveness among businesses worldwide. A country's most essential non-tariff barriers are trade costs where transport costs are the primary element. Transport costs now serve as a higher rate of protection than do tariffs. A country with high non-tariff barriers will have a reduced level of competitiveness in the global market. Lower transport costs are identified to be the driving force behind increasing international trade and

economic growth, although they have not decreased in an even manner, as air transport costs have declined, and the cost of sea transport has increased.

Transport costs were first introduced in the theories of the neo-classical economics, although in these theories, transport costs were not considered a determinant of trade. However, this principle does not apply in reality, as transport costs are proven to affect the patterns of foreign trade. Transport costs were again introduced through the "iceberg" method in Krugman's new trade theory. Consequently, transport costs play the leading role in the new economic geography, as it is identified to cause scattering or clustering of economic activity. From the evolvement of trade theories, it is evident that the more recent theories started to acknowledge the importance of transport costs and its effect on international trade and economic growth.

The empirical studies conducted on this topic further support the theory that transport costs affect international trade. A country's costs of production increases as high transport costs raise the price of imports and decrease the earnings of exports. Transport costs differ significantly among countries, due to nations' various geographical locations and attributes as well as infrastructure quality, import composition, and trade volumes. Landlocked countries tend to have higher transport costs than do coastal countries as they have limited port access and depend on their transit counties' infrastructure and policies. The Landlocked Developing Countries (LLDCs) are among the poorest countries in the world, and their challenging geographical location hinder their participation in international trade. A country's composition of imports highly affects transport costs. An increase in the volume of low-value imports results in an increase in CIF/FOB ratios and an increase in high-value imports will cause the CIF/FOB ratios to decline, *ceteris paribus*. Consequently, researchers should not assume the composition of imports to be constant. Furthermore, nations which are able to produce large volumes of products will benefit from lower freight costs due to increasing economies of scale.

International transport costs can be measured by using direct or indirect measures. Direct measures include freight cost data collected from shipping companies, while indirect measures use the distance between the trading partners or a country`s CIF/FOB ratio to calculate transport costs. Chapter 3 explains in detail the different measures of international maritime transport costs.

CHAPTER 3: MEASURING INTERNATIONAL TRANSPORT COSTS

3.1 Introduction

Transport costs impede international trade in a similar way as do tariffs. Baier and Bergstrand (2001) found that the reduction in transport costs is responsible for the average growth in world trade of 8% in the post-World War II period. In Chapter 2 an overview was given of the past research and has shown that transport cost is an important determinant of a nation`s export competitiveness and ability to participate in international trade. Several different methods can be used to measure transport costs. Past research on transport costs have used both direct and indirect transport costs data. The most accurate method for measuring transport costs is by obtaining the actual freight rates charged by shipping companies and freight forwarders. However, past research from Hummels (2000), Radelet and Sachs (1998) and Limão and Venables (2001) has indicated that these direct shipping costs can be challenging to acquire for a large volume of countries. Also, the data may be lacking as a result a of privately negotiated rates which are viewed as proprietary information. Indirect measures such as the CIF/FOB ratio therefore are frequently used as a substitute for direct measures. Chapter 3 investigates the various measures of transport costs and analyses the trends in South Africa's transport costs over time.

3.2 Direct measures of transport costs

Shipping companies and freight forwarders may offer direct transport costs. However, researchers may be met with reluctance from the shipping companies to share these rates. This might be due to the opportunity costs of the time spent on quoting for non-business purposes or the fact that the shipping rates are proprietary information.

Although data on direct transport cost measures do exist, they have restricted accessibility. The US Department of Commerce offers disaggregated air, ocean, and land freight rates for US imports on a global basis. Official export and import statistics of the United States serve as the base for this data, which represents both non-government and government shipment of merchandise between the United States and approximately one hundred and sixty of its foreign trading partners. The database offers monthly import and export values from the HS10 digit level from the year 1974 until present (United States Census Bureau, 2017). Additionally, some transport companies may provide freight rates. However, the freight rates' private nature results in difficulties in obtaining the data. Panalpina, for example, offers shipping costs for 40-foot

containers from Baltimore to sixty-four nations (World Trade Organisation, 2004). However, these freight rates are not freely available to researchers. The Norwegian Shipping News also calculates a freight rate index for numerous essential shipping routes globally, yet the data only includes the cost of tramp shipping from 1945 to 1982 (UNCTAD, 2017).

Various Internet sources also provide estimates of direct international transport costs. World Freight Rates (World Freight Rates, 2016) offer transport costs per commodity from the main ports of all countries. The rates are collected from global freight forwarders and entails data for containerised goods, for both 20-foot and 40-foot containers. Sea Rates is a global freight forwarder that also provides freight rates online for road, rail, ocean and air transport for international shipments worldwide. Sea Rates collect freight rates from a network of independent freight agents. The website offers transport costs for containerised goods as well as bulk and cargo shipments. When considering air freight rates, World Air Transport Statistics provide global airfreight revenues and ton-kilometres from 1955 to 1997, and the International Civil Aviation Organisation offers worldwide transport rates for air cargo from 1973 to 1993 (World Trade Organisation, 2004).

Freight rates for rail or truck transportation on US export to and import from Canada and Mexico are offered by US Trans-border Surface Freight from April 1993 until present at the 2-digit Harmonized System (Bureau of Transportation Statistics, 2001). Although the direct transport cost data is only available for a small number of exporting and importing countries, the data is of relatively good quality. Transport cost charges for 72 countries is provided by Robert Feenstra and are available from 1972 to 2014 at a 2-digit Standards International Trade Classification (SITC) product level at the National Bureau of Economic Research (NBER) (Feenstra, Lipsey, Deng, Ma & Mo, 2005). However, this data is not available for countries other than the US and covers only merchandise imports (Gaulier, Mirza, Turban & Zignago, 2008).

Hummels and Lugovskyy (2006) gathered direct maritime transport costs from the US and New Zealand. Research conducted by Hummels and Skiba (2004) applied maritime freight rates from 1994 provided by six different importers from all exporters worldwide for products at a 6-digit level of the Harmonised Classification System. Also, Limão and Venables (2001) applied ocean freight rates of a standard container provided by shipping companies to selected destinations from the Port of Baltimore.

The shortcomings of the direct data sources include that it rarely offers information on transport cost variability among all accessible country pairs. Consequently, this data cannot be applied in price equations, cross-country gravity models or market selection methods, unless it is collected for a larger number of countries and repetitively over time and include the same countries, as well as the same types of products and transport mode over time. As the direct transport costs are limited in coverage and difficult to assemble, this study investigates the use of CIF/FOB ratios as an alternative to direct measures.

3.3 Indirect measures of transport costs

Due to the difficulty in assembling direct transport costs and their limited coverage, proxies are frequently used by researchers when analysing transport costs. The different proxies applied include *ad valorem* iceberg costs, distance and CIF/FOB ratios. The easiest transport costs measure is the one assuming *ad valorem* iceberg types of costs, where the cost of transportation is a fraction, usually between 10% and 20%, of the value of trade. Transport costs therefore are represented as the portion of the shipment that does not reach the final destination (see section 2.2.3 for a more detailed explanation of iceberg transport costs). The main limitations of this type of transport costs measure include that it is based on the hypothesis that transport costs are a linear function of the value of the goods shipped. In addition, this measure does not depend on the destination and origin country, the mode of transport or the type of industry. Sub-sections 3.3.1 and 3.3.2 investigate the use of distance and CIF/FOB ratios as measures of international transport costs.

3.3.1 Distance as an indirect measure of international transport costs

The distance between trading partners is a common method used to determine international transport costs (see Section 2.4.1). Further distances between trading partners are expected to have a negative impact on countries' trade flow (Hummels & Lugovskyy, 2006). In today's economy, there has been a large expansion of intra-firm trade, rising emphasis on efficient supply chain management and international outsourcing, which highlight new extents of transport costs (Hummels & Lugovskyy, 2006). One of the main aspects is the distance to various markets. Distance serves as a determining factor of trade, as it apprehends the time cost. High transport costs due to long distances and transport time hinder international trade. Consequently, importers are willing to pay to avoid such costs (Hummels, 2007). Importers' willingness to pay for saved time explains the increased use of air transportation, although this

mode of transport is considerably more expensive than sea or land transportation (Hummels & Lugovskyy, 2006). Hummels (2001) explains that the cost of a product increases with 0.5% for every day spent in shipping, which is roughly thirty times higher than the cost of holding inventory. The distance measures assume that the transport cost rises as the distance between trading partners increases, and declines as the distance falls. However, transport cost also depends on the time products spend in customs, countries' level of trade facilitation, common language between trading partners and the degree of transport network integration (Behar & Venables, 2010). Furthermore, information relocates easier between nearby located countries (Hummels, 2006).

Numerous studies investigating the relationship between international trade flows and the distance between trading partners apply the distance elasticity of trade. The distance elasticity of trade shows the percentage variation in the trade flow related to a certain percentage increase in the distance between the trading partners. Venables (2001) and Hummels (2007) conclude that the trade volume between two countries decreases as the distance between the countries increases. Venables (2001) investigated elasticities of trade volumes at various distances relative to their value at 1 000 kilometres. Venables (2001) found that if the distance elasticity equals -1.25, the volumes of trade decrease with 58% at 2 000 kilometres, 82% at 4 000 kilometres and 93% at 8000 kilometres.

3.3.1.1 Sources of data on distance

The French *Centre d'Études Prospectives et d'Informations Internationales* (CEPII) tool *GeoDist* is useful for evaluating distance between different exporting and importing countries (Mayer & Zignago, 2011). *GeoDist* finds the distances between two nations by applying city-level statistics to describe the physical spreading of inhabitants in countries. Weighted and simple distance applications determine the distance between nations (CEPII, 2014). CEPII measures simple distances by applying the great circle formula, by which the latitudes and longitudes of the official capital or the most important city (in terms of population) are used. When the weighted distances are measured, city-level information is used to evaluate the physical spreading of residents in every country. The distance between two nations is measured by comparing the weight of each nation's central city's inhabitants on the inter-city distances with the country's overall inhabitation (Mayer & Zignago, 2011). The formula used is a generalised mean of city-to-city bilateral distances founded by Head and Mayer (2002), which takes the harmonic means and arithmetic means as special cases. The distance measures

comprise variables that are effective for pairs of countries and measure the distance in kilometres.

3.3.1.2 Distance in the Gravity Model

Although there is a constant focus on how globalisation is influencing the world, a surprising aspect of the economic activity is how local most of the economic interaction between countries is, and how sharply economic activity deteriorates as the distance between trading partners increases (Hummels, 2006). Researchers commonly analyse the relationship between trade and distance by using the gravity model, in which variables include exporter and importer countries' economic mass (e.g., GDP), distance, and market access variables such as common language or border explain bilateral trade flows (Brakman *et al*., 2001). Past studies find the elasticity of trade flow with respect to distance to be between approximately -0.9 and 1.5, indicating a very sharp decline in trade volume when distance increases (Anders & Van Wincoop, 2004). An empirical gravity specification would look like the following:

$$trade_{ij} = \beta_1 GDP_i + \beta_2 GDP_j + \tau_1 Distance_{ij} + \tau_2 Landlocked_i + \tau_3 Infrastructure_i + \tau_4 Trade\ facilitation_i + u_{ij} \tag{3.1}$$

Equation 3.1 measures trade as exports from country i to country j. The gravity model commonly applies a log-linear form, where τ_1 represents the elasticity of trade with respect to distance. The fact that the distance coefficients' absolute value appears to have increased through time is a puzzle which has attracted attention in economic research (Brun *et al*., 2005). Studies conducted prior to 1960 found an average estimate of approximately -0.75, whereas studies conducted on data from later periods increases the average estimate to -0.90 (Disdier & Head, 2008). These findings do not necessarily mean that trade on long distances has declined, but merely that trade on short distances has increased at a higher rate than trade on long distances. The period 1962-2000, shows a steady decline in the distance of average trade flows (Carrere & Schiff, 2004).

Behar and Venables (2010) investigated the effect of distance on trade flow expressed in elasticity form using the following equation:

$$\frac{\Delta Trade}{\Delta Dist} \times \frac{Dist}{Trade} = \left(\frac{\partial Trade}{\partial Cost}\right) \times \frac{(\Delta Cost)}{(\Delta Dist)} + \frac{\partial Trade}{\partial Dist} \times \frac{Dist}{Trade}$$

$$-0.9 \qquad\qquad -3 \qquad\qquad 0.2 \qquad\qquad\qquad (3.2)$$

The left-hand side of the equation shows the reduced form effects of distance on trade, and the right-hand side decomposes it into a part associated with freight costs and a residual. Behar and Venables (2010) found that the gravity model estimates indicate a consensus reduced-form elasticity of trade with respect to the distance of -0.90 and that the elasticity of trade with respect to the freight costs factor equals -3. The estimates of the elasticity of freight costs with respect to distance do vary largely between the different modes of transport but have an overall magnitude of 0.2. The above relationship proposes that the freight costs are responsible for two-thirds of the effect of distance (0.2 x -3= -0.6). The remaining third could be accounted for by delays, although the time and distance relationship are highly non-linear as a result of its effects on the choice of transport mode (Behar & Venables, 2010).

Cross-section data can be applied to explain the substantial dispersion in countries' transport costs. According to the review in Abe and Wilson (2009), the elasticity of transport costs per unit weight with respect to port-to-port distance is between 0.14 and 0.21. The elasticity therefore is below unity and indicates diminishing average costs with respect to distance. The reduce-form gravity model does not consider whether the transport mode is by sea or by land. However, some studies do consider the different modes of transportation. Research conducted by Limão and Venables (2001) found that an additional thousand-kilometre distance increases the transport costs by seven times more if goods are shipped overland rather than by ocean transport. Hummels (2001) found that the elasticity of transport costs with respect to distance is 0.22 by sea, 0.46 by air, 0.275 by road and 0.39 by rail. Furthermore, Hummels (2007) concluded that, even though distance elasticity of cost was higher by air than by sea, it has declined at a faster rate over time. Therefore, the elasticity was practically equal in 2004, with the elasticity of 0.15 by sea and 0.16 by air. Abe and Wilson (2009) emphasise the importance of being located near the ocean, as they conclude that elasticity is higher by land than by sea.

3.3.1.3 Quality of distance as a measure of transport costs

Although the distance between trading partners can serve as an indicator of countries' transport costs, some studies argue that distance as a measure of transport costs is flawed for several reasons. Firstly, when using distance as a proxy for direct transport costs, the direct distance is measured instead of the actual distance (as the crow flies), as the great circle formula is applied (Coughlin, 2004). Secondly, transport costs consist of many other elements than distance, and as the distance measure does not include these costs, the transport costs will be biased (Coughlin, 2004).

The loading and unloading costs of a ship, as well as the cost of queuing outside a seaport (dwell costs), are the same even if the distance increases. Another issue with this measure of transport costs is that in most cases it only considers one transit route and one mode of transportation (Coughlin, 2004). The distance measure of transport costs does depend on the destination and origin country; however, it does not overcome all the shortcomings of the iceberg costs. The measure does not capture the variations in transport costs due to different commodities and modes of transport. In addition, this measure fails to capture transport costs variations over time. However, adding a variable which indicates whether or not the country is landlocked may correct the differing transport cost modes, and adding country-specific infrastructure variables may capture variations over time (Coughlin, 2004).

3.3.2 CIF/FOB ratio as an indirect measure of international transport costs

Many researchers use the CIF/FOB ratios as a proxy for international transport costs (please see Chapter 1 for the explanation of the terms). Consequently, researchers assume that the import composition of a country is constant and consequently CIF/FOB ratios reveal true variations in shipping cost rather than variations in a country's commodity mix (Radelet & Sachs, 1998). However, applying the IMFs intra-national Financial Statistics data for calculating CIF/FOB ratios results in an aggregated ratio consisting of several errors and faults (see Section 3.3.2.2).

Looking further into previous empirical research, it is easy to reveal misuse and misinterpretation of the CIF/FOB ratios. Misunderstandings between the international trade and maritime definitions of CIF and FOB Incoterms are among the primary reasons for the misuse (Chasomeris, 2006). The CIF/FOB ratios' nature and complexity further challenge the use of the ratios as a dependable measure of international transport costs. To better understand the nature of CIF/FOB ratios, a simple illustration can be made regarding disaggregated import levels, e.g. import classes of homogeneous products. An increase in the CIF/FOB ratios of these products can be the result of three different scenarios. Firstly, the ratio can increase due to a decrease in the FOB value of the product, *ceteris paribus*. Furthermore, a rise in the transport cost of homogeneous products can result in an increase in the ratios, *ceteris paribus*. Lastly, an increase in the CIF/FOB ratios can be a result of both a decrease in the value of the homogeneous products and an increase in the cost of transporting the products. Either way, an increase in the CIF/FOB ratios does not necessarily represent an increase in transport costs.

When the rise in the CIF/FOB ratios indicates an increase in transport costs, these are *ad valorem* transport costs and not direct shipping costs. In theory, it therefore is a possibility for the *ad valorem* transport costs (derived from the CIF/FOB ratio) to increase, even though the direct transport costs decreased (Chasomeris, 2006). For aggregated, composite, and heterogeneous import CIF/FOB ratios the possible misinterpretation is even larger than for disaggregated ratios for homogeneous products.

Transport costs also depend on the trade composition or type of goods shipped. There will, for example, be a significant low CIF/FOB mark-up for high value-added goods such as precious metals. Similarly, the transport cost of agricultural products will depend on the characteristics of the goods, e.g. if the products are dry bulk, perishable and whether or not they are processed goods. Therefore, nations' aggregated CIF/FOB ratios will differ, not only because of differences in the transport costs for a specified composition of products but also due to countries' commodity mix variations (Radelet & Sachs, 1998). Radelet and Sachs (1998) applied CIF/FOB ratios as a transport cost proxy and state that because developing countries have a more homogeneous composition of exports, the CIF/FOB measure is assumed to expose true alterations in transport costs rather than commodity mix effects. Naudé (2000), Rose (1991), Limão and Venables (2001) have all applied country CIF/FOB ratios as a proxy for transport costs in their research. Researchers assuming that the ratios reveal true variations in transport costs instead of commodity mix effects, link a country CIF/FOB ratio increase to a rise in direct transport costs, and consequently a decrease of the ratio with a decline in direct transport costs (Chasomeris, 2006).

However, evidence does exist that where direct transport costs data are lacking, nations' import composition has a significant effect on CIF/FOB ratios in cases where the data is reliable (Chasomeris, 2006; Hummels & Lugovskyy, 2006). Therefore, researchers must be aware that they are applying trade-weighted and aggregated average ratios, where the import compositions which differ across nations influence the weightings (Chasomeris, 2006). The ratios, as well as the trade weightings, vary with time, supplementing additional elements of non-comparability, both between nations and in comparing differences in a specific nations' ratios over time. As a result, several researchers have misused the measure of CIF/FOB ratios, which probably has led to incorrect conclusions that might influence policy decisions Chasomeris (2006).

3.3.2.1 Sources of CIF/FOB ratios

The IMF and the French research centre CEPII both calculate CIF/FOB ratios.

3.3.2.1.1 The IMF's CIF/FOB ratios

The IMF offers aggregated CIF/FOB ratios from 1948 to the present and is the most commonly applied international transport cost estimate. The IMF uses aggregation procedures to compile operative transport cost measures based on disaggregate CIF/FOB ratios calculated from the UN's COMTRADE dataset. COMTRADE offers trade data on a bilateral level in US dollars at a product level, 6-digit Harmonized System Nomenclature for more than 5 000 products for an excess of 200 nations (Gaulier *et al*., 2008).

The IMF offers three different sources of CIF/FOB ratios, namely (i) the Direction of Trade Statistics (DOTS) data tapes, (ii) the International Financial Statistics (IFS) and (iii) the DOTS yearbook. The DOTS data tapes contain bilateral data aggregated over all commodities, while the International Financial Statistics (IFS) and the DOTS yearbook include data aggregated over all commodities and partners for a particular importer. The advantage of the IMF's CIF/FOB ratios is their breadth and easy to access. This has resulted in many authors using the IMF ratios to analyse the impact of transport costs on trade.

Radelet and Sachs (1998) studied CIF/FOB ratios retrieved from the IMF data and found that measurement errors may affect the ratios. They found that several countries only see a marginal variation in the ratios over time. This indicates that constant CIF/FOB conversion factor is retained once the IMF establishes it for a country, and the IMF's members of staff revise it only on an infrequent basis. Therefore, these CIF/FOB ratios are not necessarily a complete or accurate measure of the true CIF/FOB ratios, since they rely on staff estimates and not actual values. Furthermore, Hummels (1999a) investigated the trends found from the IMF's International Financial Statistics (IFS) dataset and found that large volumes of these data were imputed. In other words, a known CIF/FOB ratio is combined with a fixed CIF/FOB ratio to generate an imputed FOB flow, or the other way around (Chasomeris, 2006). Significant amounts of the ratios available from the IFS are equal to 1.1. This is because a missing CIF value is imputed by 10% added to the FOB value, and a value of 9% is subtracted from the CIF value if no FOB value is available for the country concerned (Hummels & Lugovskyy, 2003). It is not documented for the users of the data where these imputations took place and which countries were affected, making it impossible to track the corrections (Hummels, 1999a).

However, using this type of data is a good place to start when researching the general international transport costs for many countries worldwide.

3.3.2.1.2 CEPIIs CIF/FOB ratios

CEPII offers trade data through CEPII's Base pour l'Analyse du Commerce International (BACI) database[8]. Although UN COMTRADE is rich in data, the large amounts of missing flows in the database were the driving force behind the development of the BACI database. A strategy of mirror statistics is used in BACI to impute missing values or differences in reported values for the same trade flow. Both the exporting country i, and importing country j, should report the same HS 6-digit level trade flow, as exports and imports respectively. However, either the export or import value or both can be missing (not reported). Also, the export value is reported FOB and import value CIF causing different trade values reported for the same trade flow in the UN COMTRADE database. In the case of missing values, BACI applies the mirror statistic reported by the applicable trading partner. Thus, the amount of missing data is considerably less as the only missing data remaining is between trading partners where both failed to report their trade flows (Gaulier *et al*., 2008).

To justify differences in the reported import and export values for the same trade flow, CIF/FOB ratios are computed where each CIF and FOB flow is checked against the matching quantity documented by the customs authorities of the reporting importer and exporter concerned. An alternate CIF/FOB ratio is then acquired founded on unit values named CIFu/FOBu (Gaulier *et al*., 2008). As value and quantity errors correlate by construction, applying CIFu/FOBu ratios can regulate these errors only to some degree. Quantity and value-error types are supposedly correlated as individuals who report values poorly would also report quantities in a poor manner. In addition, differences in mirror quantities and values might be a result of variances in countries' accounting methods.

CEPII`S BACI produces reliable CIF/FOB ratios by applying three steps. Firstly, BACI eliminates the quantity error-type as only the flows from importers and exporters who report similar quantities apply. Merely 11% of CEPII`s dataset meet these criteria. However, the remaining flows are simply treated for value-error type (Gaulier *et al*., 2008). Secondly, an econometric method to address any outstanding errors is applied. Control variables based on a COMTRADE questionnaire to each nation's reporting authority containing information

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[8] The BACI data offered by CEPII are CEPII's proprietary information which are not readily available to researchers. Several attempts were made to requested access to the data, but no response from CEPII was grated.

regarding the partner's data reporting methods are used in this method. Considering these measurement errors, the econometric analysis calculates new CIF/FOB ratios by also applying factors such as transport infrastructure and distance which influences true transport costs (Gaulier *et al*., 2008). Lastly, assumptions are made that transport costs behave in a similar manner for the observations which did not meet the criteria of the first step. CIF/FOB estimates are then replicated for all out of sample data by applying the in-sample data coefficients.

CEPII undertook a comparison between the COMTRADE CIF/FOB ratios and the modified CIFu/FOBu ratios. The distribution of the values is expected to lie within the plausible range for CIF/FOB ratios of between 1 and 2, where the maximum rate must not exceed the transported products' value and the minimum rate should be higher than unity (Hummels & Lugovskyy, 2006). CEPII found that the data from the original CIF/FOB ratios could not be used to represent transport costs without being modified, as several observations lie far below and above the plausible range of between 1 and 2. Modifying the CIF/FOB ratios presents the alternative CIFu/FOBu ratios. These ratios represent 30% of all observations and they all lie within the plausible range of between 1 and 2 (Gaulier *et al*., 2008). Although the rates lie within the usable range, they cannot necessarily be applied to represent transport costs. Take as an example that the true *ad valorem* freight cost to ship a product from one destination to another is 10%. The rate will still be within the plausible range of between 1 and 2, even if the CIF ratio is 90% higher than the FOB ratio (CIF/FOB=1.9). The cost of transport therefore is stated with a bias of 80 percentage points higher than the actual transport rate (Gaulier *et al*., 2008). To eliminate these errors, the measurement variations between two declarations cannot be higher than 10%. Thus, the declarations of the exporter`s physical quantities match the importer`s declarations more precisely.

CEPII constructed a quality indicator of the quantities reported across partners:

$$w = \text{Max} \, (QM, QX) \, / \, \text{Min} \, (QM, QX) > 0.90 \qquad (3.3)$$

In Equation 3.3, QM represents the quantity of the importing country and QX represents the quantity of the exporting country. Consequently, the implied freight rates better represent the expected outcomes. The CIF/FOB ratios constructed with the use of this indicator is much more adequate than the ratios constructed without any quality indicators, although some rates still lie outside the plausible range.

The above section presents some of the most commonly used sources of CIF/FOB ratios, including the IMF`s DOTS, IFS, DOTS yearbooks and CEPII`s BACI. The CIF/FOB ratios offered from CEPII are modified and a more accurate measure of transport costs. However, CEPII only makes the BACI trade data available to subscribers and does not give access to their alternative CIF/FOB ratios described above. Therefore, CEPII's CIF/FOB ratios could not be used in this study. The next section presents the limitations of using the CIF/FOB ratios as a substitute for direct transport cost measures.

3.3.2.2 Factors affecting the accuracy of CIF/FOB ratios in measuring transport costs

The degree of similarity between the IMF CIF/FOB ratios and true transport costs was investigated by Hummles and Lugovskyy (2006). After comparing the true transport costs between New Zealand and the US gathered by Robert Feenstra to the aggregated CIF/FOB ratios of the IMF, Hummels and Lugovskyy concluded that these CIF/FOB ratios could not serve as a substitute for actual transport costs. At best, the ratios could be used as a transport costs proxy in research analysing differences between exporters. Hummels and Lugovskyy (2006) also compared CIF/FOB ratios compiled from the UN COMTRADE dataset to Feenstra's direct transport costs for US imports and found some negative correlations. Furthermore, when analysing the UN COMTRADE data at commodity-level, Hummels and Lugovskyy (2006) found that merely 10% of the CIF/FOB ratios calculated using this data source lies within the range of between 1 and 2 representing *ad valorem* transport costs of between 0 and 100%. Therefore, Hummels and Lugovskyy (2006) concluded that it would not be sensible to use CIF/FOB ratios to represent transport costs. However, it is important to

consider that the data used in Hummels and Lugovskyy`s research date back to 1974-1983, and improvements in the quality of the data may have been made at a later stage.

The quality of CIF/FOB ratios in measuring transport cost is affected by differences in reported export and import data for reasons other than the shipping cost. These may include but are not limited to the following:

(i)   Differences in the documented quantities recorded by the exporter and importer. For example, the volume of shoes declared by the Italian authorities as exports to South Africa may not truly correspond with the South African records, as the South African side may declare a smaller or larger number (Hummels & Lugovskyy, 2006).

(ii)   Changing exchange rates midway shipment (Hummels & Lugovskyy, 2006).

(iii)   Data imputations used for missing data. This is more often the case with export data, as importers tend to track consignments with added caution, as they are responsible for levying tariffs (Hummels & Lugovskyy, 2003, 2006).

(iv)   Differences in exporters' interpretation of the FOB valuation, specifically regarding inland shipping cost (Hummels & Lugovskyy, 2006). For example, are the goods being valued at dockside, after being loaded onto the vessel or at the factory gate?

(vi)   Differences in importers' interpretation of the CIF value to include loading and unloading costs or not (Hummels & Lugovskyy, 2006).

(v)   Disagreements between the importer and exporter when it comes to identifying the correct product classifications for a certain good (Hummels & Lugovskyy, 2006).

(vi)   Incomparability of disaggregated data beyond the HS 6 level (Hummels & Lugovskyy, 2006).

(vii)   CIF/FOB ratios being subject to the mode of transportation, countries' composition of trade and trading partners (Hummels, 2007). For instance, the world has seen a much faster growth in global trade of high-value-to-weight manufactured goods than the trade in low-value-to-weight primary products. Even though the unit cost of shipping remains unaffected, this will affect the CIF/FOB ratio transport costs measure. Hummels (1999b) found that the CIF/FOB ratios do not capture the significant decline in transport costs that the world has experienced over the years. If the time issue becomes more important, or if the price of fast means of transport declines relative to slow means of transport, there is reason to believe that there could be a shift in demand towards air transport and faster vessels due to technical innovations. These absolute and relative price differences are not

captured in the CIF/FOB ratios, and the decrease in transport costs is therefore underestimated (Hummels, 1999b).

A more recent study conducted by Gaulier *et al*. (2008) investigated the hypothesis that the accuracy or quality of CIF/FOB ratios as a measure of transport costs is influenced by countries' compliance with the UN's recommendations for reporting trade data. They argue that a large portion of reporting errors are due to variation in countries' procedures of registration regarding incoming and outgoing trade flows. If for example, the UN COMTRADE recommendations of reporting are not followed and the incoming flows are reported as FOB flows and not CIF flows, the CIF/FOB usually turn out to be miscalculated as lower as the FOB flow approximate unity. Also, errors may arise if the importing country reports the importing flows as coming from a transit country, and not from the origin country. For example, if China declares a product to be imported from Italy, although the product was produced in France and merely transit through Italy, a mismatch of declaration appears between China and Italy as well as between China and France.

Gaulier *et al*. (2008) argued that errors in the CIF/FOB ratios are mainly a result of exporting and importing countries not accurately reporting trade data. Therefore, they investigated the number of countries complying with the UN COMTRADE reporting guidelines. The study examined the answers of each reporting country on a series of questions uploaded on the UN COMTRADE website. The questions were developed to be able to investigate the extent of compliance with UN recommendations. The questions in Table 3.1 below are directly or indirectly involved with the procedures of registering incoming and outgoing trade flows.

Table 3.1: COMTRADE questionnaire on compilation with UN recommendations

Q106 :	Do you use customs declarations as a source?
Q117 :	Is the exchange rate used for currency conversion that which is in effect at the time of exporting or importing?
Q143 :	Do you use a standard unit of weight for quantity measurement of all commodities where applicable?
Q148 :	Do you use units of weight on a net basis (e.g. excluding packing)?
Q61-64 (Qexp):	As an exporter, do you declare the importer as Last Known Destination?
Q58-60 (Qimp):	As an importer, do you declare the exporter as Origin?

Source: UN COMTRADE, 2008.

The reporting countries answering `YES` on these questions are complying with the UN recommendations. Gaulier *et al*. (2008) compiled some descriptive statistics on these questions. The percentages in Table 3.2 below are percentages of trade flows from countries following the UN recommendations. It is clear that most countries use the customs declarations as data sources. The cross-country heterogeneity found in the data regarding exchange rate application is more challenging, as it serves to convert all outbound and inbound product values into and from a specified nation into US dollars (Gaulier *et al*., 2008). This results in differences in mirror values which do not have anything to do with the skill of the staff responsible for registering the trade flows at the border crossings.

Table 3.2: Frequency of countries meeting UN Recommendation

Country	COMTRADE QUESTIONNAIRE	Code	Frequency
Exporter	Use customs as a source of data	Q106i	98.84%
Importer	Use customs as a source of data	Q106j	97.85%
Exporter	Exchange rate in effect at date of exports	Q117i	63.23%
Importer	Exchange rate in effect at date of imports	Q117j	64.23%
Exporter	Declares a standard unit of weight	Q143i	67.09%
Importer	Declares a standard unit of weight	Q143j	70.36%
Exporter	Net weight declaration (no packaging included)	Q148j	87.30%
Importer	Net weight declaration (no packaging included)	Q148j	86.5%
Exporter	Declares importer as last known destination	Q des export	77.05%
Importer	Declares exporter as origin producer	Q des import	90.45%

Source: UN COMTRADE, 2008.

In addition, the standard units of weight are not applied in an effective manner in all nations as roughly 60% of the nations responded positively to this question. The CIF/FOB ratios are mechanically biased when two partner countries report various weight units. Also, net weight declarations (weights excluding product packaging) are not applied at all times, as not more than 87% of the respondents fulfil this UN recommendation (Gaulier *et al*., 2008). This heterogeneity of weight declaration emphasises the significance of CEPII applying `matched quantities` data when new CIF/FOB ratios are estimated (see Section 3.3.2.1.2). Lastly, another important finding is that 23% of the exporting countries do not report the importer to be the final destination country, but a country where the goods merely move through. However, 90% of the importing countries report the exporter to be the country of product origin (Gaulier *et al*., 2008). This affects the quantities and values of the reported products.

The differences in reported data do not have to be large to have a significant impact on the CIF/FOB ratios. Consider an *ad valorem* transport cost of 6%, represented by a CIF/FOB ratio of 1.06. Let's say that the exporters FOB value of trade undervalued by 1.5% and the importers CIF value of trade overvalued by 1.5%. The CIF/FOB ratio then becomes 1.09%, which implies a change in transport costs with as much as 50% (Hummels & Lugovskyy, 2003). Accordingly, Hummels (1999b: 27) explains that the CIF/FOB ratio of the United States in 1970 could be calculated as *ad valorem* transport cost of 13%, 9% or 6%, depending on the different DOTS yearbooks editions used. Additionally, Yeats (1978: 35), found that COMTRADE CIF/FOB ratios do not approximate transport costs, although this is the hypothesis frequently made regarding trade-related and gravity flow models. Thus, errors in empirical and theoretical findings arise due to the differences exposed in official trade statistics, even though the discrepancies might be minor. It seems, however, that the quality of data improves the more aggregated the data is (Hummels, 1999b: 27). Therefore, Hummels (1999b: 27) c there is a possibility that a transport cost time series drawn from aggregated data might encompass more accurate information.

It is, however, possible to use CIF/FOB ratios even though it is not totally accurate in measuring transport costs. CIF/FOB ratios may co-vary strongly with direct transport costs even if they are methodically incorrect in levels (Hummels & Lugovskyy, 2003: 4). Different valuation rules among exporters may result in poor measures of cross-exporter variation in match partner data. Nevertheless, match partner techniques can serve as a good source of time series data if the rules of valuation change marginally over time. Lastly, commodity classification discrepancies might produce weak commodity-level measures of shipping costs, although aggregate data

would still match direct transport costs (Hummels & Lugovskyy, 2003: 3). Hence it is not recommended to apply match partners data for studies where the levels of transport costs are essential. This includes structural regressions where the aim is to directly interpret coefficient magnitudes, or in the selection of parameters to model calibration. Match partner data is also not suitable for research analysing cross-commodity variations. Yet, match partner data can be implemented as a control variable for aggregate bilateral transport costs, and are particularly useful if the match partner data is applied together with instrumental variable methods where the match partner data are fitted to plausible correlates before being used as controls. The helpfulness of time series variations in CIF/FOB ratios were left as an open question, as Hummels and Lugovskyy (2003: 13) found some ability to fit cross-section variations in the IMF data, but limited ability to draw any reliable conclusions from time series data. Radelet and Sachs (1998) argue that although the data have several drawbacks, it is still relatively comprehensive and continuous and may serve as a decent starting point for analysing international shipping costs for a very large number of countries.

To summarise section 3.3, several measures for international transport costs exist. However, the accuracy and availability of the measures vary significantly. The distance between trading partners is the most widely used transport costs measure, although this measure may be biased as it only applies to the direct distance and not the actual distance, and only considers one transport route and one mode of transport (see section 3.3.1). The CIF/FOB ratios are readily available for researchers, which can compute the ratios from several different data sources, including the IMF`s Financial Statistics (IFS), DOTS, UNCTAD and WITS. The match partner CIF/FOB ratios technique is applicable to any dataset that includes both import and export flows of the same product. Although the CIF/FOB ratios have a broad coverage and are available for a significant number of countries and years, the accuracy of the CIF/FOB ratios as a measure of international transport cost are questionable. The CIF and FOB values may differ for other reasons than variations in the cost of transportation. The transported goods may be valued differently due to price or exchange rate changes during shipment as well as product classification, definition, and terminology inconsistencies. CIF/FOB ratios are also subject to the mode of transportation, the country's composition of trade and the country's trading partners. Furthermore, significant amounts of missing data can make it challenging to gain a consistent overview of transport costs over time (see section 3.3.2.2).

However, when evaluating the various transport cost measures, the CIF/FOB ratios remain the easiest for researchers to apply due to its breadth and availability. This study set out to investigate the accuracy of using CIF/FOB ratios as a measure of international transport costs in the South African case. Because previous research has shown that transport mode and product type affect this accuracy, this study was demarcated to ocean freight and automotive parts (see Section 1.5). More detail follows in Chapter 4. Section 3.4 summarises the findings of previous studies on South Africa's historical transport costs and more specifically CIF/FOB.

3.4 Overview of past research on trends in South Africa`s international transport costs (CIF/FOB ratios)

Studies often refer to CIF/FOB ratios when determining a country`s transport costs, due to the challenges of obtaining direct transport cost measures. Only a few studies have investigated South Africa`s CIF/FOB ratios. These studies include Naudé's (2001) study on the impact of transport costs on South African exports, in which he found that the country`s relatively high transport costs hinder trade. Chasomeris (2003a, 2003b, 2004, 2005a, 2005b, 2006) studied South Africa`s transport costs and the use of CIF/FOB ratios as a proxy for direct measures. South Africa`s average CIF/FOB ratio was 7% in the years 1988-1991, which is much higher than the world average of 3% as well as the developing countries' average of 5% (Naudé, 2001). South Africa, therefore, faced transport costs which were approximately 50% higher the developing countries' average. Naudé (2001) further found that South Africa's transport costs had a significant negative impact on the country's export volumes, although the magnitude is relatively small with an elasticity of 0.08%. According to Chasomeris (2003a), South Africa`s simple mean CIF/FOB ratios have been increasing from 4.54% in 1960, 7.9% in 1970, 8.8% in 1980 to 10.84% in the 1990s. This trend is highly in contrast to the world average, which has seen a decrease in international transport costs. The rest of this section will give an overview of the most relevant findings of Chasomeris` studies.

South Africa's high transport costs resulted in less revenue for the country's exports, together with higher import charges for the nation's intermediate products. High transport costs threaten South Africa's economic growth, as capital goods become more expensive, serving as a disincentive towards further investments and technological allocation. During the period 1985 to 1993, South Africa faced economic sanctions. However, the transport costs (CIF/FOB ratios) were merely 8.87%, which is considerably lower than the ratio of 12.3% which the country faced after the removal of the sanctions in 1994 (Chasomeris, 2003b). Chasomeris (2003b)

found that the historical trade data for South Africa are not dependable due to data quality issues including concealed trade data for political motives, re-classifications, and re-enumeration of trade data. He concluded that South Africa`s erroneous historical trade data produce undependable and imprecise CIF/FOB ratios that cannot be used to measure South Africa`s actual *ad valorem* freight rates or the country's direct transport costs. Chasomeris (2004) maintains that South Africa's import composition also significantly affects the CIF/FOB ratio, and the ratio therefore is not a viable indicator of the country's direct freight rates. The CIF/FOB ratios are composite indicators that depend on variations in a country's import composition as well as the transport cost levels. A country can expect an increase in the CIF/FOB ratio if the proportion of manufactured goods decreases. A rise in the CIF/FOB ratio appears when the proportion of low-value goods such as mining, or agriculture increases. Changes in the country's import composition to lower proportions of manufactured imports, due to preferential trade agreements, integration into the global markets and the focus on trade liberalisation policies, can explain the rise in South Africa`s CIF/FOB ratios.
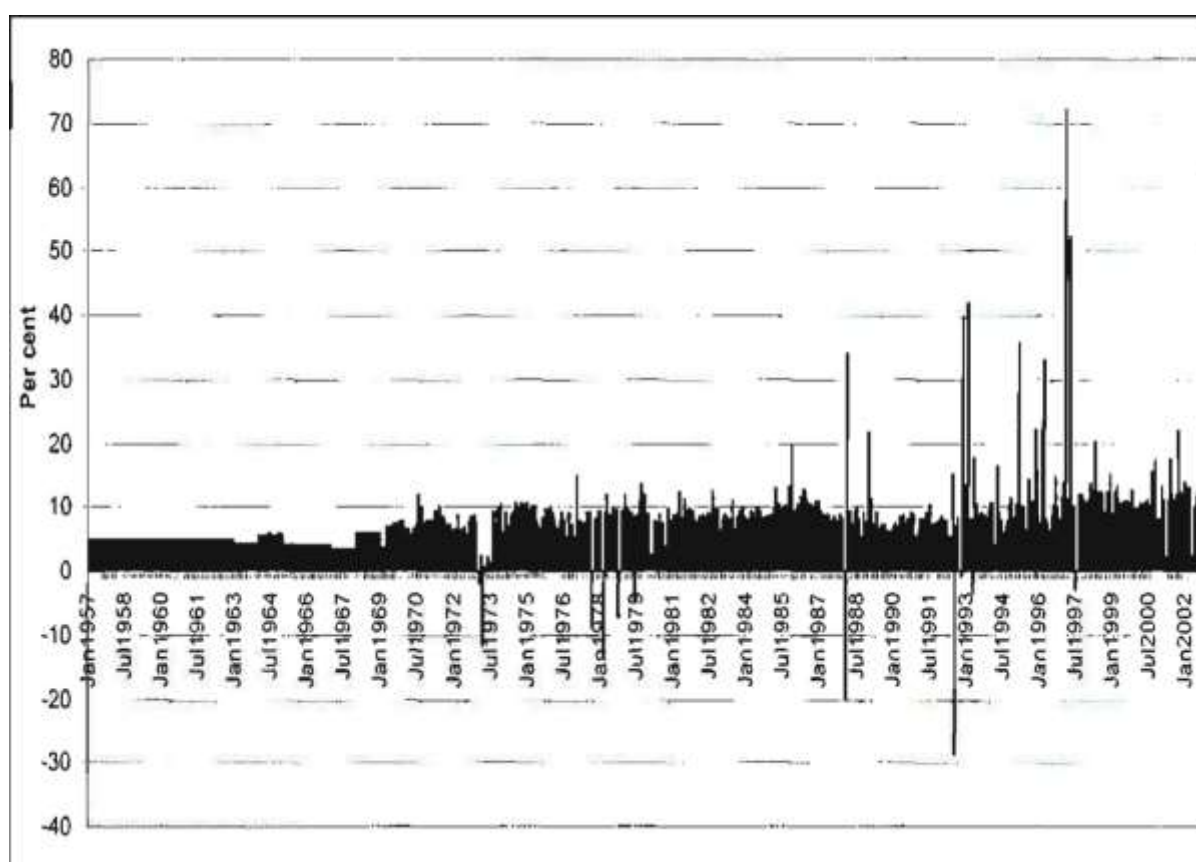
Figure 3.1: CIF/FOB ratios for South Africa, January 1957 – October 2002

Source: Chasomeris, 2006.

Figure 3.1 depicts South Africa`s monthly CIF/FOB ratios calculated by Chasomeris (2006), using data from IMF International Financial Statistics (IFS). In the period January 1957 to October 2002, 11 out of 550 monthly observations have negative CIF/FOB ratios (errors). Errors appear where the CIF/FOB ratios are below zero, as the ratios should lie within a range of between 0% and 100% *ad valorem*. Errors (negative values) were spotted on the following dates: January 1973, March 1973, September 1977, February 1978, October 1978, June 1979, January 1988, July 1992, October 1992, April 1993, and July 1997. According to Chasomeris (2006) negative CIF/FOB ratios were last recorded in July 1997, which may be an indication that the quality of South Africa`s trade statistics is improving. Notably high monthly ratios appeared in February 1997 (72.7%) and in April 1997 (52.3%). These spikes caused the annual CIF/FOB ratios of 1997 to reach an all-time high of 17%. Researchers should be aware that monthly errors are aggregated into South Africa`s annual CIF/FOB ratios, even though all the annual CIF/FOB ratios lie within range (Chasomeris, 2006).
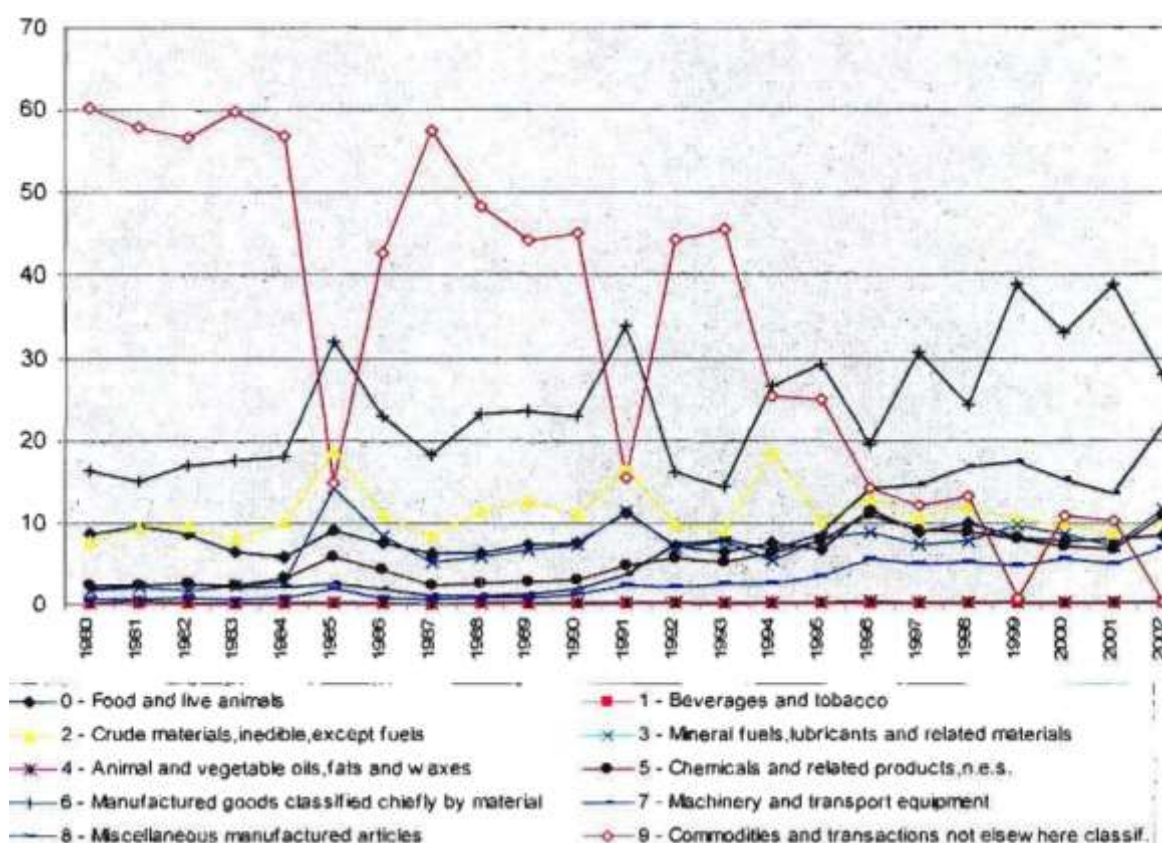
Figure 3.2: SITC imports as a proportion of total imports, South Africa between 1980-2002
Source: Chasomeris, 2006.

Figure 3.2 displays the actual changes in South Africa's import composition between 1980 and 2002. The figure reveals that a large portion of South Africa`s SITC imports as a portion of total imports was unclassified for many years (SITC-9, Commodities and transactions not elsewhere classified). Chasomeris (2006) found serious quality issues on South Africa`s disaggregated SITC data from TIPS, including incorrect classifications of goods and non-disclosure of imports. A large majority of goods were aggregated together under SITC-9, as a result of economic sanctions levied on South Africa. Consequently, the trade data of South Africa are not likely to indicate the nation's actual *ad valorem* transport costs or its direct transport costs in an accurate manner (Chasomeris, 2006).

According to past research on South Africa`s CIF/FOB ratios, researchers must exercise caution when substituting the ratios for direct measures of transport costs. During the period covered in past research, South Africa was undergoing a transition towards trade liberalisation, where changes in the nature of the imported commodities were experienced. A country moving towards freer trade and trade-liberalisation might experience a decline in manufactures as a proportion of total imports. Thus, the CIF/FOB ratios tend to increase. However, the rise in the CIF/FOB ratios does not necessarily indicate an increase in the country's transport costs, but may be interpreted as such due to the effect trade liberalisation has on the characteristics of the imports of a country. Therefore, this research might have estimated the countries' transport cost trends, true levels, and its impact on trade incorrectly.

In cases where researchers use the CIF/FOB ratios as a proxy for direct measures, it is essential to analyse the ratios by considering the fluctuations of countries' composition of imports and compare the ratios to more direct measures, e.g., international ocean freight rates. According to Chasomeris (2004), South Africa's import composition greatly affected the CIF/FOB ratio in his research, and he could not regard the ratio a viable indicator of the country's direct freight rates. The CIF/FOB ratios are composite indicators that depend on variations in a country's import composition as well as the transport cost levels. To summarise, the rise in South Africa's CIF/FOB ratios in Chasomeris' research can be explained by changes in the country's import composition at that stage, due to integration into the global market and the focus on trade liberalisation policies.

Chasomeris (2005b) also investigated South Africa`s transport costs by analysing the Europe-South Africa Liner freight rates. South Africa imported goods for € 23 billion from the European Union in 2016, making South Africa the EU's largest business partner in Africa (European Commission, 2017). The European Union invested € 78.8 billion in Foreign Direct

Investments (FDIs) to South Africa in 2015 (European Commission, 2017). South Africa's main trading partners in the EU include Germany, France, Italy and the United Kingdom (ITC Trade Map, 2017). The European Union and South Africa signed the Trade Development Cooperation Agreement (TDCA) in 2000 and established a Free Trade Agreement (FTA) between the parties through the rules of the WTO. To comply with the bilateral trade agreement, South Africa and the EU eliminated customs duties on 90% of all traded goods between the countries within a 12-year period. To be able to accomplish this duties elimination, EU terminated the tariffs on 86% of imports within 12 years. After a 10-year period, South Africa acquired duty-free access on 96% of its exports to EU (European Commission, 2017). As the tariff barrier becomes less important due to the tariff reductions and tariff removals, the effect of transport costs as a barrier to trade volumes and competitiveness becomes more significant.

Chasomeris (2005b) studied the CIF/FOB ratios of South Africa, the freight rates of the Europe-South Africa Conference liner and the balance of payments for the years 1971 to 2002. A current account surplus occurred in two different periods, the first period occurring in 1977 to 1980 and the second in 1985 to 1994. The US Congress imposed sanctions on South Africa in the aftermath of then State President PW Botha's Rubicon speech in 1985. Thus, South Africa faced international financial sanctions, and the country was obliged to pay back its foreign debts. Current account deficits were therefore not affordable, and South Africa had to use non-tariff and tariff measures to safeguard a surplus on the current account. These actions affected the import composition and served as a disincentive towards imports. During the time of current account surpluses, South Africa's experienced low CIF/FOB ratios, as the simple mean CIF/FOB ratios of the period 1985 to 1993, was 8.87%, which is considerably less than the simple mean of 12.9% in the post-sanctions period 1995 to 2000 (see Figure 3.3). Post-sanctions South Africa had average costs that were 43% higher than transport costs faced during the sanctions if the CIF/FOB ratio serves as a proxy for direct transport costs. The high CIF/FOB ratios emerged regardless of the country's effort towards increased competitiveness and trade liberalisation policies (Chasomeris, 2005b).

When considering the Europe-South Africa freight rate index (indicated as "Southbound" in Figure 3.3), an entirely different picture is however revealed since it largely diverges from the CIF/FOB ratios. Compared to the freight rates of 1991 when the EU lifted the economic sanctions on South Africa, the nominal US$ rates on the Europe-South Africa routes diminished by 52.5% by 2002. This can be explained by low levels of competition in the shipping industry during the sanctions period followed by a new boost of trade liberalisation as South Africa was

relieved from the economic sanctions. Thus, when the sanctions were lifted, a significant unexploited potential for the country as well as for demand of liner services going between Europe and South Africa emerged. As South Africa changed its focus to trade liberalisation, the interest in trade and domestic investments has grown considerably. South Africa`s trade liberalisation policies attracted new shipping lines and increased cargo volumes which were necessary for economic growth in the country.
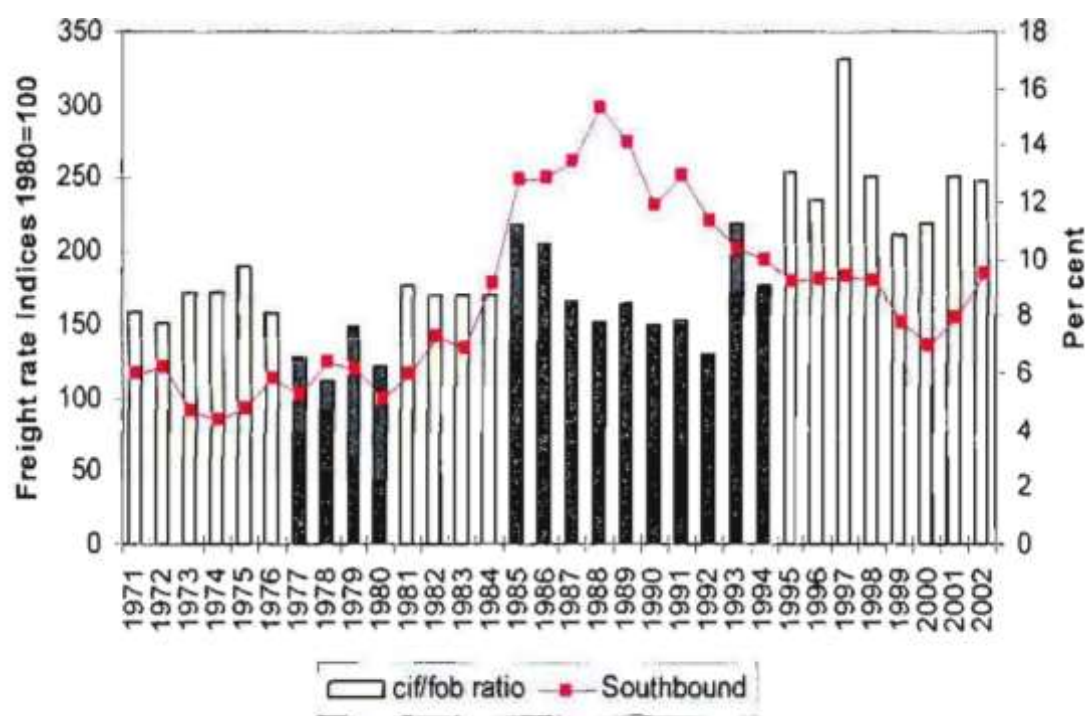
Figure 3.3 CIF/FOB ratios of South Africa and liner freight rates, 1971-2002
Source: Chasomeris, 2006.

The volumes of global sea trade increased in 2001-2002, resulting in worldwide rises in freight rates for containers. The post-sanctions mean freight rates for 1992-2002 were 32% below the average in 1986-1991 during sanctions, which is in stark contrast to the increasing transport cost perspective illustrated with the CIF/FOB ratio (Chasomeris, 2005b). The global circumstances involve deteriorating tariffs for both developed and developing nations. South Africa's import duties declined from 11.2% in 1998 to 4.4% in 2001, representing the country's commitment towards trade liberalisation. Several nations, according to Chasomeris (2005a), have experienced declining *ad valorem* transport costs over time. However, South Africa's CIF/FOB ratio as a proxy for transport costs increased significantly from 8.4% in 1989 to 12.9% in 2001. Put differently, South Africa's *ad valorem* transport costs (measured by means of the

CIF/FOB ratio) were 25% lower than the *ad valorem* tariffs in 1989, while the *ad valorem* transport costs were approximately 200% greater than *ad valorem* tariffs in 2001. A 43% decline in the Europe-South Africa liner freight rates appeared in the same period, which highly contradicts the CIF/FOB results. The peak in 1988 is a result of the sanctions the country faced at the time and the freight rates increased with 121% from 1988 to 1983. The freight rates declined after 1988 and by 2000 the South-bound freight rates had dropped by 55%. The oil crisis in Iraq led to the peak in 1991.

To conclude, Chasomeris (2003a, 2003b, 2003c, 2004, 2005a, 2005b, 2006) found South Africa`s historical trade data to suffer from several data quality issues. Chasomeris (2003c) points out that South Africa`s simple mean CIF/FOB ratio average increased in the period 1951-2002, while the world saw a decline in their CIF/FOB simple mean average. Consequently, Chasomeris` (2003c) study concludes that South Africa`s CIF/FOB ratios are an imprecise measure of the country's international transport costs, and the ratios could not be used as a substitute for direct transport cost measures. As past research on South Africa`s CIF/FOB ratios dates back to 2005/2006, Chapter 4 revisits, adapts and recalculates the country`s CIF/FOB ratios to determine whether it can be used more accurately to measure the international transport costs the country faces.

3.5 Concluding remarks

Direct quotes from shipping companies and freight forwarders are difficult to obtain. Therefore, indirect measures are used, of which CIF/FOB ratios are of interest in this study. The IMF and CEPII both calculate CIF/FOB ratios. However, the ratios offered by CEPII are not readily available for researchers. Several factors affect the accuracy of CIF/FOB ratios as a measure of transport costs, including the following: Changing exchange rates mid-shipment, data imputations used for missing data, differences in exporters' interpretation of FOB and CIF valuation, disagreements between the exporter and importer regarding product classifications, incomparability of disaggregated data beyond the HS 6 level and the fact that CIF/FOB ratios are subject to the mode of transport used, composition of trade and trading partners.

Chasomeris (2003a, 2003b, 2003c, 2004, 2005a, 2005b, 2006) investigated South Africa`s CIF/FOB ratios and concluded that the ratios were not a suitable measure of the country's transport costs at the time. However, these South African studies comparing CIF/FOB ratios to direct shipping cost dates back to 2005/2006. Chapter 4 revisits and recalculates South Africa`s CIF/FOB ratios by using more recent sources to establish whether their conclusions still hold. Therefore, in Chapter 4, South Africa`s CIF/FOB ratios for fourteen European and eleven Far East countries are compared with direct freight rates for containerised general cargo (automotive parts). The freight rates are for ocean freight only, between the years 2007-2015. The updated data might be more reliable in the South African case since the sanctions period no longer influences it.

CHAPTER 4: EMPIRICAL WORK

4.1 Introduction

The previous chapters investigated the development of transport costs in trade theories, the impact of transport costs on trade flows and presented the findings of previous research on South Africa`s historical CIF/FOB ratios compared to direct transport costs (see Section 1.1.1, Section 2.2, and Section 3.4). However, to gain a better understanding of South Africa`s transport cost trends, an analysis of more recent CIF/FOB ratios and direct transport costs is needed. Newer data is particularly important, as the latest research on South Africa specifically dates back to the early 2000s and previous analyses were done on an aggregated level.

Hummels and Lugovskyy (2006), and Chasomeris, (2003b, 2006) questioned the quality of CIF/FOB ratios as a substitute for direct transport costs. To investigate whether these concerns are still valid with newer data and for more specific product types, Chapter 4 presents an empirical analysis and comparison of South Africa`s CIF/FOB ratios and the country's direct transport costs for both general containerised cargo and automotive parts specifically. Chapter 4 focuses solely on South Africa`s maritime transport costs and all other modes of transport are excluded from the analysis in this chapter as sea freight is South Africa`s main mode of transportation, and due to data limitations on the other modes of transport (see Section 1.2).

Section 4.2 outlines the methodology applied in this study and Section 4.3 gives a thorough presentation of the various data sources used to construct the CIF/FOB ratios used in this study. It also includes a discussion on how the direct transport costs of South Africa were collected in this study. Sections 4.4 and 4.5 present the results of the analysis of the data and correlations between the CIF/FOB ratios and South Africa`s direct ocean freight transport costs. Finally, Section 4.6 compares the actual freight rates with ocean freight rates available on the Internet.

4.2 Research method

The empirical part of this study investigates the accuracy of substituting CIF/FOB ratios for direct transport costs. To obtain a clear view of the accuracy of the CIF/FOB ratios, this study uses a correlation analysis between South Africa`s CIF/FOB ratios and the country`s direct transport costs. The match partner technique of calculating CIF/FOB ratios is applicable to all datasets which include the reported trade values by exporters and importers of the same flow of traded goods. The CIF/FOB ratios in this study are calculated based on trade data collected from the different data sources presented in Section 4.3. The differences between the import

CIF and export FOB value of the same product flow represent the cost of transportation (see Section 3.3.2 for a detailed description of the CIF/FOB ratios). The CIF/FOB ratios are calculated from a South African perspective, where South Africa`s reported export value is represented by the FOB value of the products, and the import value reported by South Africa`s partner countries represent the CIF value of the products.

The aim of the correlation analysis was to indicate whether any correlation exists between the direct (actual quotes from shipping companies) and the indirect (CIF/FOB ratios) measures of South Africa`s maritime transport costs between 2007 and 2015. This study focuses on particular countries and products to address some of the issues influencing the accuracy of CIF/FOB ratios in measuring direct transport costs (see section 3.3.2.2). The correlation analysis will give an indication on whether or not the CIF/FOB ratios, which are much easier to obtain, can serve as a substitute for actual freight rates. The CIF/FOB ratios calculated are for South Africa`s trade with the eleven Far East countries and fourteen European countries from which actual shipping rates could be obtained over time (see Section 4.3 for the list of countries included in this study).

Section 4.4 investigates South Africa`s CIF/FOB ratios for ocean freight, aggregated over all containerised general products included in the various data sources for the years 2007-2015. As the freight rates collected from the South African freight forwarder are for containerised automotive parts, South Africa`s CIF/FOB ratios are investigated at a product level for the automotive sector in Section 4.5, to determine whether the CIF/FOB ratios correlate better with the direct transport costs at a more disaggregated level. Section 4.6 compares the actual freight rates with freight rates available on the Internet.

4.3 Data sources

To analyse the validity and accuracy of substituting CIF/FOB ratios for direct transport costs, actual freight rates need to be assembled and compared with the computed CIF/FOB ratios. Therefore, the research included numerous discussions and conversations with freight forwarders and shipping companies in South Africa. Most of these conversations led to valuable insights into the shipping industry but did not yield freight rate data needed for the research. The experiences of other researchers including Hummels (2001), Radelet and Sachs (1998) and Chasomeris (2006), that direct freight rates is seen as proprietary information and is as a result difficult to assemble, was therefore confirmed (see Section 1.2).

Most of the shipping companies that were willing to share their freight rates were only able to provide freight rates dating back one year or two. After further inquiries, a freight forwarder located in Johannesburg, South Africa, was willing to share quarterly freight rate data between South Africa and eleven Far East countries and fourteen European countries, from 2007 to 2015. The average of the quarterly freight rates was used to obtain a yearly freight rate. The freight rates are for containerised goods shipped from the main ports of South Africa. These actual freight rates were compared with South Africa's CIF/FOB ratios, which were calculated using various data sources, including the (i) WITS, (ii) UNCTAD, (iii) DOTS, (iv) IFS, (v) GTAP.

(i)   WITS provide a user-friendly interface to access the UNSD Commodity Trade (UN COMTRADE) database[9]. COMTRADE provides a broad range of information on merchandise trade imports and exports by partner country data for more than 170 nations. The research constructed CIF/FOB ratios for eleven Far East countries and fourteen European nations at a product HS 6-digit level[10]. The WITS data are broad in coverage; however, the data suffers from missing values, and many of the calculated CIF/FOB ratios from the WITS data lie outside the plausible range of between 1 and 2. This means the CIF value is lower[11] than the FOB value, which is by definition not accurate (World Bank, 2017).

(ii)   UNCTAD statistics provides bilateral trade data between partner countries at the HS2-digit level for all products, from 1995 to 2015[12]. The UNCTAD statistics data are collected from national and international sources (UNCTAD, 2017). CIF/FOB ratios calculated from the UNCTAD data were used both as aggregated ratios for HS 39-99 and at a product level for the automobile sector HS 78 Road Vehicles. The data from UNCTAD offers broad coverage and little data errors when aggregating the CIF/FOB ratios over all products. However, when evaluating the automotive sector, data for several countries are lacking.

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[9] The World Banks World Integrated Trade Solution (WITS) are available at: http://wits.worldbank.org.
[10] The European countries used in this research are Belgium, Croatia, Denmark, France, Germany, Netherlands, Italy, Poland, Portugal, Russia, Slovenia, Spain, Turkey, and the United Kingdom. The Far East countries used are Hong Kong, Singapore, Korea, Japan, Thailand, Vietnam, Sri Lanka, Indonesia, India, Malaysia and the Philippines.
[11] Or the CIF value is more than two times higher than the FOB value which is by definition not accurate and points to a reporting on either the exporter or the importer's side.
[12] The UNCTAD statistics are available at: http://unctad.org/en/Pages/Statistics.aspx.

(iii)   The IMF provides import and export data reported by countries to the IMF in three different data sources. The IMF DOTS data tapes provide bilateral trade data aggregated over all commodities for all advanced, developing, and emerging economies with large shares of world trade. Coverage of DOTS statistics is augmented by collecting trade data available from other international organisations. European Union members' trade data are collected from COMEXT obtained from EUROSTATS. Annual data reported from the UN COMTRADE database are incorporated in DOTS for countries that do not report to the IMF (International Monetary Fund, 2017). This study applies CIF/FOB ratios calculated from IMF DOTS and IFS data. To find South Africa's CIF/FOB ratios to the selected Far East and European countries, South Africa represents the exporter, and each of the partner countries represents the importing country. In other words, when analysing the export data, South Africa is the reporting (exporting) country. When analysing the import data, South Africa is the partner (exporter), and the destination countries are the reporting (importing) countries (International Monetary Fund, 2017).

(iv)   The IFS offer selected indicators for trade in goods per country. IFS is one of the IMF`s principal statistical datasets and have been available from January 1948. The IFS data are aggregated over all partners and all products and therefore is not very detailed. Furthermore, the IMF applies a 10% imputation rule when compiling their data. In other words, if the exporter value is missing, the CIF value is reduced by 9% to create a FOB value. Similarly, if the importer value is missing, 10% is added to the FOB value to create the CIF value (Feldmann, 2011).

(v)   GTAP data were also used to calculate CIF/FOB ratios. GTAP offers the GTAP database, a global database which is abundantly documented. The database comprises complete information regarding bilateral trade, protection, and transportation linkages. The latest GTAP 9 database offers data for the years 2004, 2007 and 2011 for 140 regions and 57 GTAP commodity sectors[13]. The GTAP databases are derived from individual country input-output data tables (Aguiar *et al*., 2016). As GTAP databases do not apply the HS product codes, but rather the GTAP commodity sectors, the HS code used in this research is matched with the GTAP commodity level codes by means of a concordance list provided by GTAP (Aguiar *et al*., 2016). The GTAP sectors used in this research therefore

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[13] This study could only get access to the GTAP 2011 data, through a research contact.

include categories 4-8, 12, 18-31 and 38[14]. The CIF/FOB ratios from the GTAP data ground on bilateral trade between South Africa and the selected Far East and European countries included in this research. South Africa represents the exporting country, and the destination countries represent the importing countries. The GTAP data has a relatively broad coverage. However, the data consisted of identical CIF and FOB ratios for several countries, resulting in a CIF/FOB ratio of 1.

To distinguish the study from past research in the field of international maritime transport costs and CIF/FOB ratios, this research investigates South Africa`s CIF/FOB ratios on an aggregated as well as on a product level. As the actual freight rates collected from the freight forwarding company in Johannesburg are mainly transporting containers filled with automotive parts, it would be interesting to determine whether there is a better correlation between the actual freight rates and CIF/FOB ratios on this more disaggregated level.

Section 4.5 investigates South Africa`s CIF/FOB ratios for the automotive sector, by analysing CIF/FOB ratios calculated from WITS, UNCTAD and Global Trade Analysis Project (GTAP) data, as these databases provide CIF and FOB values at a product level. Contrarily, the CIF and FOB values offered by the IMF DOTS and IMF IFS databases do not contain values at a product level but merely values aggregated over all product groups. Therefore, the CIF/FOB ratios calculated from these databases do not provide any insight into the trends of South Africa`s CIF/FOB ratios at a sector level and are excluded from the more disaggregated analysis. Furthermore, the CIF/FOB ratios from the various sources are compared with each other to determine whether large discrepancies occur between the rates. However, not all data sources were able to provide CIF/FOB ratios that lie within the plausible range of between 1 and 2. As a result, some of the sources will have missing CIF/FOB ratios for various countries and years. This research applied CIF/FOB ratios both as a percentage (12% *ad valorem*) and as a true ratio (1.12).

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[14] The following GTAP sectors is included in this study: 4 vegetables, fruits, nuts, 5 oilseeds, 6 sugarcanes, sugar beets, 7 plant-based fibres, 8 crops, 12 wool, silk-worm cocoons, 18 minerals, 19 bovine meat products, 20 meat products, 21 vegetable oils and fat, 22 dairy products, 23 processed rice, 24 sugar, 25 food products, 26 beverages and tobacco products, 27 textiles, 28 wearing apparel, 29 leather products, 30 wood products, 31 paper products, publishing, and 38 moving vehicles and parts.

4.4 Correlation analysis of South Africa's aggregate CIF/FOB ratios and actual shipping cost

This section investigates the correlation between South Africa`s CIF/FOB ratios and actual shipping quotes for fourteen European and eleven Far East countries between 2007 and 2015. The WITS, UNCTAD, IMF DOTS, IMF IFS and GTAP[15] databases for the years 2007 to 2015 are used to calculate South Africa`s CIF/FOB ratios. A correlation analysis is conducted to compare these CIF/FOB ratios with actual shipping quotes for both 20-foot and 40-foot general-purpose containers. The correlation results contributed towards a conclusion on whether or not the CIF/FOB ratios can serve as a suitable substitute for direct freight rates.

4.4.1 Correlation results: WITS aggregated CIF/FOB ratios and direct transport costs

Data collected from WITS was used to construct CIF/FOB ratios for the years 2007 to 2015. Analysing the data from the WITS database revealed significant amounts of CIF/FOB ratios which were not within the plausible range of between 1 and 2 (0%-100% *ad valorem* transport costs). In fact, only less than half of the CIF/FOB ratios could be used to represent transport costs as the ratios were negative or out of range in most cases. For the European countries, only 1 886 of the 5 337 computed CIF/FOB ratios lie within the plausible range, representing merely 35.4% of the data. For the Far East countries, only 1 290 of the 4 946 calculated CIF/FOB ratios lie within the plausible range, representing 26.08% of the data. Extensive modifications of the data therefore are necessary before the CIF/FOB ratios constructed from the UN COMTRADE database are usable as a substitute for real transport costs.

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[15] Data from the GTAP database was only available for year 2011.

Table 4.1 South Africa's CIF/FOB ratios to selected countries, 2007-2015, WITS

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Belgium	1,31	1,31	1,42	1,4	1,45	1,19	1,4	1,32	1,49
United Kingdom	1,23	1,37	1,34	1,26	1,25	1,39	1,39	1,36	1,46
Hong Kong	1,25	1,29	1,30	1,38	1,16	1,51	1,04	1,46	1,77
Italy	1,27	1,29	1,18	1,29	1,22	1,26	1,42	1,32	1,32
Singapore	1,27	1,33	1,28	1,38	1,25	1,30	1,31	1,33	1,45
Germany	1,28	1,38	1,38	1,43	1,45	1,30	1,30	1,26	1,31
France	1,30	1,31	1,26	1,22	1,42	1,32	1,35	1,21	1,57
Korea	1,30	1,27	1,19	1,31	1,26	1,30	1,23	1,22	1,26
Netherlands	1,30	1,29	1,34	1,29	1,31	1,27	1,22	1,16	1,42
Portugal	1,31	1,42	1,26	1,40	1,19	1,20	1,33	1,30	1,36
China	1,32	1,24	1,23	1,16	1,36	1,22	1,40	1,25	1,28
Spain	1,32	1,38	1,55	1,33	1,51	1,32	1,36	1,29	1,49
Denmark	1,33	1,26	1,23	1,32	1,36	1,28	1,28	1,25	1,35
Croatia	1,34	1,58	1,53	1,49	1,35	1,39	1,45	1,40	1,57
Japan	1,34	1,28	1,25	1,49	1,43	1,36	1,37		1,49
Poland	1,34	1,40	1,64	1,45	1,32	1,29	1,69	1,40	1,48
Thailand	1,43	1,23	1,29	1,28	1,33	1,30	1,29	1,29	1,31
Russian Federation	1,45	1,33	1,44	1,33	1,36	1,23	1,36	1,41	1,48
Slovenia	1,45	1,39	1,40	1,42	1,24	1,30	1,42	1,39	1,41
Turkey	1,45	1,19	1,34	1,29	1,22	1,25	1,24	1,23	1,34
Vietnam		1,45	1,40	1,07	1,28	1,49	1,36	1,40	1,55
Sri Lanka		1,33	1,24		1,36	1,31	1,40		1,23
Indonesia				1,25	1,35	1,35	1,24	1,30	1,36
India			1,40		1,30	1,44	1,32	1,43	1,43
Malaysia			1,27	1,31	1,33		1,47	1,5	1,33

Source: Author`s own calculations from WITS, 2017.

WITS provide bilateral trade values between partners, per product code. Table 4.1 shows South Africa`s CIF/FOB ratios aggregated over product codes HS 39-99[16] to the Far East and European countries included in this research, from 2007-2015. The table only includes ratios lying within the plausible range of between 1 and 2. Vietnam, Sri Lanka, Indonesia, India, and Malaysia had CIF/FOB ratios out of range in 2007, and are therefore not included in the table. In 2008, CIF/FOB values were out of range for Indonesia, India, and Malaysia. Only Indonesia had CIF/FOB ratio out of range in 2009, and Indonesia and Sri Lanka had erroneous rates in 2010. Malaysia and Sri Lanka had out of range CIF/FOB values in 2012 and 2014 respectively. The highest CIF/FOB ratio emerged in 2008, as South Africa`s CIF/FOB ratios to Russia was 1.58 (58% *ad valorem*). The lowest CIF/FOB ratio was found in South Africa`s trade with

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[16] This study only uses product codes HS 39-99, as it focuses on goods that can fit in a general container. Therefore, the study is trying to eliminate any products that are more likely to be transported in bulk form or by air. Hazardous products are also excluded from this study.

Vietnam in 2010, with a CIF/FOB ratio of only 1.07 (7% *ad valorem*). As South Africa`s CIF/FOB ratio to Vietnam was 1.28 (28% *ad valorem*) in 2009, the 2010 ratio represents a substantial decline in transport costs from South Africa to Vietnam. However, the rate increased again to 1.28 in 2011.
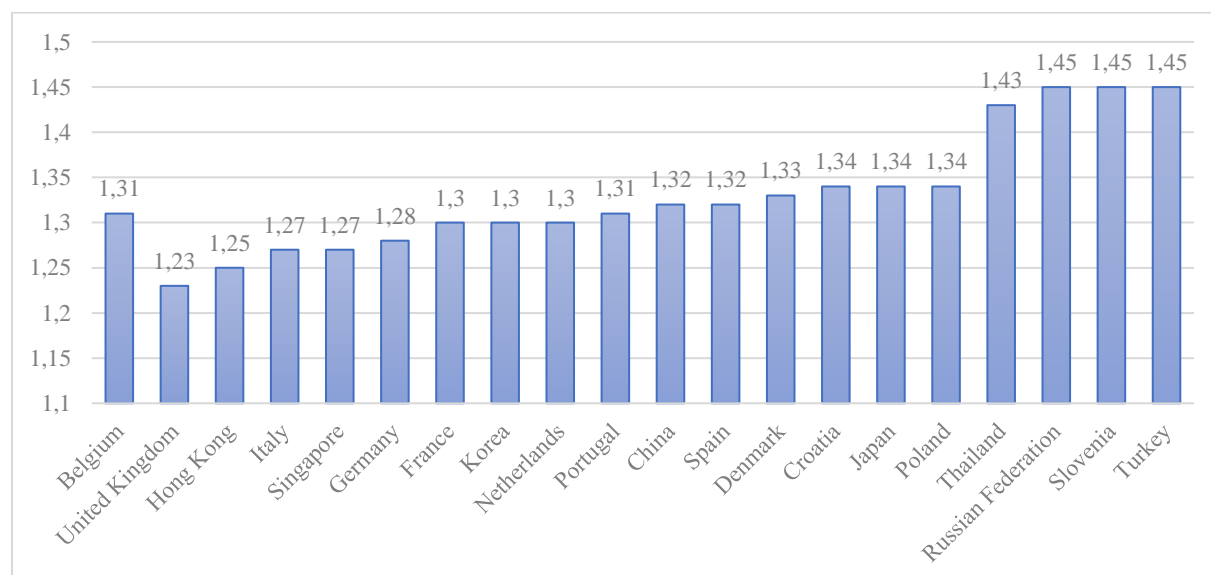
Figure 4.1 South Africa's CIF/FOB ratios to selected European and Far East countries, WITS 2007

Source: Author`s own calculations from WITS, 2017.

Figure 4.1 depicts South Africa`s CIF/FOB ratios calculated from the WITS database to the various Far Eastern and European countries, aggregated over product codes HS39-99 in 2007. South Africa`s CIF/FOB ratio was highest to the Russian Federation, Turkey, and Slovenia, which all had CIF/FOB ratios of 1.45 (45% *ad valorem*). The lowest rates were between South Africa and the United Kingdom, with CIF/FOB ratio of 1.23 (23% *ad valorem*), and South Africa and Hong Kong, China, with a CIF/FOB ratio of 1.25 (25% *ad valorem*). The average of South Africa`s CIF/FOB ratios to all countries included in this study was 1.33 (33% *ad valorem*) in 2007.
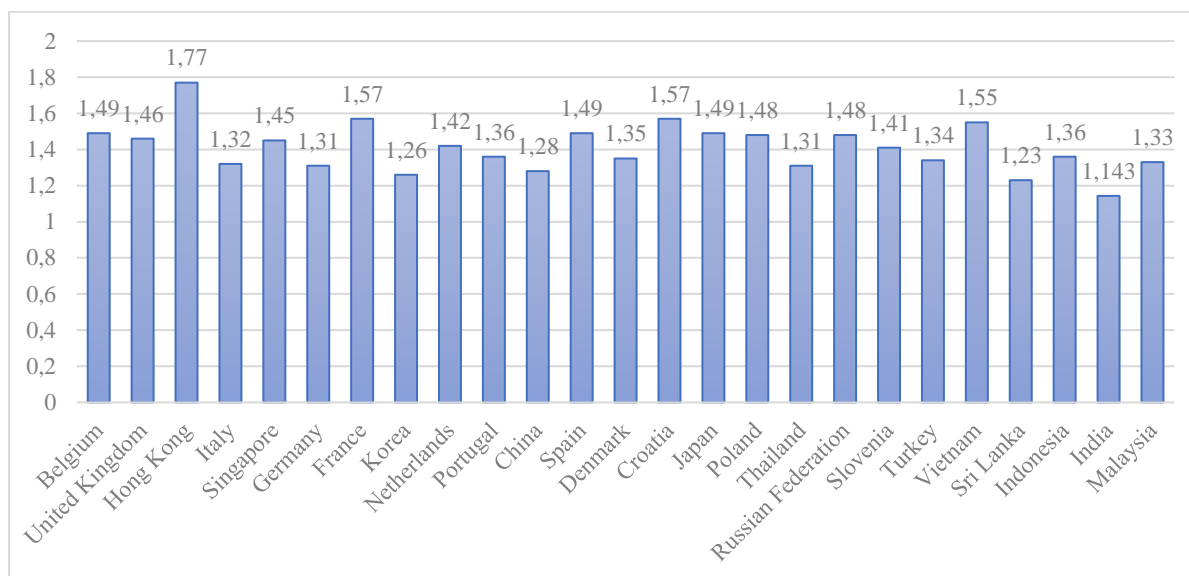
Figure 4.2 South Africa's CIF/FOB ratios to selected European and Far East countries, WITS 2015

Source: Author`s own calculations from WITS, 2017.

Figure 4.2 shows South Africa`s CIF/FOB ratios to various Far East and European countries, aggregated over product codes HS 39-99 in 2015. The highest CIF/FOB ratios in 2015 were noticed between South Africa and Hong Kong, with a CIF/FOB ratio of 1.77 (77% *ad valorem*). Compared to South Africa`s CIF/FOB ratio of 1.25 to Hong Kong in 2007, this rate indicates a large increase in South Africa`s shipping costs to Hong Kong. South Africa`s CIF/FOB ratio to the United Kingdom increased to 1.46 in 2015, from 1.23 in 2007. South Africa`s trade with Croatia faced a large increase in CIF/FOB ratios with a rate of 1.57 in 2015 from 1.34 in 2007.

The average of South Africa`s CIF/FOB ratio to all countries included in this study was 1.41 (41% *ad valorem*) in 2015, which is 8% higher than the average ratio of 1.33 in 2007 (see Table 4.2). Consequently, the data from WITS show an increase in average CIF/FOB ratios from South Africa to the selected countries between 2007 and 2015, which contradicts the common belief that freight costs have declined over time. However, when analysing the actual freight rates, a steady downward trend is revealed for both the 40-foot and the 20-foot containers. Please see Table A.2 and Table A.3 in Appendix (p.114) for the average actual freight rates.

Table 4.2 South Africa's average CIF/FOB ratios, WITS

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015
CIF/FOB ratio	1,33	1,33	1,34	1,33	1,32	1,32	1,35	1,32	1,41

Source: Author`s own calculations from WITS, 2017.

To analyse the relationship between the CIF/FOB ratios and the actual freight rates, panel data were used to conduct a correlation analysis. South Africa`s CIF/FOB ratios to the selected Far East and European countries are aggregated together for each year. Table 4.3 presents the correlation results of South Africa`s CIF/FOB ratios and the actual freight rates for a 20-foot general-purpose container collected from the South African freight forwarding company.

Table 4.3: Correlation results: South Africa's CIF/FOB ratio and actual freight rates 20-foot general-purpose container, WITS

Years	Number of observations (n)	Correlation coefficient	Sig. (2-tailed)
2007	17	0,564**	0,018
2008	13	0,108	0,726
2009	8	-0,381	0,352
2010	9	-0,202	0,603
2011	18	0,385	0,115
2012	20	-0,163	0,492
2013	18	0,067	0,792
2014	15	0,406	0,133
2015	17	-0,283	0,271

Source: Author`s own calculations WITS, 2017.

Notes:

*: Correlation is significant at probability level $(p) \leq 0.100$

**: Correlation is significant at probability level $(p) \leq 0.050$

***: Correlation is significant at probability level $(p) \leq 0.01$

Table 4.3 shows a negative relationship between South Africa`s CIF/FOB ratios and the actual freight rates for the years 2009, 2010, 2012 and 2015. This means that South Africa`s average CIF/FOB ratios increased as the average actual freight rates decreased in this period. A positive relationship is noticed between South Africa`s average CIF/FOB ratios and the average actual freight rates in the year 2007, 2008, 2011, 2013 and 2014, indicating that the CIF/FOB ratios rise along with the actual freight rates. The probability levels in Table 4.3 show that only the 0.018 value in 2007 is statistically significant at the probability level 0.05, which indicates that the actual freight rates increase together with the CIF/FOB ratios. The p-value of 0.018 specifies that there is a very small chance that the correlation arises purely by chance. None of the other values are statistically significant, and a null hypothesis cannot be rejected that the coefficient is actually zero at the 0.050, 0.010 and 0.100 significance levels (Asteriou & Hall, 2016).

Table 4.4: Correlation results: South Africa's CIF/FOB ratio and actual freight rates 40-foot general-purpose container, WITS.

Years	Number of observations (n)	Correlation coefficient	Sig. (2-tailed)
2007	17	0.557**	0,02
2008	18	-0,097	0,754
2009	8	-0,381	0,352
2010	9	-0,202	0,603
2011	18	-0,194	0,441
2012	20	-0,214	0,365
2013	18	0,123	0,628
2014	15	0,291	0,293
2015	17	-0,407	0,105

Source: Author`s own calculations from WITS, 2017.

Notes:

*: Correlation is significant at probability level (p) = 0.100

**: Correlation is significant at probability level (p) = 0.050

***: Correlation is significant at probability level (p) = 0.01

Table 4.4 presents the correlation results of South Africa`s average CIF/FOB ratios and average actual freight rates for 40-foot general-purpose containers. The correlation coefficient for the year 2007 is the only statistically significant correlation result between the WITS CIF/FOB ratios and the actual freight rates. The positive relationship in 2007 indicated that the actual freight rates increased together with the CIF/FOB ratios. Again, the p-value of 0.020 specifies that there is a small probability that the correlation arises purely by chance. However, the remaining correlation coefficients are not statistically significant and add little valuable information regarding the relationship between the WITS CIF/FOB ratios and the actual freight rates of a 40-foot general-purpose container.

4.4.2 Correlation results: UNCTAD and direct transport costs

UNCTAD data are used to calculate CIF/FOB ratios for the years 2007 to 2015. Table 4.5 show CIF/FOB ratios calculated from values provided by UNCTAD's import and export matrix per country and product. The ratios are aggregated over products HS 39- 99 to create an average ratio per trading partner, for South Africa`s bilateral trade flows. The CIF/FOB ratios are used as a true ratio, e.g., 1.40. A CIF/FOB value of 1.40 proposes that transport and other associated charges are 40% of the import CIF value of the product transported.

Table 4.5: South Africa's CIF/FOB ratios to selected European and Far East countries, UNCTAD 2007-2015

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Denmark	1,37	1,18	1,31	1,21	1,27	1,27	1,31	1,22	1,29
France	1,39	1,42	1,43	1,36	1,35	1,4	1,35	1,38	1,35
Germany	1,27	1,33	1,38	1,28	1,29	1,29	1,36	1,24	1,38
Hong Kong	1,33	1,36	1,29	1,24	1,34	1,4	1,28	1,2	1,37
India	1,22	1,23	1,34	1,39	1,3	1,32	1,21	1,23	1,35
Indonesia	1,26	1,25	1,19	1,28	1,31	1,25	1,18	1,28	1,48
Italy	1,28	1,29	1,32	1,3	1,25	1,24	1,26	1,25	1,37
Japan	1,26	1,25	1,35	1,23	1,22	1,26	1,22	1,2	1,36
Korea	1,39	1,4	1,34	1,39	1,39	1,25	1,35	1,31	1,4
Malaysia	1,41	1,38	1,33	1,29	1,35	1,39	1,36	1,26	1,41
Netherlands	1,24	1,22	1,25	1,25	1,21	1,22	1,2	1,19	1,29
Philippines	1,36	1,28	1,45	1,39	1,41	1,33	1,33	1,33	1,29
Poland	1,25	1,39	1,39	1,58	1,47	1,34	1,53	1,52	1,54
Portugal	1,38	1,37	1,27	1,34	1,34	1,34	1,31	1,28	1,36
Russian Federation	1,22	1,25	1,35	1,34	1,26	1,25	1,31	1,27	1,34
Belgium	1,42	1,41	1,39	1,28	1,32	1,32	1,34	1,28	1,39
China	1,3	1,43	1,3	1,26	1,26	1,35	1,36	1,41	1,47
Croatia	1,57	1,6	1,34	1,5	1,34	1,3	1,46	1,36	1,5
Singapore	1,35	1,29	1,32	1,36	1,32	1,33	1,36	1,31	1,33
Slovenia	1,45	1,45	1,41	1,48	1,57	1,36	1,34	1,39	1,22
Spain	1,33	1,3	1,31	1,22	1,31	1,29	1,3	1,32	1,25
Sri Lanka	1,23	1,27	1,25	1,31	1,21	1,24	1,4	1,33	1,37
Thailand	1,33	1,4	1,39	1,34	1,34	1,32	1,43	1,32	1,33
Turkey	1,44	1,43	1,47	1,31	1,33	1,38	1,35	1,36	1,43
United Kingdom	1,28	1,3	1,33	1,36	1,26	1,26	1,26	1,17	1,23
Vietnam	1,5	1,49	1,55	1,31	1,45	1,31	1,33	1,48	1,49

Source: Author`s own calculations from UNCTAD 2017.

Table 4.5 shows South Africa`s CIF/FOB ratios to the various Far East and European countries used in this study, from 2007 to 2015. All the CIF/FOB ratios are within the plausible range (between 1 and 2). The highest CIF/FOB ratios were between South Africa and Poland in 2010 (1.58), South Africa and Slovenia in 2011 (1.57), and South Africa and Croatia in 2007 (1.57). The lowest CIF/FOB ratios were between South Africa and the United Kingdom in 2014 (1.17), Denmark in 2008 (1.18) and the Netherlands with a CIF/FOB ratio of 1.19 in 2014. The year 2015 display the highest average of South Africa`s CIF/FOB ratios, with a CIF/FOB ratios average over all countries of 1.37 (37% *ad valorem*).
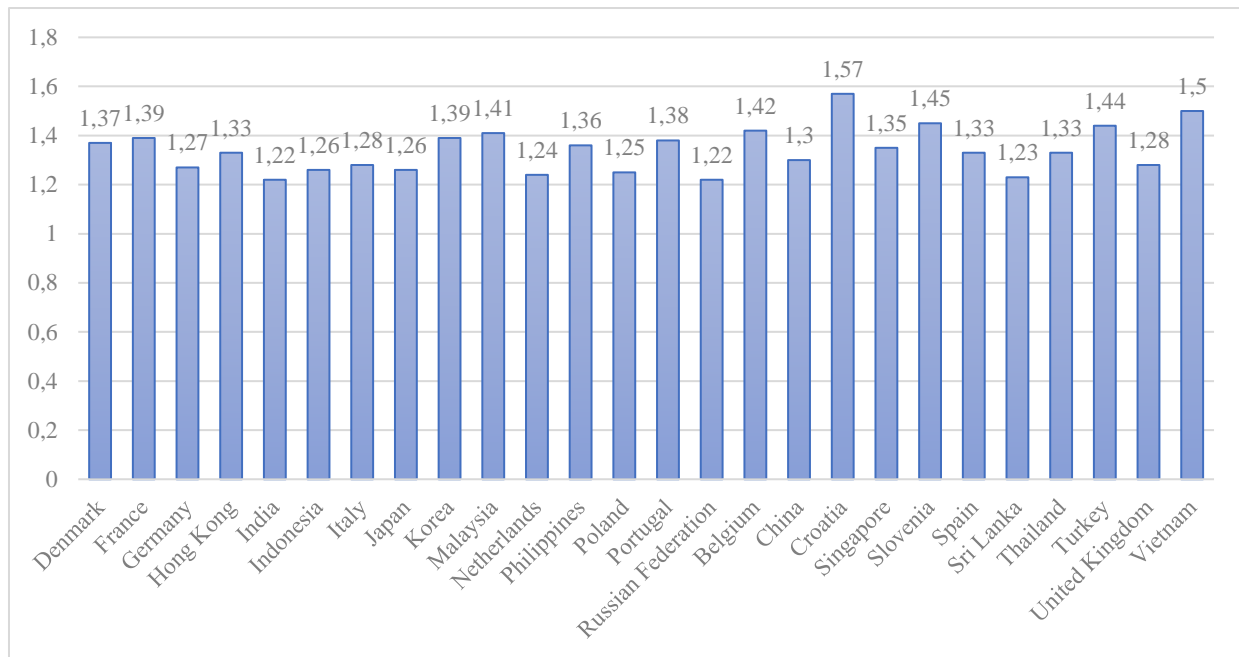
Figure 4.3: South Africa's CIF/FOB ratios to selected countries, UNCTAD 2007

Source: Author`s own calculations from UNCTAD, 2017.

Figure 4.3 presents South Africa`s CIF/FOB ratios to the Far East and European countries included in this study, for 2007. South Africa`s trade with Croatia, Slovenia, and Turkey display the highest CIF/FOB ratios, with ratios of 1.57, 1.45 and 1.44 respectively. The lowest CIF/FOB ratios are between South Africa and the Russian Federation, India, and Sri Lanka, with CIF/FOB ratios of 1.22, 1.20 and 1.23 respectively. The average of South Africa`s CIF/FOB ratios to all the above countries was 1.34 (34% *ad valorem*) in 2007.
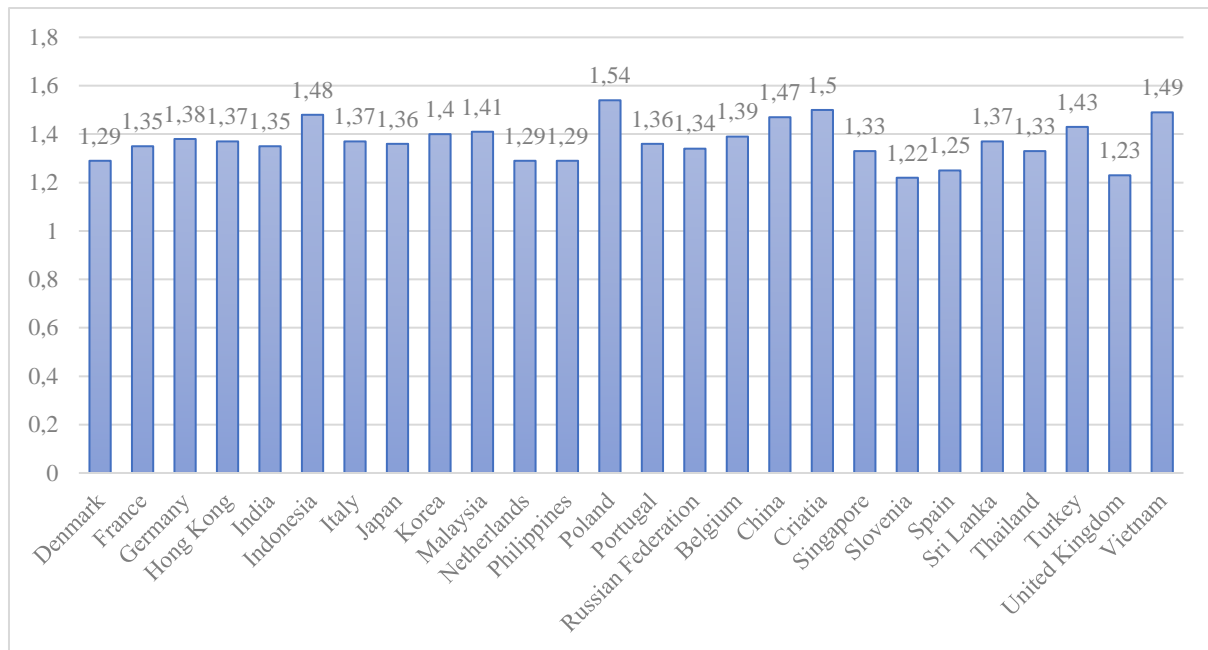
Figure 4.4: South Africa's CIF/FOB ratios to selected countries, UNCTAD 2015

Source: Author`s own calculations from UNCTAD, 2017.

Figure 4.4 shows South Africa`s CIF/FOB ratios to the Far East and European countries included in this study, for 2015. The highest CIF/FOB rate was noticed between South Africa and Poland, Vietnam, and China, with ratios of 1.54, 1.49 and 1.47 respectively. The lowest ratios are found between South Africa and Slovenia (1.22), United Kingdom (1.23) and Spain (1.25).

Table 4.6 present South Africa's CIF/FOB ratios aggregated over all countries included and all product groups. The average of South Africa`s CIF/FOB ratios to all the included countries was 1.37 in 2015. Compared to the average CIF/FOB ratio of 1.34 in 2007, the ratio represents an increase in South Africa`s CIF/FOB ratio, similar to the increase found in the calculated CIF/FOB ratios from the WITS database.

Table 4.6: South Africa's average CIF/FOB ratios, UNCTAD

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015
CIF/FOB ratio	1,34	1,35	1,35	1,33	1,33	1,31	1,33	1,30	1,37

Source: Author`s own calculations from UNCTAD, 2017.

Table 4.7: Correlation results: South Africa's CIF/FOB ratio and actual freight rates 20-foot general-purpose container, UNCTAD

Years	Number of observations (n)	Correlation coefficient	Sig. (2-tailed)
2007	21	-0,1	0,66
2008	17	-0,011	0,966
2009	10	0,770***	0,009
2010	10	0,128	0,725
2011	19	-0,017	0,911
2012	27	0,046	0,839
2013	19	0,12	0,625
2014	19	0,417*	0,079
2015	18	0,189	0,452

Source: Author`s own calculations from UNCTAD, 2017.

 Notes:

*: Correlation is significant at probability level (p) = 0.100

**: Correlation is significant at probability level (p) = 0.050

***: Correlation is significant at probability level (p) = 0.010

Table 4.7 depicts the correlation results for South Africa`s average CIF/FOB ratios and average actual freight rates for 20-foot general-purpose containers. A negative relationship is noticed between the CIF/FOB ratios and the actual freight rates for the years 2007, 2008 and 2011, as the CIF/FOB ratios and the actual freight rates did not move in the same direction. A positive relationship between the ratios and the actual freight rates are noticed in 2009, 2010, 2012, 2013, 2014 and 2015, representing similar movements in the CIF/FOB ratios and the actual freight rates. Years 2009 and 2014 show significant values, with correlation coefficients of 0.770 and 0.417 with p-values of 0.009 and 0.079 respectively. The value of 0.009 makes the correlation significant at the probability level 0.010, indicating only a slight probability that the correlation between the CIF/FOB and the actual freight rate in 2009 arises purely by chance. It can therefore be concluded that the coefficient significantly differs from zero at the 0.010 level as the p-value is less than 0.010. Furthermore, the 2014 value of 0.079 makes the correlation

statistically significant at the probability level 0.100. This indicates that a small chance exists that the correlation occurred merely by chance, and it can be concluded that the coefficient is significantly different from zero at the 0.100 level.

Table 4.8: Correlation results: South Africa's CIF/FOB ratio and actual freight rates 40-foot general-purpose container, UNCTAD

Years	Number of observations (n)	Correlation coefficient	Sig. (2-tailed)
2007	21	-0,133	0,564
2008	17	0,054	0,837
2009	10	0,770***	0,009
2010	10	0,128	0,725
2011	19	0,124	0,614
2012	27	-0,155	0,490
2013	19	0,121	0,623
2014	19	0,425*	0,070
2015	18	0,139	0,581

Source: Author`s own calculations from UNCTAD, 2017.

Notes:

*: Correlation is significant at probability level (p) = 0.100

**: Correlation is significant at probability level (p) = 0.050

***: Correlation is significant at probability level (p) = 0.010

Table 4.8 presents the correlation results for South Africa`s CIF/FOB ratios and the actual freight rates for 40-foot general-purpose containers. The correlation results show a negative relationship between the CIF/FOB ratios and the actual freight rates in the year 2007 and 2012. The only significant values are again noticed in 2009 and 2014, with correlation coefficients of 0.770 and 0.425 with a probability of 0.009 and 0.07 respectively. The low p-values indicate that the correlation does not occur by chance, and it is therefore clear that the coefficient is significantly different from zero at the 1% level in 2009 and the 10% level in 2014.

4.4.3 Correlation results: IMF DOTS and direct transport costs

When evaluating the CIF/FOB ratios constructed from the IMF DOTS data, 141 of the 226 ratios lie within the plausible range of between 1 and 2, or *ad valorem* transport cost of between 0 and 100%. In other words, 62.39% of the data lies within the acceptable range.

Table 4.9: South Africa's CIF/FOB ratios to various countries, IMF DOTS, 2007-2015

	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Belgium	1,56	1,49	1,47	1,21	1,19	1,30	1,10	1,06	1,19
France	0,95	1,06	1,27	1,06	1,02	0,90	0,81	0,90	0,85
Germany	0,98	1,06	1,13	1,05	1,22	1,15	1,17	1,14	1,05
Italy	2,62	2,34	2,08	1,82	1,57	1,70	1,89	2,11	1,80
Netherlands	1,06	1,05	1,34	1,20	1,08	1,02	1,07	1,13	1,23
Portugal	1,67	1,34	1,42	1,25	1,13	1,17	1,18	1,17	1,08
Slovenia	0,83	0,88	0,32	0,13	0,21	0,27	0,16	0,21	0,31
Spain	1,15	1,22	1,08	1,09	1,23	1,14	1,10	0,92	1,02
Hong Kong									
Denmark	1,26	1,72	1,35	1,29	1,14	1,10	1,04	0,51	1,06
Japan	1,10	1,11	1,21	1,13	1,10	1,13	1,21	1,17	1,24
Korea	1,52	1,39	1,24	1,35	1,37	1,40	1,37	1,22	1,31
Singapore	1,21	0,96	1,06	1,27	1,12	0,84	0,57	0,61	0,83
Taiwan									
United Kingdom	2,07	2,57	3,78	2,50	2,46	2,88	1,34	2,16	1,74
China	1,59	2,10	1,54	1,41	2,58	4,32	4,01	5,10	2,06
India	2,46	2,20	2,39	2,28	2,77	2,30	2,50	1,59	1,97
Indonesia	1,13	1,27	0,88	0,96	0,96	1,10	1,24	1,37	1,05
Malaysia	1,21	1,28	1,03	1,09	1,10	0,88	1,24	1,12	1,07
Philippines	1,50	1,27	1,01	0,75	1,87	0,82	1,01	0,78	0,92
Sri Lanka	0,65	0,72	1,13	0,44	0,96	0,85	1,20	1,31	1,06
Thailand	1,30	1,86	1,45	1,38	3,01	4,22	4,71	2,44	1,93
Vietnam	1,28	1,78	1,55	1,17	1,98	1,17	0,92	0,81	1,10
Croatia	3,98	2,97	3,03	2,55	1,52	0,65	0,44	0,54	3,15
Poland	1,02	1,18	1,00	0,67	0,56	0,74	0,90	0,94	1,11
Turkey	6,87	2,75	4,17	2,24	3,43	1,96	2,31	2,01	1,70
Russian Federation	1,63	1,87	1,72	1,71	1,12	1,61	1,93	1,89	1,93

Source: Author`s own calculations from IMF DOTS, 2017.

Table 4.9 depicts South Africa`s IMF DOTS CIF/FOB ratios to the Far East and European countries included in this study. The table includes all ratios, both within and outside the plausible range of between 1 and 2. As seen from Table 4.9 Hong Kong and Taiwan do not have any data registered between 2007 and 2015 in the IMF DOTS data. Table 4.9 indicate errors in the data as 85 of the calculated CIF/FOB ratios from the IMF DOTS data lie outside the plausible range (of between 1 and 2). For example, France has a CIF/FOB ratio of 0.95 and Turkey has a CIF/FOB ratio of 6.87 in 2007, which both lie outside the acceptable range. CIF/FOB ratios lying outside the plausible range give no valid information regarding a

country's shipping costs (see Section 3.3.2.2). The data must therefore be modified, and all the non-applicable ratios must be removed from the dataset. When excluding the CIF/FOB ratios lying outside the plausible range, the ratios shown in Figure 4.5 and Figure 4.6 are remaining. Several ratios are now missing from the data table. However, the ratios which are left might be a good starting point in understanding trends in South Africa`s shipping costs.

Figure 4.5 shows South Africa`s CIF/FOB ratios to the selected Far East countries for this research, between 2007 and 2015, calculated from the IMF DOTS data. Figure 4.5 shows South Africa's CIF/FOB ratios to the Far East countries included in this study lying within the plausible range, from 2007 to 2015. From Figure 4.5, it is evident that only Japan and Korea have credible CIF/FOB ratios for all the years 2007-2015. India has the lowest number of credible ratios, as only the ratios for years 2014 and 2015 are usable for research. Missing reports is a serious problem in the IMF data. The lack of continuous and reliable rates over all countries and years makes it challenging to evaluate the IMF DOTS CIF/FOB ratios. However, when analysing South Africa`s transport costs with Far East countries, the highest CIF/FOB ratio was found between South Africa and Vietnam, where the CIF/FOB ratios were 1.98 in 2011. An *ad valorem* transport cost of 98% is highly unlikely, which gives reason to suspect errors in the IMF DOTS data. South Africa`s CIF/FOB with India is similarity high, with *ad valorem* transport costs of 97% (1.97) in 2015[17]. South Africa`s trade with the Philippines displays the lowest CIF/FOB ratios, with ratios of merely 1.01 (1% *ad valorem*) in 2009 and 2013. South Africa's CIF/FOB ratio to Indonesia is also relatively low, with a ratio of 1.05 (5% *ad valorem*) in 2015 South Africa`s trade to Singapore shows similarly low ratios, with a CIF/FOB ratio of 1.06 in 2009. The average CIF/FOB ratio of South Africa to all included Far East countries was 1.31 in 2007 and 1.34 in 2015, indicating an increase in shipping rates from 2007 to 2015.

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[17] When comparing these "errors" with other data sources used in this study, it is clear that the IMF DOTS CIF/FOB ratios for Vietnam (2011) and India (2015) differ significantly from the CIF/FOB ratios from other data sources. Vietnam's CIF/FOB ratio for 2011 were 1.28 in the UN COMTRADE (WITS) data, 1.45 in the UNCTAD data and 1.03 in the GTAP data. India`s CIF/FOB ratio for 2015 were 1.43 in the UN COMTRADE (WITS) data and 1.35 in the UNCTAD data. The GTAP data only include 2011 values can therefore not be compared with the 2015 CIF/FOB ratios of India. IMF`s IFS CIF/FOB ratios are not country specific and cannot be used as a comparison. The large spread between the other data sources and the IMF`s DOTS CIF/FOB ratios confirms that there might be errors in the IMF`s DOTS data.
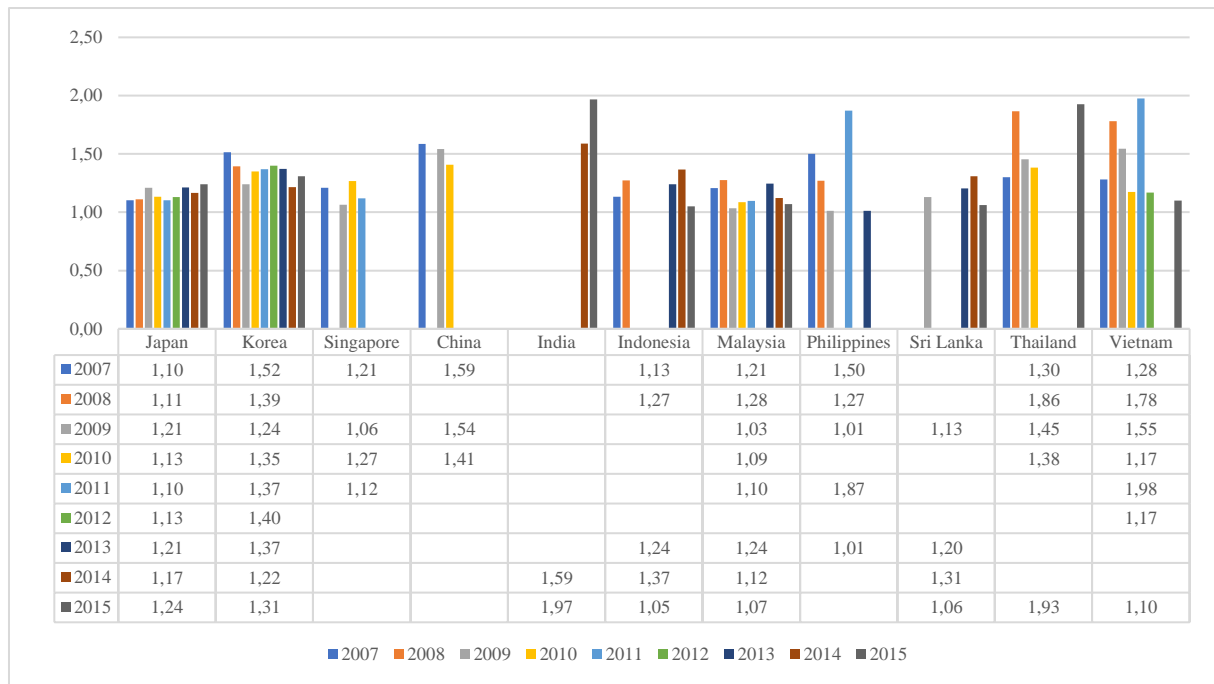
Figure 4.5: South Africa's CIF/FOB ratios to selected Far East countries, IMF DOTS 2007-2015

Source: Author`s own calculations from IMF DOTS, 2017.

	Japan	Korea	Singapore	China	India	Indonesia	Malaysia	Philippines	Sri Lanka	Thailand	Vietnam
2007	1,10	1,52	1,21	1,59		1,13	1,21	1,50		1,30	1,28
2008	1,11	1,39				1,27	1,28	1,27		1,86	1,78
2009	1,21	1,24	1,06	1,54			1,03	1,01	1,13	1,45	1,55
2010	1,13	1,35	1,27	1,41			1,09			1,38	1,17
2011	1,10	1,37	1,12				1,10	1,87			1,98
2012	1,13	1,40									1,17
2013	1,21	1,37				1,24	1,24	1,01	1,20		
2014	1,17	1,22			1,59	1,37	1,12		1,31		
2015	1,24	1,31			1,97	1,05	1,07		1,06	1,93	1,10

The IMF data can be regarded as relatively unreliable as the database relies heavily on a 10% imputation rule. If there is no data available from the importer (the CIF value), a value of 10% is added to the exporter (FOB) value. Similarly, if there is no data available from the exporting country (FOB value), IMF imputed a 9% reduction from the importer value (CIF value) to calculate the export (FOB) value (Hummels & Lugovskyy, 2006).

Figure 4.6 presents South Africa`s CIF/FOB ratios to selected European countries. Only Belgium, the Netherlands, Portugal, and the Russian Federation have CIF/FOB ratios in range for all years 2007 to 2015. Croatia merely has one single CIF/FOB ratio in range, in 2011, and the United Kingdom and Turkey have two CIF/FOB ratios within range in 2013, 2015 and 2012, 2015 respectively. The highest CIF/FOB ratio is noticed between South Africa and Turkey, with a ratio of 1.96 in 2012. South Africa's CIF/FOB ratio with the Russian Federation was also extremely high in 2013 (1.93), 2014 (1.89) and 2015 (1.93). Similarly, South Africa`s CIF/FOB ratio to Italy of 1.89 in 2013 unusually is high[18].

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[18] Comparing these "errors" with other data sources used in this study further confirms the suspicion of errors in the IMF DOTS data. Turkey`s CIF/FOB ratio were 1.96 in 2012 according to the IMF DOTS data, but merely 1.25 in the UN COMTRADE (WITS) data and 1.25 in the UNCTAD data. Similarly, the Russian Federation`s CIF/FOB ratios are considerably lower according to the UN COMTRADE (WITS) data with CIF/FOB ratios of 1.36 in

Figure 4.6 (chart) with embedded data table:

| Year	Belgium	France	Germany	Italy	Netherlands	Portugal	Spain	Denmark	United Kingdom	Croatia	Poland	Turkey	Russian Federation
2007	1,56				1,06	1,67	1,15	1,26			1,02		1,63
2008	1,49	1,06	1,06		1,05	1,34	1,22	1,72			1,18		1,87
2009	1,47	1,27	1,13		1,34	1,42	1,08	1,35			1,00		1,72
2010	1,21	1,06	1,05	1,82	1,20	1,25	1,09	1,29					1,71
2011	1,19	1,02	1,22	1,57	1,08	1,13	1,23	1,14		1,52			1,12
2012	1,30		1,15	1,70	1,02	1,17	1,14	1,10				1,96	1,61
2013	1,10		1,17	1,89	1,07	1,18	1,10	1,04	1,34				1,93
2014	1,06		1,14		1,13	1,17							1,89
2015	1,19		1,05	1,80	1,23	1,08	1,02	1,06	1,74		1,11	1,70	1,93

Figure 4.6: South Africa's CIF/FOB ratios to selected European countries, IMF DOTS 2007-2015

Source: Author`s own calculations from IMF DOTS, 2017.

According to the IMF DOTS data, the average CIF/FOB ratio of South Africa to all the selected European and Far East countries in 2007 were 1.31 and 1.35 in 2015, indicating an increase in the ratios between 2007 and 2015 (Table 4.10). The year 2008 presented the highest average CIF/FOB ratios, with a ratio of 1.38.

Table 4.10: South Africa's average CIF/FOB ratios, IMF DOTS

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015
CIF/FOB ratio	1,31	1,38	1,29	1,28	1,26	1,32	1,29	1,29	1,35

Source: Author`s own calculations from IMF DOTS, 2016.

Table 4.11 presents the correlation results of South Africa`s CIF/FOB ratios calculated from the IMF DOTS database and the actual freight rates for a 20-foot general-purpose container. Table 4.11 reveals a negative correlation between South Africa`s CIF/FOB ratios and actual freight costs in 2008, 2010, 2011 and 2013. In other words, the CIF/FOB ratios increase as the actual freight rates decrease (or the other way around). Interestingly, Table 4.11 shows a

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2013, 1.41 in 2014 and 1.48 in 2015. Comparing the Russian Federation`s CIF/FOB ratios with the UNCTAD show even lower CIF/FOB ratios of 1.31, 1.27 and 1.34 in 2013, 2014 and 2015 respectively. Italy`s CIF/FOB ratio of 1.89 in 2013 in the IMF DOTS data is also much higher than the country`s CIF/FOB ratios according to the UN COMTRADE (WITS) data and the UNCTAD data, with ratios of 1.42 and 1.26 respectively.

relatively high and statistically significant relationship between the CIF/FOB ratios and the actual freight costs in 2014, with a correlation coefficient of 0.730 and a p-value of 0.017. This statistically significant result between South Africa`s CIF/FOB ratios and actual freight rates suggests that the CIF/FOB ratios increase with the actual freight rates.

Table 4.11: Correlation results: South Africa`s CIF/FOB ratio and actual freight rates 20-foot general-purpose container, IMF DOTS

Years	Number of observations (n)	Correlation coefficient	Sig.2 tail
2007	14	0,262	0,366
2008	11	-0,427	0,19
2009	7	0,214	0,645
2010	7	-0,071	0,879
2011	12	-0,406	0,19
2012	11	0,155	0,65
2013	11	-0,123	0,719
2014	10	0,730**	0,017
2015	14	0,253	0,383

Source: Author`s own calculations from IMF DOTS, 2017.

Notes:

*: Correlation is significant at probability level (p) = 0.010

**: Correlation is significant at probability level (p) = 0.050

***: Correlation is significant at probability level (p) = 0.001

Table 4.12 presents the correlation results between South Africa`s CIF/FOB ratios and the average actual freight rates for a 40-foot general-purpose container. There appears to be a negative relationship between the CIF/FOB ratios and actual freight rates in 2008 and 2010. However, none of these correlation results are significant; therefore, it can be concluded that no significant relationship exists between the IMF DOTS CIF/FOB ratios and actual freight rates. The very high p-values of 0.790 and 0.879 for 2008 and 2010 respectively, indicate that there is a high probability that the estimated correlations could arise by chance. Only the year

2014 shows a statistically significant relationship between the IMF DOTS CIF/FOB ratios and the actual freight rates. It appears that in 2014, the CIF/FOB ratios increased together with the actual freight rates, with the positive correlation coefficient of 0.841 and p-value of 0.002.

Table 4.12: Correlation results: South Africa's CIF/FOB ratio and actual freight rates 40-foot general-purpose container, IMF DOTS

Years	Number of observations (n)	Correlation coefficient	Sig.2 tail
2007	14	0,172	0,557
2008	11	-0,091	0,79
2009	7	0,214	0,645
2010	7	-0,071	0,879
2011	12	0,007	0,983
2012	11	0,191	0,574
2013	11	0,032	0,926
2014	10	0,841**	0,002
2015	14	0,293	0,31

Source: Author`s own calculations from IMF DOTS, 2017.

Notes:

*: Correlation is significant at probability level (p) = 0.050

**: Correlation is significant at probability level (p) = 0.010

***: Correlation is significant at probability level (p) = 0.100

4.4.4 Correlation results: IFS and direct transport costs

The IFS aggregate the data over all South Africa's trading partners and all product sectors. Figure 4.7 shows South Africa`s CIF/FOB ratios calculated from the IMF IFS data tables. South Africa`s CIF/FOB ratios show large variations according to the IFS data, with the highest ratios in 2012 with *ad valorem* transport costs of 23% (Figure 4.7). A large decline in transport costs was noticed from 2012 to 2013, with transport costs of merely 6% of total *ad valorem* transport costs.
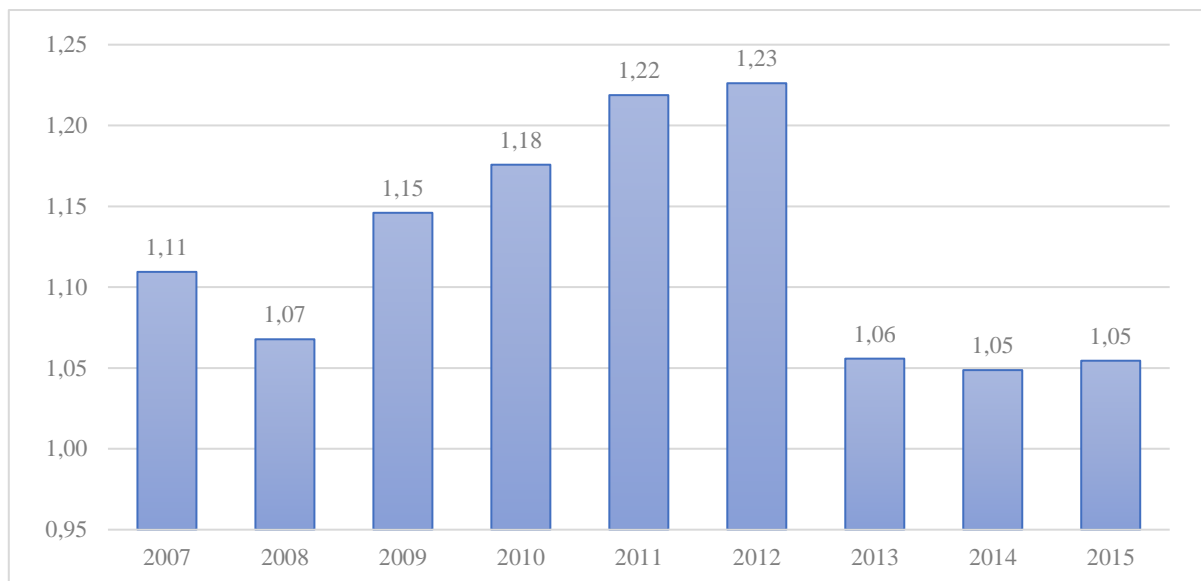
Figure 4.7: CIF/FOB ratios for South Africa, IFS 2007-2015

Source: Author`s own calculations from IFS, 2017.

Since the IMF aggregate data over all countries and all product groups in their International Financial Statistics, the CIF/FOB ratios calculated from this data do not give any specific information regarding South Africa`s transport costs to particular trading partners. As a result, no correlation analysis could be performed on this data.

4.4.5 Correlation results: GTAP and direct transport costs

GTAP offers data at a sector level and is used for calculating South Africa`s CIF/FOB ratios for the year 2011. The CIF/FOB ratios calculated from the GTAP database are shown in Figure A.1 of the Appendix. The empty spaces in the data table in Figure A.1 represents lacking data from one or both the reporting countries, making it impossible to calculate the CIF/FOB ratios for the countries concerned. Also, several CIF/FOB values in Figure A.1 equal 1.00. A CIF/FOB ratio of 1.00 represents identical CIF and FOB values in the GTAP database, indicating reporting errors in either the exporting or importing country, or both. The highest CIF/FOB ratio is noticed in India (67% *ad valorem* shipping costs) for the GTAP commodity sector 18, Minerals. Thailand and France following with CIF/FOB ratios of 1.50 for wood products (sector 30) and oilseeds (sector 5), respectively. Japan also displays high CIF/FOB ratios, with a ratio of 1.46 in vegetable oils and fats (sector 21), and Malaysia shows a ratio of 1.33 for wood products (sector 30). When excluding the CIF/FOB ratios of 1.00, which represents transport costs of 0%, China, and Korean display the lowest CIF/FOB ratios, with

ratios of 1.02 in leather products (sector 29). China and Japan have CIF/FOB ratios of 1.03 for moving vehicles and parts (sector 38) and leather products (sector 29) respectively. Korea also has a CIF/FOB ratio of 1.03 for beverages and tobacco products (sector 26).
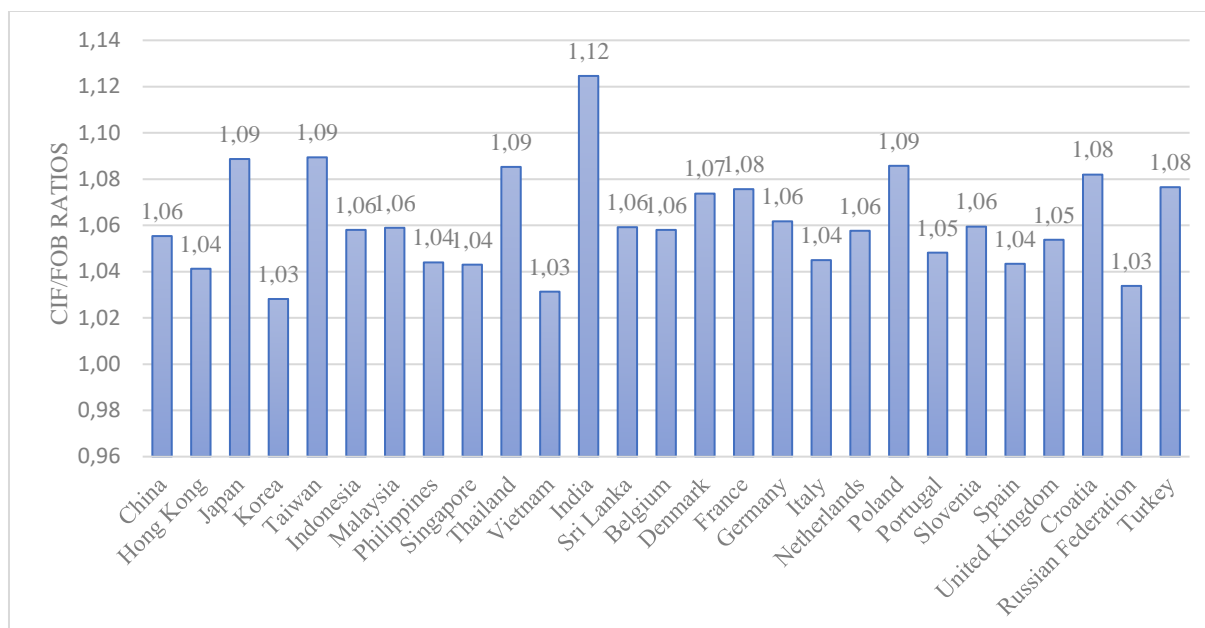
Figure 4.8: South Africa's CIF/FOB ratios to selected countries, aggregated over all products, GTAP 2011

Source: Author`s own calculations from GTAP 2011 database.

Note: The ratios are the averages of the CIF/FOB ratios calculated from the following GTAP sectors: 4 vegetables, fruits, nuts, 5 oilseeds, 6 sugarcanes, sugar beets, 7 plant-based fibres, 8 crops, 12 wool, silk-worm cocoons, 18 minerals, 19 bovine meat products, 20 meat products, 21 vegetable oils and fat, 22 dairy products, 23 processed rice, 24 sugar, 25 food products, 26 beverages and tobacco products, 27 textiles, 28 wearing apparel, 29 leather products, 30 wood products, 31 paper products, publishing, and 38 moving vehicles and parts.

Figure 4.8 shows South Africa`s CIF/FOB ratios for selected Far East and European countries calculated from GTAP data 2011. The ratios are the CIF/FOB ratios aggregated over all the included GTAP sectors. The highest CIF/FOB ratios are faced when South Africa trades with India, with a ratio of 1.12. The lowest CIF/FOB ratios are faced when South Africa trades with the Russian Federation, Vietnam, and Korea, all with CIF/FOB ratios of 1.03.

Table 4.13: Correlation results: South Africa's CIF/FOB ratio and actual freight rates 20-foot general-purpose container, GTAP

Year	Number of observations (n)	Correlation coefficient	Sig. (2-tailed)
2011	19	-0,180	0,460

Source: Author`s own calculations from GTAP 2011 database.

The correlation results of South Africa`s actual freight rates of 20-foot general-purpose containers and the GTAP CIF/FOB ratios in Table 4.13 show a negative correlation coefficient of -0.180, indicating a negative relationship between the actual freight rates and the GTAP CIF/FOB ratios. Table 4.14 presents the correlation results between South Africa`s actual freight rates for 40-foot containers and the CIF/FOB ratios calculated from GTAP data for 2011. The coefficient correlations show a positive relationship between the actual rates and the indirect CIF/FOB ratios. However, the results are not statistically significant, and there is a large probability that any correlation arises purely by chance.

Table 4.14: Correlation results: South Africa's CIF/FOB ratio and actual freight rates 40-foot general-purpose container, GTAP

Year	Number of observations (n)	Correlation coefficient	Sig. (2-tailed)
2011	19	0,082	0,739

Source: Author`s own calculations from GTAP 2011 database.

Section 4.4 presents the correlation analysis between South Africa`s actual freight rates and the CIF/FOB ratios for general cargo. The above analysis reveals that many of the correlation results yield insignificant results, and most of the correlations are therefore not statistically significant. A negative relationship between the actual freight rates and the CIF/FOB ratios was detected in several cases, indicating an increase in the actual freight rates while the CIF/FOB ratios decrease, or the other way around. Consequently, based on the above analysis, South Africa`s CIF/FOB ratios for general cargo do not serve as an accurate measure of the country`s actual freight rates. As past research on South Africa`s CIF/FOB ratios is not product-specific, and due to the errors found in the CIF/FOB ratios (see Section 3.3.2.2), Section 4.5 conducts a correlation analysis between South Africa`s CIF/FOB ratios and actual freight rates for the automotive sector. The following analysis therefore investigates whether the correlations will yield more statistically significant results when sector-specific CIF/FOB ratios are used.

4.5 Correlation analysis of South Africa's automotive sector CIF/FOB ratios and actual shipping cost

Past research on South Africa`s CIF/FOB ratios has not been product-specific. The following section will therefore investigate the accuracy of South Africa`s CIF/FOB ratios by analysing the ratios at a more disaggregated product level. As the direct freight rates obtained from the South African freight forwarder are for containerised automotive parts, Section 4.5 will compare the direct freight rates with CIF/FOB ratios for the automotive sector to establish whether a higher correlation between the CIF/FOB ratios and the direct freight rates occurs.

4.5.1 Correlation results: WITS and direct transport costs for automotive parts

Table 4.15 presents South Africa`s CIF/FOB ratios for automotive parts to the countries included in this study, calculated from WITS data. The UN COMTRADE database provides CIF and FOB values on an HS4 digit level were used. The data in Table 4.15 presents CIF/FOB ratios calculated for the product code HS 8708 - Parts and accessories of the motor vehicles. As noticed in the table below, only a limited number of countries had CIF/FOB ratios lying within the plausible range as only 67 of the 211 CIF/FOB ratios have a value between 1 and 2. The empty spaces show where the CIF/FOB ratios lie outside the range. Consequently, it is not possible to calculate valid CIF/FOB ratios for South Africa`s trade in automotive parts with these countries.

Table 4.15: South Africa's CIF/FOB ratios to selected countries for automotive sector, WITS 2007-2015

	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Belgium		1,06	1,19		1,1				
United Kingdom	1,02	1,60	1,33	1,28	1,22	1,27	1,12		1,61
Hong Kong	1,03	1,67	1,14						
Italy		1,59			1,2	1,05	1,3		1,77
Singapore	1,22			1,44	1,25	1,01	1,15	1,91	
Germany			1,48						
France	1,46								
Korea							1,43		1,05
Netherlands				1,03	1,24				
Portugal			1,46						
China	1,74	1,05	1,16	1,03			1,88		
Spain					1,08	1,21	1,22	1,33	1,43
Denmark								1,25	
Japan			1,3	1,26	1,12	1,14	1,12		
Poland									1,64
Thailand		1,47			1,25	1,21		1,16	1,1
Slovenia			1,76						
Turkey				1,35	1,44	1,21	1,73	1,75	
India				1,22	1,53	1,88	1,72	1,18	1,38
Malaysia			1,26						

Source: Author`s own calculations from WITS, 2017.

Notes: The empty spaces indicate missing or erroneous CIF/FOB values lying outside the plausible range of between 1 and 2 (0%-100% *ad valorem* transport costs).

South Africa`s trade with Singapore shows the highest CIF/FOB ratios, with a ratio of 1.91 in 2014, representing an *ad valorem* transport cost of 91%. India and China followed with the second highest CIF/FOB ratios of 1.88 in 2012 and 2013 respectively. The lowest CIF/FOB ratio is between South Africa and Singapore in 2012 with a ratio of 1.01, representing an *ad valorem* shipping cost of 1%. The extreme increase in Singapore's CIF/FOB ratio from 1% in 2012 to 91% in 2014 indicates possible errors in this data[19]. South Africa`s CIF/FOB ratio to the United Kingdom was merely 1.02 in 2007, and South Africa`s CIF/FOB ratio to Hong Kong and China was similarly low with a ratio of 1.03 in 2007 and 2010.

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[19] The other data sources for the automotive sector used in this study did unfortunately not contain data for Singapore for the relevant years. These odd results can therefore not be compared to other CIF/FOB ratios.
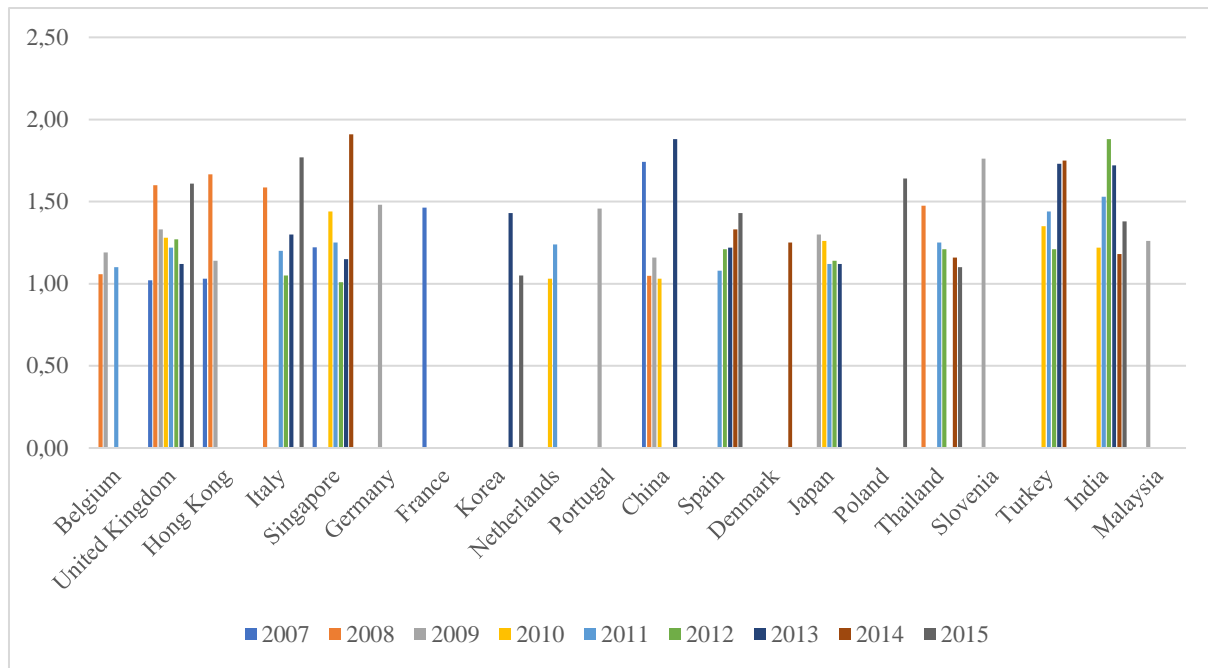
Figure 4.9: South Africa's CIF/FOB ratios to various countries for the automotive sector, WITS 2007-2015

Source: Author`s own calculations from WITS UN COMTRADE, 2017.

When aggregating South Africa`s CIF/FOB ratios to its various bilateral trade partners, the country's average CIF/FOB ratio per year are shown (see Table 4.16). South Africa`s CIF/FOB ratio rose from 2007 to 2008, as the ratio increased from 1.30 to 1.41. The years 2010, 2011 and 2012 show relatively stable CIF/FOB ratios, with ratios of 1.23, 1.24 and 1.25 respectively. An increase emerged again in 2013 when the rate rose to 1.41. An additional 2% increase occurred from 2013 to 2014, as the CIF/FOB ratios rose to 1.43.

Table 4.16: South Africa's average CIF/FOB ratios, WITS

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015
CIF/FOB ratio	1.30	1,41	1,34	1,23	1,24	1,25	1,41	1,43	1,43

Source: Author`s own calculations from WITS, 2017.

The 2007 average is lower than the 2015 average, indicating an increase in transport costs of 13% over the period 2007 to 2015. The increasing CIF/FOB rates contradict the declining actual freight rates (see Figure A2 and Figure A3).

Table 4.17 shows the correlation results between South Africa`s average CIF/FOB ratios and the average actual freight rates for 20-foot containers in the automotive sector. The year 2009 did not have a CIF/FOB ratio for the automotive sector; therefore, it was not possible to conduct

a correlation analysis for this year. Table 4.17 shows no statistically significant relationships between the WITS CIF/FOB ratios and the actual freight rates. The years 2008, 2010, 2011, 2012, 2013 and 2014 indicate a negative relationship between the CIF/FOB ratios and the actual freight rates. However, the high p-values (0.747 in 2015) indicate a high probability that the correlation could occur purely by chance.

Table 4.17: Correlation results: South Africa's CIF/FOB ratio and actual freight rates 20-foot container automotive sector, WITS

Years	Number of observations (n)	Correlation coefficient	Sig. (2-tailed)
2007	5	0,5	0,391
2008	5	-0,4	0,505
2009			
2010	3	-0,5	0,667
2011	6	-0,174	0,742
2012	6	-0,377	0,461
2013	7	-0,18	0,699
2014	3	-0,5	0,667
2015	5	0,2	0,747

Source: Author`s own calculations from WITS, 2017.

Notes:

*: Correlation is significant at probability level (p) = 0.100

**: Correlation is significant at probability level (p) = 0.050

***: Correlation is significant at probability level (p) = 0.01

Table 4.18 presents the correlation results between South Africa's average CIF/FOB ratios and the average actual freight rates in the automotive sector for 40-foot containers. Again, there are no significant statistical relationships between the CIF/FOB ratios and the actual freight rates, and the high p-values indicate that a significant probability exists that the correlation results arise purely by chance. Consequently, the correlation results are not significant, and the null

hypothesis that the coefficient is actually zero at the 1%, 5% or 10% significance levels cannot be rejected.

Table 4.18 Correlation results: South Africa's CIF/FOB ratio and actual freight rates 40-foot container automotive sector, WITS

Years	Number of observations (n)	Correlation coefficient	Sig. (2-tailed)
2007	5	0,6	0,285
2008	5	-0,2	0,747
2009			
2010	3	-0,5	0,667
2011	6	0,522	0,288
2012	6	-0,464	0,354
2013	7	-0,18	0,699
2014	3	-0,5	0,667
2015	5	0,2	0,747

Source: Author`s own calculations from WITS, 2017.

Notes:

*: Correlation is significant at probability level (p) = 0.050

**: Correlation is significant at probability level (p) = 0.010

***: Correlation is significant at probability level (p) = 0.100

4.5.2 Correlation results: United Nation Conference on Trade and Development (UNCTAD) and direct transport costs for automotive parts

UNCTAD`s trade data are available only at the HS 2-digit sector level, and HS 78 - Road Vehicles were used to calculate the CIF/FOB ratios. The UNCTAD data is also relatively limited in number, as only 67 of the 211 CIF/FOB ratios lie within the plausible range (between 1 and 2). South Africa`s trade with China presents the highest CIF/FOB ratio, with a ratio of 1.90 in 2011. South Africa`s trade with Croatia serves relatively high transport costs as the CIF/FOB ratios were 1.67 in 2015 (see Table 4.19 and Figure 4.10). South Africa`s CIF/FOB

ratio when trading with Belgium is the third highest in the UNCTAD data for automotive parts, with a ratio of 1.59 in 2010. South Africa trade with the Russian Federation in 2008 displays the lowest ratios, with a CIF/FOB ratio of 1.01[20]. The second lowest rate was noticed between South Africa`s trade with the United Kingdom in 2013 and presents the second lowest CIF/FOB ratio of 1.04 and thirdly South Africa`s rate when trading with Singapore and Indonesia in 2007, both with CIF/FOB ratios of 1.05. Analysing the average per year, the UNCTAD ratios for the automotive sector is the only ratios where the average has decreased, with an average CIF/FOB ratio of 1.26 in 2007 and 1.20 in 2015.

Table 4.19: South Africa's CIF/FOB ratios to various countries for the automotive sector, UNCTAD, 2007-2015

	2007	2008	2009	2010	2011	2012	2013	2014	2015
Belgium			1,5	1,2	1,59	1,27	1,56	1,07	
United Kingdom	1,43	1,08	1,33	1,77		1,47	1,04	1,09	
Hong Kong			1,49		1,27	1,11	1,33	1,23	1,12
Italy	1,12				1,16	1,09	1,27		
Singapore	1,05				1,18				
Germany			1,4	1,4	1,13				
Korea	1,66				1,37				1,17
Portugal		1,24	1,1		1,1				
China	1,16				1,9			1,09	
Spain	1,24	1,07			1,03	1,21		1,54	
Croatia									1,67
Japan					1,09	1,22	1,31	1,17	1,17
Poland	1,17					1,12			
Thailand					1,26	1,67	1,29	1,18	1,09
Russian Federation		1,01			1,11		1,29	1,45	
Slovenia					1,35				1,09
Turkey	1,44			1,32			1,41		
Vietnam									
Sri Lanka								1,21	
Indonesia	1,05								
Philippines									1,18

Source: Author`s own calculations from UNCTAD, 2017.

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[20] A CIF/FOB ratio of 1.01 is strange, as the Russian Federation is a distant location, and it is difficult to access its ports from South Africa. CIF/FOB ratios calculated from UN COMTRADE (WITS) data did unfortunately not give any ratios lying within the plausible range for the Russian Federation, and the low CIF/FOB ratio can therefore not be compared to other data sources.
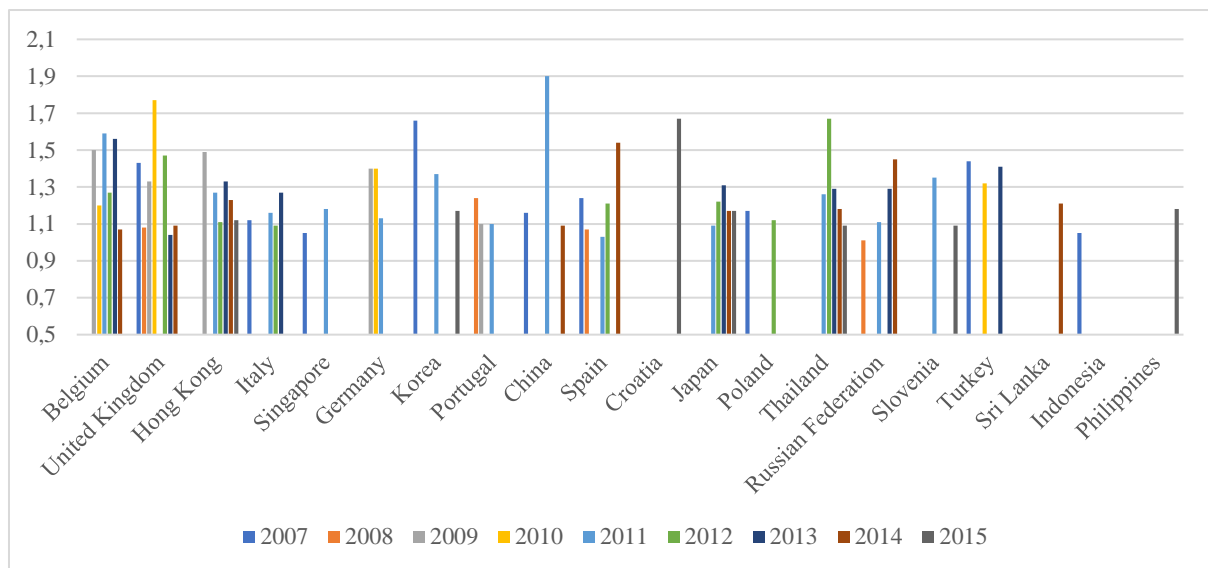
Figure 4.10: South Africa's CIF/FOB ratios to various countries for the automotive sector, UNCTAD 2007-2015

Source: Author`s own calculations from UNCTAD, 2017.

Table 4.20 reveals a slight decrease in the CIF/FOB ratio averages from 2007 to 2015. However, the CIF/FOB ratios are relatively fluctuating, without any particular trend. The averages were decreasing from 1.26 in 2007 to 1.10 in 2008, and then increased again to 1.36 in 2009 and 1.42 in 2010. The year 2011 showed a relatively large decline when the average CIF/FOB ratios dropped to 1.27. This rate was stable through 2012 and experienced a slight increase to 1.31 in 2013. The year 2014 presented another decline, when the average CIF/FOB ratios dropped to 1.23 and further to 1.21 in 2015.

Table 4.20: South Africa's average CIF/FOB ratios, UNCTAD

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015
CIF/FOB ratio	1,26	1,1	1,36	1,42	1,27	1,27	1,31	1,23	1,21

Source: Author`s own calculations from UNCTAD, 2017.

Table 4.21: Correlation results: South Africa's CIF/FOB ratio and actual freight rates 20-foot container automotive sector, UNCTAD

Years	Number of observations (n)	Correlation coefficient	Sig. (2-tailed)
2007	9	0,268	0,486
2008	-	-	-
2009	-	-	-
2010	-	-	-
2011	10	-0,176	0,627
2012	8	0,048	0,911
2013	7	0,18	0,699
2014	9	0,201	0,604
2015	5	0,616	0,269

Source: Author`s own calculations from UNCTAD, 2017.

Notes:

*: Correlation is significant at probability level (p) = 0.050

**: Correlation is significant at probability level (p) = 0.010

***: Correlation is significant at probability level (p) = 0.100

Table 4.21 presents the correlation results between South Africa`s average CIF/FOB ratios calculated from UNCTAD data for 20-foot containers for the automotive sector and the average actual freight rates. A correlation analysis was not conducted for 2008, 2009 and 2010, as data is lacking for these years. There is a positive relationship between the CIF/FOB ratios and the actual freight rates for all the years except for 2011. However, none of the correlation coefficients are statistically significant and all the p-values represent high probabilities that the correlation could occur purely by chance.

Table 4.22 Correlation results: South Africa's CIF/FOB ratio and actual freight rates 40-foot container automotive sector, UNCTAD

Years	Number of observations (n)	Correlation coefficient	Sig. (2-tailed)
2007	9	0,268	0,486
2008	-	-	-
2009	-	-	-
2010	-	-	-
2011	10	0,127	0,726
2012	8	-0,19	0,651
2013	7	-0,036	0,939
2014	9	0,201	0,604
2015	5	0,616	0,269

Source: Author`s own calculations from UNCTAD, 2017.

Notes:

*: Correlation is significant at probability level (p) = 0.100

**: Correlation is significant at probability level (p) = 0.050

***: Correlation is significant at probability level (p) = 0.001

Table 4.22 depicts the correlation results between South Africa`s CIF/FOB ratios and the actual freight rates of a 40-foot container of automotive parts. Again, data is lacking for the years 2008, 2009 and 2010. The correlation coefficients are positive in the year 2007, 20100, 2014 and 2015, indicating positive relationships between the actual freight rates and the CIF/FOB ratios. The negative relationship between the CIF/FOB ratios and actual freight rates in 2012 and 2013 represent a decline in actual freight rates when the CIF/FOB ratios increase. However, none of the correlation coefficients in Table 4.22 are statistically significant.

The IMF data is not available on a disaggregated level; therefore Section 4.5.3 continues to analyse CIF/FOB ratios calculated from the GTAP database for the automotive sector.

4.5.3 Correlation results: GTAP and direct transport costs for automotive parts

Figure 4.11 presents CIF/FOB ratios for the automotive sector between South Africa and the countries included in this study. GTAP CIF and FOB values for product 38 moving vehicles and parts are used to calculate the CIF/FOB ratios. Again, several of the CIF/FOB ratios are equal to 1.00, representing identical CIF and FOB values and a transport cost of 0%. Staff imputations or missing CIF or FOB values are most likely the underlying reason for these results. The GTAP CIF/FOB ratios are considerably lower than the ratios calculated from the WITS and UNCTAD data sources. South Africa`s export to the Philippines and Spain, show the highest ratios, with CIF/FOB ratios of 1.07 (7% *ad valorem* shipping costs). When excluding the CIF/FOB ratios equal to 1.00, South Africa`s automotive trade with Hong Kong, Japan, Malaysia, and Singapore display the lowest ratios, which all have a CIF/FOB ratio of 1.02 (2% *ad valorem* shipping cost).
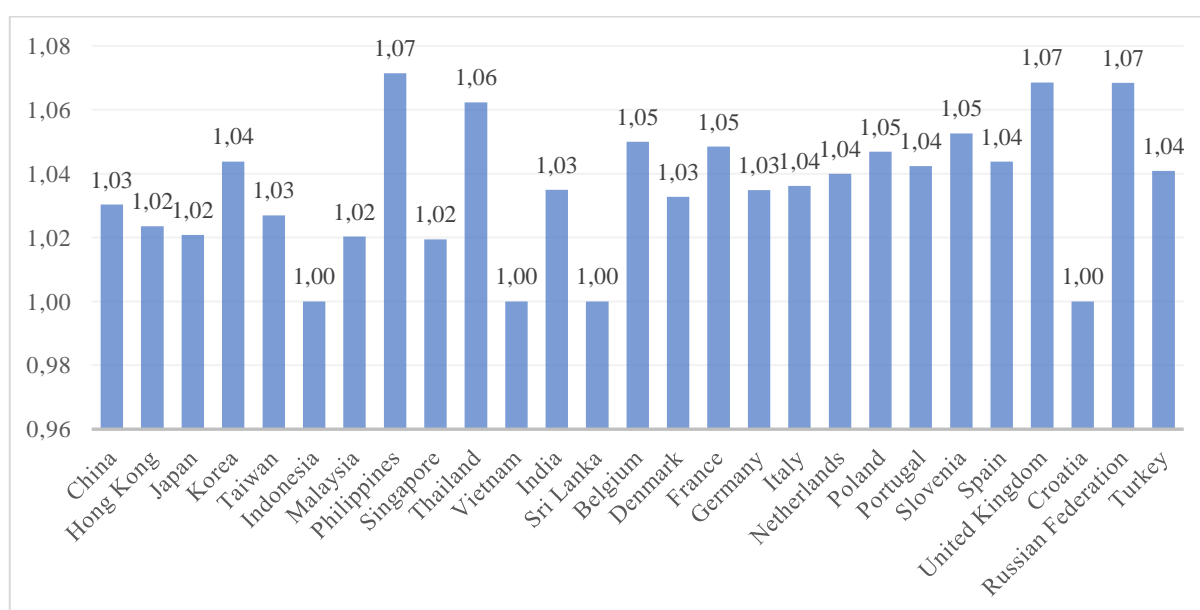

Figure 4.11: South Africa's CIF/FOB ratios to selected countries for moving vehicles and parts, GTAP

Source: Author`s own calculations from GTAP 2011 database.

Note: A CIF/FOB ratio of 1.00 represents an *ad valorem* transport cost of 0%. This implies identical CIF and FOB values in the GTAP database.

Table 4.23: Correlation results: South Africa's CIF/FOB ratio and actual freight rates 20-foot container automotive sector, GTAP

Year	Number of observations (n)	Correlation coefficient	Sig. (2-tailed)
2011	19	0,060	0,809

Source: Author`s own calculations from GTAP 2011 database.

A correlation analysis between the average actual freight rates and South Africa`s average CIF/FOB ratios calculated from the GTAP 9 database for 2011 reveals a positive relationship between the actual rates and the CIF/FOB ratios (Table 4.23). However, the correlation coefficient of 0.060 is very low, and the high p-value of 0.809 indicates that this result is not statistically significant. There is a high probability that the correlation result occurred solely by chance. Therefore, the null hypotheses that the coefficient is actually zero at the 5% significance level cannot be rejected. In other words, there is no correlation between the GTAP 2011 CIF/FOB ratios and the actual freight rates for a 20-foot container in the automotive sector.

Table 4.24: Correlation results: South Africa's CIF/FOB ratio and actual freight rates 40-foot container automotive sector, GTAP

Year	Number of observations (n)	Correlation coefficient	Sig. (2-tailed)
2015	18	-0,192	0,432

Source: Author`s own calculations from GTAP 2011 database.

The correlation results in Table 4.24 of 40-foot automotive part containers reveal a negative relationship between the CIF/FOB ratios and the actual freight rates. The correlation coefficient of -0.192 is not significant, indicating that there is no correlation between the actual freight rates and the calculated GTAP CIF/FOB ratios. The p-value of 0.432 indicates that there is a relatively high probability that the correlation occurred purely by chance.

As past research on South Africa`s CIF/FOB ratios has not been product-specific, Section 4.5 investigates South Africa`s CIF/FOB ratios and actual freight rates for the automotive sector. The only databases which offer data on a product level are the WITS database, UNCTAD, and GTAP. The IMF DOTS and IFS only offer aggregated data which are not product-specific and are therefore excluded from this section. When analysing the WITS data, an increasing trend in the CIF/FOB ratios was revealed. Contrarily, the CIF/FOB ratios calculated from the UNCTAD database show a clear downward trend from 2007-2015. The GTAP data was only available for one year, and no trend over time can be revealed from this database. The correlation analysis between South Africa`s CIF/FOB ratios and actual freight rates for the automotive sector show

no statistically significant results, and it makes no difference when product-specific CIF/FOB ratios are used. Section 4.6 investigates the correlation between South Africa`s actual freight rates and freight rates available on the Internet. The analysis is conducted to determine whether this easier-to-access, alternative measure of transport costs can serve as a more accurate substitute for direct transport costs.

4.6 Correlation results: Internet source and direct transport costs

Given the insignificant correlations between actual shipping rates and CIF/FOB ratios from various sources, this section attempts a correlation analysis between the actual shipping rate quotes and rates obtained from an Internet source. Internet rates are much easier to access than shipping quotes (see Section 1.3). Therefore, this section investigates whether it is an accurate alternative to direct transport cost measures.

The following analysis is a comparison of the actual quotes obtained from the freight forwarder and the rates obtained from the World Freight Rates website. The analysis is not conducted for determining the accuracy of the actual levels of the transport costs, but rather to test whether the quotes obtained from the website are correlated with direct shipping quotes. This relative analysis is conducted to determine whether Internet quotes could be used as a substitute in trade analyses. Various Internet sources provide international transport costs. In this study, the World Freight Rates website[21] was used to collect South Africa`s transport costs to the selected Far East and European countries, for the year 2015. The Internet rates were only accessible at a particular point in time, and no time series data are available on the Internet. The transport costs retrieved from this website are for general- purpose, 20-foot containers, averaged over the port of Cape Town, Durban, and Port Elisabeth to the main port of the selected European and Far East countries used in this study. The rates are in US dollars and from year 2015. The freight rates are actual costs, and not indirect CIF/FOB ratios.

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[21] The World Freight Rates webpage can be reached on the following webpage: www.worldfreightrates.com
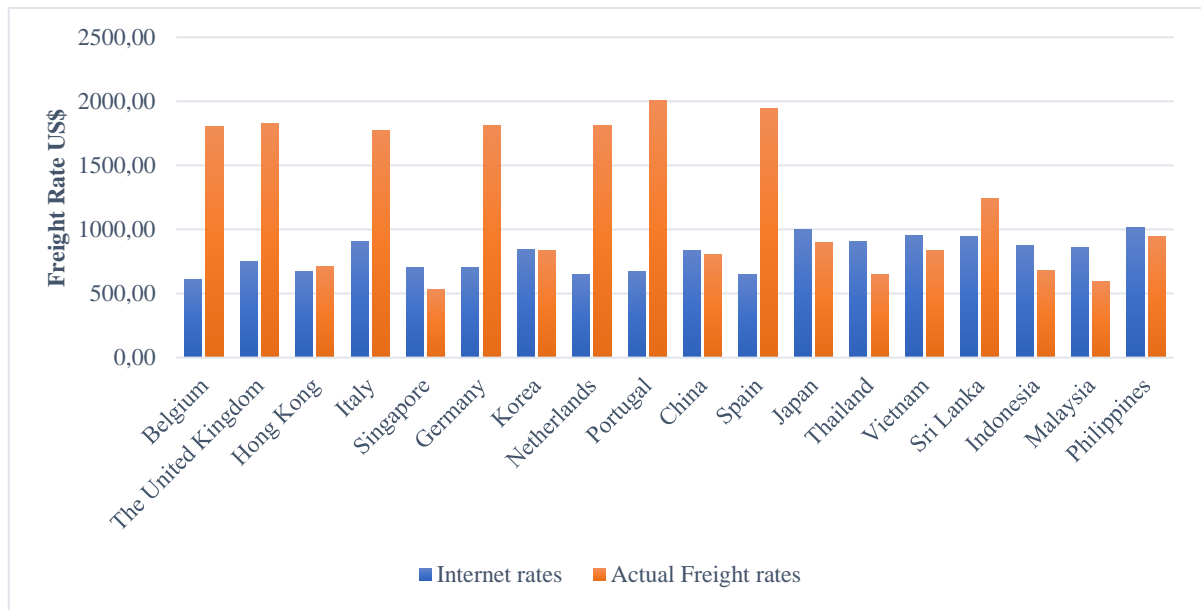
Figure 4.12: South Africa's Internet freight rates compared to actual freight rates, 2015

Source: Compiled from actual freight rates and Internet rates from World Freight Rates.

Figure 4.12 presents South Africa`s actual freight rates to selected Europe and Far East countries for 2015, compared with freight rates compiled from World Freight Rates. From Figure 4.10, it is clear that the actual freight rates are considerably higher than the Internet rates for Belgium, The United Kingdom, Italy, Germany, the Netherlands, Portugal, and Spain. South Africa`s Internet rates and the actual freight rates are relatively similar to those of the remaining countries. Portugal displays the largest difference between actual and Internet freight rates, with actual freight rates of US$ 2 007.4 and Internet freight rates of US$ 675, representing a difference of US$ 1 332.4. Table 4.25 presents the correlation results, in which the destination countries are grouped together.

Table 4.25: Correlation results: South Africa's Internet rates and actual freight rates, 20-foot general-purpose container, World Freight Rates

Year	Number of observations (n)	Correlation coefficient	Sig. (2-tailed)
2015	18	-0,355	0,148

Source: Author`s own calculations from World Freight Rates, 2017.

Table 4.25 shows a negative relationship between the actual freight rates and the rates collected from the World Freight Rates' website. The correlation coefficient of -0,355 is relatively low and is not statistically significant. The p-value of 0.148 states that there is a probability of 0.148 that the correlation arises purely by chance.

4.7 Concluding remarks

Chapter 4 analysed South Africa`s CIF/FOB ratios calculated from the WITS, UNCTAD, IMF DOTS, IMF IFS, and GTAP databases which all provide import and export data between trading partners. South Africa`s CIF/FOB ratios for general-purpose containers and containers transporting automotive parts are examined. The automotive sector is included in this study as the direct freight rates obtained from the South African freight forwarder are for containerised automotive parts. Past research on South Africa`s CIF/FOB ratios has not been product-specific. Therefore, this study investigates the country's CIF/FOB ratios on a product level to conclude whether this will yield more statistically significant results (see Section 1.5).

When CIF/FOB ratios for general-purpose containers were investigated, it revealed a clear upward trend in the ratios from the year 2007 to 2015 for all the data sources. The CIF/FOB ratios for containers of automotive parts also showed an increasing trend when analysing ratios from the WITS data. However, CIF/FOB ratios calculated from the UNCTAD database present a clear decline in South Africa's CIF/FOB ratios from 2007 to 2015. The general rise in the CIF/FOB ratios contradicts the common belief that transport costs decline over time. However, analysing the trends in the actual freight rates from the freight forwarder company reveals a different picture, as the actual freight rates declined over time from 2007 to 2015. Consequently, analysis from this study shows an increase in the CIF/FOB ratios and a decline in the actual freight rates.

A correlation analysis was conducted to further investigate the relationship between the CIF/FOB ratios and the actual freight rates provided by the freight forwarder company. The correlation was determined between the CIF/FOB ratios with actual freight rates for 20-foot and 40-foot containers from both general-purpose containers and containers of automotive parts. Statistically significant correlation results were only found between South Africa`s CIF/FOB ratios and the actual freight rates for the WITS 20-foot and 40-foot general-purpose containers in 2007, UNCTAD 20-foot and 40-foot general-purpose containers in 2009 and 2014, and IMF DOTS 20-foot and 40-foot general-purpose containers in 2014. None of the correlation results for the automotive sector provided statistically significant results. From the correlation results, it can therefore be concluded that the CIF/FOB ratios and the actual freight rates do not always move in the same direction, as many of the correlation results imply a negative relationship between the ratios and the actual freight rates. Consequently, the actual freight rates decline as the CIF/FOB ratios increase.

The Internet rates collected from the World Freight Rates' website can only be collected at one point in time, and an analysis over time could therefore not be conducted on this data. Analysis of the data shows actual freight rates which are considerably higher than the Internet rates for Belgium, The United Kingdom, Italy, Germany, the Netherlands, Portugal, and Spain. The correlation results between the actual freight rates and the Internet rates reveal a negative relationship, indicating an increase in the actual freight rates when the Internet rates decline, or the other way around. Further studies are recommended to collect data over time to be able to do an analysis over time, which might yield more reliable results.

From Chapter 4, it can therefore be concluded that *ad valorem* transport costs implied by WITS, UNCTAD, IMF DOTS, IFS and GTAP CIF/FOB ratios between South Africa and the Far East and European countries included in this study are significantly different from the collected data on South Africa`s direct freight rates. Analysing the data at a more disaggregated level through the automotive sector did not yield more statistically significant results. It therefore did not make any difference if sector-specific CIF/FOB ratios are used. Hence this study can conclude that it is unwise to use South Africa`s CIF/FOB ratios as a substitute for actual transport costs in trade research and analysis; actual transport cost measures should rather be used when investigating trends in South Africa's transport costs.

CHAPTER 5: SUMMARY, CONCLUSION, AND RECOMMENDATIONS

5.1 Introduction

This dissertation investigated the use of CIF/FOB ratios and their ability to serve as a proxy for direct transport costs. As direct costs of transportation are challenging to access, researchers frequently use the indirect CIF/FOB ratios as a transport cost measure. Transport cost has an important impact on trade between countries, but it is difficult and time-consuming to obtain direct transport quotes from shipping companies, especially time series data for many countries, to use in trade analyses (see Section 1.2). CIF/FOB ratios can be used as an alternative, because the import and export data necessary for calculating these ratios are reasonably easy to access and broad in coverage. However, existing research on the accuracy of CIF/FOB ratios as a proxy for transport cost in South Africa date back to 2002 (Chasomeris, 2003, 2006) and are mostly done on an aggregated level. Limited research has been done to analyse the relationship between CIF/FOB ratios and actual shipping rates by mode of transport, product type and partner country. This study aims to address this gap and set out to determine whether the CIF/FOB ratios can serve as a more accurate substitute for direct shipping costs for South African seaborne general containerised cargo exports, and automotive parts to specific countries for which data was available.

The main objective of this research was to analyse whether CIF/FOB ratios can serve as an accurate substitute to replace direct shipping cost in trade analysis of South African seaborne general containerised cargo trade, and automotive parts specifically. This analysis is unique since it takes into consideration transport mode, product type and partner country. Table 5.1 presents an overview of the specific research objectives of this dissertation and the Chapters and Sections in which the objectives are answered.

Table 5.1: Specific research objectives

Specific objectives	Chapter and Section
Provide an overview of the literature on transport costs and its impact on trade and economic growth.	Chapter 2, Section 2.2, Section 2.3, and Section 2.4
Compare the sources of CIF/FOB ratios and specify limitations where applicable.	Chapter 3, Section 3.3.2, and Section 3.3.2.1
Identify errors in CIF/FOB ratios from the current literature.	Chapter 3, Section 3.3.2.2
Provide a summary of South African literature on CIF/FOB ratios, with a specific focus on South African studies.	Chapter 3, Section 3.4
Compile and compare CIF/FOB ratios from different data sources to direct shipping quotes by means of a correlation analysis over time, to determine whether CIF/FOB ratios from different data sources are related to one another and can be used as a proxy for direct shipping rates	Chapter 4, Section 4.4, and Section 4.5
Determine whether the CIF/FOB ratio is a more accurate proxy for South African seaborne general containerised cargo or for a specific sector (automotive parts)	Chapter 4, Section 4.4, and Section 4.5
Compare Internet rates to direct shipping quotes to determine whether Internet rates could be used as an alternative to direct shipping rates.	Chapter 4, Section 4.6

The dissertation was divided into five chapters, in which Chapter 1 presented the background, motivation and problem statement of the dissertation together with the objectives of the research. Chapter 2 visited past literature on the impact of transport cost on trade and the determinants of a country's cost of transportation. Chapter 3 analysed the direct and indirect

measures of transport costs, together with a review of past empirical research on South Africa`s transport costs. Chapter 4 presented the correlation results between South Africa's CIF/FOB ratios and actual transport costs. A correlation between Internet rates and actual freight rates was also conducted in Chapter 4. Chapter 5 provides a summary of this research, as well as conclusions and recommendations. A brief summary of each Chapter and main conclusions follows.

5.2 Summary and conclusions

Chapter 2 provided an overview of the economic background and history of international trade and explains how transport costs affect international trade flows. The evolution of transport costs as an important element in international trade literature was investigated, together with the various factors influencing a country`s transport costs. The neo-classical theory of trade was the first theory to acknowledge transport costs. However, the cost of transportation was not incorporated to influence trade flows in these trade theories. As a result, the new trade theory emerged, where transport costs were thought to negatively affect trade through the "iceberg" effect (see Section 2.2.3). The new economic geography emerged from the new trade theory, and determined that transport costs play an important role in economic activity. The cost of transportation initially was excluded from trade theories, but evolved to acknowledge this cost as an important determinant of international trade flows.

Furthermore, Chapter 2 provided an overview of past empirical studies of international transport costs, which support the international theory by adding evidence of the implications of transport costs on trade. The consensus was that increased international transport costs influence trade flows adversely. The cost of production increases as a country with high transport costs receives lower export earnings and faces higher import costs. Several factors influence a country's international transport costs, resulting in large differences between countries' cost of transportation. A country`s geographical location is particularly important, as landlocked countries generally have much higher transport costs than coastal countries. Poor access to the sea and the dependence on transit countries' infrastructure and policies further increase landlocked countries' transport costs. Countries located far away from their main trading partners experience higher costs of transportation due to the increased time to transport. The introduction of high-speed vessels has reduced the transportation time, which in turn, reduces the transport costs and allows for more time-sensitive products to be transported over vast distances (see Section 2.4).

Chapter 3 investigated direct and indirect measures of international transport costs. As direct transport costs can be challenging to obtain, CIF/FOB ratios are frequently used by researchers when investigating international transport costs. The CIF/FOB ratios' availability and broad coverage make them an attractive indirect transport cost measure. However, when computing CIF/FOB ratios, measurement errors may arise. These errors include: (i) differences in the documented quantities recorded by the exporter and importer; (ii) changing product price or exchange rates midway shipment; (iii) data imputations used for missing data; (iv) differences in exporters' interpretations of the FOB valuation, specifically regarding inland shipping cost; (vi) differences in importers' interpretations of the CIF value to include loading and unloading costs or not; (v) disagreements between the importer and exporter when it comes to identifying the correct product classifications for a certain good; (vi) incomparability of disaggregated data beyond the HS 6-digit level; (vii) CIF/FOB ratios being subject to the product type, mode of transportation, countries' composition of trade and trading partners (see Section 3.3.2.2).

Furthermore, Chapter 3 examined past research on trends in South Africa's shipping costs. Chasomeris (2005a, 2006) found that South Africa`s CIF/FOB ratios have increased over time, while actual transport costs collected from the direct Europe-South Africa liner freight rates showed a downward trend. Consequently, the South African empirical literature supports the findings that researchers should be cautious of substituting CIF/FOB ratios for direct measures of transport costs. However, since many of the studies on this topic for South Africa date back to the early 2000s, a need was identified to revisit these analyses using more recent data. As past research has not been product- or sector-specific, this study analyses South Africa`s transport costs at a more disaggregated level to conclude whether or not this would yield more statistically significant results.

Chapter 4 provided the empirical analysis and results of this study. The accuracy of South Africa`s CIF/FOB ratios to serve as a substitute for direct transport costs was investigated. The data analysis compared direct South African containerised ocean freight rates for general cargo and automotive parts, for fourteen European and eleven Far East countries, to corresponding CIF/FOB ratios through correlation analyses. Import and export trade data from WITS, UNCTAD, DOTS, IFS and GTAP were used to calculate South Africa`s CIF/FOB ratios. A large part of these calculated CIF/FOB ratios data lies outside the plausible range of between 1 and 2. Only ratios within the acceptable range were included in the correlation analyses, since ratios outside this range may indicate reporting errors.

The correlation results between South Africa`s CIF/FOB ratios and the direct transport costs collected from a South African freight forwarder company supported the findings of past research on CIF/FOB ratios. Although, on average, South Africa`s CIF/FOB ratios for general-purpose containers increased between 2007 and 2015, the direct freight rates showed a declining trend over the same period. Also, the correlation results between South Africa`s CIF/FOB ratios for general-purpose containers and the direct transport costs yielded barely any statistically significant results. Research has shown that where a country's data is reliable, the import composition does have a considerable impact on a country`s CIF/FOB ratios. Therefore, it is essential not to assume that the import composition is constant, or to ignore it. This study therefore incorporated a sector-specific analysis to control for import composition. The CIF/FOB ratios for automotive parts showed an upward trend when analysing the WITS data from 2007 to 2015, but a downward trend when analysing the CIF/FOB ratios from the UNCTAD database. The CIF/FOB ratios from GTAP were only accessible for 2011, and no conclusions regarding time trends could be drawn from this data source. However, none of the data for the automotive sector yielded any statistically significant results. Applying sector-specific CIF/FOB ratios gave no more statistically significant results than when simply using ratios aggregated over all products.

The general increase in the CIF/FOB ratios contradicts the common belief that transport costs decline over time. The actual freight rates collected from the South African freight forwarder show a steady drop in the freight rates from 2007 to 2015 for both the general-purpose cargo and the automotive sector. To conclude, this study finds that the CIF/FOB ratios increase over time, while the actual freight rates decline. Therefore, the CIF/FOB ratios differ significantly from the collected data on South Africa`s direct freight rates. The empirical findings from Chapter 4 therefore support past empirical results and suggest that researchers exercise extreme caution when substituting South Africa`s CIF/FOB ratio for direct measures of international transport costs.

To identify alternative measures of international transport costs, a correlation analysis was conducted between the actual freight rates and ocean freight rates available on the Internet. Freight rates were collected from the World Freight Rates' website for year 2015. The correlation analysis between the Internet rates and the actual freight rates revealed a negative relationship and the correlation was not statistically significant. Consequently, the freight rates available at the Internet did not serve as an accurate alterative measure for direct transport costs in this research.

Chapter 5 concluded by pointing out the major issues with the quality of the CIF/FOB ratios and makes recommendations for how best to apply the ratios in future studies.

5.3 Recommendations

Regardless of an increasing importance of international trade costs, the lack of comparable and consistent data hinders research on the topic. Past research shows that direct shipping costs are difficult to assemble, yet still possible (see Section 1.2). This study concludes that, even when compensating for transport mode, product type and trading partner, CIF/FOB ratios are not an accurate alternative for direct transport cost quotes from shipping companies in the South African case, neither on an aggregated or sector-specific level.

More effort should be made to collect time series data on direct transport cost data over a longer time period to include trade analyses. To develop high-quality time series databases on direct transport cost measures, both private and public-sector researchers should collaborate and dedicate further determination and resources in this area of research. Gathering continuous and comprehensive direct transport cost data over time can serve as a foundation for important international trade and transport cost research.

Since trade data for calculating CIF/FOB ratios are broad in coverage and easily available, an effort can be made to address some of the shortcomings. The results of this dissertation show that the possibilities of misunderstandings and confusions are abundant, since the CIF/FOB ratios have received several different names in past literature. The inconsistency of import FOB and import CIF definitions used in textbooks are exacerbating the confusion and misuse of the CIF/FOB ratios. The CIF and FOB definitions in international trade statistics such as the IMF's International Financial Statistics state that maritime transport as well as other modes of transport can be applied when transporting shipments with the use of these Incoterms. Contrarily, the International Chamber of Commerce`s (1999) Incoterms definition clearly points out that the FOB and CIF terms are only applicable to inland waterways and ocean transports. It seems that maritime transport textbooks apply the CIF/FOB ratios and the import CIF and import FOB concepts using the official Incoterms from the International Chamber of Commerce, while international trade textbooks use the same concepts and definitions using the IMF`s international trade definitions (see Section 3.3.2). To avoid confusions and misinterpretations, it therefore is recommended that researchers apply these terms with more consistency.

The quality of countries' import CIF and import FOB time series data highly affects the accuracy of a country's CIF/FOB ratios. However, this data is of poor quality for many countries. Staff imputations are often used to calculate missing data, which is highly counterproductive for research. In addition, these imputations can potentially lead to harmful effects on a country`s economy, as a distorted perspective of an economy's transport cost can result in the discouragement of investments and foreign trade. However, these imputations are not made by the countries, but rather the institutions to which they report their data, e.g. the IMF or the UN. Furthermore, countries' compliance with the UN recommendations for reporting trade data influences the quality of CIF/FOB ratios. Large parts of the reported errors are due to variations in countries' procedures of registration regarding incoming and outgoing trade flows (see Section 3.3.2.2). The accuracy of the CIF/FOB ratios would most likely increase if countries followed the UN recommendations more closely, and reported their trade data accordingly.

It can be challenging to distinguish the countries with defective data from the countries with reliable data over time. In addition, research applying CIF/FOB ratios may be subject to severe errors from shortcomings in trade data used in calculating the ratios, as well from potential misuse of import CIF/FOB ratios in econometric analysis. It therefore is evident that research should cautiously use CIF/FOB ratios as a proxy for direct shipping costs. Some effective analytical processes can be applied to assess the accuracy of the data. For example, identifying disaggregated CIF/FOB ratio errors can assist in evaluating the quality of import time series data. The CIF/FOB ratios should not lie outside the plausible range of between 1 and 2. Hence the *ad valorem* shipping costs (CIF/FOB ratios) should not be negative or exceed a value of 100%. CEPII`s method for calculating modified and improved CIF/FOB ratios in their BACI database is based on this principle.

## 5.4 Recommendations for future research

As this research was limited by the amount of data available for the selected years and countries, further research should focus on broadening the timeframe, sectors and data sources included in the analysis. Recommendations for further research include the following:

- Obtain access to CEPII's CIF/FOB ratios, if possible, and determine whether these are a more accurate alternative to direct freight rates (also on a disaggregated level)[22].
- Collect data on more sectors and determine whether correlations between CIF/FOB ratios and actual freight rates on other sectors show any more conclusive results. Sector-level differences may indicate the importance of the nature of the product and the mode of transport used.
- Collect data on freight rates from other existing web-based sources over time to evaluate whether trends in these data correspond with actual freight quotes.

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[22] The researchers did attempt to access these ratios by contacting CEPII via e-mail; however, this was unsuccessful. As this might be proprietary information for the organisation, one could try to write a proposal explaining that the values themselves will not be published, only the results of a correlation analysis. This could be explored further in future work.

APPENDIX

Figure A1 : South Africa`s CIF/FOB ratios, GTAP 2011
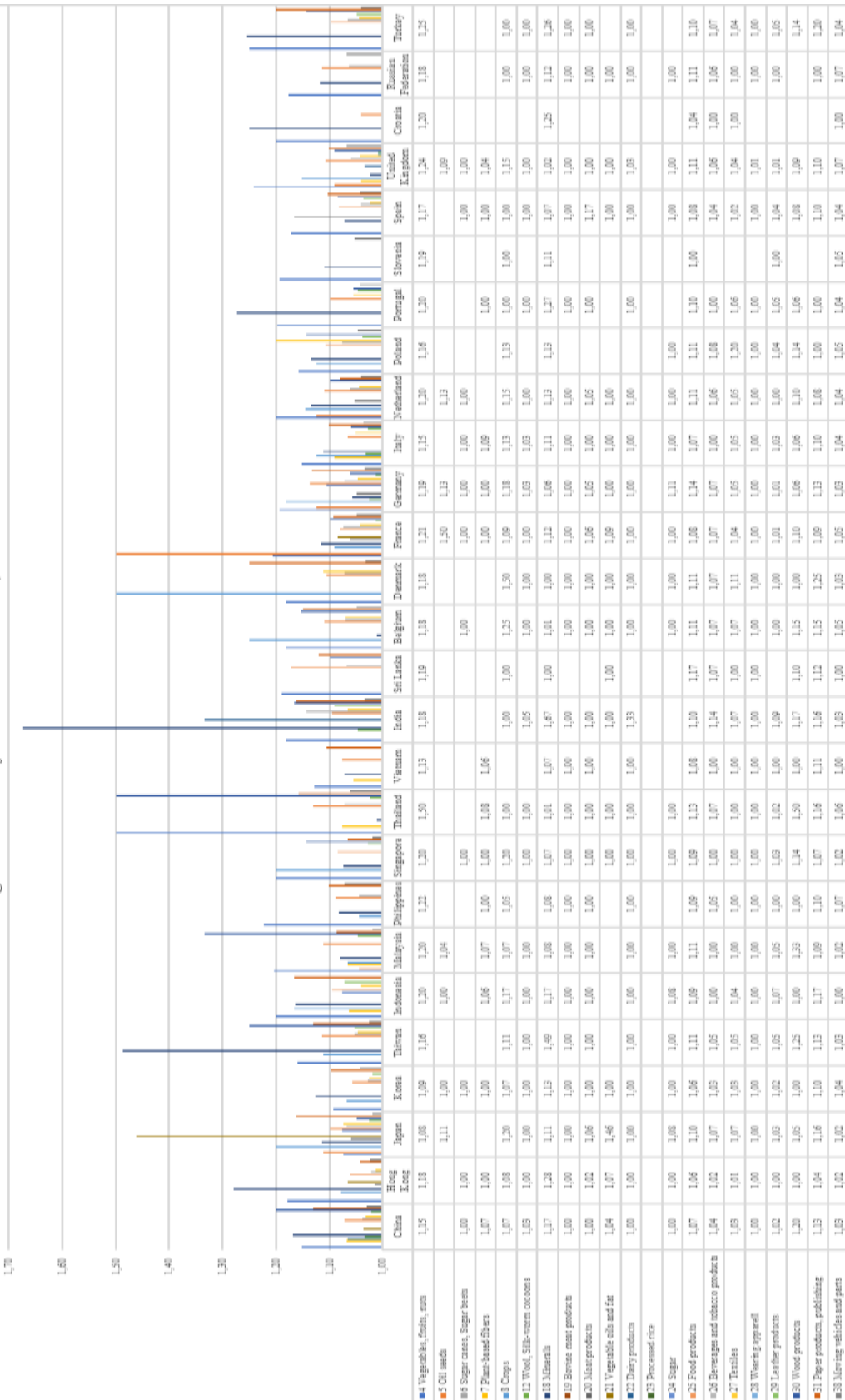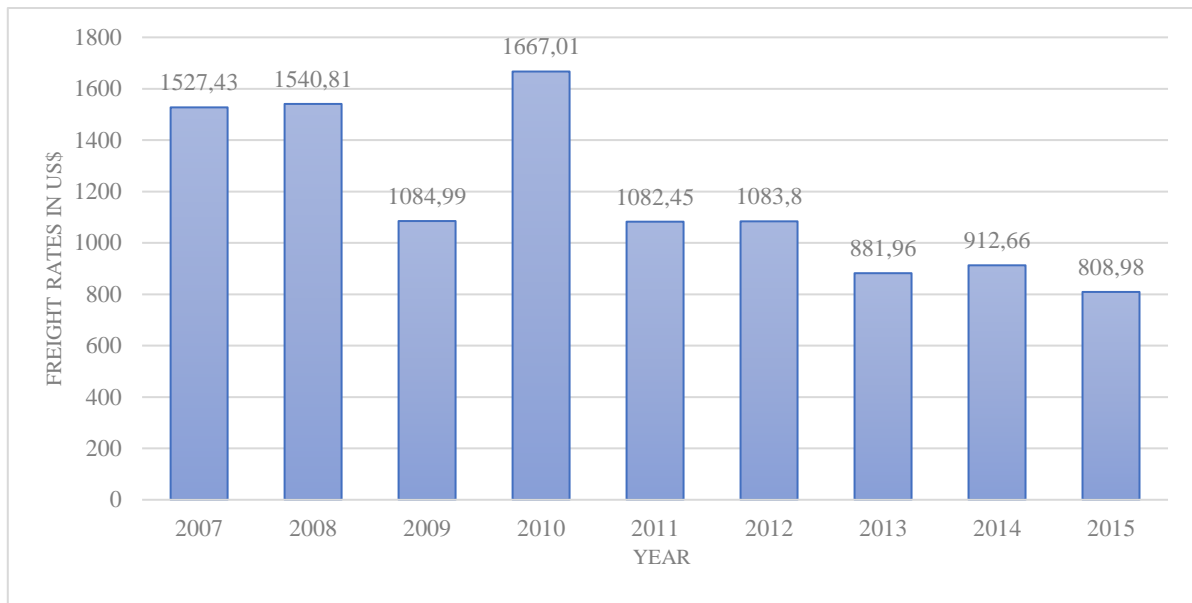
Source: Author`s own compilations from GTAP, 2017.

Figure A2: Average actual freight rates 20-foot containers

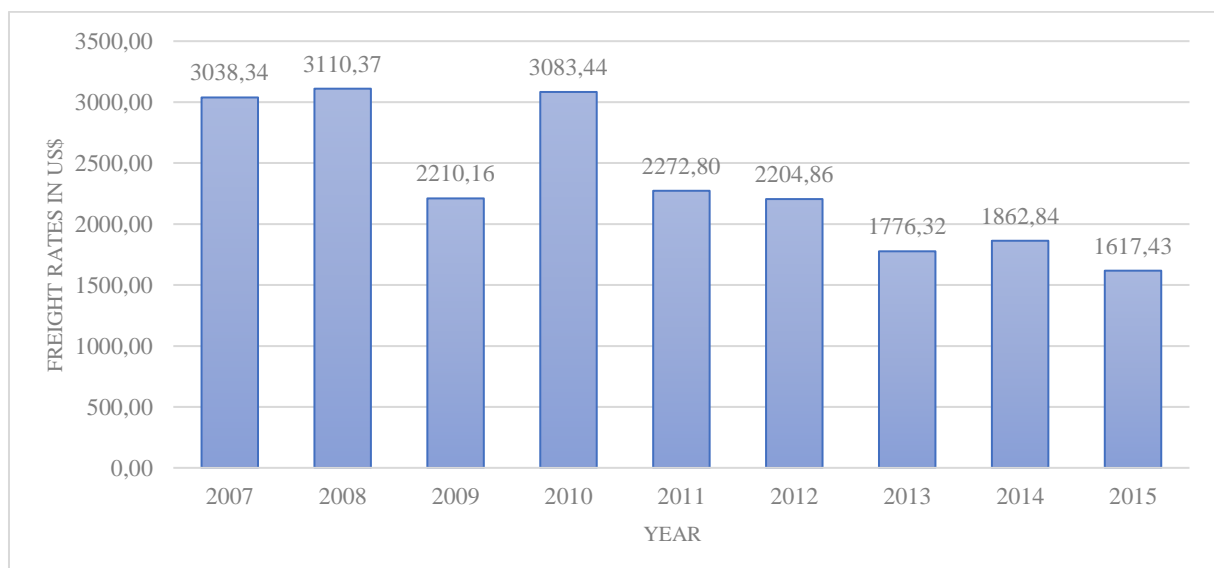*Source: Author`s own compilation on data from a South African Freight Forwarder Company.*

Figure A3: Average actual freight rates 40-foot containers

Source: Author`s own compilation on data from a South African Freight Forwarder Company.

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