

**ESTIMATING TRADE FLOWS: CASE OF SOUTH AFRICA AND  
BRICs**

By

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I, the undersigned, hereby declare that this dissertation “Estimating trade flows: Case of South Africa and BRICs” is my own original work and that it has not been presented at any other university for a similar or any other degree awarded.

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DATE: 10/03/2015

For my father and mother - Placide and Norbertine Manzombi

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## **ABSTRACT**

This study examines the fundamental determinants of bilateral trade flows between South Africa and BRIC countries. This is done by exploring the magnitude of exports among these countries. The Gravity model approach is used as the preferred theoretical framework in explaining and evaluating successfully the bilateral trade flows between South Africa and BRIC countries

The empirical part of this study uses panel data methodology covering the time period 2000-2012 and incorporates the five BRICS economies in the sample. The results of the regressions are subject to panel diagnostic test procedures. The study reveals that, on the one hand, there are positive and significant relationships between South African export flows with the BRICs and distance, language dummy, the BRICs' GDP, the BRICs' openness and population in South Africa. On the other hand, GDP in South Africa, real exchange rate and time dummy are found to be negatively related to export flows.

Keywords: South Africa, BRICs, BRICS performance, bilateral trade flows, gravity model, panel data estimation techniques, panel diagnostic tests, fixed effects model.

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## **Abbreviations and Acronyms Definitions**

ADF – Augmented Dickey Fuller refers to the standard Dickey Fuller model which has been augmented by adding the lagged values of the dependent variable in order to test whether there is a unit root in time series or either time series are stationary at some level of significance by means of t-statistic value and the related one-sided p-value. This test is used for bigger and complicated dynamic data sample.

AR- Autoregressive is a model characterised by a random process and used to identify the relationship between the dependent variable and its own past values. This model incorporates more lagged values of the dependent variable among its explanatory variables.

ASEAN – The Association of South-East Asian Nations represents an economic and political organisation of 10 countries (Indonesia, Malaysia, Philippines, Thailand, Singapore, Brunei, Cambodia, Laos, Myanmar and Vietnam) in South-East Asia region with the aims and purposes of expediting the economic growth, social and cultural advancement in the region as well as encouraging regional peace and stability among member countries.

BRIC – Brazil Russia India and China stand for a group of four large developing countries and emerging economies sharing some common characteristics, such as high economic growth rates, economic potential, large population and geographical areas. These countries aim to increase their economic performance, strengthen economic cooperation affiliations with developed countries and even further extend their strong position in the global economy.

BRICS – Brazil Russia India China and South Africa refer to the BRIC group joined by South Africa in 2011. They are emerging economic leaders and political powers in their respective regions (South America, Central Asia, South Asia, East Asia, and Africa) as well as at international level.

CEEC – Central and Eastern European Countries represent a group of 12 countries (Albania, Bulgaria, Croatia, the Czech Republic, Hungary, Poland, Romania, the Slovak Republic, Slovenia, Estonia, Latvia and Lithuania) in Central and Eastern European region with the main objective of experiencing high growth records by gaining access to the European market and benefiting from the European Union as members, and increase living standards following Western European levels.

CES – Constant Elasticity of Substitution describes the fixed percentage change of the ratio of two inputs to a production (or utility) function in regard to their marginal products' (or utilities') ratio.

CIF – Cost Insurance and Freight denotes the price of insurance and all other charges such as transportation cost invoiced by the seller. These costs are generally paid by the seller.

CLM – Cambodia Laos and Myanmar are the member countries of the Association of South-East Asian Nations (ASEAN) which can be viewed as the fastest-growing economies in the region due their high growth rate compared to other countries in South-East Asia region. Although, these economies lag behind the other ASEAN members in terms of GDP per capita.

EAC – East African Cooperation refers to the regional intergovernmental organisation of 5 countries (Burundi, Kenya, Rwanda, Tanzania and Uganda) in East Africa with the goal of expanding and intensifying economic, political, culture and social cooperation and consolidation among them for the benefit of the region such as wealth creation, life quality's improvement, amongst others.

ECOWAS - Economic Community of West African States indicates a regional group of 15 countries (Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, Gambia and Togo) in West Africa with the task to boost economic integration and stability in all fields of economic activity, support relations among them and assist the African continent's development.

EU – European Union stands for a united economic and political partnership of 28 countries (Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and United Kingdom) in Eastern, Western and Southern Europe targeting the democracy and efficiency of the nations, the establishment of a security policy, an economic and financial unification, and the expansion of the community social magnitude.

ER – Exchange Rate refers to the price or value of one country's currency with reference to another currency.

FEM – Fixed Effect Model represents one of the estimation technique in Panel data econometric analysis used to measure the unobservable individual specific effects in the regression model by supplying a method for controlling for the heterogeneity bias, that is, the omitted variables bias. This model suggests variances in intercepts only (not in slope coefficients) across cross-sections or periods of time and the unobservable specific effects are assumed to be fixed in this case.

FDI – Foreign Direct Investment describes international capital flows in which a firm in one country generates or enlarges a subordinate in another. This consists of both the transfer of resources and the acquiring control over the firm into which the investment is made.

FOB – Free On Board refers to the reimbursement of transportation costs by the buyer in addition to the price of goods.

GDP – Gross Domestic Product refers to the measure of the total value of all goods and services produced in an economy adding any product taxes and deducting any subsidies not incorporated in the value of the products.

GMM – Generalised Method of Moments indicates an estimation technique for linear and non-linear models subject to population moment conditions and identifications. This combines the observed economic data along with the information in population moment conditions in order to generate estimates of the unknown parameters in the regression model.

GNI – Gross National Income represents the total value added by permanent inhabitants in a particular country together with both income received from overseas and any product taxes (minus subsidies) not comprised in output.

HO – Heckscher Ohlin refers to a general equilibrium model of international trade expanded by Eli Heckscher and Bertil Ohlin based on the factor endowments' discrepancies between trading countries. This model describes a 2x2x2 model subject to two countries (home and foreign), the production of two goods by each country by means of two factors of production and incorporates four theorems such

as factor price equalization, Stolper-Samuelson, Rybczynski, and Heckscher-Ohlin trade acting as the significant constituents of this model.

Ho – Null Hypothesis indicates a suggestion or theory subject to a statistical analysis which is submitted to a verification to decide whether it should be accepted or rejected in favour of an alternative suggestion or theory. This is usually expressed by a no relationship or variation existing between variables.

H<sub>A</sub> – Alternative Hypothesis refers to the hypothesis which is opposed to the null hypothesis. This hypothesis is accepted as long as the null hypothesis is rejected.

HT – Hausman Taylor is an estimated test subject to an instrumental variable estimator. This test employs both the between and the within stringently exogenous variables' deviations as instruments where there is correlation between some of the regressors (not all) and the individual effects in the regression model. This resulting estimator helps to choose between the fixed effects model and the random effects model.

IMF- International Monetary Fund represents a cooperative international monetary organisation of 188 member countries operating together to promote global growth and economic stability, ease the expansion of international trade, foster high employment level and real income, offer policy advice and financing to members in difficult economic positions, assist developing countries to attain macroeconomic stability and diminish poverty.

IPS – Im, Pesaran and Shin suggest individual unit root tests in panel data analysis when performing unit root test for each time series.

LIC – Low Income Countries represent nations with lower Gross National Income per capita, limiting manufacturing and industrial capacity, low level of employment, less access to capital, skills and technology, and poorer infrastructure and standard of living for people.

LLC – Levin Lin and Chu proffer common unit root tests when checking for unit root in panel data analysis for each time series.

LM – Lagrange Multiplier refers to a test performed in panel data analysis in order to check the null hypothesis of no individual effects or time effects of the OLS pooled regression model (usually, the OLS residuals).

LSDV – Least Square Dummy Variables represent a fixed effects model by means of dummy variables which acknowledges heterogeneity among units such as individuals, firms, states, and countries, so that each cross-section entity has its own intercept value or dummy variable. With this model, the unobserved effect is brought absolutely into the model and is treated as the coefficient of the individual specific dummy variable.

MA – Moving Average refers to a model defined by a stochastic process which determines the weighted sum of a white noise disturbance term and the lagged values of the white noise disturbance term.

MERCOSUR – Southern Common Market represents a regional and economic bloc of 10 countries (Argentina, Brazil, Paraguay, Uruguay, Venezuela, Bolivia, Chile, Colombia, Ecuador and Peru) in South America aiming to stimulate free trade and the flowing movement of goods, services, factors of production, capital, people and currency across the member nations, fix a common external tariff, and ensure free competition between them by regulating properly macroeconomic and sector policies.

NAFTA – North American Free Trade Agreements specifies a contract signed by Canada, Mexico and the United states displaying the benefits of trade liberalization and how free trade rises wealth, competitiveness, economic growth, and the standard of living for these member countries. This agreement also facilitates these countries to compete with the European Union.

NTT – New Trade Theory designates an expansion of classical theories of international trade (Heckscher-Ohlin model, absolute and comparative advantage theories) based economies of scale, imperfect competition, product differentiation, and manufacturing trade used to explain patterns of trade in the global economy.

OECD – Organisation for Economic Cooperation and Development is an international economic organisation of 34 countries (Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Finland, France, Germany, Greece,

Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom and United States) intending to promote sustainable economic growth, prosperity, permanent development together with high employment level and an ascending standard of living not only in member countries but also in non-member countries they deal with so that the development of the world economy is enhanced.

OLS – Ordinary Least Squares refer to an estimation technique in statistics or econometrics used to determine the unknown parameters, being expressed in terms of the perceivable quantities such as X and Y, of the linear regression model. With this method, a single point of the pertinent population parameter is supplied by each estimator and the OLS estimates are obtained from the sample data and consistent providing that the regressors are strictly exogenous and independent of the disturbance terms, there is no perfect multicollinearity in the regression model, and the error terms are homoscedastic and serially uncorrelated.

POLS – Pooled Ordinary Least Squares describe one of the estimation procedure in Econometric analysis of panel data which ignores the presence of the unobserved heterogeneity among units (individuals, firms, states, and countries amongst others). The individual specific effects are not explicitly identified across cross-sections through a period of time in the pooled regression model.

PPP – Purchasing Power Parity refers to a theory arguing that the disparities in the general price levels between countries are reflected in the exchange rate.

REM – Random Effect Model represents one of the estimation method in panel data econometric examination which permits heterogeneity among units (individuals, firms, states, and countries amongst others) by investigating differences in error variances and assuming that the intercept of each unit is a random extracting from a large population with a constant mean value and the individual specific effects are unrelated with the explanatory variables. The deviation from the constant mean value is captured in the individual intercept.

RSS – Residual Sum of Squares measures the disparity between the actual data and the values foreseen by the estimation regression model. The amount of

discrepancy in data sample, which is not explained by the regression model, is computed by the residual sum of squares.

SA – South Africa is a country situated in Southern Africa having 1,221,000 sq.km in terms of land area with nine provinces, a population of 54 million peoples, enveloping an extensive diversity of cultures, languages, and religions. The Rand is the official currency and English appears to be the first spoken language. South Africa is surrounded by Botswana, Namibia and Zimbabwe in the north, and Mozambique and Swaziland in the east.

SADC- Southern African Development Community represents a regional economic community connected with 15 countries (Angola, Botswana, Democratic Republic of Cong, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe) in Southern Africa targeting to attain development and economic growth by reducing poverty, by using efficiently natural resources and heightening the quality and standard of peoples' life in the region through the inter-dependence of member countries, encourage and maintain peace and security through effective protection of the region, and strengthen cultural, historical and social links among them.

SSA – Sub-Saharan Africa describes the geographical area of the African continent located in the south of the Sahara desert consisting of 48 countries with the purpose of stimulating strong growth in much of the region, investing in infrastructure, education, skills and agricultural production, expanding social protection system, creating employments, improving services sector, competitiveness and access to finance.

UNCTAD – The United Nations Conference on Trade and Development is an international institution of 194 member states dealing with development matters, especially through international trade and investment seen as the major instruments of development. This organisation supports the macroeconomic policies appropriate to terminating inequalities in the global economy so that sustainable development for people is generated, provides member countries with expertise on all subjects relevant to the development of investment and enterprises, and incites innovation in developing countries with technical assistance so that their competitiveness is improved.

USA –United States of America is a federal republic of 50 states and one federal district situated in the Central Southern section of the North America holding 9,857,306 sq.km with regards to land area, a population of nearly 320 million peoples with a variety of cultures, languages and religions. The United States of America are encircled by Canada in the north, Mexico in the south, the Atlantic Ocean in the east and the Pacific Ocean in the west. The U.S dollar is the official currency and English proves to the most commonly used language in this country.

USD – United States Dollars designates the official currency in the United States of America and its overseas areas. This currency is extremely used in international transactions and serves as the world's most influential reserve currency.

WTO – World Trade Organisation represents an international organisation of 160 countries based on rules of negotiations and decisions among members. This organisation aims to ensure a loose trade and transparency of both regional and bilateral trade arrangements for the benefit of all by diminishing obstacles to trade such as import tariffs and other barriers to trade, supervising the consented rules trade in goods, in services or even trade-related intellectual property rights, and inspecting the trade policies of all members.

# CHAPTER ONE

## INTRODUCTION

### 1.1 General Overview

The main purpose of this chapter is to provide an overall introduction to this study of South African flows of trade with the BRIC countries. Studies such as the impact of international trade on economic growth by Afonso (2001) – amongst others – have shown that many countries have gained from trade flows and foreign direct investment. International trade has always been a key factor in the economy of South Africa as well as the BRIC nations. However, although many studies examine South African export flows and potential with its major partners of trade applying the gravity model, only few studies have centred on the investigation and expansion of trade flows between South Africa and the BRIC economies by means of trade indicators or indices. It follows that the gravity model of trade has been used substantially in literature which explores bilateral trade flows between countries.

This study fills the lacuna that exists in the existing literature review by employing a gravity model framework to scrutinise the impact of the economic integration of South Africa into the BRICs, with a specific focus on the magnitude of export flows between South Africa and the BRIC countries. In addition, this study conducts an econometric analysis by using panel data from the period of time 2000-2012. This specific sample period is of great importance because it includes years of the BRIC's creation and South Africa's inclusion into this group. The country sample thus contains the five BRICS countries.

### 1.2 General Background and Problem Statement

In the last few decades, there has been a strong evidence of increased global integration that has been accompanied by increasing global production of goods and services and trade relationships to a great extent. In fact, international flows of trade have not only increased but they have also been extensively liberalised, supporting many nations in their process of economic development. In addition, trade relationship acts as an important aspect of economic integration between countries, and the role of trade flows remains significant in the global economic growth given that the patterns and compositions of bilateral trade flows might possibly describe how countries are integrating and flourishing in the world economy (Anaman and

Atta-Quayson, 2009). Furthermore, economic ties are created and developed in view of international trade openness, which is associated with increases in the flows of trade and, in turn, generates rapid economic growth and welfare (Wilson and Purushothaman, 2003).

South Africa – as a developing country – is not excluded from these facts. Since the early 1990's, trade liberalisation by means of an export-oriented trade procedure has been adopted in South Africa to contribute to the process of globalisation, which has resulted in a substantial increase in the value of exports in the country (Kusi, 2002). It follows that empirical evidence also shows that the effects of globalisation stimulate more than 90% of the economic growth performance in the country (Loots, 2003). However, the main focus of this study addresses questions regarding the economic integration of South Africa into the BRIC economies using trade flows, which implies a specific analysis of trade flows between South Africa and the BRIC countries.

In 2001, the term 'BRICs' was suggested by Goldman Sachs to symbolise the four big developing countries of Brazil, Russia, India, and China. The BRIC countries display selected common characteristics. They are some of the biggest emerging markets economies – with high economic growth rates – inhabited by large populations, constituting strong consumption markets. In addition, they are bound by large geographical territories with a range of affluent natural resources (De Almeida, 2009). Economic activities in these countries also have significant ramifications on the rest of the world, considering their enormous economic strength and their contribution towards world GDP growth. Finally, the BRIC countries have been globally integrating through trade and financial undertakings as they continue to play a significant role in the global economy. Nevertheless, the above-mentioned characteristics may not be true for South Africa, despite the fact that the country has been included in the BRIC group at the 3rd BRICS Summit in April 2011. Its inclusion may conceivably have been motivated by geopolitics, which considers the fact that South Africa was the largest economy in Africa – as well as an important trade destination.

With regards to trade flows, there have been improvements in the trading relationship between Brazil, Russia, India and China, but the difference that needs to

be emphasised lies on how factors of production are endowed in each of these countries (O'Neil et al., 2005). Moreover, it should be noted that international trade shows how factors of production, specifically the nature and composition of exports and imports, seem to have an impact on the rate of economic growth in a particular country (Pettersson, 2005).

Generally, trade activities enhance the integration of the BRIC economies – including South Africa – into the world market, leading to the increase of the share of the total trade for each BRICS country from 1998 to 2008. The resulting increase was from 6.7% in 1998 to 14.8% in 2008 for all BRICS countries (OECD, 2010). For instance, China's share climbed from 3.4% to 9%, Brazil's from 0.9% to 1.2%, India's from 0.6% to 1.1%, Russia's from 1.3% to 2.9% and South Africa's increased from 0.3% to 0.4%. It is also important to note that the overall performance of the BRICS trade flows and the rise of their share of global trade have been impressive, showing a continuous increase, surging by approximately 17% in 2012. However, South Africa's economic and trade performance was still lower than that of the BRIC countries. For that reason, South Africa aims to increase its rate of exports in order to achieve more dynamic economic growth. Furthermore, the subsequent significant growth in South African exports flows may probably constitute an important feature of the country's attempts to emulate the BRIC economies as well as further contribute to the global economy (Pettersson, 2005).

Nevertheless, in contrast with the BRIC countries, the characteristics of South Africa's exports are still of a developing country consisting predominantly of natural resources. In fact, the flows of trade among the BRIC countries are rising due to trade in manufactured goods. That being so, the BRIC economies seem to be more incorporated in global trade than South Africa in terms of their production efficiency.

According to Wilson and Purushothaman (2003), The BRIC countries are growing steadily and, by the next 50 years, they will become more influential in the world economy by following the four fundamental factors listed in the report that serve as the conditions for the predicted growth. The BRIC nations could surpass the level of expansion in most present developed countries. In addition, their patterns of growth are displaying the mutual dependence of the BRIC countries. The report also looked at Africa, principally at South Africa, owing to the importance of the country as the

major leading African economy and one of the most significant political players of the continent. However, in Goldman Sachs, O'Neil has long resisted South Africa's invitation into the BRICs because of its population of 54 million people, which is currently too small compared with the populations the BRIC countries. Moreover, South Africa's economy was lower than one quarter that of China's, Russia's, and India's GDPs over the past ten years, especially after dealing with the financial crisis in 2008. As a consequence, South Africa is listed as the poorest of the BRICS economies.

Subject to the background and problem statement described above, the principal purpose of this study is to investigate and evaluate the magnitude of trade flows between the small, open, and fastest-growing in Africa's economy of South Africa and the BRIC countries, a group of the most dominant emerging economies globally, with strong economic progress and competence.

### **1.3 Aim of the Study**

The aim of the study is to ascertain whether the BRIC countries need South Africa as much as South Africa needs the BRIC nations with particular reference to trade flows. This is done by examining export flows between South Africa and the rest of the BRIC nations by applying the gravity model of trade along with panel data econometric technique from 2000 to 2012, based on data availability.

#### **1.3.1 Specific objectives**

- Identify the composition and structure of trade flows in South Africa, with a focus on trade from the individual countries of BRICs.
- Investigate the significance of trade flows, economic growth, exchange rate, and geographical distance among the BRIC economies and South Africa's economy.
- Analyse the recent patterns of the above-mentioned components between South Africa and the BRIC nations, as well as the economic performance of each BRICS country.
- Investigate the determinants of trade flows between South Africa and BRIC countries, using the gravity model framework together with the panel data estimation method.

### **1.3.2 Research questions**

In order to explore the magnitude, impacts, and outcomes of trade flows that might benefit the BRIC countries as a result of the South African economic integration and trade liberalization. The following research questions raised in this study include: firstly, to determine whether South Africa is an attractive trade partner to the fastest emerging market economies given, its characteristics; secondly, to explore whether any substantial increase in trade flows can be expected between South Africa and the BRIC nations for the period of time under consideration; and thirdly, to investigate whether the gravity model together with panel data methodology should be applied to describe bilateral flows of trade between South Africa and the BRIC countries.

### **1.4 Layout of the Study**

The remainder of this study consists of a further four chapters:

Chapter two looks at the economic growth and trade flows performance of the BRIC nations compared with South Africa over the time period 1994-2013. This comparison is based on the illustration and analyse of figures on real GDP, population, real GDP per capita, exports, imports, nominal exchange per US dollars, and real effective exchange rate. It also investigates the sectoral contribution to GDP of BRICS in their economies, which is done by evaluating main sectors such as agriculture, industry, manufacturing, and services for each BRICS country.

Chapter three reviews the existing literature in bilateral trade flows' assessment between two or more countries. It examines theories of international trade such as the absolute advantage theory, comparative advantage theory, the Heckscher-Ohlin model, the new trade theory, and the gravity model to provide a better understanding on the patterns of trade among countries. It discusses the motivation for the specific selection of the gravity model by highlighting important empirical studies, which suggest that this model serves as a significant tool in explaining bilateral trade flows across many countries. For instance, this model can be used for the analysis between South Africa and BRIC countries.

Chapter four provides the advantages of this specific theoretical framework and methodology in consideration of different frameworks that have been implemented in

the previous literature. It provides a concise summary of classical and new trade theory, emphasizing reasons of trading worldwide. It examines different theories and assumptions behind the preferred framework –the gravity model. It specifies the standard and the augmented gravity equations, as well as data used to analyze bilateral export flows between South Africa and the BRIC nations. It discusses the estimation technique of the gravity model by means of panel data methodology, as well as numerous panel tests that may be applied for empirical results in this thesis. The chapter also analyses the various data used in the study.

Empirical analysis constitutes the focus of chapter five. It conducts an analysis on the estimated results of both gravity equations' regressions, explaining meaningful bilateral trade flows between South Africa and the BRIC countries. Diverse diagnostic tests such as fixed effects, random effects, poolability, Hausman specification, Heteroskedasticity, serial correlation, and panel unit root are performed to ensure the efficiency and adaptability of the gravity models specified in this thesis. Thereafter, it reports and examines the findings of the appropriate equations using the best panel estimation technique.

Chapter six concludes the study by detailing the main findings, providing some recommendations and areas for future research.

# **CHAPTER TWO**

## **THE PERFORMANCE OF BRICS: A COMPARISON WITH SOUTH AFRICA**

### **2.1 Introduction**

BRICS is an emerging economic bloc which seeks to increase their own economic performance. By reviewing the regional and developmental performance and demography, it can be noted that they belong to the South – consisting of developing nations – in contrast to the North, which comprises advanced industrialised countries. BRICS, which consists of Brazil, Russia, India, China and South Africa, have common characteristics owing to their classification as emerging countries. Their economic collaborations within the global economy over the past five years have resulted in a paradigm shift of global economy strategy. BRICS has become the most important economic bloc in the global economy. Their economic synergy has welcomed and created some significant changes in the economic diplomacy and strategies in Africa, as well as for certain western countries, such as France and the United States.

The purpose of this chapter is to provide a general overview and analysis of the BRICS economic growth, trade flows – which consist of the magnitude of exports and imports – exchange rates, and geographical distance between each country. This analysis is based on a comparative analysis carried out between the BRIC economies and South Africa's economy, and is completed in six sections. Section 2.2 provides the background of the BRICS nations regarding their economic performance and the changes each has made in the world economy. Section 2.3 examines the growth performance of the BRICS countries and how these economies have the potential of becoming the largest – and the richest group of countries – in the world. This investigation is based on the assessment of the economic profile of the BRICS countries in terms of real GDP, real GDP growth rate, and real per capita GDP. Section 2.4 explores the role trade flows play in the BRICS development and why they are important for these countries; this is done by analysing the structure of exports and imports of the BRICS countries. Section 2.5 examines the role of exchange rates and exchange controls. Section 2.6 reports the geographical

distance between each of these countries, and section 2.7 reports on the possible most important findings, and draws towards concluding the chapter.

## **2.2 Background Observations**

It has been thirteen years now since the term BRICs was coined in the Global Economics Paper 'Building better Global Economics BRICs', by Jim O'Neill (2001). The BRIC acronym has become universally accepted since 2001 to refer to four countries, comprising the first letters of Brazil, Russia, India and China, before the inclusion of South Africa (O'Neill, 2001). These emerging economies were identified by Goldman Sachs, primarily selected on the basis of having vast populations (Cairns and Meilke, 2012). Special attention was given in particular to Brazil, Russia, India and China (BRICs), because of their strong economic performance and potential as compared with other developing countries. Significant positive changes and gains were achieved by BRIC countries in both economic and political aspects between 2001 and 2010 (Singh and Dube, 2013). While there is a strong economic harmony in this economic bloc, it is evident that these countries do not particularly have the same foreign policy approach. Also, while some tend to be democratically orientated, others are authoritatively administrated. For the purpose of the research, an emphasis will be placed on economic approach in view of trade flows, rather than a political point of view, even though they seem to be related at some level of analysis.

As emerging countries, the BRIC economies have accounted for a considerable share of the global economy, spreading out amongst more countries demand, as well as manufacturing production and generating wealth in modern society. Some commonalities are shared by these nations and this is reflected in how their structures change rapidly and their economic performance improve during the 21<sup>st</sup> century (Szirmai et al., 2012). There is no doubt that the BRIC group has become dominant in the global economy. Surely, BRIC's growth is strategically watched by the European Union and the United States. However, there are to a certain extent economic differences across BRIC countries on the subject of their history, resources and economic policies, since they have different preferences in and approaches to economic growth strategies. It is important to mention that, compared to previous years, the BRIC's output per capita in the global economy have shrunk

significantly, despite the vast scale of economies. In other words, it appears that the BRIC nations have been facing some kind of economic regression before 2000. In addition, these countries have experienced deterioration in their GDP growth rates in the recent financial and economic crisis of 2007 to 2009 (Schrooten, 2011). In 2010, reversal to the earlier economic growth's trend took place, owing to the impressive increasing growth rate of Brazil by almost 8 per cent, Russia by 4.5 per cent, India by 11.2 per cent, and China by 10.4 per cent (International Monetary Fund, 2013). As a result, the BRIC nations have attracted considerable international attention and have significantly grown by contributing to world production, and their share has increased from 15 per cent in 1995 to almost 25 per cent in 2010 (International Monetary Fund, 2013).

According to Purushothaman and Wilson (2003), it has been claimed by Goldman Sachs' projections that the BRIC countries are emerging rapidly and if they continue their substantial growth, their joint economies could overtake the world's largest and richest countries by 2050. In addition, these emerging economies' average real growth rate of 6.2 per cent was approximately four times larger than the G7 countries' average real growth between 2000 and 2010 (Cairns and Meilke, 2012).

The request for South Africa to join the annual BRICs (Brazil, Russia, India and China) summit was made on the 14 April 2011 in China by the BRIC leaders. The organisation's name thus has been transformed from BRIC into BRICS as a result of the official inclusion of South Africa (Duncan, 2013). In fact, there have been some debates and criticisms over the admission of South Africa into BRIC(S). Some analysts suggest that the South African economy and demography represent serious economic handicaps to the other BRICS nations' economies and demography. Some academics and economists suggest that South Africa is being used as gateway to Africa, as the BRICs have an agenda for African natural resources, and it is believed that South Africa is a strategic partner to achieve their agenda. Also, it is important to note that South Africa may have some continental and international objectives as well.

There is certainly a difference between South Africa and other BRICS members in many respects, due to the fact that South Africa lags behind in terms of its economic performance and production structure. However, South Africa is assumed to be the

most dominant political power: an advanced and developing economy in Africa that has been attracting more international attention (Arkhangelskaya, 2011). It should be noted that the African continent is very rich in terms of resources; for instance, it is top in the global reserves of manganese ore, chrome, gold, platinum group metals, vanadium, diamonds, and phosphate. Furthermore, Africa holds the second biggest reserves of copper ore and uranium, and third major reserves of oil, gas, and iron ore.

South Africa's economic power and experience in developmental programmes cannot be underestimated. From the Democratic Republic of Congo to the central Africa amongst others, it has developed a major strategy to engage itself in the exploration of other African countries' natural resources and the transformation of raw materials. South Africa offers its expertise on various aspects on the continent; whether political, economic, security, energy and industrial matters. Its assistance in social and economic development and leadership on the continent has made South Africa hugely influential on the continent. Moreover, its role and capacity to influence international economy and relations is non-negligible. Finally, in having access to Sub-Saharan Africa markets, South Africa plays a leading role in the region in terms of mineral wealth, industrial productivity, electricity output, infrastructure, sophisticated financial markets, and service industries (Duncan, 2013).

The inclusion of South Africa into the BRICs is important contribution to this group, owing to the country's economic significance in Africa. As, one of the major suppliers of mineral raw materials to developed countries, South Africa possesses substantial scientific and technical potential that can create opportunities for and enhance the power and prominence of all BRICS economies.

At the moment, BRICS countries have a combined population of three billion people (almost 43% of the global population) in the geographical area of 39.72 million sq.m (more than a quarter of world land surface). In addition, these countries produce nearly 16 trillion US dollars GDP, which consist of approximately 21 per cent of global production (Arkhangelskaya, 2011). Each of these five countries has a significant geostrategic location, which is the reason that they also serve as regional economic leaders in their respective regions – Brazil in Latin America, China in East Asia, India in South Asia, the Russian Federation in Central Asia and South Africa in

Africa. However, these countries do not only influence their respective regions, but also the rest of the world. The World Bank's report ranking indicated that, in terms of their growth performance (GDP) either real or based on PPP, China is now the largest economy in the BRICS group – and the second largest in the world – followed by India, Russia, Brazil and South Africa (World Bank, 2012).

In terms of land area, Russia is the biggest country in this group as it covers an area of 17,098,000 square kilometres (sq.km) followed by China (9,600,000 sq.km), Brazil (8,515,000sq.km), India (3,287,000 sq.km), and then South Africa (1,221,000sq.km). China is the most populated within this economic bloc and had an estimated population of 1,360.32 million in 2013, followed by India (1,239.26), Brazil (198.04), Russia (141.44), and, lastly, South Africa (52.98). Each of the BRICS nations has its own unique currency. The Real, the Russian Ruble, the Rupee, the Renminbi and the Rand are the respective official currencies of Brazil, Russia, India, China and South Africa (International Monetary fund and Statistics South Africa, 2013).

## 2.3 BRICS Economic Growth Performance

BRICS economies represent significant regional and global economic players and have a great emerging prospective, given a combined GDP of more than 15 trillion US dollars (International Monetary Fund, 2013). In addition, they are all considered to be the most rapidly growing or newly industrialised nations of the world, with a greater number of important resources. South Africa is seen as one of the leading countries, as it drives growth and development in the African continent (Arora and Vamvakidid, 2005). South Africa accounts for almost 25 per cent of Africa's Gross Domestic Product, and 5 per cent of the continent's population (OECD, 2013).

Table 2.1. BRICS Sectoral Contribution to GDP (in percentage)

Contribution % of GDP (2011-12)								
Sectors	Agriculture		Industry		Manufacturing		Services	
Year	2011	2012	2011	2012	2011	2012	2011	2012
Brazil	5.46	5.24	27.53	26.29	14.60	13.25	67.01	68.47
Russia	4.25	3.9	37	36	15.99	13.9	58.75	60.1

India	17.55	17.39	26.73	25.75	14.39	13.53	55.72	56.86
China	10.04	10.1	46.64	45.3	30.57	41.26	43.32	44.6
South Africa	2.46	2.57	29.21	28.41	12.81	12.38	68.33	69.02

Source: The World Bank, 2013; the World Bank, 2012.

Table 2.1 presents the BRICS economies' sectoral contribution to GDP. Brazil is considered to be one of the fastest growing economies in the South America region in terms of the performance of its GDP, especially in the agriculture, service, and industry sectors. In 2012, 5.24 per cent of Brazil GDP was made up by the agricultural sector, and 26.29 per cent is attributed to the industrial sector. Services have been a vital portion of the Brazilian GDP, owing to its contribution of 68.47 per cent, while the manufacturing sector consisted of 13.25 per cent of the country's GDP.

For Russia, commodities seem to determine the size of the economy in terms of fuel and energy. The industry and services sectors have also been the two of the important sectors of the Russian economy – especially the service sector – which have contributed 36.1 per cent and 60.1 per cent respectively of Russia's GDP in 2012. Agriculture and manufacturing also seem to play an important role in the economy of Russia, mainly for their incomes contributing about 4 per cent and 14 per cent respectively of the aggregate GDP of the country in 2012.

As far as the growth in India is concerned, the country's economy is driven by services, which represent more than 50 per cent of its GDP and has been a predominant source of the Indian expansion. This sector has experienced increases from 55.72 per cent to 56.86 per cent during 2011-12. In addition, India's economy is more diversified, consisting of farming, agriculture, industries, and excess services. Industries such as software, IT, and pharmaceutical industries are more competitive in India. The contribution of agricultural and industrial sectors has also promoted rapid growth in India, accounting for 17.39 per cent and 25.75 per cent respectively of India's GDP in 2012.

At the moment, China represents the second largest economy in the world (the USA is the largest). Among the BRICS countries, China is progressively becoming a leading figure in the world economic market by means of its largest population and

its fastest growing economy in the world. The country's economic growth depends enormously on the manufacturing industry, with more than 40 per cent of its total GDP coming from the manufacturing sector (Polodoo et al., 2012). Both the industry and services sectors produced around 45 per cent of the country's GDP, while agriculture accounted for 10.1 per cent in 2012.

In terms of the economic performance of South Africa, the agricultural and manufacturing sectors appear to grow slower than other sectors, contributing about 3 per cent and 12 per cent respectively of the country's GDP in 2012. The agriculture sector appears not to be the leading sector in South Africa owing to its slight growth as the country tends to move towards the manufacturing sector. The manufacturing sector has developed, showing its flexibility and potential to take part in the global economy. South Africa's industrial and services sectors have grown immensely and are substantial contributors to the GDP and economic activities of South Africa – their combined proportion has accounted for the most economic growth. In 2012, the service sector contributed about 69 per cent of services to the GDP of the country followed, by the industry sector's contribution of 28.41 per cent.

Table 2.2. BRICS Average annual economic growth by sectors (in percentage)

Average annual % growth (1990-2000; 2000-11)								
	Agriculture		Industry		Manufacturing		Services	
Period	1990-2000	2000-2011	1990-2000	2000-2011	1990-2000	2000-2011	1990-2000	2000-2011
Brazil	3.6	3.7	2.4	2.9	2	2.4	4.4	3.9
Russia	-4.9	1.8	-7.1	3.7	..	..	-4.7	6.2
India	3.2	3.2	6.1	8.4	6.9	8.6	7.7	9.4
China	4.1	4.4	13.7	11.7	12.9	11.2	11	11.4
South Africa	1	2	1	2.5	1.6	2.7	3	3.8

Source: The World Bank, 2013.

There has also been progress in the economic growth of BRICS nations by sector, with moderate increases during 2000-11, as presented in Table 2.2. With regards to the BRIC's average annual growth, it seems that Brazil and Russia are richer than China and India in terms of material resources. It is important to note that Brazil possesses abundant natural resources such as oil, iron, and tropical rain forest, which favours the development of agriculture, but the country depends on the

exportation of the raw material goods for the growth of its economy. Among the group of the four BRIC countries, Brazilian economy appears to perform weakly in the industry, manufacturing, and services sectors, which have sharply increased to almost 3 per cent, 2 per cent and decreased by 3.9 percent respectively for the period 2000-11.

Russia continues to be a powerful country. As the biggest country in the world, covering more than one-ninth of the world's land area, it is a country with fabulous natural resources. It owns the highest mineral resources reserves, the largest natural gas reserves, the primary fresh water reserve, the second largest coal reserves, as well as holding the eighth greatest oil reserves (Sheng-Jun, 2011). A strong economic growth was perceived in Russia due to the fact that oil prices were rapidly increasing; however, its economy was deteriorated by the global financial crisis, causing the country to perform poorly, with annual average growth reaching 1.8 per cent, 3.7 per cent, and 6.2 per cent respectively in the agriculture, industry, and services sectors during 2000-11 (Table 2.2).

China and India are the fastest growing markets in percentage growth by sector amongst the BRICS countries. From Table 2.2, it is clear that most Chinese growth comes from the industry, manufacturing, and services sectors. A sharp drop in Chinese industry by 11.7 per cent and manufacturing by 11.2 per cent, and an increase in services by 11.4 per cent have been observed for the period 2000-11. However, the economy in China has sustained higher rate of growth and has shown signs of positive trend. During the last decade, India had also had positive rates of growth in the agriculture, industry, manufacturing, and services sectors. Their average annual growth also increased from 2000 to 2011. The services sector grew by 9.4 per cent, followed by the manufacturing sector with 8.6 per cent, and then the industry sector with 8.4 per cent.

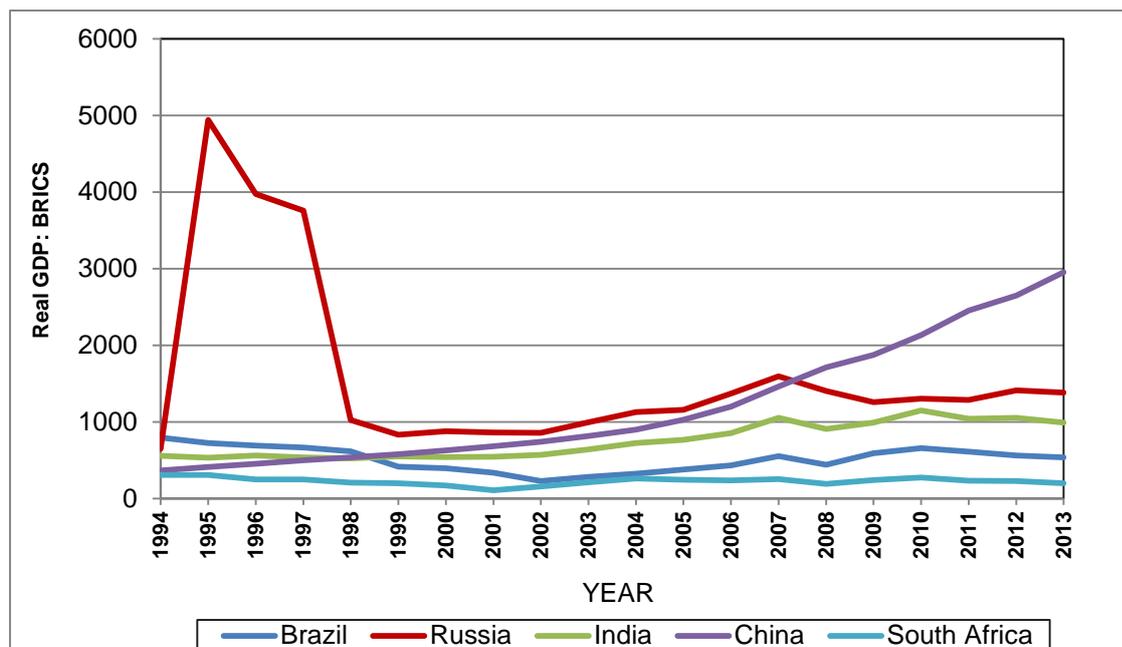
Since the country has been making incontestable development since 1994 across a number of precarious areas, South Africa became one of the richest and economically most dynamic countries in Africa. For example, there have been economic policies implemented by the government in order to restore and preserve macroeconomic stability from a difficult global economic environment perspective. However, the democratic transition has been the major contributor to its economic

improvement, leading the country to an industrialised economy (OECD, 2013). Moreover, South Africa is a country rich in natural resources, contributing to more than a third of the sub-Saharan Africa's output. The annual growth in South Africa has been driven by the industry and services sectors, contributing on average approximately 3 per cent and 4 per cent respectively during 2000-11. The manufacturing sector has also been growing from an annual average of 1 per cent during 1990-2000 to 2.5 per cent during 2000-11. The agriculture sector does not appear to be driving growth in South Africa, contributing only 2 per cent during 2000-11.

Although, Figure 2.1 shows that the BRICS economies have been able to traverse the global recession and financial crisis quite well – except for Russia –there has been a significant slowdown in these countries' growth during the financial crisis in 2008. (Slobodníková and Nagyová, 2011). It is important to mention that the economic wealth that the BRIC countries have registered before the financial crisis led to favourable economic prospects. Accordingly, the economic performance of BRIC countries has been speeding up in 2010 after dealing with the financial crisis and recovering from the global recession. They became the most important marketplaces and were economically growing more rapidly than the Global market, with their share of 20 per cent of the overall GDP (an impressive 18.48 trillion US dollars in PPP terms) according to the World Bank (2011). The BRICS countries have preserved positive growth levels despite the fact that the real GDP growth in most of these countries, except for China, is slowing after experiencing a positive economic progress in 2010 and the first half of 2011. For instance, GDP growth dropped by 6.5 per cent then below 5 per cent in the second half of 2012 for both Brazil and South Africa, and in 2013 for all the BRICS nations except for China (Figure 2.4). From Figure 2.1, the increase in China's GDP is very impressive, from \$368.203 billion in 1994 to practically \$3 trillion in 2013. India has also reached global growth of GDP by increasing from \$557.99 billion in 1994 to approximately \$1 trillion in 2013. Robust growth has been observed in Brazil over the last twenty years and, currently, the share of GDP accounts for more than half \$1 trillion. The trend of the Russian growth has been unpredictable with no consistency; however, Russia's GDP has also risen from \$651.23 billion in 1994 to more than \$1.3 trillion in 2013. South African economic growth shows a positive trend as well – its GDP has more

than doubled. Conversely, the slight decline in South Africa's GDP from \$310.51 billion to \$201.55 billion was due to the substantial depreciation of the rand. The growth in this country still remains the lowest of the BRICS economies.

Figure 2.1: Real Gross Domestic Product (GDP), Constant Prices US \$ billion, 1994-2013

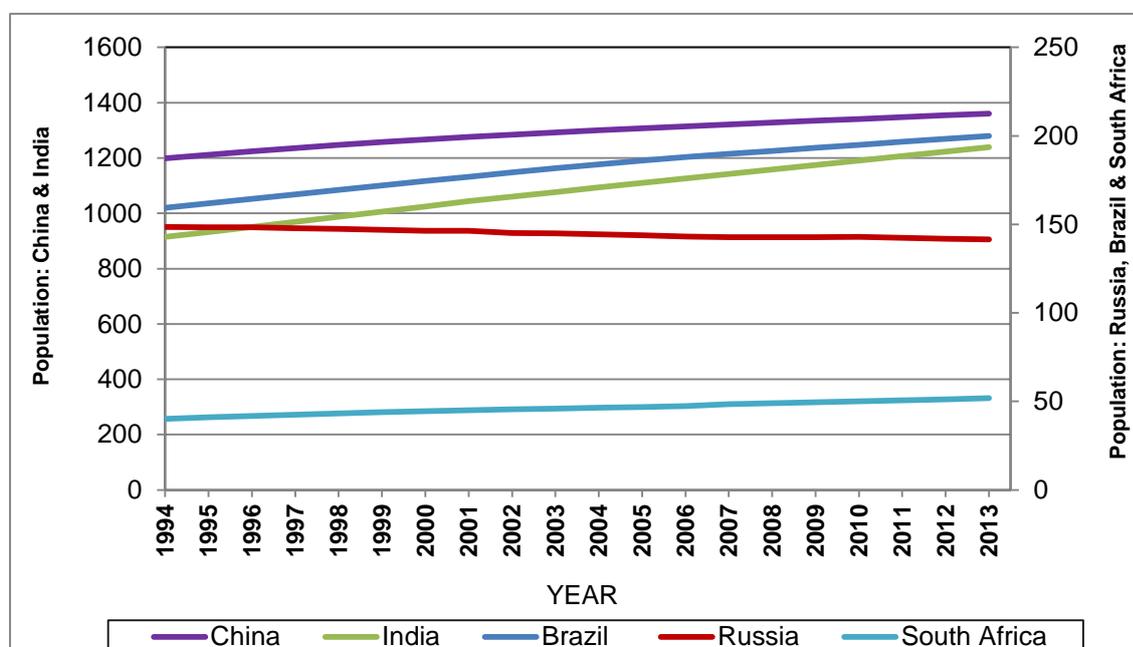


Source: Based on International Monetary Fund data (2013).

Figure 2.2 shows that the combined BRICS population has been increasing since 1994. China shows the most population growth, followed by India. Chinese population grew by 162.5 (million persons) during 1994-2013, while the increase in population of India was also remarkable, growing by 325 (million persons) under the same period of time. After the two most populous countries in the BRICS' bloc is Brazil, with a population size rising from nearly 159 (million persons) in 1994 to 200 (million persons) in 2013. Russia is the only country within the group displaying a

declining trend of population after 1994, decreasing from 148.3 (million persons) to 141.4 (million persons) during 1995-2013. South Africa remains the country with the smallest population size, despite the fact that its population has risen from almost 40 (million persons) to about 52 (million persons) during 1994-2013.

Figure 2.2: Population (million persons), 1994-2013



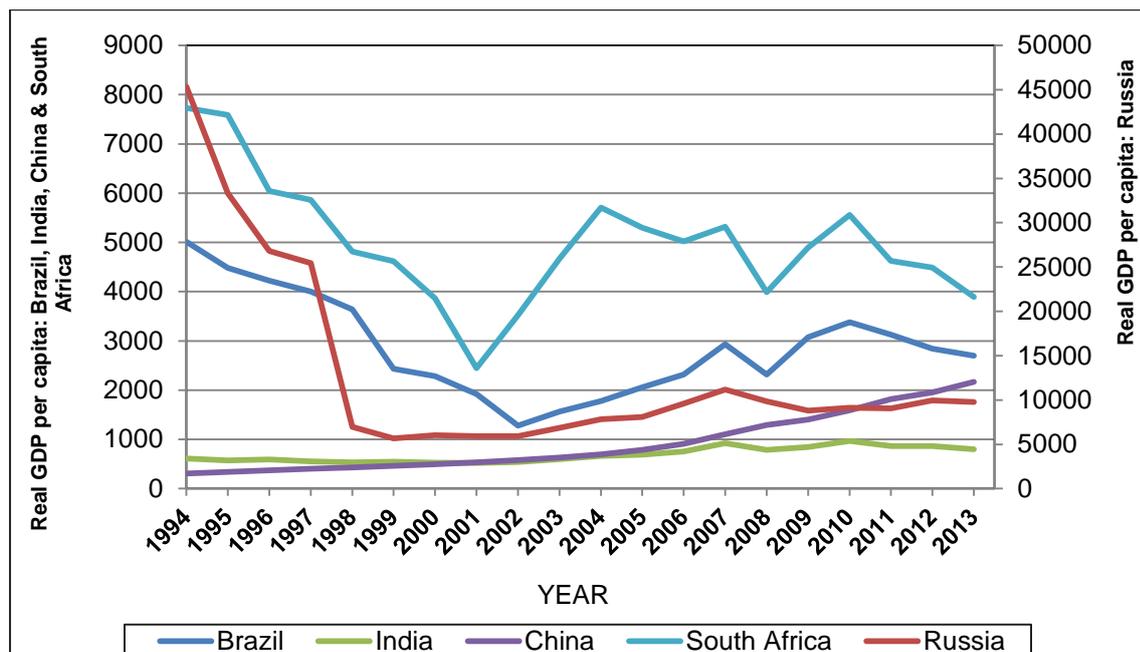
Source: Based on International Monetary Fund data (2013).

In terms of real per capita GDP, figure 2.3 indicates that the value of the real GDP per capita has been growing more rapidly in Russia than other BRICS countries after 2000 with an ascending real GDP per capita from about 5916.55 US dollars to 9773.53 US dollars in 2013, even though Russian economic performance was resilient during 1994-1999. After 2007, China real economic performance was impressive and better than Russia's, India's, Brazil's, and South Africa's; however, the figure shows again that Russia grew and continues to grow faster than any other BRICS nations, maintaining its position above all other BRICS countries. From 2007

to 2013, China real GDP per capita growth was significantly stronger than India, but lower than Brazil and even South Africa. During this period, Chinese real GDP per capita increased from approximately 1108 US dollars to 2170 US dollars. Brazil and South Africa showed negative trends of real GDP per capita during 1994-2002, and their level of per capita GDP look weaker. After 2004, a positive trend occurred, and this is reflected in the fact that, during 2005-10, Brazil's real GDP per capita rose from almost 2055 US dollars to 3383 US dollars and South Africa's real GDP per capita rose from 5297.55 US dollars to 5556.38 US dollars.

However, in India a low level of real GDP per capita was observed since 1994, and it continues to lag behind. Figure 2.3 reveals that Russia and Brazil have maintained higher levels of per capita GDP than the other BRICS economies since 2010, especially when these countries experienced positive and significant economic growth. However, China, India and South Africa are rapidly catching up. Thus, in 2013 the value of real GDP per capita is found to be greatest in Russia (9774 US dollars) due to its small population as compared to other BRICS economies, followed by South Africa (3890 US dollars), then Brazil (2700 US dollars), and then China (2170 US dollars). India recorded the lowest real GDP per capita (801 US dollars) in 2013.

Figure 2.3: Real Per capita GDP, constant Prices US \$, 1994-2013



Source: Based on International Monetary Fund data (2013).

In terms of the GDP growth rate, figure 2.4 indicates that the Brazilian economy has been unstable since 1994 and experienced a slower growth from 1995 to 2003. Although there was an expansion of growth of 5.7 per cent in 2004, it suddenly decelerated during 2005-06. After this period, there was an upward shift of growth in 2007, increasing by around 6 per cent, but followed by a decrease of -0.3 per cent in real growth in 2009 after the financial crisis. Despite the fact that there was a substantial economic upswing in 2010 owing to the country's robust economic performance, the trend in Brazil has been descending from 7.5 per cent from 2010, to 2.7 per cent in 2011, to 0.9 per cent in 2012. It is uncertain that a change or reversal in this trend will occur anytime soon. The economy of Brazil heavily depends on the exports of commodities and the prices, yet demand for commodities has been depressed due to the stagnant global economy, making it difficult for the country to strive for growth, either at home or out of the country (Duncan, 2013).

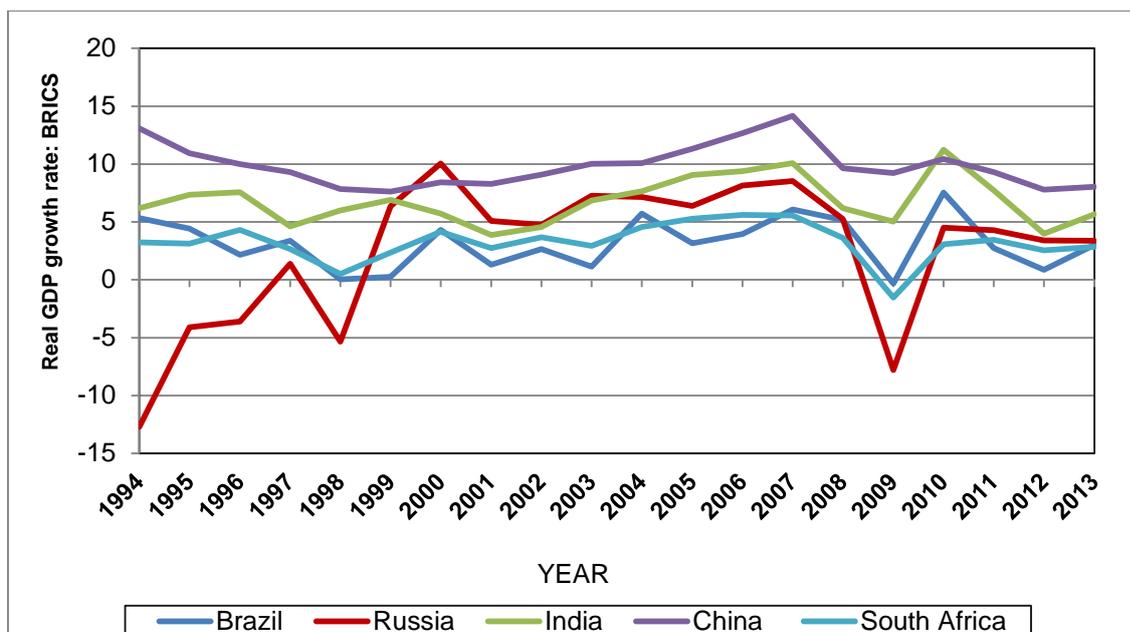
The Russian economy largely relies on the exports of oil and gas – which serve as a tool for the country's prosperity and growth. In the Russian economy – yet the economy never less experienced an extensive recession leading to a severe decline in its growth during 1994-98. Although the GDP expanded after 1999, this crisis has deteriorated the country's overall economic performance in 2009. Its rate of growth decreased from 4.5 per cent in 2010, to 4.3 per cent in 2011, to 3.4 per cent in 2012, followed by a considerable slower economic growth in the first half of 2013, while acceleration of growth was projected in the fourth quarter of 2013 (Figure 2.4). In addition, due to the US investment in local shale gas and the persistent stagnation of the world economic growth, more moderation of Russian economic growth is expected, resulting in the country having to face substantial uncertainties in export revenue, which, in turn, is dangerous to growth.

Since 1994, the Indian economy has displayed a strong, permanent growth, however, the real GDP growth weakened by 6.2 per cent during 2007-08 from 10.1 per cent during 2006-07 (Figure 2.4). In India, the rate of growth has been decelerating from 11.23 per cent in 2010, to 7.75 per cent in 2011, to 3.99 per cent in 2012. Aside of this, there are a number of challenges experienced by the country and, owing to the lack of serious restructuring efforts, India failed to achieve the 9 per cent target set by its government.

Amongst BRICS economies, China is the strongest, possessing a good fiscal position, a strong export-led manufacturing sector, and a well-funded infrastructure investment framework. However, China is confronted with major social challenges, and a large population, which slows global growth. The Chinese economy has exhibited a slight downward trend in growth during 1995-99, but the country's economic performance was mostly relatively stable. After 1999, a faster growth was marked in China, especially in 2007 when the country's GDP stood at 14.2 per cent (Figure 2.4). China also faced a declining growth during the global financial crisis of 2008-09. In 2010, the economy recovered and grew at a rate of almost 10.4 per cent.

South Africa's economic performance has revealed significant growth fluctuations during 1994-2003. From 2004-2007, economic growth in South Africa has been strong due to its major recovery from currency depreciation and inflationary pressures, recording an average growth rate of about 5 per cent (Figure 2.4). Since the period of the financial crisis, however, South Africa's GDP has been struggling to grow at a significant rate. On the one hand, the growth of the country's economy showed an upward trend in 2011, increasing from 3.09 per cent in 2010 to 3.5 per cent in the final quarter of 2011 because of the recovery and stabilisation of the mining and manufacturing sectors. On the other hand, this growth rate has subsided since 2012, indicated by a growth of 2.5 per cent due to structural constraints in the domestic economy and the insubstantial recovery of the global economy. Improvement in growth was, however, recorded in the second quarter of 2013, indicating a GDP growth rate of around 3 per cent (International Monetary Fund, 2013).

Figure 2.4: Real GDP Growth Rate (Percentage change), 1994-2013



Source: Based on International Monetary Fund data (2013).

## 2.4 BRICS Trade Flows (Exports and Imports) Performance

As far as globalisation is concerned, it is clear that there should be increasing economic openness, interdependence, and deeper integration in the world economy. Rapid economic growth in the BRICS countries has been influencing the growth performance of the global economy by improving international trade and providing markets for exports, capitals for investment, sources of finance for expansion, and technologies for efficient production (Nayyar, 2008).

Over the previous few decades, the important role played by individual countries of the BRICS in the global economy has resulted in their identification as some of the great producers of goods and services, receivers of capital, prospective consumer markets, and drivers to the world economy recovery process. However, the economic structures of BRICS and their organisational patterns are relatively different. The numerous, diverse features embraced by each of the BRICS countries gave each an enormous opportunity and potential to develop (BRICS report, 2012). Some evidence shows that economic growth prospects have been stimulated and development has been encouraged through trade liberalisation in all the BRICS countries (Singh and Dube, 2013).

However, this thesis is concerned with whether South Africa joining the BRICs will accelerate their trade flows and developmental process, given that South Africa

would merely constitute an access point to Africa's resources and market. This assertion is tremendous because Africa is the fastest growing market with its vast resources.

BRICS exports to the international market are significant, and not only contribute to the global development, but also play a major role in the prosperity of their respective regional economic communities (Szirmai et al., 2012). As for the openness of trade, BRICS economies are more concerned with the growth of exports as they are also becoming dominant in international trade (Polodoo, 2012). It is from this perspective that BRICS intends to become the world economic dominant group through trade liberalisation. To this extent, although, the BRICS economies are still regarded as exporters of natural resources, they are making progress in becoming exporters of manufactured goods instead of primary goods (BRICS report, 2012).

The strategy of export-led growth especially exports of manufactured goods – the key device of growth in China – is well recognised. India has been progressively adding the exports of IT services in addition to manufactured goods, while Russian and South African exports predominantly consist of resource-based goods and commodities, which have contributed to their economic development. Brazil has also exported natural resources in addition to some kinds of manufactured goods. Services also tend to play also a significant role in the economies of South Africa, Brazil, and Russia, while India's exports accelerations could be attributed to its high share of the agricultural sector (Szirmai et al., 2012).

Brazil is a resource-endowed country with agricultural to mining and crude oil resources, which make its economy very rich. Russia is a global force in oil production and exploration, with approximately 20 per cent of globe's oil and gas reserves. China too possesses nearly 12 per cent of mineral resources in the global economy. India is distinguished by providing a solid service sector, with an intensifying manufacturing base and technological innovation. China's strength lies in the manufacturing sector; however, this sector seems to constitute a manufacturing factory, which comprises an impressively skilled labour force with quite low wage costs (BRICS report, 2012).

South Africa, like Brazil, is a resource-endowed country. From platinum and chromium to manganese, gold, and vanadium amongst others, its mining sector has boomed over the past years and it is the base of its growing economy. South Africa's advantage also comes from its infrastructure development, and unexploited possible growth of the African continent (BRICS report, 2012).

BRICS countries' global dominance has also been noticeable in international trade. Within the BRICS economies, China seems to dominate South Africa-BRIC trade flows of total goods by becoming a market with a high potential for imports and exports, and by being the largest partner of trade for Brazil, Russia, and South Africa, and the second-biggest trading partner for India (Singh and Dube, 2013). However, the structure of trade differs for each BRICS country. Based on figure 2.5, BRIC's share of South Africa's aggregate exports has shown a significant increase from 2000 to 2012. Indeed, each BRIC country's exports with South Africa have expanded considerably, particularly in the case of China and, to a smaller extent, India (Figure 2.5a-d).

Chinese exports with South Africa grew from US dollars 1013.65 million in 2000 to US dollars 15272.67 million in 2012, while Indian exports with South Africa increased from US dollars 307.80 million in 2000 to US dollars 4973.30 million in 2012 (Figure 2.5c-d). Russian and Brazilian exports with South Africa are increasing at a negligible rate (Figure 2.5a-b). In the meantime, South African exports to each BRIC country have also become greater than before, and at an increasing rate (Figure 2.5e). However, the country's exports to the BRIC countries have grown less rapidly than the country's imports from BRIC economies over the period 2000-12 (except for Russia), and, in the case of India, only over the period 2000-02, in 2005 and during 2008-10.

The trend of exports tends to be greater than that of imports<sup>1</sup>. This implies that Brazil, India, and China had a trade deficit with South Africa, while Russia ran a trade surplus (Figure 2.5a-e). South African exports with China rose from US dollars 335.19 million in 2000 to US dollars 10139.15 million in 2012, and, in India, rose from US dollars 371.74 million to US dollars 3674.82 million over the same period of time. Exports in South Africa with Brazil and Russia reached US dollars 790.46

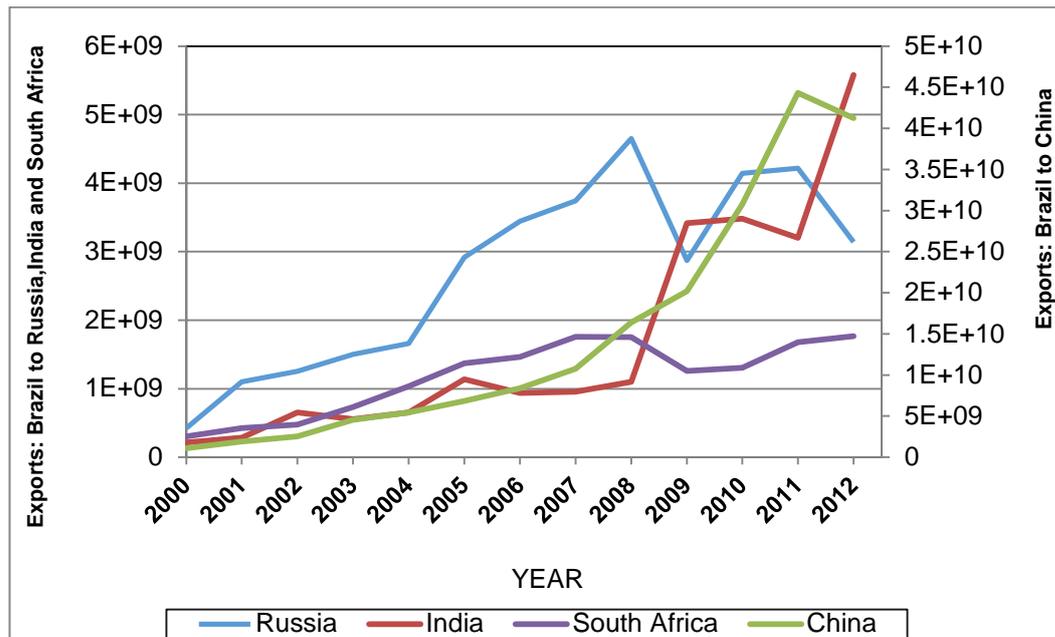
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<sup>1</sup> A country's export to other BRICS countries will be those countries' imports.

million and US dollars 412.37 million respectively in 2012 (Figure 2.5e). In general, Figure 2.5 indicates the bilateral flows of trade in terms of exports. Each BRICS country tends to export more to China, while China exports more to India, followed by Russia, then Brazil.

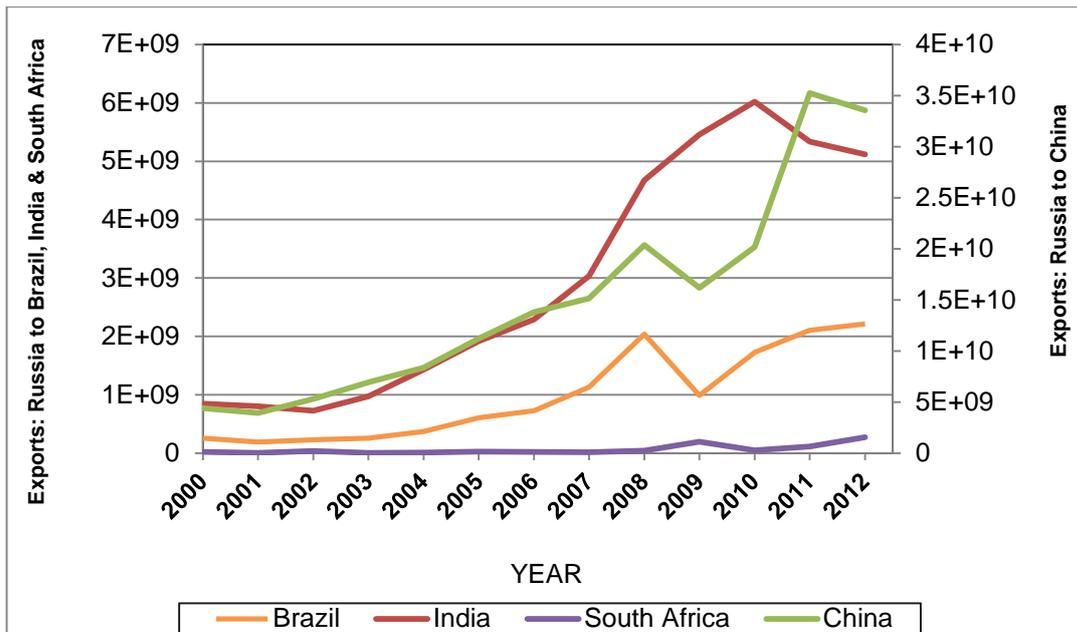
Figure 2.5: Intra-BRICS exports, 2000-2012

(a) Exports from Brazil to the rest of BRICS



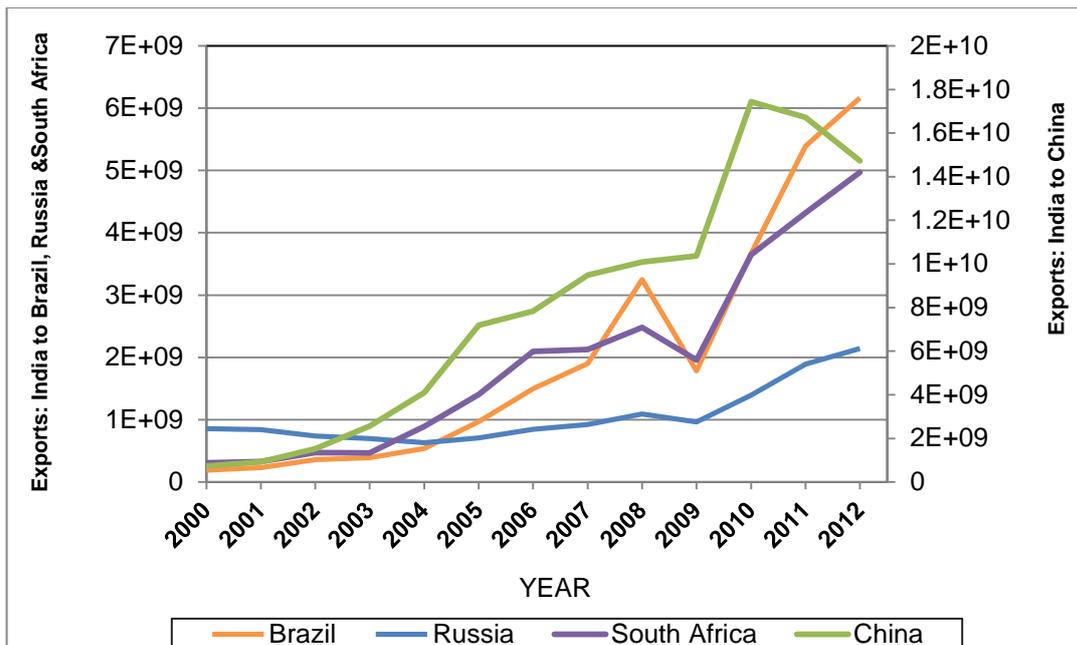
Source: Organization for Economic Co-operation and Development (OECD) (2013).

(b) Exports from Russia to the rest of BRICS



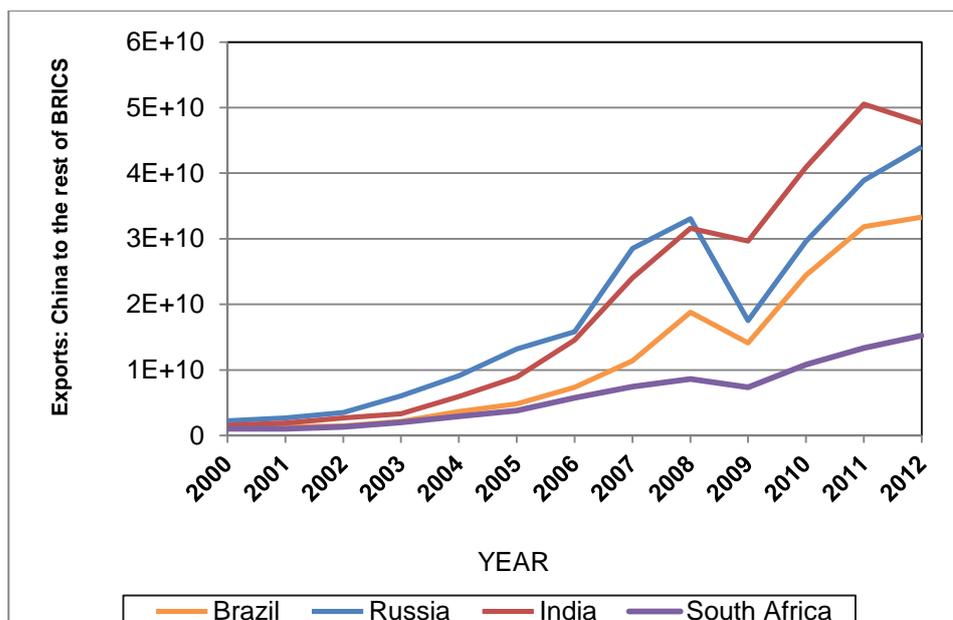
Source: Organization for Economic Co-operation and Development (OECD) (2013).

(c) Exports from India to the rest of BRICS



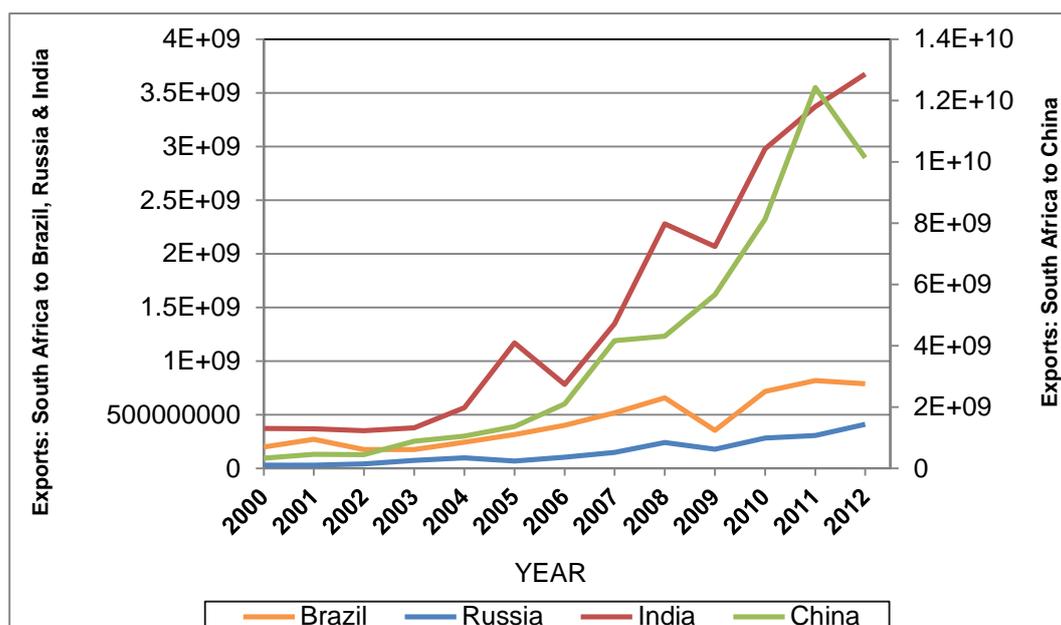
Source: Organization for Economic Co-operation and Development (OECD) (2013).

(d) Exports from China to the rest of BRICS



Source: Organization for Economic Co-operation and Development (OECD) (2013).

(e) Exports from South Africa to the rest of BRICS



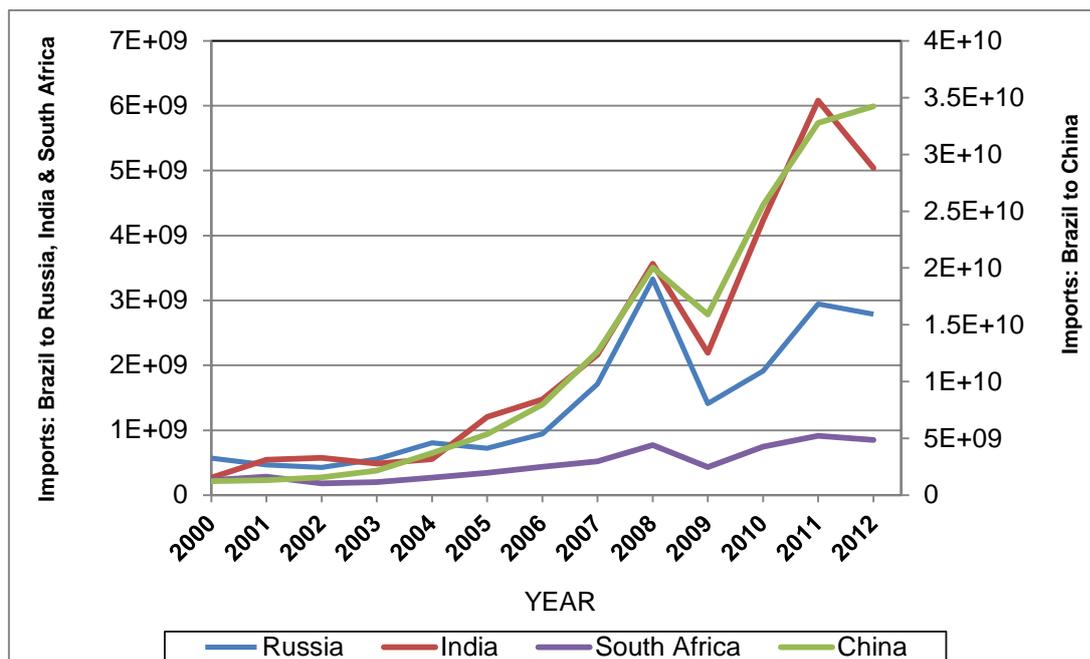
Source: Organization for Economic Co-operation and Development (OECD) (2013).

On the import side (figure 2.6), South Africa’s remarkable growth has been driven by China, which is the most dominant source of the country’s imports. South Africa’s imports from the rest of the BRICS countries have increased during 2000-12. In 2012, South Africa’s imports from other BRICS countries stand at about US dollars 14643.87 million from China, US dollars 4597.53 million from India, US dollars 1671.50 million from Brazil, and US dollars 203.531 million from Russia (Figure 2.6e). Hence, the share of BRIC’s imports from South Africa has also increased

during 2000-12, especially in China, which is an important and the largest import market for these countries. With all of the four BRIC nations, international trade can be very complimentary due to the composition of trade's divergence. It is evident that the importance of BRIC trade flows to South Africa has been growing, and this trend is expected to continue in the next years.

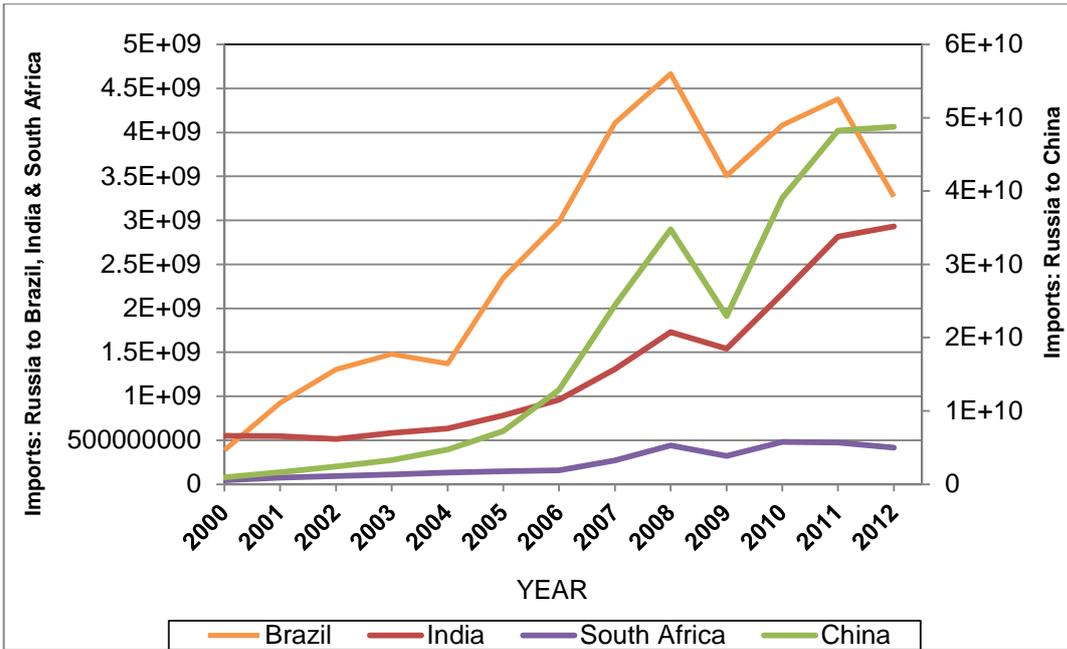
Figure 2.6: Intra-BRICS imports, 2000-2012

(a) Imports from Brazil to the rest of BRICS



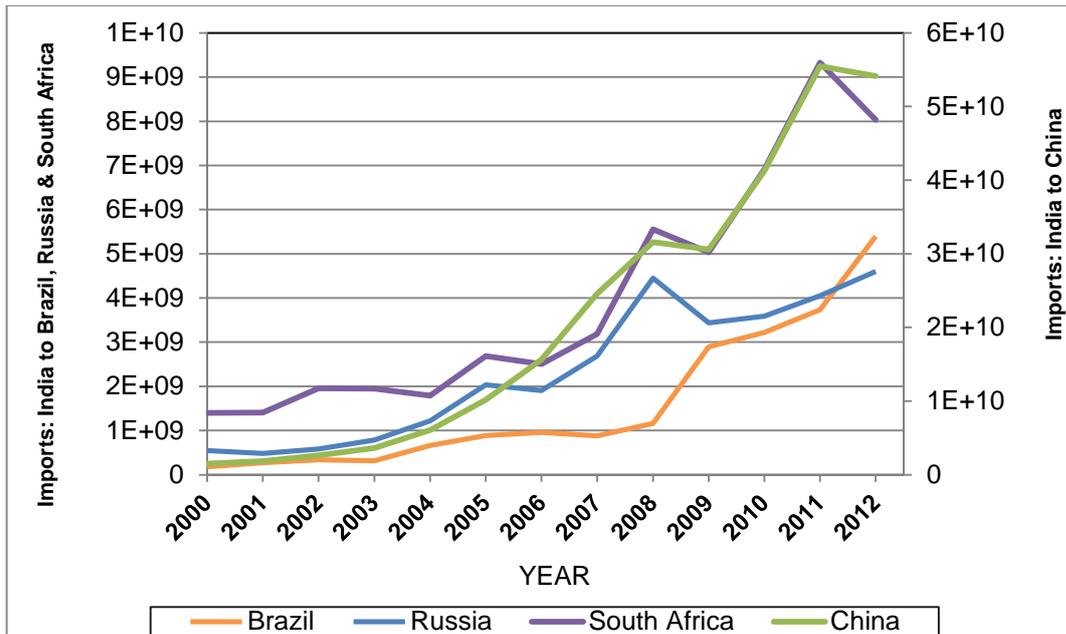
Source: Organization for Economic Co-operation and Development (OECD) (2013).

(b) Imports from Russia to the rest of BRICS



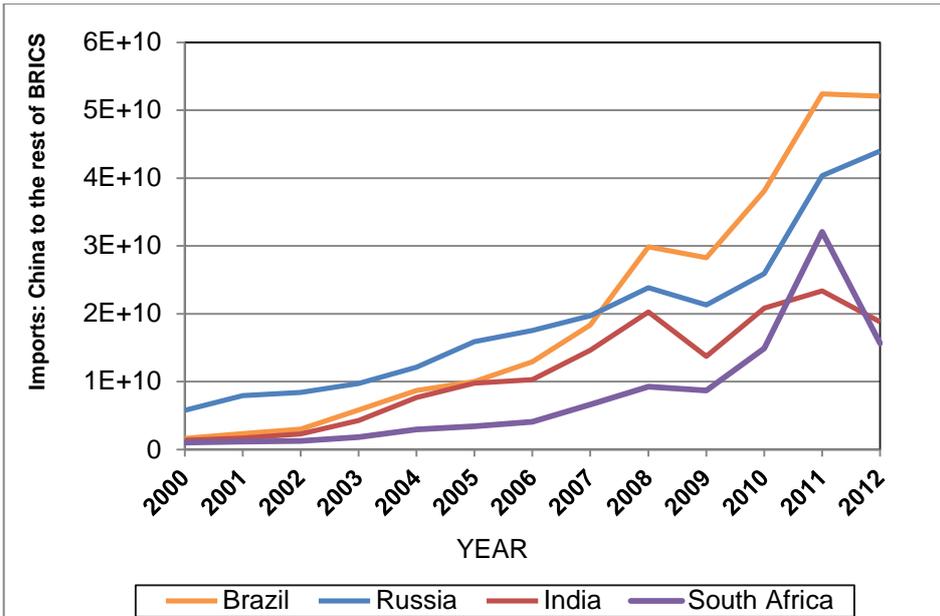
Source: Organization for Economic Co-operation and Development (OECD) (2013).

(c) Imports from India to the rest of BRICS



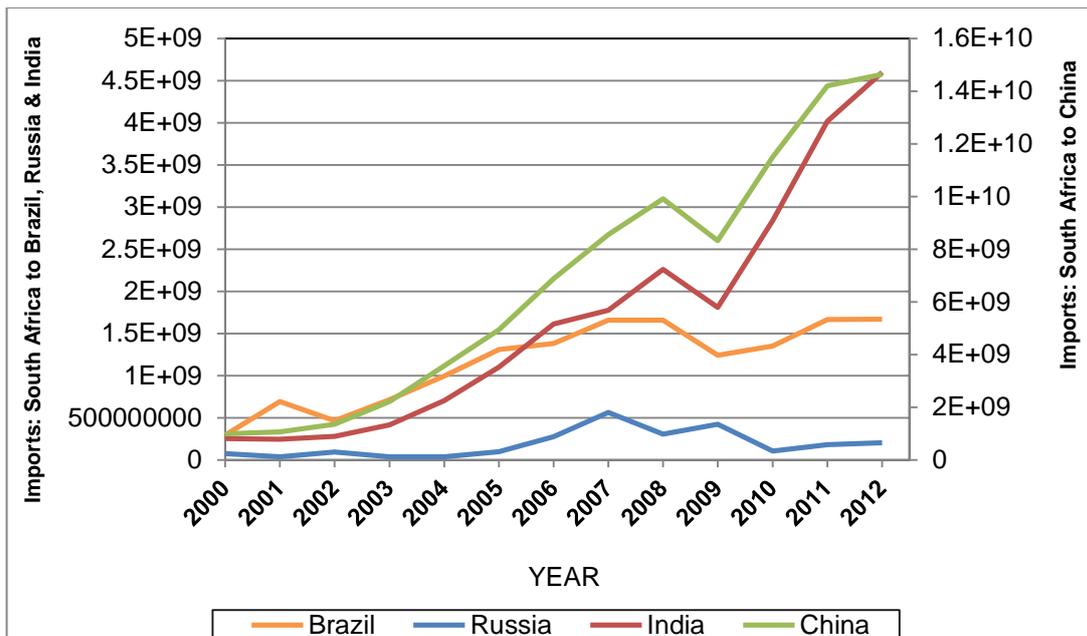
Source: Organization for Economic Co-operation and Development (OECD) (2013).

(d) Imports from China to the rest of BRICS



Source: Organization for Economic Co-operation and Development (OECD) (2013).

(e) Imports from South Africa to the rest of BRICS



Source: Organization for Economic Co-operation and Development (OECD) (2013).

### 2.5 BRICS Exchange Rates and Exchange Controls

One of the most important policy variables that determine the flows of trade in countries is the exchange rate, which represents the local currency measured in terms of foreign currency (Aziz, 2008). Conventionally, the standard regimes used in international trade are fixed exchange rates, assigned by an agreed, precise, official target and floating exchange rates determined by the demand and supply of the

foreign exchange market. The proponents of the fixed exchange rate regime argue that they are less risky, which is beneficial to exporters and importers in making decisions in international financial markets, and determining how home inflation converges to external inflation. However, there are also great risks associated with such a regime for larger emerging countries, leading their economic policies to lose flexibility in facing external shocks, or their government to lack aptitude in preserving the secured exchange rate (de Paula, 2007). The autonomy of monetary policy could, however, be raised under the floating exchange rate regime, even though this system creates a situation of instability or uncertainty about the price that is paid or received by exporters or importers for foreign exchange (de Paula, 2007).

Exchange rates are instrumental features in determining the stability of exports and imports. In addition, exchange rates are favourable tools for international trade flows as they foresee the welfare of a nation. Real exchange rate fluctuations should be taken into consideration in exports or imports markets since they create uncertainties that could, in turn, hinder international trade. There is thus a need for diversifying exports and hedging options to reduce such risk (Maradiaga et al., 2012). Besides, fluctuations in real exchange rates are also one of the reasons for deviations from PPP. Real exchange rates tend to be more volatile under the floating system rather than the fixed regime (Bacchetta and Wincoop, 2000).

The important issue is how to choose the optimal exchange rate regime and to properly manage that particular exchange rate system. In addition, the main concern about the exchange rate policies should be determining the essential elements related to the profitability and competitiveness of local exporters and industries that challenge imports. Any factors that restrain exports and encourages imports should be taken into consideration since the flows of trade may well be improved by policies of trade (Edwards and Garlick, 2008). Many emerging countries' exchange rates – including the BRICS countries – are managed in a floating regime under the supervision of their respective central banks.

Moreover, there have been limitations to the emerging economies' exchange rates, in that in international trade the use of these currencies is scarce, despite the fact that these economies are growing and consistently contributing to the global economy (Maziad et al., 2011). On the one hand, a number of advanced countries'

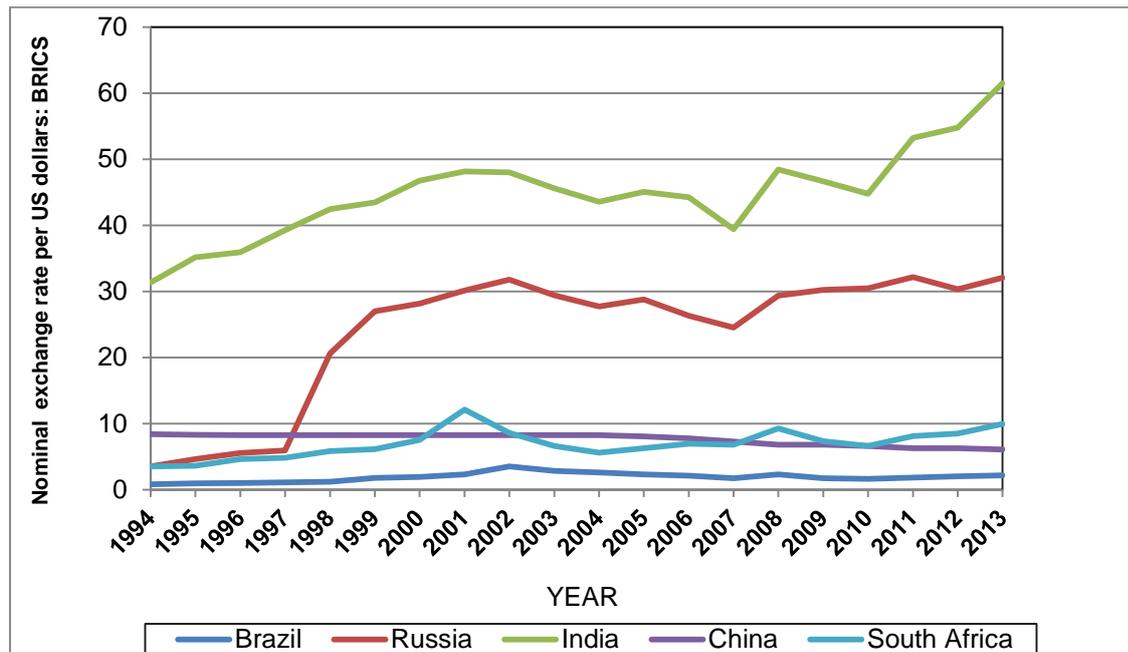
currencies is still significantly used in international transactions. For instance, international trade flows are mostly invoiced in the U.S. dollar and Euro (Goldberg and Tille, 2008). In fact, the use of the U.S. dollar is more dominant than the Euro when making payments for both exports and imports by countries outside the Euro area (Goldberg and Tille, 2008). On the other hand, the Chinese Renminbi has displayed the possibility of internationalization on a global scale due to its economic potency; it is making great progress in international financial transactions and expanding trade relations with neighbouring economies (Ranjan and Prakash, 2010). In fact, the use of Chinese and Russian currencies has already started in international trade. China's currency, the Renminbi (RMB), seems to be moving ahead toward international ranking (Ito, 2011), which will help BRICS to manage risk involved with the volatility of exchange rates. In addition, by using their own currencies, BRICS transactions costs will decline compared to the USD (Maradiaga et al., 2012).

Figure 2.7 shows the nominal exchange rates of BRICS countries from 1994 to 2013 in terms of US dollars. Among the BRICS group, the Rand and the Rupee appear to be the weakest currencies performing against the US dollar since 1994, due to their highest rate of depreciation. In 2013, the Rupee-US dollar exchange rate was estimated at 61.50. From 1998, the Russian Rubble has also been depreciating, losing its value against the US dollar. The Chinese Renminbi, however, has been appreciating over the period 1994 to 2013 from 8.45 to 6.09, implying that the exports-based industry will face some challenges. There have also been some fluctuations in the Brazilian Real-dollar exchange rate since 1994, showing a tendency of depreciation from almost 0.85 to 3.53 during 1994-2002. After 2003, Brazil experienced an appreciation of the Real and continued gradually appreciating until 2011. As a result, the rate of appreciation was from 2.65 to 1.86 over the period 2004-2011. Following the epoch of appreciation, the Brazilian Real depreciation occurred again from 1.86 to 2.20 during 2011-13.

Since 1994 – after apartheid – the South African exchange rate trend has showed a significant depreciation against the US dollar worse than the Rupee depreciation. This depreciation is especially noticeable in 2001, with a nominal Rand-US dollar exchange rate of 12.13 from a rate of 3.54 in 1994. This rapid rate of depreciation was possibly caused by the fact that the inflation rate in South Africa was higher than

those of its major partners of trade. Also, the Rand was greatly volatile during the crisis periods in 1998 and 2001 (Ricci, 2006). From 2002 to 2004 the opposite trend did occur, indicated by the rand appreciation against the US dollar, but this was followed by another substantial depreciation, which was particularly high in 2008 during the financial crisis.

Figure 2.7: Nominal exchange rates per US dollars, 1994-2013

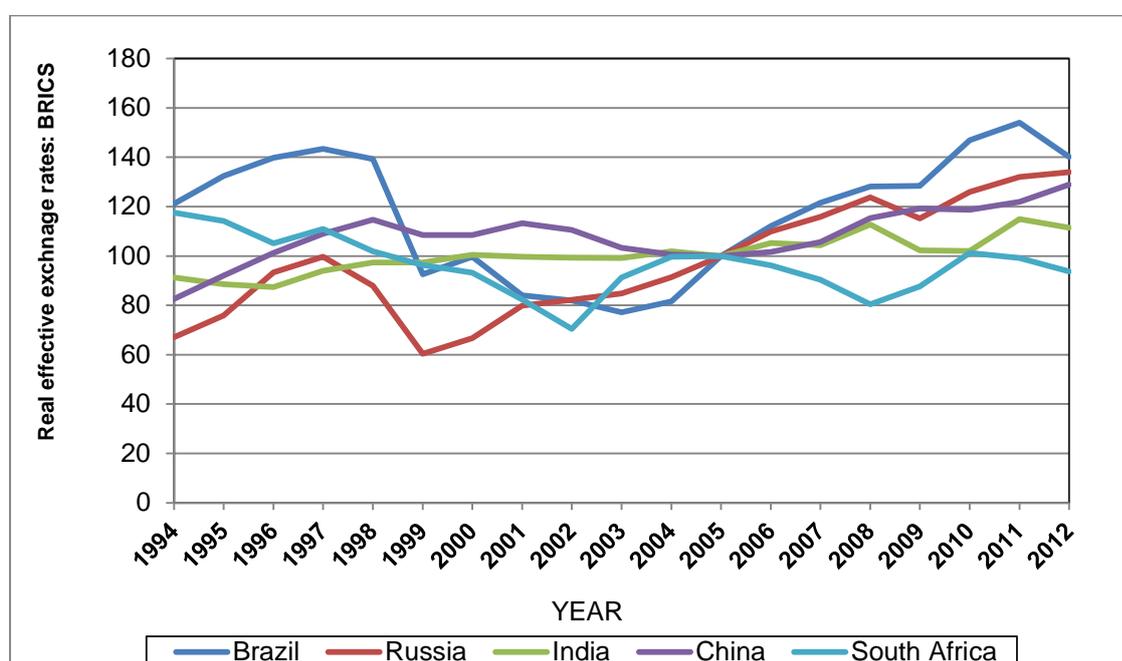


Source: Based on International Monetary Fund data (2013).

In general, volumes, flows and balance of trade tend to be more sensitive to real exchange rate movements than the nominal exchange rate, since the effects of the real exchange rate are counterbalanced by home inflation (Edwards and Garlick, 2008). For instance, depreciation of the real exchange rate boosts the competitiveness of exports by lowering foreign currency price of the export goods, increasing the local currency price of exports, raising the foreign demand for exports, motivating the diversification of exports by protecting home industries from imports, and enhancing trade balance. In fact, the effectiveness of a real depreciation is indicated when export volumes are expanded; volumes of import are dropped thus the trade balance is improved. In addition, real depreciation also diversifies efficiently, and successfully exports away from primary merchandises to manufacturing, especially non-commodity manufacturing (Edwards and Garlick, 2008). From 1994 to 1998, the BRIC economies experienced real depreciation while

the South African real exchange rate has appreciated, as presented in figure 2.8. After 2000, the BRICS real exchange rate appears to be overvalued, except for China. The period from 2004 to 2011 was characterised by a steady real depreciation in the BRICS economies, except for South Africa, which indicated an upward trend. In fact, South African rand particularly experienced significant real depreciation during 2009-10. In 2012, the real effective exchange rate was estimated at 140.18, 133.95, 111.5, 128.87, and 93.72 respectively for Brazil, Russia, India, China, and South Africa.

Figure 2.8: Real effective exchange rates (indices), 1994-2012



Source: International Monetary Fund (2013); United Nations conference on trade and development (Unctad) Statistics, 2013) and Reserve bank of India (2013).

In terms of exchange controls, there recently have been several policies endorsed by the Brazilian government that aim to ease the complication of its foreign exchange market so that the market becomes unified without too many fragments. The Brazilian exchange market is regulated by its central bank and the International Capital and Foreign Exchange Market Regulation, so all transactions performed in this market are authorised through a formal exchange contract (Deloitte, 2008). This regulation aims to enable more flexible and simplified cross-border transactions and preserve funds held in foreign currency overseas by Brazilian citizens in order to avoid an unnecessary appreciation of the currency.

In India, both the government and the reserve bank of India set out the principles and procedures to be followed by market participants under the Foreign Exchange Management Act (FEMA). However, the Indian currency is still limited on the capital account, even though it is freely bought from any bank for most of the present account transaction (Venkatesan, 2011).

Exchange controls in Russia are regulated by the government and the central bank in terms of the federal law on currency regulations and currency control. Particular foreign currency transactions are restricted to operate between residents and non-residents of the country. In general, residents are obliged to make payment in Russian Rubbles (Hills, 2012).

Severe exchange controls under the State Administration of Foreign Exchange (SAFE) are maintained by the Chinese government, despite the fact that there has been a tendency towards a progressive liberalization of the country's foreign exchange markets. Due to strict foreign exchange restrictions, capital market participants and investors are facing some serious obstacles, such as their inability to hedge the exposure risk to the Chinese currency (Petersen, 2012).

The control over the South African exchange market is held by the treasury and the reserve bank under the exchange control guidelines that were announced in 1961 in the Currency and Exchanges Act terms (Farrell, 2001). In general, various restrictions are enclosed in the South African exchange control regulations. These restrictions – which relate to trading and loan in foreign currency or securities and gold and the discount of funds off-shore, amongst others – are imposed on dealers. Unless permitted by the exchange control authorities of the South African Reserve Bank, the exchange control regulations offer an opportunity to authorised dealers to support their trading and improve their prospective business by buying or borrowing any foreign currency or gold from – or selling foreign currency or gold to – any person subject to purposes or conditions determined by the treasury (Van der Merwe, 1996). No person residing in South Africa is able to engage in financial transaction or to make any payment to a person residing abroad without prior consent of the exchange control authorities. For that reason, no payment involving debt-instruments is made by a South African resident to a non-resident without prior authorisation of the treasury and reserve bank. Debt-instruments issued by

foreigners should be listed on the bond market and be approved by the exchange control authorities based on conditions adhering to the listings established under the regulations of exchange control (Farrell and Todani, 2004). The regulation of capital flows thus has been successful, and the transfer of capital by non-residents in and out of South Africa is done without obstruction; however, the exchange control in the country has showed its incapability to avert volatile movements in the South African foreign exchange holdings (Farrell, 2001).

## **2.6 BRICS Geographical Distance**

Another important aspect that needs to be considered when investigating trade flows between the BRICS countries is the distance between and among these countries. Geographical distance appears to reduce the flows of trade between countries (Disdier and Head, 2008); it not only leads not to the costs of trade but also to the costs of insubstantial trade or transaction costs (Linders et al., 2005). Remoteness causes multilateral trade resistance to increase because countries are likely to trade more locally than trading with countries that are further away. Conversely, distant, isolated countries are less likely to prefer trading at home, as compared with those countries with numerous neighbouring countries and trading opportunities (Melitz, 2007).

However, it is obvious that the impact of distance between trading partners in bilateral trade does have positive effects when determining the absorptive capacity of the partner country, known as remoteness. This positive relationship illustrates that if a pair of countries is more remote from the rest of the world, then their bilateral trade will also be greater if the absorptive capacity of the partner country is reflected in the average weighted distance. In addition, there can be a reduction of the negative effect of distance and remoteness in the presence of competitive transport costs (Borgatti, 2008). Finally, international trade can be stimulated if distance and differences in latitudes between countries are well controlled (Melitz, 2007).

The location of the BRICS countries thus does have an impact on the patterns of trade amongst these countries. For example, In the case of Russia, it is difficult to access Moscow from the East Asia where China is located because it is squarely encountered by Western Europe. That is the reason why most Russian trading partners come from Europe. In addition, East Asia is very far from West and South

Asia where India is located. In the case of Brazilian trade, the Sao Paulo- Rio Cluster faces the South Atlantic, which facilitates the country's high degree of export diversification from North America, Western Europe and Western Africa. In the same way, China's main economic provinces' produces activities are conveyed by the sea, as are the products of India's most important economic centres. Trade at the sea thus has also influenced patterns of trade (Deutsche Bank, 2009).

Table 2.3. BRICS geographic distance

Geographic Distance ( Kilometres)					
	Brazil	Russia	India	China	South Africa
Brazil	0	14450.82	14774.6	16632.05	7776.76
Russia	14450.82	0	4985.43	2854.48	12576.59
India	14774.6	4985.43	0	2983.65	8254.63
China	16632.05	2854.48	2983.65	0	11236.5
South Africa	7776.76	12576.59	8254.63	11236.5	0

Source: distance fromto.net (2013).

From Table 2.3, Brazil and South Africa appears to be very far from Russia, India, and China within the BRICS group.

## 2.7 Conclusion

Over the previous few years, the BRIC abbreviation has been created to highlight the exceptional importance of these emerging economies and their progressive role played in the global economy. The BRIC countries, which incorporate Brazil, Russia, India, and China, have received global attention due to their economic power and growth prospects, regardless of each country's differences in terms of background, strategies for growth, resources, and economic policies. Brazil has been experiencing high economic growth over the previous ten years, its economic growth has almost doubled, and its economic performance was stable in the 2000s. China has been increasing at an economic growth rate of more than 10 per cent during the past decade, and Indian economic growth has been accelerating from 5.5 per cent to nearly 8 per cent as the result of the economic reforms in the early 1990s. Finally, Russia has been growing at nearly 5 per cent just after the recovery from the 1998 default, following the stabilisation and increasing prices of energy (Jaeger, 2012).

BRIC countries have maintained world growth by providing new markets for corporations and investors and restructuring institutions of the global economy since 2001, the year of the creation of this economic bloc. The growth of these economies tends to accelerate more strongly than the developed countries, leading to a considerable increase in these countries' prosperity. It is clear that these countries are significant to the global economy (Duncan, 2013). In 2011, the group was renamed as the BRICS, owing to the inclusion of South Africa. South Africa has emerged as one of the most refined and proficient developing markets in the world, with many competitive advantages and opportunities in terms of its location and access to the rest of the African continent (OECD, 2013). The BRICS countries have become an indication of the central growth of the future by stimulating increased demand for an extensive variety of commodities.

Among BRICS economies, China seems to have the highest rate of economic growth and the greatest share of manufacturing in GDP and exports, and it seems to be the most vigorous in terms of productivity growth. For instance, China became the largest market of exports in India in 2012 (followed by Russia). The emergence of Brazil's economic growth is being determined by sectors other than manufacturing; India has been growing by means of the service sector; Russia's growth is determined by its oil and gas production (Szirmai et al., 2012); and South Africa has been growing in terms of natural resources. Persistent trends of increasing exports' share have been preserved by all BRICS economies; however, their imports also rose significantly through increased investment and demand for consumption, which was propelled by the cumulative purchasing power of BRICS economies. Progress also has been made by these countries in terms of exchange rates and exchange controls. Finally, it has been observed that distance should be taken into consideration when determining trade flows among BRICS countries, as it can produce both positive and negative effects on the trade flows.

## **CHAPTER THREE**

### **LITERATURE REVIEW**

#### **3.1 Introduction**

Trade has always been the most essential factor in economic relations amongst countries. The theory of international trade shows how the flows of goods and services are exchanged between two or more countries in order to enhance economic growth. The notion of international trade is a key feature of a nation's economic improvement and has always been one of the preferred areas of interest amongst researchers and policy makers. International trade assists countries in playing an essential role in the economic integration of their regions. The allocation of resources, the access to markets, and the growth of the economy are promoted in order to be a potential driver of trade in the globalised economic environment, while reciprocal trade in goods and services are expanded and liberalised (Krugman and Obstfeld, 2009).

Given the importance of international trade in the economic growth process, it is indispensable to analyse characteristics determining trade flows and patterns among nations. Moreover, trade flows are fundamental elements of globalisation, which has had mainly positive effects on economies. Globalisation improves the macro-economy through trade integration by allowing free flow of goods and services among countries. However, it is necessary to facilitate trade flows between trading partners and to manage the challenges and the changes brought by globalisation. The literature on regional economic integration has been inclined, over the past few decades, to acknowledge that economic integration seems to have a significant impact on trade flows and increase trade among the trading countries. Thus, regional economic integration may have contributed to the improvement of the economic performance of these nations – and better standards of living for the populace – as a result of gains from trade flows (Venables, 2001).

The BRIC countries had long played an important role in their individual regions in terms of trade before becoming powerful. Since 1994, South Africa also seems to encourage regional integration in Africa and other parts of the world – especially

among developing countries – based on international trade. BRICS trade is thus expanding and seems to be integrating effectively into the global trade flows.

This chapter reviews the literature dealing with previous research and methodologies used to estimate trade flows between two or more countries. To this extent, the second section of this chapter will be devoted to a review of theories that explain the pattern of trade, and the third section looks into some important previous empirical studies based on the gravity model for bilateral trade flows –the focus of this study. The last section concludes the chapter.

## **3.2 Concept of International Trade Theories**

The international trade concept can be evaluated using a number of theories such as the absolute advantage theory, comparative advantage theory, and the Heckscher-Ohlin model. In addition, there is also the evolution of the ‘new trade theories’ (NTT), which highlights the weaknesses of the H-O model, and in which the gravity model – used for explaining bilateral trade flows – is embedded.

### **3.2.1 Absolute advantage theory**

The first model of international trade was identified by Adam Smith (1776), who is considered as the originator of modern economics. Though, Smith contradicted the ideas and economic policies of mercantilists by creating the notion of absolute advantage in order to support free trade, he was conscious that comprehensive free trade is unrealistic. In general, the aim of Smith was to demonstrate that all nations involved in trade could gain in equal portions from the international trade, yet with the caveat that trade is not necessarily likewise beneficial to all countries.

According to Smith, trade permits countries to specialize in producing goods or services that they have absolute advantage in. This is done both by using a minor quantity of resources at a lower resource cost compared to another country, and by using the equivalent amount of production yet yielding more product and service than other countries. This idea of trade envisages that all countries will benefit from international trade with condition that free trade is experienced and specialisation is done in accordance with their absolute advantage.

In his book “*Wealth of nations*” (1776), the theory of international trade was based on the ideas of division of labour and specialization. Conforming to Smith’s doctrine,

the more the division of labour was advanced and economies of scale were exploited, the greater the production would be, while retaining the same quantity of labour, as it enhanced the real wealth of nations and promoted the growth of the general economy. However, division of labour was constrained by the power of exchange –the extent of market–, which requires the expansion of the market for the division of labour to rise and be advantageous to economic growth, wealth, and the overall productivity of resources within the stated country. It was observed that the theory of trade developed by Smith was intimately connected with the theory of economic development because of the division of labour, which consisted of a growth in the total volume of the resources and an augmentation in the level of productivity.

One of the most important elements in Smith's theory of trade was the vent-for-surplus principle. When this principle was combined with the notion of division of labour, Smith was able to examine foreign trade's impact on the development of the domestic economy. This could imply that the theories of the vent-for-surplus and productivity are closely linked (Myint, 1977). Smith's analysis of trade was based on three factors: land, labour and capital, which contrasts with the one-factor Ricardian model of international trade theory. Using the three-factor model, the modern Heckscher-Ohlin approach to theory of international trade focussed on supplies of factors– labour and capital – and their price changes. However, Smith did not assume that the factor endowments were provided exogenously. For him, factor supplies and their price differences contributed to the long-run development procedure. Smith also included transports costs in his analysis, since they influenced the economic development process and the determination of the market's extent.

According to Myint (1877), the major criticism of Smith was based on his failure to include the doctrine of comparative costs because the absolute advantage lacked the recognised rigidity of comparative costs and the efficiency of the resources' distribution. Smith made use of a single theory of value, the theory of natural price (in the sense that there was one dominant price to which all goods' prices had a continuous tendency). This natural price diverged at a point when the total amount of natural rates of rent, wages, and profits was required to be paid for the production. Furthermore, full employment of capital and labour was assumed to support greater opportunity of output growth (Myint, 1877).

Richardson (1975) interpreted the study of Smith as a theory which was constantly unstable and uncertain and created many changes on the inside. For example, the division of labor was viewed simultaneously as both the reason and consequence of the development in the economy. According to Richardson, if the division of labor is restricted by the extent of market, then it would be evident that monopoly would take the place of the free competition assumed by Smith because of increasing returns.

West's (1990) criticism of Smith reasoned that Smith failed to apply modern econometric approaches even though that he had suggested testable hypotheses to check the theory of modern economics, such as agent problems, rent seeking, non-profit organizations, public goods, and externalities. However, Richardson did point out that Smith did anticipate modern policies by looking at the constitutional issues of the public choice school, the importance of government's role in the economy, and the autonomy of private enterprises related to the growth of the economy.

For Ricardo (1817), Smith comprehensively failed to ascertain comparative costs and was more interested in the theory of economic development than the effective allocation of resources. Ricardo thus introduced the comparative advantage theory.

### **3.2.2 Comparative advantage theory**

In the nineteenth century, David Ricardo (1817) wrote of the theory of comparative advantage after discovering a defect in the absolute advantage approach. Ricardo reworked Smith's ideas, indicating that a country might produce goods at lower opportunity cost compared to another country and specialize in goods in which the country has the comparative advantage in a more efficient way. Ricardo thus pointed out the importance of the law of comparative opportunity costs instead of financial costs (Krugman and Obstfeld, 2000).

Chipman (1965) highlighted the mathematical structure which dealt with the values of international trade theory by dividing the theory into three components: classical theory by Torrens, neo-classical approach by Ricardo and Mill; and modern theories by Heckscher and Ohlin. He found that, while Ricardo observed the mobility of goods was perfect within countries and among countries, factors of productions were in fact immobile among countries but absolutely mobile within countries. Ricardo (1817) did acknowledge that all industries were well integrated with the production of one output

and the use of one crucial input – labour – which is internally mobile, but the mobility of capital was limited on the inside.

Ricardo also supposed that domestic trade was different from the international trade due to the fact that the former was determined by absolute advantage and the latter by comparative advantage. This was the reason why two different values of trade theory were applied: the labour theory of value – based on production costs – and the comparative advantage theory – based on comparative costs and mutual demand. In addition, the theory of foreign trade was based on a single factor model of trade in the domestic economy: the one-factor of production: labour (Myint, 1977). The theory of comparative advantage did not support tariffs or other restrictions of trade and presumed that international trade should be balanced by adopting an automatic mechanism of adjustments so that the value of imports and exports should be equal within a nation. Based on these ideas, more of the existing resources were efficiently used because of international trade, in that nations would benefit from effective allocation of these resources (Ricardo, 2004).

Chipman (1965) believes that Torrens should be given the credit for the discovery of the law of the comparative advantage, even if Ricardo's achievements and contributions was greater than Torrens in terms of the progress of the law and the theoretical principles of comparative advantage. For Torrens, the concept of comparative advantage was related to the principle of territorial division of labour in such way that the number of gains from trade depended on the increased productiveness of individual industry due to the foreign division of labour. In addition, Torrens first developed the doctrine of comparative advantages or comparative cost, but, he did not expand much upon, simply providing a summarised theory (Seligman and Hollander; 1911).

Mill (1844) too analysed the theory of comparative costs from the identical perceptions and assumptions as Ricardo, did also indicated that the interchange of nations was determined by the difference in comparative cost of production and not by the absolute cost. Mill aimed to determine in which percentage the increased produce was divided between countries as a result of the saving of labour and how these countries would share the advantage of international trade. This was an attempt to find out a solution to the dilemma left by Ricardo. Mill applied the principles of demand and supply in order to identify the existence of a price ratio, which would enable successful distribution of foreign trade's gains among countries.

Stigler (1952) examined how Ricardo contributed to the theory of value and distribution in the context of population and rent. According to Stigler, the theory of population was considered as the primary pillar in Ricardo's structure as Smith's principles of free competition were not taking into account in his own analysis. In addition, the theory of rent and the effects of diminishing returns on the profit rates also formed integral parts of Ricardo's structure. These concepts were related to the theory of wages and the measure of value. Based on the measure of value, Ricardo showed that there was a negative relationship between wages (the value of labour) and rates of profit (the capital's value). Moreover, despite the fact that West (1990) briefly established the classical theory of rent as a result of the theory of diminishing returns, Ricardo went further than West by analysing the effects of improvements on rent by ignoring the diversity of uses of land and distinguishing two categories: where output was raised due to the specified land and the amount of product demanded did not depend on its price, which implies the reduction of rent; and where the quantity of labour was decreased for the production of a certain product from a particular land. In this case, the impact on rent was dependent on the shape changes of the marginal product of the labour curve (Stigler, 1952).

In reality, this principle of comparative advantage allows countries to specialize in those particular goods and services in which they have the highest absolute advantage, which improves resource allocation and increases production internationally. The theory of comparative advantage serves as a tool used by economists in order to explore international trade. However, the Ricardian model does not provide an explanation on the motives for a country's comparative advantage, for example in terms of the extent of different productivity. In order to rectify this, the Ricardian model was subsequently adapted and extended by Eli Heckscher (1919) and Bertil Ohlin (1933), who developed the trade theory known as the Heckscher-Ohlin model, also known as the factor endowment theory of trade (Todaro, 2000). This model attempts to clarify the reason that there are certain countries producing the same amount of final goods given the same inputs, yet have comparative advantages for certain goods. Based on the assumptions of the model, two countries (home and foreign) are needed, followed by the production of two goods by each country using two factors of production, instead of the one factor of production found in the Ricardian model: labour and capital. These factors of production are completely immobile between countries but mobile within countries

through manufacturing sectors. In addition, changes in all inputs will be accompanied by changes in output so that all productivities remain unaffected, which indicates constant returns to scale of the production functions. The emphasis of this model is on the differences in endowments of factors of production such as labour, capital, and human capital as determinants of comparative advantage and trade flows among nations instead of technological differences.

The Heckscher-Ohlin theory incorporates four basic theorems so that the relationship between the factor endowment and the trade pattern of goods can be improved: the Heckscher-Ohlin theorem of trade, the Factor-Price Equalization Theorem, the Stolper-Samuelson Theorem and the Rybczynski Theorem.

According to Ohlin's analysis (1933), each country should use a large amount of its most abundant factor to specialise in the production of the goods of trade so that the good in which the nation's abundant factor is intensively used to produce would be exported by that country. Following the comparative advantage theory, the resultant specialisation and trade would lead to a partial reduction of earlier differences in the factor prices due to their immobility. Then, since goods are to some extent absolutely mobile, the absence of mobility in the factors was compensated by the product's mobility. Therefore, according to the Factor Price Equalization Theorem (Samuelson, 1948, 1949), factor prices would tend to equalise relatively and absolutely between the two specified countries after trade in the Heckscher-Ohlin model.

Despite the fact that the Heckscher-Ohlin model assumed that there were no transportation costs, no imposed tariffs, nor other barriers to trade. In reality, it is imperative to note that these costs always exist and are practically important. As a consequence, the Factor Price Equalization Theorem would be limited since these costs obstruct advantages associated with trade. Thus, in order to compensate for this deficit, the Stolper-Samuelson Theorem suggested that the relative price of the scarce factor would rise in terms of the other relative factor's price – or any good's price – if tariff was imposed so that their long-run relationship and patterns of trade were maintained in a single country, which is important for the distribution of income (Bhagwati, 1959).

The Rybczynski Theorem, like the Stolper Samuelson Theorem, deals with comparison within a single economy. However, this theorem emphasised how factor

endowments were related to goods' outputs. It also exhibited that, if there was an increase in a country' factor endowment, this would affect the production of goods by expanding the good's output that used intensively this factor, for example capital, and by decreasing the productivity of the other good using labour as a factor of production (Rybczynski, 1955). Nevertheless, regardless of these theorems, the Heckscher-Ohlin model does not provide all descriptions of international trade.

### **3.2.3 New trade theory**

The new trade theory was developed due to the fact that the traditional theories failed to explain and provide the most important evidences about the trade data post World War II, according to Helpman (1981) and Krugman (1979). In addition, the Heckscher-Ohlin model of trade could not describe patterns of trade in manufactured goods according to the Linder theory of trade (Greytak and McHugh, 1977).

David Greytak and Richard McHugh (1977) examined the validity of the Linder preference similarity of trade hypothesis, suggesting that trade in manufacturing products is demand-oriented, having a positive relationship with structures of internal demand. In addition, the factor of distance is an important determinant of the patterns of trade in manufactured goods. According to Linder's theory (1961), trade among countries is not different from trade within a country; the distance factor serves as costs of transport and market opportunities' considerations, and not as barriers imposed by political restrictions. The similarity of income between two nations should be regarded as their trade's source; trade intensities depend on income similarity between and among countries by making a difference in underdeveloped countries and growing countries, owing to the potential of trade. Since there are similarities within a nation and between nations in terms of social, political and cultural backgrounds, the effects of the external noneconomic disruptions are moderated by the magnitude of regional data. The Linder hypothesis thus proves that patterns of trade in manufactured products are only determined by demand structures.

Nevertheless, the absence of a formal mathematical approach serves as a constraint to the subjective understanding of Linder's theory. In their empirical investigation, Greytak and McHugh (1977) tested the effectiveness of Linder trade theory using two hypotheses. These hypotheses proposed that trade intensity variations between

and among partners of trade are respectively determined by the separation of geographical distance and demand structure disparities. In addition, a positive relationship between trade intensities and per capita income was assumed in the Linder theory of trade. Even though manufacturing trade was demand-oriented according to Linder's hypothesis, Greytak and McHugh (1977) found that patterns of trade among regions were not satisfactorily explained by this connection, and that the Linder theory of trade failed to observe that income variations were strongly related to import intensities. This may be due to the fact that factors of patterns of trade between nations are distinct from factors of trade between regions within nations. However, the distance factor should be considered as a significant element when determining patterns of trade in manufactured goods.

Krugman (1979) developed a model of trade based on economies of scale instead of technological differences – like Ricardo (1817), or factor endowments differences – like Heckscher (1919) and Ohlin (1933), because the classical theory of trade did not give much attention to increasing returns and its implications for international trade. Linder did not clearly refer to economies of scale when observing the effects of trade but was more concerned with trade volumes based on how income per capita was changed by relative demands. In Krugman's analysis, it was revealed that international trade can be beneficial if the market is extended and economies of scale are exploited relative to the growth of the labour force and regional agglomeration. This may be convenient in explaining trade among the industrial nations.

Helpman (1981) incorporated product differentiation, economies of scale, and monopolistic competition methodologies to the Heckscher-Ohlin method regarding international trade. This is done in order to address the gap in classical international theories of trade, which did not include these basics in their analysis and generalize Heckscher-Ohlin theory of trade. Based on the factor price equalisation theorem, the pattern of trade between sectors can be estimated from factor endowments or relative factor compensation under monopolistic competition, depending on whether the production function is homothetic or not. The composition of trade was examined by Helpman, and he hypothesized the link between the share of intra-industry trade and incomes per capita.

### **3.3 Gravity Model for Bilateral Trade Flows**

When international trade flows are analysed, economists usually make use of another model, known as the gravity model, which was first introduced by Tinbergen in 1962. Tinbergen (1962) and Pöyhönen (1963) initially identified specifications and assessments on how trade flows are determined, then applied gravity models to international trade. They followed the general principles of the Newton gravitational model in Physics, which states that when two bodies are attracted to one another, the resultant attraction between them is positively proportionate to the product of their masses and negatively proportionate to the distance between the objects. Based on Newton's theory, Tinbergen (1962) and Pöyhönen (1963) established that when the two bodies (countries) are involved in international trade, respectively represent the exporting and importing countries, their 'mass' variables are their GDP and population (economic extents). However, their contribution was intuitive without robust theoretical foundations and assertions. Nevertheless, Tinbergen (1962) and Pöyhönen (1963) were the first to conduct econometric studies on bilateral trade flows based on this gravity model. Based on this model, bilateral trade volume between two countries is determined by their economic sizes and decreases with bilateral trade resistance.

#### **3.3.1 Theoretical studies on the gravity model**

Linnemann (1966) suggested theoretical descriptions for the gravity model in terms of imperfect competition, increasing returns to scale, and transport costs. According to Linnemann, the gravity model was derived from a Walsarian general equilibrium model, stating that the exports of one country to another country deal with the prospective supply of exports of one country, prospective demand of imports from the other country, and trade barriers. However, the Walsarian system incorporates various explanatory variables for each trade flow that need to be applied to the gravity equation.

Most of the existing studies show that the gravity model could be derived from either theories of trade or models of trade, with differentiated goods by the source country, economies of scale, or technological or factor endowment differences. In addition, these studies have tested and improved the theoretical foundation of the gravity

model by looking at trade costs or restrictions of trade and by providing an econometric methodology.

Anderson (1979) provided a theoretical interpretation and economic justification for the gravity equation applicable to commodities under the assumption of Cobb-Douglas preferences (constant elasticity of substitution (CES)). Here, it is assumed that consumers have preferences defined over all goods differentiated by the home country. This suggests that, where products are differentiated, a country will at least consume a certain number of each good from every country so that there would be trade for all goods by all countries. He proposed a reduced-form gravity equation derived from a general equilibrium model which contains the properties of expenditure systems.

Bergstrand (1985, 1989) further developed this subject by implementing the microeconomic foundations of the gravity equation within the increasing returns to scale concept. He demonstrated that the gravity model is obtained from a model of trade based on monopolistic competition, where differentiated goods are traded by the same countries, since all individuals have numerous preferences. He presented the general equilibrium model of World trade under the assumption of the economic agent utility- and profit-maximisation, and as well as the impact of the price variables on aggregate trade flows. In addition, he further presumed Dixit-Stiglitz<sup>2</sup> monopolistic competition in the economy and product differentiation among firms instead of countries.

Deardorff (1998) indicated that a gravity model could be a direct indication of a traditional factor-proportions model describing international trade. He has identified that the gravity model can also be applied to the Heckscher-Ohlin models and

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<sup>2</sup>Dixit-Stiglitz monopolistic competition represents a general equilibrium between two groups of goods which consist respectively of monopolistic goods and the numeraire good. This refers to all other goods in the rest of the economy where the monopolistic firm is assumed to know the true demand curve, and one is able to choose the equivalent price and take the price of all other goods as given so that the utility function is maximised, subject to a budget constraint. Fixed costs are minimised fulfilling demand functions and maintaining the positive profit. In addition, the concavity of consumers' preferences corresponds to an increasing utility function, implying economies of scale. Consequently, imperfect competition and the elasticity of substitution between monopolistic goods and the numeraire good are constant (Dixit and Stiglitz, 1977).

product-differentiated models. He derived the resultant gravity equation from two cases of the Heckscher-Ohlin framework by showing that the equation relies on the Heckscher-Ohlin model of trade in homogeneous goods through perfect competition.

In contrast, Feenstra et al. (2001) argued with the assumption of an existing theory for the gravity model by indicating that gravity equation could also be obtained from the reciprocal dumping model of trade where goods are not only differentiated, but also are homogeneous. The market structure for the homogeneous goods was represented as Cournot-Nash competition in order to display trade patterns. They also showed the different implications of the home market effect on both homogeneous and differentiated goods in terms of domestic-income elasticity or partner-income elasticity. Therefore, both differentiated and homogeneous goods could raise gravity equations.

Egger (2000) provided a more convenient econometric specification of the gravity equation. He improved the gravity model by suggesting that the fixed effects model or the random effects model econometrically illustrate accessible data that is strongly dependent on the correlations of individual effects. When there is zero correlation between individual variables, the random effect specification is supported.

### **3.3.2 Empirical studies on the gravity model and other trade flows**

Empirical studies have shown that the gravity model has become the standard tool in explaining bilateral trade flows, not only for developed countries, but also for many developing countries and African economies, which produce homogeneous goods rather than differentiated goods (Hummels and Levinsohn, 1995). Generally, Hummels and Levinsohn (1995) made use of the gravity equation to test trade theories. For example, they tested if the monopolistic competition is relevant in international trade by using intra-industry trade data. They found that country pairings are more defined by intra-industry trade. Hence, the gravity model could be derived based on the assumption of either perfect competition or monopolistic market structure. In addition to various studies dealing with trade flows and gravity models between countries, the significance has been placed on the investigation of the trade potential, trade determinants, trade costs, trade direction, and trade enhancing effects. Their papers use both the cross -section and panel data methodologies.

Frankel (1997) investigated the role of geographical factors and trading blocs by expressing a more complex and advanced type of gravity equation. This was done in order to determine bilateral trade flows and assess the impact of regional integration on bilateral trade flows. The emphasis was placed on the geopolitical factors such as border-sharing and adjacency, common language, distance and historical links. He found that regional trading arrangements are statistically significant on trade flows and

encourage trade among a group of countries. Regional membership bloc positively influence bilateral trade flows when trading partners are neighbours.

Anderson and Wincoop (2003) showed how important is for a well-specified gravity model to control for relative trade costs because of many implications of trade barriers on trade flows. The results of the theoretical gravity equation indicated that bilateral trade is determined by relative trade barriers, so that the tendency of country  $j$  to import from country  $i$  is subject to country  $j$ 's trade cost towards  $i$ 's resistance to imports and to the average resistance faced by exporters in country  $i$ . They did not look merely on the absolute trade costs between country  $i$  and country  $j$ . Based on their assumption, trade costs are carried by the exporter. For a single good transported from country  $i$  to country  $j$  there would be export costs experienced by the exporter. The price indices are referred as to the multilateral resistance variables. The logic behind the multilateral trade resistance is that if two countries are enclosed by other vast trading economies then there will be less trade between themselves. The opposite will occur if they were bordered by oceans, deserts or mountains.

Furthermore, Helpman et al. (2008) explored how international trade flows are assessed with the use of the gravity equation, paying attention to numerous measures of trade resistance. They improve the standard gravity model estimation of trade flows by correcting certain prejudices in the estimation procedure. They develop an international trade theory, which describes zero trade flows between couples of countries, enabling larger numbers of exporters to fluctuate across many different destination countries. Following the above trade theory, a two-equation system is derived in order to show the influence of trade resistances on trade flows, which, in turn, lead to the impact of intensive (trade volume per firm) and extensive

(number of exporting firms) margins. The result reveals that a two-stage estimation technique can be applied parametrically, semi-parametrically, and non-parametrically. Given the three parameters, this method emulates the effects of trade frictions. Additionally, with this procedure, the intensive and extensive margins of trade are determined and the variation of exporters among countries depends on how developed the nation is.

Studies on developed economies have also examined trade integration between regional trading blocs; investigating bilateral trade patterns and trade relationships by the use of the gravity model for the aggregate bilateral trade and also for the trade at product level. For example, Hellvin and Nilsson (2000) used the gravity model to examine the level of trade integration between three trading blocs: the EU, Asia, and the North American Free Trade Agreement (NAFTA) by comparing actual trade between the blocs with projected trade. They identified that among these blocs, trade flows were significantly determined by the national income of the countries, the per capita income, distances, trade agreements among these nations, the allocation of common borders, and language resemblances.

Evenett and Keller (2002) examined the standard gravity model based on the Heckscher-Ohlin model with perfect production specialisation, and the increasing returns theory with imperfect product specialisation. They have analysed the model by gathering a sample of 58 countries' cross sectional data in 1985, which had respectively GDPs above U.S. \$1 billion with the total share of 67 percent of global imports and 79 percent of overall GDP, in order to estimate the regression parameters. They found that when the share of intra-industry trade in total trade rises, specialisation and trade will also increase. However, specialisation does not properly predict the production of more differentiated goods compared to imperfect specialisation. This is due to the differences in factor endowments since the size of the differentiated goods sector is related to the share of intra-industry trade. They also established that the variations in trade patterns and volumes were explained better by models of trade with imperfect product specialisation rather than those with perfect product specialisation.

Eaton and Kortum (2002) developed a gravity-type equation from a Ricardian – type model based on technology and geography. The model expressed that bilateral

trade volumes are related to distance and to the product of the home and destinations countries' GDPs by using the two parameters of technology and geographical barriers. The parameters of the model were estimated with the use of cross-sectional data on trade flows in manufactures, prices and geography among 19 OECD countries. However, although they ignored other Ricardian assumptions, they assumed that mobile labour is the only globally factor and technology is common to the world.

Zarzoso and Lehman (2003) explored the determinants of Mercosur-European Union trade flows by using the gravity model in order to examine the relationship between the volume and direction of international trade and to forecast trade potentials between the two blocs. The paper used an augmented gravity model by including a number of variables such infrastructure, income differences, and exchange rates in order to investigate their role in influencing bilateral trade flows in a panel data analysis. They found that all the variables were statistically significant, except for the infrastructure variable, implying the need of some important economic policy. In addition, their findings showed that the fixed effects model is more appropriate than the random effect model in explaining trade flows when more variables are included in the standard gravity model.

Cortes (2007) evaluated the bilateral trade relationship and trade performance between Australia and a selection of nine Latin American countries based on the gravity model, focussing on the appropriate factors or variables regarding the composition of trade. In the paper, the analysis used cross-sectional data for wide categories of total exports and total imports and has included non-traditional variables such as openness and political changes. The results showed that political power significantly influenced bilateral trade flows in most of Latin American countries, openness played an important role for Australian imports; and distance seemed to restrict the flows of trade between these countries.

Rault et al. (2008) examined trade flows between CEEC and OECD countries with the use of progressive panel data techniques through fixed effects in order to consider and regulate unobserved heterogeneity. In previous studies, estimation with cross-section data did not seem to pay attention to the unobservable characteristics of bilateral trade relationships, which may lead to biased and inconsistent results of

parameter estimates. Consequently, the OLS technique is not the most appropriate method for individual heterogeneity estimates because heterogeneous trading relationships are not controlled. These authors estimated the gravity model by applying pooled ordinary least squares (POLS), random effect estimator (REM), within estimator (FEM) instrumental variables, and Hausman–Taylor estimator (HT) methods. Among the techniques, the HT approach seems to be the most suitable, generating consistent parameter estimates and deriving parameter estimates for the time-invariant variables.

On the empirical front, most findings show that gravity models across countries has been a successful formulation in describing trade flows between different nations. There have been a number of studies on developing or African economies investigating the effects of trade or trade flows in a single country or between multiple countries to evaluate further prospective for trade development. For example, Chan-Hyun (2001) analysed Korea's trade patterns empirically based on the gravity model, seeking to identify the factors determining Korea's bilateral trade flows. In this context, the analysis used cross-sectional bilateral trade flows data between Korea and its 30 main trading partners. The result of the analysis showed that the bilateral trade flows of the country follow the basic gravity model with a positive effect on trading partner's GDP, and, with distance retaining negative implications His paper also included the trade conformity index in order to measure bilateral trade structures, which was done to investigate whether Korea's trade patterns are based on the Heckscher-Ohlin model through inter-industry trade, or the differentiated products model through intra-industry trade. In addition, this study looked at how a regional economic bloc can influence Korean bilateral trade flows. Finally, Chan-Hyun's analysis implied that the country should trade with countries in close proximity, with large economic growths, and the patterns of trade should follow inter-industry trade rather than intra-industry trade.

Rahman (2003) analysed Bangladesh's trade with its major partners by applying the generalised gravity model. The paper used the panel data estimation technique in order to examine the main determinants of Bangladesh's trade that affect exports or imports when evaluating the gravity model, considering the most important economic factors such as the exchange rate, partner countries' total import demand, and the openness of this country's economy, rather than natural factors. The result showed

that all three economic factors are positively related to exports. However, transportation costs affected Bangladesh's trade negatively.

Batra (2004) used the gravity approach to estimate trade prospective for India by analysing primarily the bilateral trade flows in the world with an augmented gravity model. Even though there is an advantage of using panel data in order to apprehend the relevant relationships over time, the estimation of this gravity model was done by means of the OLS technique with cross-section data between pairs of countries. The use of the gravity model with cross-section data was to evaluate trade effects and trading relationships at a specific period of time. Furthermore, India's trade potential was compared across diverse regions of the world. The result revealed that India can potentially trade with the Asia-Pacific region, followed by Western Europe and North America. The magnitude of trade between India and countries such as China, the United Kingdom, Italy, and France is significant, which implies further potential for expansion of trade.

Huot and Kakinaka (2007) explored bilateral trade flows between Cambodia and its 20 trading partners using a modified gravity equation for the period 2000-2004. Here they included a trade structure variable in order to check which trade model could dominate the other: the Heckscher-Ohlin model (inter-industry trade) or an Increasing Return Scale model (intra-industry trade). Empirically, the results of this gravity model showed that trade flows are better explained by the Heckscher-Ohlin model in terms of trade complementarity level where there is difference in factor endowment between countries rather than monopolistic competition. The paper also examined the negative impact of foreign exchange rate volatility on trade flows, implying the need of a stable foreign exchange rate.

Xu and Sheng (2009) examined trade patterns across the Taiwan Strait, investigating the trade abnormality affecting both Mainland China and Taiwan. The paper used the gravity model to normalise bilateral trade flows and measure the determinants and potential of trade between Mainland China and Taiwan so that many trade restrictions could be removed. According to the structure of trade, inter-industry trade dominated bilateral trade flows between Mainland China and Taiwan, leading to the increase of trade flows. The prediction of trade potential between

these countries was based the OLS and panel random effect estimations. They also found that Mainland China was more open to Taiwan than the other way around.

Lwin (2009) analysed the trade patterns and directions of the Cambodia, Laos, and Myanmar (CLM) economies due to their similar characteristics as members of ASEAN, following the standard gravity model in order to assess the effectiveness of the model in explaining trade flows of these economies, which seemed to grow faster in the region than other economies. The bilateral trade flows between each CLM country and their partners have been examined in order to investigate the determining factors of trade flows and identify trade policies. The OLS methodology with pooled cross-sectional data is used in the paper. Partner country's GDP was found to largely affect CLM's trade patterns. The free trade agreement helped in rising bilateral trade flows between them, while geographical distance being a factor of resistance for the flows of bilateral trade.

Thapa (2012) used the gravity model in order to appraise the determinants of trade flows between Nepal and its 19 major trading partners, and also evaluate and forecast trade potential for Nepal. The analysis was based on cross-section data of goods trade at an aggregate level with limited independent variables, such as GNI, per capita GNI, and distance. The result showed that the elasticity coefficients of income and distance were significant, while per capita income and distance variables were insignificant. It was suggested that trade promotional strategies should be adopted as the result of the increased trade.

Looking at trade flows within a country, Daumol and Özyurt (2011) investigated how Brazil's trade flows can influence the economic growth of Brazilian states based on the level of their income. They use the system GMM (Generalized Method of Moments) instead of the gravity model estimator to determine the impact of international trade flows on growth. However, the result indicates that wealthier Brazilian states gain from trade openness – which delivers more supplementary advantages – than that of poorer states, leading the poorer states to further traditional goods' specialization with no technological advancement or long-term growths. Brazil's international trade seems to exacerbate regional inequalities of the nation.

Studies on African countries put emphasis on the improvement of steady trade policies to enable these economies to exchange diversities of goods and benefit through trade, contributing to their sustained economic growth. Simwaka (2006), for example, examined bilateral trade between Malawi and its major trading partners with the use of an econometric gravity model. His analysis used the panel data estimation served to determine the main factors of Malawi's trade. The result revealed that the fixed effect model was more suitable compared to the random effects of the gravity model. Additionally, he found that one of the challenges faced by Africa when estimating bilateral trade flows is transport infrastructure network – which needs to be improved – and the exchange rate policy, which should be stable. The trade flow in regional blocks was found to have an insignificant impact on bilateral trade flows.

Zannou (2010) examined the key factors affecting the intra-Economic Community of West African States (ECOWAS) trade flows by means of the pooled form of the gravity model. The panel data econometric analysis has been used in this paper in order to eradicate the prejudice related to the heterogeneity of the trade flows by including fixed effects in the gravity model. This model was found to be important in explaining significantly intra-ECOWAS trade flows and ECOWAS' positive and considerable impact on trade flows among States of the economic and trading union. Exchange rates, population, and openness of these economies were the major factors determining the volume of the intra-community trade flows.

Adekunle and Wanjiru (2013) assessed the trade flow between China and Sub-Saharan Africa (SSA) countries by detecting the impact of the variables such as Gross Domestic Product (GDP), distance, foreign direct investment (FDI), inflation, exchange rate, and GDP per capita. In addition, the examination of trade flow between China and oil-rich SSA Countries was done, using the gravity model. The panel data (cross-sectional cum time series) methodology was applied – along with the use of the Hausman test – in order to identify which models of trade – fixed or random model – is the most suitable for required policies that will develop China-SSA trade, protecting the industries in SSA. The result indicated that SSA countries should improve GDP, be able to manage the exchange rates correctly, and, where there is a comparative advantage, local production of goods should increase so that they will gain from the trade relationship.

Mjema et al. (2012) analysed the trade flows between Tanzania and Kenya as members of the East African Cooperation (EAC), with a particular focus both economic and non-economic factors. The paper showed that the fact that the countries have power over the economy of EAC and share similar characteristics – such as border within EAC, large population, access to Indian Ocean, and same languages – necessitated trade facilitation. The modified version of the gravity model was used in the paper in order to question how trade flows are determined between these countries and if they have gained from the creation of the EAC. The fixed, random, pooled effects, and the Hausman test have been used in this paper in order to find out how stable trade policies and regional integration system can be implemented in East Africa.

Studies on South Africa and its major partners of trade have usually used the gravity model to consider the potential of exports. For example, Sichei et al. (2008) explored South African exports of motor vehicles, parts and accessories by applying the augmented gravity model. As the country ranked 19<sup>th</sup> in the global production of motor vehicles, South Africa benefited from vehicle production. This was the second fastest growing industry in the manufacturing sector of the country, owing to the establishment of the Motor Industry Development Programme. However, there was little contribution of the South African share to the world's motor vehicles output. This study was done by examining amount of bilateral trade between South Africa and its 71 partners from 1994 to 2004, following the panel data analysis method to specify the model, estimate the parameter coefficients, and control and avoid heterogeneity among the trading nations. They found that the significance of the importer GDP was positively related to South Africa's exports. In addition, how effective the importer government was, how quality was regulated, how corruption was controlled, and the whether or not the countries shared English as a common language played an important role in exports. These issues significantly affected the exports of automobile goods in the country. In addition, it was noted that the country's trade (exports and imports) of motor vehicles improved due to the fact that South Africa is a member of the EU, NAFTA, MERCOSUR, Middle East, and SADC, as well as that fact that it plays a key function in the African continent. However, distance and importer price index both had a negative impact on South Africa's exports and trade between the country and its partners.

In addition to their working paper (2007), Eita and Jordaan (2011) investigated South Africa's exports of woods and articles of woods with the use of the gravity model. The paper analysed the flows of trade between South Africa and its 68 major partners of trade for the period 1997 to 2004 within the industry of wood products. The paper also incorporated a dummy variable – the English Language – in order to encourage exports between countries that have this language in common, as well as regional trade agreement (NAFTA, EU and SADC) dummies. They adopted the methodology based upon the panel data econometric techniques in order to assess the gravity model. They found that the fixed effect model was more suitable than the random effect model when determining export flows between countries. The empirical results based on the fixed effect model revealed, on the one hand, the positive and statistical significance of importer GDP and South Africa's population on the exports of wood and wood products. On the other hand, the relationship between South Africa's GDP, importer population, distance and exports of woods was negative and statistically significant for all variables except for distance. Additionally, the negative outcome of South Africa's GDP was inconsistent with the expected theory of the gravity model. The country's status as a member of NAFTA and EU also adversely influenced exports, yet exports of woods were growing as a result of South Africa's membership with SADC. In looking at the potential of wood exports, it is clear that there was a requisite to promote growth in order to diminish unemployment and ease poverty.

Much work has been done on comparative study of the trade flows between the European Union and the BRICs, using the revealed comparative advantage method. Most of the literature usually examines the importance of BRIC in the world trade, in the developing world, and the growing trade among themselves (among others, O'Neil et al., 2005; Georgieva, 2006; Hongna and Zengfeng, 2011; Morazán et al., 2012; Oehler-Şincail, 2011; Baumann and Ceratti, 2012).

Moghadam (2011), for example, explored the role of BRIC countries in the development of Low-Income Countries (LIC), showing how the rapid growth of these economies' trade has a positive impact on LIC's trade flows based on the analysis of exports, trade complementarity index, and gravity model. He examined the recent progress of trade relations between LIC and BRIC economies, analysed the exports by destination between these countries, and showed how the pattern of LIC-BRIC

trade is usually explained by the revealed comparative advantage method. His paper indicated an intersection between the composition of LIC exports and those of the partner country using a trade complementarity index. The gravity model analysis appears to confirm that LIC-BRIC trade complementarity is very important for overall LIC exports. The outcome of the study revealed that LIC imports from China and India are greater than the impact of Russia and Brazil on LIC trade.

Groot et al. (2011) showed the importance of BRIC countries for Dutch trade by using the revealed comparative advantage method (the Balassa index) to describe the intensity and the development of trade of the Netherlands, as well as the competitive position's implications for their industries. In the last twenty years, there was the rising aggregate share in Dutch exports and imports to and from utmost BRIC countries. In addition, the portion of BRIC countries in Dutch imports has increased much faster than the BRIC's portion in Dutch exports, representing a current trade deficit with the BRIC countries. The significant growing import share is that of Chinese products, and the country is also presently the second largest importer of Dutch products.

Oehler-Şincail (2011) presented a comparative analysis of the trade and investment flows between the EU member states and the BRICs during 2004-2009, and the USA-Japan-BRICs relations. Factors that mainly contributed to the economic growth of these countries' trade and investment flows are also determined. The interrelations and trade exchange between the EU and the BRICs, based on trade in goods, services, exports, imports and FDI flows, are analysed and determined depending on the statistics published by Eurostat, the WTO, the UNCTAD, and the national authorities. Oehler-Şincail revealed a significant increase of the BRIC's shares in the EU exports and imports of goods greater than these countries' share in the EU trade in services during the previous decade except in 2009. In addition, the share held by the BRIC countries in the EU FDI flows is much lower, as compared to their respective share in trade. These investment flows are thus expected to increase over the next years resulting from the implementation of innovation strategies influenced by the EU, the USA and Japan.

De Castro (2012) assessed the evolution of the intensity of bilateral trade flows among BRIC countries, as well as with EU during the period 1995-2009, based on

the measures of trade indices such as trade intensity, trade complementarity, and revealed comparative advantage. The trade intensity index, which designated the quality of intra-trade with other partners, was examined in order to test if some changes have been made in trend patterns between the pre-BRIC period and the post-BRIC period. In terms of trade relations, De Castro found that the EU has been and continues to play a significant role for each of the BRICs. Since 2001, Russia's trade intensity with other BRIC countries indicates declining trends, while the country is the most important intensive partner for the EU. The findings also revealed that the EU intra-trade intensity with Brazil and India was decreasing owing to trade diversion to other BRIC partners, yet the intra-trade intensity with China was rising as a result of the significant role of the country in European trade and the other way around.

Baumann and Ceratti (2012) assessed the trade flows between Brazil and the other BRICS countries by identifying the relative importance of revealed comparative advantage and the tariffs applied by many countries faced with Brazilian products. They also recognised that the tariffs applied by each BRICS country to the products of each Brazilian competitor in the neighbour country, were then applied to Brazil's products in order to provide a general image of the trade relations among BRICS countries. The paper also analysed trade among these nations, based on the markets conditions of access to the economies, taking into account the economic influence of each BRICS country.

There have been a number of studies on the exploration and development of trade flows among the BRICS countries using trade indicators and indices such as trade intensity, trade complementarity, revealed comparative advantage, regional orientation, market share, export share, and competitiveness (Havlik, Pindyuk and Stöllinger, 2009; Singh et al., 2010; Hongna and Zengfeng, 2011). For instance, Havlik et al. (2009) examined the trade between the EU and the BRIC countries by analysing their revealed comparative advantages with their global economic site in world trade. They found the most important role of EU in the BRIC trade was that Russia was BRIC's main export partner, and China was its principal import partner. In addition, China is emerging as a factor in the EU's industrial competitiveness, because of the performance and the composition of Chinese exports, especially its manufacturing export, which is comparable to a developed country. However, there

was a trade deficit between the EU and all BRIC countries, except for India. The authors also considered the bilateral trade relations between Triad countries (Japan, Western Europe, and North America) and the BRIC countries, based on the analysis of the revealed comparative advantages. These results showed how BRIC contributes to the trade deficit of the EU and the U.S.A.

Singh et al. (2010) analysed the mutual flows of trade between Brazil, Russia, India, China, and South Africa by evaluating several trade flows indices collected from the World Integrated Trade Solution database and UNESCAP during 2001-2010. They found an overall increase in the values of almost all the indices for the majority of the BRICS countries. However, Russia's trade with South Africa was negligible.

Hongna and Zengfeng (2011) made use of comparative, statistical, and historical analyses to evaluate the BRICS' foreign trade, the competitiveness of trade, and the composition of exports and imports. Their analysis indicated an increased trend of the overall imports and exports from 2004 to 2010. However, in 2009, the rate of growth decreased as a result of the global economic crisis. In terms of the characteristics and levels of national trade, they found that BRICS countries may complement each other.

Only few studies have been done on the inclusion of South Africa into the BRICs, including BRIC's economic perspective that South Africa must acknowledge, the expected contribution of South Africa, and the examination of BRICS trading relationships (Sandrey and Jensen, 2007; Sidiropoulos, 2011). In addition, these mentioned authors assessed the trading relationship between BRIC and South Africa from a South African perspective. For example, Sandrey and Jensen (2007) explored the major factors of the bilateral trade and the flows of trade from respective partners by providing figures, which also indicated the performance of these trading relationships between Brazil, India, and South Africa. By analysing the data of exports and imports, they found that South Africa could be viewed as a way of connecting the developed world and developing countries in the African continent. South African imports are stronger than Indian imports, with gold being the main import into India. Brazil seemed to be more important than South Africa in terms of any country's source of imports, with oil being the leading import. To some extent, equivalent trading relationships are shared by all three partners in the world

economy. South Africa is a major global exporter of minerals and associated products India of precious metals and stones, mineral fuels, clothing, and organic chemicals; and Brazil of vehicles, machinery, iron, steel, and ores, as well as being a main agricultural exporter.

Sidiropoulos (2011) acknowledged the fact that South Africa's joining with the BRIC economies implied economic opportunities for the country to play a significant role in both the African continent and at the global level. Being a member of IBSA (India, Brazil and South Africa) and BRICS, South Africa should make use of the given opportunities. This necessitates a close relationship between the national government and the private sector and an open market. In addition, SA should also lead foreign investment in developing countries in Africa by reducing barriers of trade with the purpose of intensifying bilateral trade and investment with the other BRICS economies.

Other studies have been done on the trade linkages between BRIC and South Africa, showing how South Africa – and the growing trend of investment and trade in the African continent – does serve the BRIC economies (Laverty, 2011; Çakir and Kabundi, 2011). Laverty (2011) indicated that, even though the South African economy is small compared to the other BRICS members in terms of GDP or the rates of growth, the country's magnitude of trade with Africa, particularly Southern Africa, is valuable in light of the current trend of trade and investment in the continent. He examined the extent of South Africa's participation and relationship with the continent in order to investigate the motives of BRICS in South Africa. He found that South Africa would certainly benefit from the growth of the African market, so the BRIC countries would grow as well, becoming competitors in the continent. Çakir and Kabundi (2011) investigated the trade linkages and shock transmission between South Africa and the BRIC economies by applying a global autoregressive model and examining the response of trade and output in South Africa when shocks are created by the BRIC countries as a bloc, or individual countries. 32 countries were included in the model for the period 1995 to 2009. They found that the BRIC-SA trade flows are dominated by China, and South Africa's most important exports to the BRICs are usually basic commodities. Based on the empirical results, real exports and imports shocks from the BRIC economies positively and significantly

affected the imports and exports of South Africa. However, output remained unchanged.

Despite the fact that the theory of the gravity model has been relevant for trade flows and performs successfully empirically, there are not many detailed studies dealing with BRICS' international trade flows using the gravity model in order to explain the trade patterns between South Africa and other BRICS countries. In addition, there is still a gap in the literature on estimating trade flows of BRICS economies using panel data techniques. This paper thus intends to conduct the analysis of trade flows between South Africa and the BRIC economies, using a gravity model framework with a panel data econometric technique (instead of trade indicators or indices) to investigate how South Africa is integrated into the BRICs. This study will serve as an incentive for future studies and will provide information that can be used by the BRICS government executives to generate practical trade policies for further economic growth, investment prospects, and development.

### **3.4 Conclusion**

It has been evident that openness to international trade – where there is exchange of goods and services between nations – is a fundamental element in achieving economic growth. In response to the view that countries benefit from trade, theories of international trade (such as the absolute advantage theory, the comparative advantage theory, the Heckscher-Ohlin model, the new trade theory and the gravity model) have been assessed to understand the pattern of trade flows between and among countries, which is necessary for trade performance and trade policy reforms. Among them, the gravity model has shown the weaknesses of the classical and modern theories; indeed, it has been criticized for its poor economic theoretical foundations. However, the gravity model has been adjusted and improved in terms of a better specified econometric model to appropriately explain bilateral trade flows, trade patterns, and trade relationships among countries in the global economy.

Some dated and recent studies on developed, developing, or African countries in the literature discuss the significant and positive impact of economic integration on trade flows and economic performance among trading countries. They examined trade flows between countries or trading blocs with the use of gravity model, and provided an econometric assessment by means of cross-sectional or panel data estimation

techniques. Most of the findings indicated that the gravity model has been empirically successful in determining factors of trade flows, potential for trade expansion, and identifying suitable trade policies, especially for developing and African economies.

Studies on BRICS have generally highlighted their importance in the global trade, in the developing world, and the rising trade among themselves. These studies have analysed trade flows with the use of the revealed comparative advantage method and trade indicators or indices. In addition, a small number of studies have explored the patterns and magnitude of trade flows between South Africa and the BRIC economies as a result of South African economic integration into the BRICs. However, an empirical analysis of trade flows using the gravity model among the BRICS economies is still required.

## **CHAPTER FOUR**

### **THEORETICAL FRAMEWORK, METHODOLOGY AND DATA**

#### **4.1 Introduction**

The purpose of this chapter is to examine the preferred theoretical framework and the methodology in view of the different frameworks that have been adopted in the literature, as well as the data used in this study. Section 4.2 first explains the assumptions and principles behind the absolute and comparative advantage theories. It also describes the basics of the new trade theory, and finally discusses theories relating to the gravity model. Section 4.3 provides the empirical framework in which the gravity equations used in analyzing trade flows between South Africa and the BRIC countries are specified. Section 4.4 discusses the methodology

adopted in the study, which includes the use of panel data estimation technique as well as the processes of panel data tests to evaluate the extent of trade among BRICS economies. Data used in this study and variables included in the estimation models are covered by section 4.5, while section 4.6 concludes the chapter.

The gravity model, established in the literature by Tinbergen (1962) and Pöyhönen (1963), is commonly utilized in analyzing international trade flows among countries, it has also been used more intensively in literature to explain and investigate bilateral trade flows than any other international trade theory. The gravity model of trade is better estimated using a panel data framework. The use of panel data methodology in estimating trade flows across countries is suitable due to the fact that it allows the recognition of country-specific effects, which control for unobserved important variables (Judson and Owen, 1999).

## **4.2 Theoretical Underpinnings of the Various Trade Theory Applications**

This section provides brief theoretical underpinnings of trade theories and their application. A summary of the classical and new trade theory will highlight reasons for trading internationally, while the assessment of the gravity model will explore the magnitude of trade flows between countries, which cannot be described by other theories of international trade.

### **4.2.1 Absolute and comparative advantage theory**

The first trade theory, which is credited to Adam Smith (1776), was one that signified that all nations could equally gain from international trade if free trade is practiced. Specialization in production of goods or services and division of labor were key facets in this theory – the absolute advantage theory. Moreover, it is important to note that Smith built his theory of international trade based on the concepts of division of labor and specialization (1776). This showed that countries specializing in the production of goods or services in accordance with their absolute advantage, and then trading with other countries, could lead to mutually beneficial international trade, allowing all countries to gain in international trade. However, Smith's argument could not clarify the reason why other countries, which do not have absolute advantage, appear to perform in international trade.

With regards to the division of labor, Smith (1776) demonstrated that the more advanced the division of labor was, the more exceptional the production, which, in turn, led to the expansion of the economy in general and improvement in the wealth of a nation. As a result of the division of labor, it seems that the theory of trade and the theory of economic development were closely related (Myint, 1977). Nevertheless, Smith's argument failed because he neglected to address comparative costs, the efficiency of the resources' distribution and modern econometric approaches (Myint, 1977; West, 1990).

Criticisms and questions about Smith's ideas were addressed by David Ricardo, who established the principle of comparative advantage as a vital theory of international trade in his book *The principles of Political Economy* (1817). He revealed that countries specialising in goods or services with the highest comparative advantage in efficient productivity gain from international trade by exporting those goods or services. Countries will also import goods or services with the smallest comparative advantage.

It seems that both comparative advantage and disadvantage were described by the Ricardian model, indicating that the opportunity cost in the production of goods or services is lower or greater in one country than another. In addition, tariffs and other barriers to trade are not assumed of the theory of comparative advantage, and opposed by Ricardo, since the only way for countries to specialise in goods and attain a more efficient production is by the use of the comparative advantage principle (Henderson, 1993).

However, the Ricardian model is still limited and fails to elucidate the motives for a country's comparative advantage related to the magnitude of different productivity. In addition, the highest degree of specialisation that is presumed in this model is unrealistic for countries in the world that produce and import particular goods at the same time (Davis, 1995). It is also important to mention that different resources among nations, intra-industry trade, and the significance of economies of scales, amongst other factors, are not taken into consideration in the Ricardian model.

In the twentieth century, two Swedish economists, Eli Heckscher (1919) and Bertil Ohlin (1933), proposed a persuasive theory of trade known as the Heckscher-Ohlin (H-O) model, or the factor endowment theory. They modified and extended the

Ricardian model after discovering a defect in the classical theory (Todaro, 2000). The Heckscher-Ohlin model added a new factor of production – capital – alongside labour, the old factor in the classical methodology.

Based on the H-O model's assumptions, differences in relative factor endowments of production seem to be the only difference among countries, while technological productions are the same among nations, which contrasts with the assumption of technological production in the Ricardian model (Leamer, 1995). The H-O model pointed out that countries specialising in the production of goods, using their abundant factors effectively, would have their goods exported, while the goods imported would be the ones using scarce factors efficiently. In general, with this model, international trade does not seem to lead to thorough specialisation between countries, but could lead to a partial bargain of pre-differences in the factor prices because of their immobility. This differentiates the Heckscher-Ohlin model from the Ricardian model, which suggests complete specialisation. The H-O model excluded this deficiency in Ricardian model, with its proponents arguing that international trade is not beneficial to every country. Profits from trade depend on the country's abundant factors of production. This implies that a country with scarce factors of production is unable to gain from trade due to the fact that goods which are being imported turn to be quite expensive to produce as opposed to the exported goods which are relatively cheap in production for a country using much of the abundant factor. In addition, the distribution of income is intensely affected by international trade. Inter-industry trade is thus often elucidated by the use of the Heckscher-Ohlin model.

Despite the fact that the classical trade theory (based on four theorems, which are the Heckscher-Ohlin theorem of trade, the Factor-Price Equalization Theorem, the Stolper-Samuelson Theorem and the Rybczynski Theorem), has assisted economists and policy makers to understand some important aspects of international trade patterns of goods related to the factor endowment, the model still fails to describe all features of trade. For instance, neither the proportion of trade between countries with the same factor endowments is clarified, nor intra-industry trade between developed economies. This was the motive for new trade theory to be acknowledged in the 1980's.

### **4.2.2 New trade theory**

The establishment of the new trade theory by Krugman (1979), Helpman (1981), Lancaster (1980), Greytak and McHugh (1977), and Markusen et al. (1995), amongst others, took place in the twentieth century because of the failures of traditional theories of trade. This theory is based on constant returns to scale, perfect competition, and homogeneous goods in order to explain intra-industry trade. It provides important facts about the trade data for the period of post-World War II and describes patterns of trade in manufactured goods in accordance with the Linder theory of trade.

The new trade theory was developed to extend classical trade theory by incorporating the roles of economies of scale, imperfect competition, product differentiation, and manufacturing trade in the world economy. For instance, the presence of economies of scale in production displays that more varieties of goods are produced by firms and costs of production are decreased in a particular country, making foreign varieties available as well (Krugman, 1979). This suggests increasing returns to scale by means of diminished costs of production, creating intra-industry trade in a diversity of products.

Helpman (1981) also showed that, with the existence of product differentiation, economies of scale, and monopolistic competition, patterns of trade between sectors could be assessed and intra-industry trade in sectors could be generated from factor endowments according to the factor price equalisation theorem.

It was also noted that, according to Linder preference similarity of trade hypothesis, trade in manufactures and structures of internal demand were positively associated (Greytak and McHugh, 1977). From the Linder theory (1961), the similarity of trade among countries and within countries is emphasised, with the distant factor observed as costs of transport. Market prospects were substantial component when determining patterns of trade in manufactured goods and their income, which serve as the source of trade. In addition, it is important to note that trade intensities and per capita income seem to be absolutely related.

### **4.2.3 The gravity model**

The classical and new trade theories have indicated the reasons that countries trade in the global economy, as well as a framework for analysing trade between nations.

However, when it comes to the magnitude of trade flows, these theories cannot explain, successfully examine patterns and performances of international trade in current years. In order to address this lacuna, another theory of trade was introduced in the literature by Tinbergen (1962) and Pöyhönen (1963) – the gravity model. This trade theory is able to model and empirically analyse international trade flows between countries. The fundamentals of the gravity model in international trade were implemented in conformity with the Newtonian gravitational model in physics designed by Isaac Newton in 1687 (Head, 2003). Generally, in Newtonian physics, a flow is observed when two objects are attracted to one another, resulting in a positive relationship between the masses of these objects. The attraction is higher between two bodies with greater masses than two bodies with lesser masses. Also, the greater the distance between the two objects, the smaller the attraction. This means that the gravitational attraction between two bodies is proportionate to their masses and inversely proportionate to their distance.

According to Head (2003) and Baldwin and Taglioni (2006), the expression of the gravity model is given as follows:

$$F_{ij} = G \frac{M_i M_j}{D_{ij}^2} \quad (1)$$

$F_{ij}$  (in Newton's model) stands for the gravitational attraction or force, which corresponds directly to the product of the two masses  $M_i$  and  $M_j$ , and inversely proportionate to the square of the distance  $D_{ij}$ .  $G$  is the gravitational constant, which is contingent on the units of measurement for mass and force, with a value resolved empirically.  $M_i M_j$  represent the masses of two bodies (in kilograms).  $D_{ij}$  is the distance between two bodies ( $D^2$  in meters).

The application of the relationship between the elements shown above is suitable to any flows or movements.

From its role in Newton's law of gravitation, this rule was inserted into an international economics context in order to generate the gravity model. When the patterns of international trade flows between two countries are described, the two bodies refer respectively to the exporting and importing countries and their mass variables usually represent their GDP and population. This suggests that the bigger the economy of certain countries, the more trading that will take place among these

countries. In this case, the simplified version of the gravity model – generally adopted in bilateral or international trade – appears in the following form (Krugman and Obstfeld, 2005):

$$T_{ij} = A \frac{Y_i Y_j}{D_{ij}} \quad (2)$$

The trade volume between country  $i$  and  $j$  is deemed to be  $T_{ij}$ , and their economic masses are assigned as  $Y_i$  and  $Y_j$ , embodying each country's GDP.  $T_{ij}$  is often replaced by  $X_{ij}$  – the volume of exports from country  $i$  to  $j$ . Distance ( $D_{ij}$ ) refers to the geographical distance between two countries or capital cities evaluated, represented in sailing or land miles (Head, 2003).

With the innovative work of Tinbergen (1962) and Pöyhönen (1963), first specifications and assessments on the determination of trade flows were constructed and the standard gravity model was applied to international trade. Here, bilateral trade volume between two countries is directly proportional to the product of their masses measured by their economic sizes, and inversely proportional to the distance between them (as proxy of bilateral trade costs/resistance). The relation is depicted as follows:

$$X_{ij} = A \frac{Y_i^\alpha Y_j^\beta}{D_{ij}^\gamma} \quad (3)$$

In this case, values other than 1 are only expected for the exponents  $\alpha$ ,  $\beta$ , and  $\gamma$ , as they serve to measure the elasticity of the exporting country, the importing country, and distance respectively. In the context of Newtonian gravitation equation, this will implicate that  $\alpha = \beta = 1$  and  $\gamma = 2$ .

Furthermore, the linear form of the equation above is found by computing the natural logarithm. Hence, the formulation can be obtained as follows:

$$\ln(X_{ij}) = \ln A + \alpha \ln(Y_i) + \beta \ln(Y_j) + \gamma \ln(D_{ij}) + \varepsilon_{ij} \quad (4)$$

$\varepsilon_{ij}$  refers to an arbitrarily distributed log normal error term, apprehending any surrendered effects in the explanatory variables of the model.

The study was empirically successful in the 1960's, as Tinbergen supported the fact that both countries masses were incorporated in order to show the dependence of

aggregate exports dispensed by country  $i$  on its economic size  $Y_i$ , and the reliance of the importing country  $j$  on its purchasing power or revenue  $Y_j$  when goods are sold. Distance not only represented the geographical distance between countries but also acted as an important factor or index that helped to inform about export markets (Tinbergen, 1962). This is the reason why distance can be seen as a proxy of numerous factors, for instance, transportation costs, synchronization costs, communication costs, and transaction costs, among others – which may possibly influence flows of trade (Head, 2003). Nevertheless, it is worth mentioning that impoverished and irrelevant theoretical foundations and assertions were initially established to support the gravity model, their contribution was just intuitive. In addition, another addition to gravity equation used by Tinbergen (1962) and Pöyhönen (1963), as well as other authors such as Pulliainen (1963) and Geraci and Prewo (1977), amongst others, to demonstrate bilateral gross aggregate in international trade flows:

$$PX_{ij} = \beta_0 (Y_i)^{\beta_1} (Y_j)^{\beta_2} (D_{ij})^{\beta_3} (A_{ij})^{\beta_4} \mu_{ij} \quad (5)$$

$PX_{ij}$  symbolizes the flow of trade or exports from country  $i$  to country  $j$  measured in the U.S. dollar value, then  $Y_i(Y_j)$  stands for the U.S. dollar value of nominal GDP (domestic expenditures) in  $i$ , and ( $j$ ),  $D_{ij}$  represents the geographical distance from the economic middle of  $i$  to that of  $j$ , a constant characterized by  $\beta_0$ , the coefficients of the model described by  $\beta_1, \beta_2, \beta_3$  and  $\beta_4$ . There can be further factor(s) either supporting or resisting international trade between  $i$  and  $j$  denoted by  $A_{ij}$  and, finally,  $\mu_{ij}$  is a log-normally distributed error term subject to the condition  $E(\ln \mu_{ij}) = 0$  (Bergstrand, 1985).

However, the mathematical formula described above did not include exporter and importer populations. The similar description of the gravity equation (5) was thus used by Linnemann (1966), but with the inclusion of both exporter and importer populations, due to their excellent explanatory power in delineating some fluctuations in volumes of trade between nations. As a consequence, a partial equilibrium model of export supply and import demand gave rise to Linnemann's gravity equation.

For the perusal of international trade flows, the gravity equation was specified with the following form:

$$PX_{ij} = \beta_0 (Y_i)^{\beta_1} (Y_j)^{\beta_2} N_i^{\beta_3} (N_j)^{\beta_4} (D_{ij})^{\beta_5} (A_{ij})^{\beta_6} \mu_{ij} \quad (6)$$

$N_i$  and  $N_j$  designate the populations of the exporter country and the importer country, which have been included in equation (5).

Moreover, the GNP (incomes) of the two countries  $i$  and  $j$ , distance (transport costs or transaction costs), and regional agreements seem to be the fundamentals of the model in investigating bilateral flows of trade between the exporter country  $i$  and the importer country  $j$ . Derived from a Walsarian general equilibrium model, the gravity model portrays that both the offer of the exporter country and the demand for the imports of another country will directly depend on the level of income (Linnemann, 1966).

However, despite the works of Linnemann toward a theoretical justification and use of aspects of the gravity model in terms of a Walsarian general equilibrium model to examine the patterns in international trade, the weaknesses inherent in the theoretical foundation of the gravity model persisted. After many debates and reproaches about the lack of robust theoretical foundations for the gravity model, there has been increasing interest by researchers such as Anderson (1979), Bergstrand (1985 and 1989), Helpman and Krugman (1985), and Deardorff (1995 and 1998), amongst others, in offering a number of theoretical improvements to support the gravity model during the second half of the 1970's.

The first economist to discuss the inadequacy of a sturdy theoretical foundation of the gravity model was Anderson (1979). A theoretical explanation and economic justification for the gravity equation was proffered by Anderson in considering commodities under the assumption of Cobb-Douglas preferences (constant elasticity of substitution (CES)) in light of international trade, suggesting that homothetic preferences are identical across some regions in the world. Anderson intended to demonstrate that the expenditure system was bound by the gravity model, stipulating that expenditure by nations constantly depends on income and population. Due to the difficulty in modelling the flows of trade, Anderson constructed a model where goods are differentiated by the home country, following the assumption of

Armington<sup>3</sup>, so that all products are marketable and traded by all countries. In addition, tradable goods were distinguished from the non-tradable ones.

Based on two countries  $i$  and  $j$  and the production of one differentiated good by each country, Anderson's gravity model exhibits that Cobb-Douglas preferences are identical in all countries, with the assumptions of no tariffs or transport costs. Also, the same portion of income is spent on tradable goods of country  $i$  designated by  $b_i$  for both countries. Besides, constant prices are observed at equilibrium value (Anderson, 1979).

Notice that in a frictionless world, imports of product  $i$  by country  $j$  are given by the following formulation:

$$M_{ij} = b_i Y_j \quad (7)$$

In the same way, exports of goods from country  $i$  to country  $j$  are assumed to be as follows:

$$X_{ij} = b_i Y_j \quad (8)$$

$Y_j$  refers to the income in country  $j$ .

It should be noted that expressions (7) and (8) are subject to budget constraints, specified as

$$Y_j = b_i (\sum_j Y_j) \quad (9)$$

This signifies that income and sales will be equal. From the equation (9), the resolution of  $b_i$  will be substituted into the equation (7) or (8). From this illustration, the gravity model is represented in its simplest form, also known as the traditional gravity equation, which appears as follows:

$$M_{ij} = \frac{Y_i Y_j}{\sum_j Y_j} \quad (\text{For imports}) \quad (10)$$

Or

$$X_{ij} = \frac{Y_i Y_j}{\sum_j Y_j} \quad (\text{For exports}) \quad (11)$$

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<sup>3</sup> According to Armington (1969), products are discerned by their categories and their places of production. In addition, there is an imperfect substitution of products in demand when similar sorts of products are originated from different countries.

After finding the gravity equation based on the Cobb-Douglas preferences under restrictive assumptions, Anderson creates an unrestricted gravity equation by assuming that a tradable and a non-tradeable good are produced by each country, so that their utility function from the traded and non-traded products is maximised. When preferences are considered to be homothetic, this maximisation is only subject to traded goods' budget constraint. Thus, country  $j$ 's imports of tradable goods by country  $i$  is denoted by:

$$M_{ij} = \theta_i \phi_j Y_j \quad (12)$$

$\theta_i$  stands for the expenditure of traded goods by country  $i$  divided by country  $j$ 's tradable goods, and the expenditure share on tradable products of the total expenditure by country  $j$  is regarded as  $\phi_j$ . This implies that the new budget constraint generated indicates the importer country's balance of trade relation so that the expenditure spent on tradable goods and income of country  $i$  are identical:

$$Y_i \phi_i = (\sum_j Y_j \phi_j) \theta_i \quad (13)$$

The resolution of  $\theta_i$  from equation (13), is substituted into equation (2), yielding

$$M_{ij} = \frac{\phi_i Y_i \phi_j Y_j}{\sum_j \phi_j Y_j} = \frac{\phi_i Y_i \phi_j Y_j}{\sum_i \sum_j M_{ij}} \quad (14)$$

Following this illustration, Anderson established that  $\phi_i = F(Y_i N_i)$ , mentioning that  $\phi_i$  may possibly be a function of income  $Y_i$  and population  $N_i$  amongst other factors.

When the equation (14) is revised with the addition of a constant  $m$  and a log-normal error term  $U_{ij}$ , subject to the condition that  $E(\ln U_{ij}) = 0$ , this results in

$$M_{ij} = \frac{m(Y_i N_i) F(Y_i N_i) Y_i F(Y_j N_j) Y_j}{\sum_j F(Y_j N_j) Y_j} U_{ij} \quad (15)$$

When the log-linear form for  $m$  ( ) and  $F$  ( ) is assumed and the denominator is replaced by a constant term  $k'$ , which can be viewed as the global trade expenditure or income, the gravity equation can be obtained as follows:

$$M_{ij} = \left(\frac{m}{k'}\right) Y_i^{\alpha_1} N_i^{\alpha_2} Y_j^{\beta_1} N_j^{\beta_2} U_{ij} \quad (16)$$

By taking the natural logarithm of equation (16), this yields

$$\ln M_{ij} = \ln \left(\frac{m}{k'}\right) + \alpha_1 \ln Y_i + \alpha_2 \ln N_i + \beta_1 \ln Y_j + \beta_2 \ln N_j + \ln U_{ij} \quad (17)$$

After examining patterns of international trade where there are no trade barriers and distance is not present, Anderson (1979) expands his gravity model by adding tariffs and transports costs in each country. Under the assumption of transportation costs, he pointed out that numerous differentiated tradable goods are produced by each country instead of only two kinds of goods: traded and non-traded goods. In doing so, the aggregate version of the gravity model was found by assessing bilateral flows of trade in a multitude of potential trade flows, based on the attributes of countries 'expenditure techniques.

Nevertheless, it seems that there are several other variables of interest, such as prices variables, which are incorporated by Bergstrand (1985), which may be consequential in explaining international trade flows by the use of the gravity model. This motivated Bergstrand in 1985 to propose subsequent reforms of theoretical foundations concerning the gravity model. Based on the new trade theory of Krugman (1979) and Helpman (1981), Bergstrand (1985) further explored microeconomic foundations related to the gravity model by investigating bilateral trade flows within monopolistic competition models, as well as the traded differentiated products' concept. Moreover, Helpman and Krugman (1985) established a theoretical justification for the gravity model of bilateral trade flows in a monopolistic competition framework, with the roles of increasing returns and transportation costs.

From the perspective of utility and profit maximisation, a general equilibrium model of global trade – where a single commodity was produced in each country – was developed by Bergstrand (1985). This implies that the flows of trade from country  $i$  to country  $j$  do not only rely on all available resources, but also on trade barriers and transportation costs among all countries. Unfortunately, the general equilibrium model was not considered as a gravity equation.

In addition, Bergstrand (1985) demonstrated that the gravity model, analogous to the first description used by Tinbergen (1962) and Pöyhönen (1963), among others (see equation 5), could also be a result of a system that deduces that goods across countries are perfectly interchangeable. Due to the omission of particular price variables, Bergstrand (1985) asserted that the gravity equation (5) might be

misspecified when the differentiation of aggregate flows of trade is done by national origin.

Given that some assumptions were restrictive when solving for the gravity equation from a partial equilibrium tactic of the general equilibrium model of trade, income and prices variables for both countries (importer and exporter) were treated as exogenous variables in explaining bilateral flows of trade. Some examples of such assumptions are the perfect commutability of goods in consumption and production across many countries as well as complete commodity arbitrage transaction. The subsequent model of trade known as the generalized gravity equation was therefore found by means of a market equilibrium clearance (Bergstrand, 1985).

In 1989, the microeconomic foundations for the gravity equation were identified by Bergstrand in order to encompass factor endowments and taste variables (CES preferences) within both the Heckscher-Ohlin (H-O) model and the Linder framework. Bergstrand (1989) further presumed the Dixit-Stiglitz monopolistic competition in the economy and good differentiation among firms instead of countries. The generalized gravity model based on monopolistic competition with differentiated goods as well as economies of scale was given, following this form:

$$PX_{ij} = \Psi_0 Y_i^{\Psi_1} \left(\frac{Y_i}{L_i}\right)^{\Psi_2} Y_j^{\Psi_3} \left(\frac{Y_j}{L_j}\right)^{\Psi_4} D_{ij}^{\Psi_5} A_{ij}^{\Psi_6} e_{ij} \quad (18)$$

The value of exports from country  $i$  to country  $j$  in terms of U.S. dollars is denoted by  $PX_{ij}$ , the nominal GDP's value (U.S. dollars) of country  $i$  and country  $j$  is represented by  $Y_i$  and  $Y_j$ .  $L_i$  and  $L_j$  symbolize the population size for both countries.  $D_{ij}$  indicates the distance between the two centers of economy or countries.  $A_{ij}$  refers to any factors influencing the bilateral flows of exports, positively or negatively.  $e_{ij}$  stands for a log-normally distributed error term. A constant term is signified by  $\Psi_0$ . The exponents  $\Psi_1$  to  $\Psi_4$  are positively estimated, while the exponent of distance  $\Psi_5$  is assumed to be negative.

Based on theories of inter-industry and intra-industry trade and the use of two-factor, two or multi-industry, and multi-country Heckscher-Ohlin-Linder model, the exporter's income seems to be commensurate with the national output in capital unit terms. In the same way, the exporter's income per capita corresponds to the ratio of the

capital-labour endowment of the country. However, the importer's income or income per capita's changes may possibly be reflected in expenditure capabilities' modifications being amenable for adjustments according to taste preferences.

From the utility maximisation perspective, consumption of manufactured and non-manufactured commodities produced is subject to a nominal income constraint so that equivalent incomes per capita shared by countries will lead to identical demands (Linder, 1961).

From the profits maximisation perspective, a differentiated manufactured good is produced by each firm with the use of two output factors (labour and capital) under a Chamberlinian monopolistic competition context. Technology is expected to be identical among all firms and countries. In addition, similar market prices are set by firms within the same industry in each country. Following Bergstrand's (1985) assumptions, substitutions of exports supply by the profit maximising firm into the market demand, resolution for reduced forms, and some mathematical operations gives rise to the generalised gravity equation, represented as follows:

$$PX_{ij} = \Psi_0 Y_i^{\Psi_1} \left(\frac{K_i}{L_i}\right)^{\Psi_2} Y_j^{\Psi_3} \left(\frac{Y_j}{L_j}\right)^{\Psi_4} C_{ij}^{\Psi_5} A_{ij}^{\Psi_6} E_{ij}^{\Psi_7} P_i^{\Psi_8} P_j^{\Psi_9} e_{ij} \quad (19)$$

$PX_{ij}$  stands for the value of exports, depending on the exporter national output in capital units (country  $i$ 's GDP) and the importer national income (country  $j$ 's GDP).  $\left(\frac{K_i}{L_i}\right)$  represents the capital-labour endowment ratio of country  $i$  corresponding to the exporter GDP per capita. The importing country's ( $j$ 's) income per capita refers to the income-labor ratio  $\left(\frac{Y_j}{L_j}\right)$ .  $C_{ij}$  corresponds with the geographical distance, which is seen in this equation as the c.i.f./f.o.b.<sup>4</sup> transportation factor.  $A_{ij}$  refers to country  $j$ 's tariff rate measures on the exports of country  $i$ . The bilateral exchange rate represented by  $E_{ij}$  and the two price terms for both countries (exporter and importer) are expressed by  $P_i$  and  $P_j$ .

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<sup>4</sup> F.o.b. and c.i.f. refer to the two different ways of paying transportation costs. Free on-board is symbolised by the f.o.b., designating the indemnification of transportation costs by the buyer additional to the price of goods. Cost, insurance, and freight are denoted by the c.i.f., indicating the inclusive (widespread) price of transportation and insurance and their costs being paid by the seller.

According to Bergstrand's (1989) empirical analysis, incomes and incomes per capita coefficient estimates have revealed positive signs in reference to equation (18) for the exporting and importing countries when aggregate flows of trade are investigated.

Moreover, in attempt to obtain the gravity model from theories of international trade, Deardorff (1995, 1998) also departed from the Heckscher-Ohlin model to address the questions and criticisms of Krugman (1979), Helpman (1981), Helpman and Krugman (1985), and Bergstrand (1985, 1989), since there have been many debates arguing the basis and consistency of theories of the Heckscher-Ohlin model for the gravity model. Deardorff revealed that the gravity equation could arise from an altered version of the Heckscher-Ohlin approach by presuming frictionless trade and trade with impediments.

In the case of frictionless trade, it should be emphasised that transport costs or other barriers to trade are absent, making not only trade cheaper than national transactions, but also consumers and suppliers indifferent to the location where goods are bought or sold. Furthermore, products are homogeneous. The indifference of producers and consumers among markets would also make trade flows bigger. Since no transport costs exist then there is no role played by distance in the gravity model. Furthermore, when homothetic and identical preferences are suggested as well as balanced trade, the implications are that income and expenditure must be equal. Each transaction of trade is selected arbitrarily from a pool of goods in the world, where importers choose and purchase their goods from exporters. Due to perfect competition, market prices are cleared for each good in the world. Then, the value of exports from country  $i$  to country  $j$  would be represented by:

$$\begin{aligned}
 PX_{ij} &= \sum_k P_k C_{ijk} = \sum_k \gamma_{ik} \beta_k Y_j \\
 &= \sum_k \frac{X_{ik}}{X_k^w} \frac{P_k X_k^w}{Y^w} Y_j = \sum_k P_k X_{ik} \frac{Y_j}{Y^w} \\
 &= \frac{Y_i Y_j}{Y^w} \tag{20}
 \end{aligned}$$

$T_{ij}$  stands for the value of export flows between the two countries.  $C_{ijk}$  represents the consumption of good  $k$  by country  $j$ . The share contribution of country  $i$ 's products  $k$

to the world refers to  $\gamma_{ik} \cdot \beta_k$  and  $X_k^w$  characterises the proportion of income on good  $k$  and world output of good  $k$  respectively. The exporting, importing, and world incomes (GDP) are denoted by  $Y_i$ ,  $Y_j$ , and  $Y^w$ . The equation above is also known as the frictionless gravity model, according to Deardorff (1998). However, if preferences are not the same and not homothetic across some nations then the proportion of expenditure will also differ. Therefore, fluctuations of specific bilateral flows of trade will be similar to the frictionless gravity equation (expressed in equation 20). With arbitrary preferences, it seems that different shares of income on each good  $k$  are expended by each country, then the value of trade from country  $i$  to country  $j$  is given by:

$$T_{ij} = \frac{Y_i Y_j}{Y^w} (1 + \sum_k \lambda_k \alpha_{ik} \beta_{jk}) \quad (21)$$

$\lambda_k$  stands for the portion of world income in good  $k$ , and  $\alpha_{ik}$  and  $\beta_{jk}$  represent the share of production and consumption in good  $k$  by both countries  $i$  and  $j$  respectively. In addition,  $\alpha_{ik}$  and  $\beta_{jk}$  are reflected in proportionate deviations from world averages. Equation (21) also suggests that trade between two countries will be either more or less than the amounts or values specified by the frictionless gravity model, depending on the exporter production and the importer consumption.

The existence of even negligible trade impediments is important to all flows of trade because factor price equalization is not exhibited between two countries avoiding identical prices of all products. With obstructed bilateral trade, the production of each good is only done in a single country so that differentiated products are also produced by each country. Extreme specialisation in accordance with Armington (1969) preferences is assumed in this case. International trade may be valued separately from transport costs and their patterns, relying on identical and Cobb-Douglas preferences. This means that if a fixed share of each country's incomes  $\beta_i$  is spent by consumers on the acquisition of products from country  $i$ , then the income of this country is indicated as follows:

$$Y_i = p_i x_i = \sum_j \beta_j Y_j = \beta_i Y^w \quad (22)$$

The output and income of country  $i$  are denoted respectively by  $x_i$  and  $Y_i$ . From equation (22), the value of  $\beta_i$  refers to  $\beta_i = Y_i / Y^w$ . According to Deardorff (1998), it

appears that the assessment of trade can be done by using either exclusive (f.o.b.) or inclusive (c.i.f.) transportation costs.

Based on c.i.f. trade, the gravity equation seems to be frictionless with no impediments to trade and homogeneous preferences. In this case, the flows of trade do not depend upon distance or transport costs:

$$T_{ij}^{cif} = \beta_i Y_j = \frac{Y_i Y_j}{Y^w} \quad (23)$$

Based on f.o.b. trade, this yields

$$T_{ij}^{fob} = \frac{Y_i Y_j}{t_{ij} Y^w} \quad (24)$$

$t_{ij}$  refers to the transport cost factor as an alternative to distance. Owing to the incorporation of distance, this equation is comparable with the standard version of the gravity model usually implemented in bilateral or international trade analysis (see equation 2). This is consistent when trade is diminished by the presence of transport costs. Since trade costs do not seem to lower trade between two nations with Cobb-Douglas formulation, CES preferences are taken into consideration within the Deardorff-Heckscher-Ohlin model to address this problem. After defining the CES utility function on all countries' goods subject to their income and finding their consumption and prices index, it follows that the f.o.b. exports' value from country  $i$  to country  $j$  is indicated by

$$T_{ij}^{fob} = \frac{Y_i Y_j}{Y^w} \frac{1}{t_{ij}} \left[ \frac{\rho_{ij}^{1-\sigma}}{\sum_h \theta_h \rho_{ih}^{1-\sigma}} \right] \quad (25)$$

$\theta_h$  stands for the share of world income by country  $h$ , replacing  $\beta_i$ , the elasticity of trade substitution is denoted by  $\sigma$ , and the relative distance between the two countries  $i$  and  $j$  is indicated by  $\rho_{ij}$ . As a result, close countries will trade more when the elasticity of substitution among products is higher compared to the trade with distant countries, by exceeding trade value in the frictionless (standard) gravity equation. Due to the transportation technological enrichment, it follows that transport costs are also lessened, shifting trade flows closer to the expected amounts in the frictionless gravity equation. This leads to trade expansion between distant nations, while diminishing close nations' trade as some of their disadvantage with respect to distant ones is removed.

However, the logic behind alternative theories for the gravity model was discussed by Feenstra et al. (2001), who demonstrated that the gravity model could be obtained from the monopolistic competition model or the reciprocal dumping model of trade where goods are not only differentiated also but homogeneous. Trade patterns were displayed in accordance with Cournot-Nash competition, representing the market structure in the homogeneous products. Diverse home market effects on both homogeneous and differentiated goods were measured by different theories of trade regarding the elasticity of domestic-income or even partner-income. Therefore, this implies that both differentiated and homogeneous goods could generate gravity equations. In addition, the gravity equations for bilateral flows of exports between two countries were estimated through the home-market effect.

Furthermore, in attempt to find the coherent theory – which, in fact contributed the most for the success of the gravity equation with data sample – a model identification problem was empirically investigated by Evenett and Keller (2002), who tested theories of Heckscher-Ohlin and increasing returns. In contrast to perfect specialisation, the gravity equation was assessed based on theories of imperfect specialisation in production. Four distinct models of trade were examined from a Heckscher-Ohlin and a Helpman-Krugman perspective to test for the relevance of both complete and incomplete specialisation in each case model, so that a solid empirical outcome for a unicone Heckscher-Ohlin model instead of the multicone one is supported.

From a perfect specialisation of production framework with increasing returns to scale (IRS), both models generate the gravity equation equal to

$$M^{ij} = \frac{Y^i Y^j}{Y^w} \quad (26)$$

This model is also refers to the multicone Heckscher-Ohlin model. Here, the value of country  $i$ 's imports from  $j$  is signified by  $M^{ij}$ . In this case, the gravity equation obtained from this IRS model of trade will be successful if bilateral imports are strictly related to the GDP of all countries denoted by  $Y^i$  and  $Y^j$ . As a result of equilibrium, good prices are the same for all consumers with corresponding homothetic preferences, leading to balanced trade under the Helpman-Krugman assumptions. There is a dissimilarity between the countries' relative endowment ratios and the

products' relative input ratios so that production diversification and factor price equalisation are consistent with international trade under the Heckscher-Ohlin analysis.

However, in the case of imperfect specialisation of production, the Helpman-Krugman model (1985) specified gravity theory together with balanced trade, represented as follows

$$M^{ij} = (1 - \gamma^i) \frac{\gamma^i \gamma^j}{\gamma^w} \quad (27)$$

From the equation above, any value of  $\gamma^i$  refers to the share of homogeneous goods  $z$  produced under constant return to scale in country  $i$ 's GDP. It follows that the two countries ( $i$  and  $j$ ) are supposed to be similarly capital-abundant and labour-abundant. This specifies that country  $j$  ( $i$ ) will then export more labor-intensive (capital-intensive) products to country  $i$  ( $j$ ). Thus, the greater the level or volume of imports, the smaller the share of homogenous products in country  $i$ 's GDP.

Apart from good  $z$ , the production of good  $x$  under increasing returns to scale is expected, according the Helpman-Krugman approach. In addition, this product seems to be differentiated and more capital-intensive in manufacture.

Following the 2x2x2 (two goods, two factors of production, and two nations) unicone Heckscher-Ohlin model (1919, 1933), both goods  $x$  and  $z$  were displayed as homogeneous products produced under constant returns of scale in both nations changes. As above-mentioned, the gravity equation (27) is converted to

$$M^{ij} = (\gamma^j - \gamma^i) \frac{\gamma^i \gamma^j}{\gamma^w} \quad (28)$$

$\gamma^j$  and  $\gamma^i$  reflect the fact that the capital-labour ratios of both nations merge, especially when  $i$  and  $j$  factor proportions are the same. In such case, no trade is foreseen between the two nations in the Heckscher-Ohlin theorem. Nevertheless, increased factor proportions' differences are demonstrated by Evenett and Keller (2002), who predict the imports' volume of the multicone Heckscher-Ohlin model (equation 26) and imply that  $\gamma^j$  and  $\gamma^i$  approximate and tend to zero respectively. With the unicone Heckscher-Ohlin model, bilateral imports are less than proportionate to the nations' GDP. In addition, the volume of imports generally grows with discrepancies in factor proportions and is forecast under imperfect specialisation

of production for both products among nations. Evidence shows that the multicountry Heckscher-Ohlin model was rejected by Evenett and Keller (2002) since they did not support the perfect specialisation in production. Then, imperfect specialisation was found to be significant in enlightening bilateral flows of trade due to factor proportions' dissimilarities. After describing that the gravity equation can result from diverse theoretical models, Evenett and Keller (2002) utilize the index suggested by Grubel and Lloyd (1975) in order to make a distinction between nations that usually trade intra-industry or inter-industry and to estimate the magnitude of trade based on increasing returns to scale. This reveals that bilateral trade subject to increasing returns to scale and product differentiation makes a country to simultaneously export and import ranges of a specific product, exhibiting intra-industry trade as opposed to trade based on the Heckscher-Ohlin model illustrating inter-industry trade.

To be thorough and exact, the Ricardian tactic with regard to the reliability of a theoretical gravity equation is subsequently discussed because bilateral trade based on technology differences appears to be a reason for intra-industry trade in Ricardo's context. In reference to the assumption of the Ricardian theory of trade, it follows that international trade is beneficial to countries due to the principle of comparative advantage.

The Ricardian model of bilateral trade, which is hinged on technological differences encompassing the geographical role, was extended and computed by Eaton and Kortum (2002). From their framework, the state of technology was contained within each country conducting absolute advantage; technological heterogeneity was incorporated, commanding forces of comparative advantage in order to stimulate trade; and geographic barriers were also considered in order to indicate transport costs, tariffs, and quotas, among others, that bilateral trade is insusceptible to. As for Eaton and Kortum's assumptions (2002), they followed the Ricardian model, believing that the only factor of production is labour, which seems to be internationally immobile.

Following Dornbusch, Fischer, and Samuelson's (1977) model of bilateral trade, the maximization of CES preferences was due to the consumers or firms purchasing global goods produced under constant returns to scale, with iceberg geographic barriers, at the cheapest price (Eaton and Kortum, 2002). However, this did not

succeed for multi-countries' cases, yet was also indispensable to bilateral flows of trade's experiential investigation. After representing technologies probabilistically for a number of countries' trade flows with a continuum of products, Eaton and Kortum (2002) stated that the efficiency of a particular good produced by a given country is expected to be random and distributed effectively. This allows the state of technology and technological heterogeneity in terms efficiency to be independent and fluctuate across several countries.

In addition, prices for goods evaluate the state of technology, the costs of input, and the geographic barriers encountered by each country. For instance, it can be advantageous for a certain country with a greater state of technology and smaller costs of input or geographical barriers to sell varieties of goods, where the selling prices distribution and the overall price distribution are equal in the same country. After a detailed mathematical manipulation and derivation by Eaton and Kortum (2002), the bilateral flows of trade are conveyed as the fraction of goods bought by country  $n$  from  $i$ , corresponding to the expenditure of country  $n$  on goods from country  $i$ . The standard gravity equation refers to

$$X_{ni} = \frac{\left(\frac{d_{ni}}{p_n}\right)^{-\theta} X_n}{\sum_{m=1}^N \left(\frac{d_{mi}}{p_m}\right)^{-\theta} X_m} Q_i \quad (29)$$

$X_n$  stands for the total purchase or expenditure by country  $n$  on goods. The total sales of the exporter country  $i$  is denoted by  $Q_i$ .  $d_{ni}$  represents the geographic barrier between country  $n$  and country  $i$ , contracted by the price level of the importer country  $p_n$ , while  $d_{mi}$  refers the geographic barrier between  $i$  and any other importing countries  $m$  shrunken by  $p_m$  (importer's price degree).  $\left(\frac{d_{ni}}{p_n}\right)^{-\theta} X_n$  can be considered as the market size of country  $n$  as apprehended by country  $i$  and the denominator of equation (29) is thought of as the total global market from country  $i$ 's perspective. Indeed, it is observed that country  $n$ 's share in total sales of country  $i$  and country  $i$ 's share in the world market are alike. The parameter  $\theta$  is perceived as the technological heterogeneity of goods in production rather than in consumption. In this case, the way flows of trade respond to costs and geographic barriers relies upon this technological parameter. Eaton and Kortum (2002) have also established a relation between trade flows and price variances to show that a decline or a rise of

prices in country  $n$  or  $i$  respectively correspond to an increase of geographic barriers between the two countries. In addition, price levels are adjusted due to the presence of CES preferences. When input costs and price levels are taken into consideration in Eaton and Kortum' empirical analysis, the gravity equation can be obtained with the following form

$$\ln \frac{X'_{ni}}{X'_{nn}} = S_i - S_n - \theta_{m_n} - \theta_{d_k} - \theta b - \theta l - \theta e_h + \theta \delta_{ni}^2 + \theta \delta_{ni}^1 \quad (30)$$

The competitiveness of country  $i$  is measured by  $S_i$  and the overall impact of destination for each country is reflected by  $m_n$ .  $d_k$  stands for the distance effect between the exporter's country  $i$  and the importer's country  $n$  within  $K$ th interval ( $K = 1, \dots, 6$ ). The effect of border when  $n$  and  $i$  share a similar border is denoted by  $b$ . When an identical language is spoken in both countries, this effect of language is represented by  $l$ .  $e_h$  with  $h = 1, 2$  refers to the shared trading area of both countries, and, finally, the error term is specified by  $\delta_{ni}$ , indicating geographic barriers merged with added factors.

Anderson and Wincoop (2003) departed from an overview of the theoretical foundation of the gravity equation based on the Heckscher-Ohlin and Helpman-Krugman models, in which products are differentiated by factor endowments and by devotion of goods' diversities respectively (in contrast to the Ricardian model of trade, where technologies vary in the production of goods as a result of the law of comparative advantage). Here, these authors introduced the importance of relative trade costs or multilateral resistance terms (average barriers of trade) due to omitted variables, making the results of estimated gravity equations biased.

With reference to McCallum's 1995 research paper analysing patterns of trade between Canadian provinces and the United States of America, their study shows that there is a strong reliance between bilateral trade flows among two regions and both their output and their bilateral distance. This is despite the fact that these regions are separated, revealing that the impact of two regions' or countries' borders seems to be very significant, although they are culturally, institutionally, or even economically analogous. This was labelled as the border puzzle by McCallum. For instance, two provinces tend to trade more than 20 times more than a trade between a province and a state (McCallum, 1995).

The following gravity equation assessed by McCallum (1995), demonstrating the inter-provincial and state-province flows of trade correspond to

$$\ln x_{ij} = a_1 + b \ln y_i + c \ln y_j + d \ln dist_{ij} + e DUMMY_{ij} + u_{ij} \quad (31)$$

The flows of exports from region  $i$  to region  $j$  are expressed by  $x_{ij}$ . Both regions' GDP are represented by  $y_i$  and  $y_j$  respectively.  $dist_{ij}$  stands for the geographical distance between the two regions  $i$  and  $j$ . A dummy variable is referred by  $DUMMY_{ij}$ , which is added in the equation to distinguish between inter-provincial trade within Canada ( $DUMMY_{ij} = 1$ ) and state-province trade, where a Canadian province and a U.S. state trade ( $DUMMY_{ij} = 0$ ), and, finally, the error term denoted by  $u_{ij}$ .

After the empirical findings of McCallum (1995) regarding the border puzzle, Anderson and Wincoop were inspired to expand and elaborate the gravity theory within the effect of border puzzle in 2003. In attempt to solve for the border puzzle, Anderson and Wincoop (2003) intended to appraise the gravity equation more accurately and coherently, subject to a virtuous theory, so that they remain as close as possible to the estimation of McCallum's gravity equation. Also, they wished to detect the border's effects on trade flows by performing the general equilibrium comparative statics so that the U.S.-Canada border barrier is removed. However, the addition of multilateral resistance variables such as product or trade costs alters McCallum's equation. Additionally, their analysis revealed that levels of bilateral trade between nations are substantially reduced by borders.

Based on the theoretical foundation for the gravity model of Anderson (1979) and Deardorff (1998) with the CES preferences and expenditure structure, Anderson and Wincoop (2003) extended the theory by describing multilateral resistance terms as price indices, connected with all barriers of bilateral trade and shares of income. In addition, the resistance of trade consists of comparative barriers of trade between regions  $i$  and  $j$  and the resistance of region  $i$  and  $j$  to trade with all other respective regions.

Their gravity model was obtained using a market clearance subject to the equilibrium price indexes, determined by them, and assuming that there is symmetry among barriers of trade. This basic gravity equation was expressed as follows

$$x_{ij} = \frac{y_i y_j}{y^w} \left( \frac{t_{ij}}{P_i P_j} \right)^{1-\sigma} \quad (32)$$

Subject to 
$$P_j^{1-\sigma} = \sum_i P_i^{\sigma-1} \theta_i t_{ij}^{1-\sigma} \forall_j \quad (33)$$

Their gravity model is related to the shares of trading countries' income, bilateral barriers of trade, and price indices. Frictionless trade with no impediments appears as  $\frac{y_i y_j}{y^w}$ , corresponding to equation (10) or (11) derived by Anderson (1979), and equation (23) under the Heckscher-Ohlin model of Deardorff (1998). In this case, no transport or trade costs exist and no significant role is played by distance in the gravity model. With barriers of trade,  $\left( \frac{t_{ij}}{P_i P_j} \right)^{1-\sigma}$  refers to multilateral trade impediments on average rectifying frictionless trade and serving as trade resistances.

This implies that the resultant formulations by Anderson (1979) and Deardorff (1998) were significantly simplified by the expression (equation 32) derived by Anderson and Wincoop (2003). From equation (32), it should be noted that multilateral resistance variables acting as price indices rely the most on  $t_{ij}$  which stands for all bilateral resistances. For instance, if barriers of trade increase among trading partners, the price index will therefore rise, and where barriers of trade are not present, it follows that all bilateral resistances of trade and price indices are equal to 1.

Furthermore, the correlation of bilateral trade with barriers of trade between two regions and the product of their multilateral resistance can be seen as the crucial characteristic of the gravity model. A large number of types of trade costs connected to national borders, fluctuating through both goods and countries, which affect national welfare, were mentioned by Anderson and Wincoop (2004). By looking at the development of multilateral resistance terms, the theoretical foundations of the gravity model were incorporated into recent practice by Anderson (2011) so that spatial associations designated by the gravity model are assessed and interpreted more appropriately.

On the empirical front, the gravity model has been elucidating bilateral trade flows for developed countries, as well as for many developing countries and African economies. In addition, it has also been scrutinising trade integration and the

relationship between regional trading blocs. It is also important to indicate that some factors such as geographical factors, population, technology, and trade resistance, among others, have to be taken into consideration in describing the variability of bilateral trade flows. Studies on the BRIC's trade flows have mostly been compared to the European Union and the emphasis is generally put on the significance of these countries in the world trade as well as the developing world. Studies on South Africa have been done on the investigation of trade flows between South Africa and its leading partners of trade, with the use of gravity model, considering generally the potential of their exports.

The applicability of the gravity model has been predominantly acknowledged in the analysis of international trade flows, as patterns of international trade flows are described with the use of this model. Another important point to emphasize is that the gravity specifications also serve to model other flows, such as foreign direct investment and migration, amongst others, in international economics.

### **4.3 Theoretical Framework adopted for the Study**

This section presents the theoretical specifications used in the study. In addition, the generalised as well as extended gravity models employed in the analysis of trade flows among the BRICS economies are discussed in this section.

The gravity model is selected amongst the above-mentioned theories of trade to compute South Africa's trade flows with the BRIC countries, given that several empirical findings have demonstrated that the gravity model has been a successful formulation that explained trade flows between different nations. Based on the innovative work of Tinbergen (1962) and Pöyhönen (1963), and other empirical specifications discussed above, the model specification adopted in this study describes the flows of trade between country  $i$  and  $j$ , which are precisely proportionate to their GDPs and indirectly proportional to the distance between them. This equation appears in the following form:

$$T_{ij} = X_{ij} = f(GDP_i^\alpha GDP_j^\beta D_{ij}^\gamma) \varepsilon_{ij} \quad (34)$$

The volume of bilateral trade among BRICS economies is represented by  $T_{ij}$ , which is frequently replaced by  $X_{ij}$  standing for the exports between two countries (in the context of this study, between South Africa and countries in the BRIC's economic

bloc). The distance between South Africa and the BRICs or vice versa is expressed by  $D_{ij}$ . The parameter estimates in this equation refer to  $\alpha$ ,  $\beta$ , and  $\gamma$ , which will convert into elasticities when the natural logarithm (log) of both sides are computed.

By taking the natural log of all the variables, the gravity model then turns into a linear model with the following formulation:

$$\ln(T_{ij}) = \alpha_0 + \beta_1 \ln(GDP_i GDP_j) + \beta_2 \ln(D_{ij}) + \varepsilon_{ij} \quad (35)$$

Conforming to the general form of the gravity model where the volume of exports between two countries is not only elucidated by their economic extents (GDPs), distance, but also by population, and a collection of dummies, and following Martinez-Zarzoso and Nowak-Lehman (2003), the generalised gravity model of trade implemented is specified by:

$$X_{ij} = \beta_0 Y_i^{\beta_1} Y_j^{\beta_2} N_i^{\beta_3} N_j^{\beta_4} D_{ij}^{\beta_5} A_{ij}^{\beta_6} \mu_{ij} \quad (36)$$

The GDPs of the exporter (South Africa) and importer (the BRIC nations) are signified by  $Y_i$  and  $Y_j$  and their populations are indicated by  $N_i$  and  $N_j$  respectively.  $A_{ij}$  consists of a set of dummies influencing trade between pairs of countries and the error term represented by  $\mu_{ij}$ .

The model intended for estimations is usually expressed in log-linear form as follows:

$$\ln X_{ij} = \beta_0 + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 \ln N_i + \beta_4 \ln N_j + \beta_5 \ln D_{ij} + \beta_6 A_{ij} + \mu_{ij} \quad (37)$$

It follows that per capita income may possibly be used in place of population as an alternative conceptualisation of equation (35), given by:

$$X_{ij} = \gamma_0 Y_i^{\gamma_1} Y_j^{\gamma_2} \left(\frac{Y_i}{N_i}\right)^{\gamma_3} \left(\frac{Y_j}{N_j}\right)^{\gamma_4} D_{ij}^{\gamma_5} A_{ij}^{\gamma_6} \mu_{ij} \quad (38)$$

The exporter GDP per capita and the importer per capita GDP are denoted by  $\frac{Y_i}{N_i}$  and  $\frac{Y_j}{N_j}$  respectively. In a log linear form, the model (37) is displayed by:

$$\ln X_{ij} = \gamma_0 + \gamma_1 \ln Y_i + \gamma_2 \ln Y_j + \gamma_3 \ln \frac{Y_i}{N_i} + \gamma_4 \ln \frac{Y_j}{N_j} + \gamma_5 \ln D_{ij} + \gamma_6 A_{ij} + \mu_{ij} \quad (39)$$

This implies that the two equations (36 and 38) above are equivalent. In addition, the model specification (38) is commonly utilized when bilateral flows of exports are

estimated by means of the gravity model (Bergstrand, 1989) while bilateral aggregate flows of exports are frequently determined by the specification given by equation (36) (Endoh, 2000). Since both models in their general form are similar, model (36) in log linear form is used for estimation purposes in this study and is expressed with the following formulation:

$$\ln X_{ij} = \alpha_0 + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j + \beta_3 \ln N_i + \beta_4 \ln N_j + \beta_5 \ln D_{ij} + \beta_6 A_{ij} + \varepsilon_{ij} \quad (40)$$

$A_{ij}$  refers to dummy variables such as time (Time) and also a common language (Lang).

In addition to the above generalised form of gravity model, an augmented gravity equation is also appraised in this study so that some factors or variables that may possibly influence trade flows are taken into consideration. The gravity model is then extended by incorporating some important variables such as exchange rate (ER), openness to trade (Open) and the same dummy variables such as time (Time) and also for the BRICS economies sharing a common language (Lang) in order to analyse the flows of trade between South Africa and the BRIC nations. The empirical gravity model applied in this study is expected to be as follows:

$$\ln X_{ij} = \alpha_0 + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j + \beta_3 \ln N_i + \beta_4 \ln N_j + \beta_5 \ln D_{ij} + \beta_6 ER_{ij} + \beta_7 Open_i + \beta_7 Open_j + \beta_8 lang_{ij} + \beta_9 Time_{ij} + \varepsilon_{ij} \quad (41)$$

## 4.4 Methodology

### 4.4.1 Estimation technique

This study adopted a panel data econometrics framework as the estimation technique for the gravity model of trade flows between South Africa and the BRIC countries. In the panel data approach, three models, which are pooled OLS, fixed effects, and the random effects can be estimated. The panel data estimations applied in this study to conduct an empirical analysis for the BRICS' trade flows are mostly evaluated under either the fixed effects or the random effects estimation procedures. Panel data methodology used in this study (as opposed to the cross-sectional or time series analysis) provides many benefits, such as monitoring individual heterogeneity; apprehending more appropriate relationships, variability, and decreasing collinearity among the explanatory variables over time; avoiding the problem of multicollinearity resulting from cross-section data; and observing all the

possible trading-partner-pairs individual effects –for instance, country-specific differences (Chen and Wall, 2005).

Some fundamental econometric specifications of the gravity equation have been provided and enhanced by the works of Matyas (1997, 1998), Breuss and Egger (1999), and Egger (2000, 2002), amongst others, by suggesting the fixed effects model or the random effects model and contributing to the improvement of the gravity model's performance. When estimating the flows of trade between countries, a decision should be made whether individual effects incorporated in the regressions are treated as fixed or random.

Regarding panel econometric techniques, the main concern is related to the concept of heterogeneity bias in the model's estimations. In general, when an important variable is missing from the model, such bias is produced. Panel data analysis prevents the heterogeneity bias by taking the individual effects associated with cross-sections into consideration, usually in view of countries' involvement in international trade and/or units of time (Matyas, 1998, 1999). Thus, the relevant variables' progress through time is acknowledged and the specific time or country effects are identified by means of a panel framework. This is the reason why the OLS pooled specification is not applicable for analyzing gravity models, because of the absence of the unobserved heterogeneity between country-pairs, leading to a specification error in the estimations (Cheng and Wall, 2005).

Following the gravity model's specification by Chen and Wall (2005), the general model of trade in this context between South Africa and other BRICS nations ( $i$  and  $j$  respectively) may possibly be denoted by

$$\ln X_{ijt} = \alpha_0 + \alpha_t + \alpha_{ij} + \beta'_{ijt} Z_{ijt} + \varepsilon_{ijt}, \quad t = 1, \dots, T. \quad (42)$$

The volume of trade (exports) from country  $i$  to country  $j$  is symbolized by  $X_{ijt}$  in a particular year  $-t$ .  $Z'_{ijt} = [Z_{it} Z_{jt} \dots]$  stands for the  $1 \times k$  row variables such as GDP, population, and distance, amongst others, in the gravity model. With respect to the three intercepts, the one common to all years and all pairs is symbolized by  $\alpha_0$ , the one exactly to year  $t$  and common to country pairs is represented by  $\alpha_t$ , and the one common to all years and particular to country pairs is signified by  $\alpha_{ij}$ . The error term being normally distributed is indicated by  $\varepsilon_{ijt}$ , implying that the mean and variance

are zero and constant for all observations. In addition, it is important to note that the disturbance term between country pairs are, in this case, uncorrelated.

With the pooled ordinary least squares (POLS) model, constraints are imposed on the general model of trade (see equation (42)) where the parameter vector is similar for all  $t$ , implying that  $\beta_1 = \beta_2 = \dots = \beta_T = \beta$ , even though that the intercepts are allowed to differ over time. The coefficients in this model seem to be constant for all individuals for all periods of time, implying that heterogeneity cannot be allowed across individuals in this case.

The POLS estimation method emerges with the following form:

$$\ln X_{ijt} = \alpha_0 + \alpha_t + \beta' Z_{ijt} + \varepsilon_{ijt}, \quad t = 1, \dots, T. \quad (43)$$

When flows of trade from South Africa to the BRICs are estimated, the expanded POLS model is expected to be as follows:

$$\ln X_{ijt} = \alpha_0 + \alpha_t + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln N_{it} + \beta_4 \ln N_{jt} + \beta_5 \ln D_{ij} + \beta_6 ER_{ijt} + \beta_7 Open_{it} + \beta_7 Open_{jt} + \beta_8 lang_{ij} + \beta_9 Time_{ij} + \varepsilon_{ijt}, \quad t = 1, \dots, T \quad (44)$$

Considering that OLS specification assesses all available data for the given years when the pooled model is computed, biased estimates are generated. To address this problem, the restriction, suggesting that the intercept terms amount to zero across country pairs, is displaced, while the restraint, in which the country-pair slope coefficients are constant, is preserved.

With the fixed effects model (FEM), the country-pair specific effects are assessed in order to demonstrate how high bilateral trade openness is among BRICS economies and apprehend the factors connected with the volume of bilateral. In addition, unobserved or misspecified factors are allowed to explain the volume of trade between two countries (Chen, 1999). The unobserved heterogeneity element appears to be constant over time but affecting each individual pair of countries in a distinct way. Moreover, the incorporation of exporter and importer dummies in the sample is to avoid perfect collinearity among countries (Matyas, 1997). Furthermore, many studies have been conducted using the fixed effects model to illustrate the effects of currency union and borders on trade, as well as to estimate trade potentials and the costs of protection across countries (Micco et al., 2003; Glick and Rose, 2001).

Following the fixed effects model of Chen and Wall (1999), the gravity equation among BRICS economies is expressed as follows:

$$\ln X_{ijt} = \alpha_0 + \alpha_t + \alpha_{ij} + \beta' Z_{ijt} + \varepsilon_{ijt}, \quad t = 1, \dots, T. \quad (45)$$

This is equivalent to

$$\ln X_{ijt} = \alpha_{ij} + \alpha_t + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln N_{it} + \beta_4 \ln N_{jt} + \beta_5 \ln D_{ij} + \beta_6 ER_{ijt} + \beta_7 Open_{it} + \beta_7 Open_{jt} + \beta_8 lang_{ij} + \beta_9 Time_{ij} + \varepsilon_{ijt}, \quad t = 1, \dots, T \quad (46)$$

The specific country-pair effect between South Africa and the BRIC nations is indicated by  $\alpha_{ij}$  which is permitted to differ in accordance with the direction of trade. The effects of all omitted variables are incorporated by the intercepts, which control distinctive characteristics of each individual across country pairs. In addition, these effects seem to be cross-sectionally specific but ceaseless over time.

As it can be either a one-way or two-way fixed effects model or a classical regression model, the fixed effects model can be appraised by means of LSDV (least squares dummy variables), where the explanatory variables are presumed to be likened to  $\alpha_{ij}$ . In addition, an important point which needs to be noted is that the effects of country pairs can be different for each direction of trade.

However, there are also challenges encountered in using the fixed effects model. This is when the unobserved variables vary over time and when there is a correlation between the error differences and covariates discrepancies. In this case, biased estimates are also generated under the fixed effects model. For that reason, the regressors are required to be stringently exogenous and the omitted relevant variables as well as the unobserved individual effects need to be constant over time under this approach. In addition, the fixed effects model faces some other problems related to the fact that variables are time unresponsive and cannot be estimated immediately. It follows that another regression is required to be conducted in a second step so that these variables can be estimated to solve this matter. In this case, the individual effects refer to the dependent variable and distance and dummy variables correspond to the explanatory variables. This is signified as follows:

$$IE_{ij} = \gamma_0 + \gamma_1 D_{ij} + \gamma_2 Lang + \gamma_3 Time + \mu_{ij} \quad (47)$$

$IE_{ij}$  stands for the individual effects, other variables are denoted as before.

With the random effects model (REM), distinctive trade flows are estimated from a larger population amongst randomly drawn samples of trading partners and no individual specific effects are reflected on its estimated coefficients (Gujarati, 2009).

It is important to note that no correlation exists between individual effects and the regressors, which differentiates the random effects model from the fixed effects model, in which the correlation between individual effects and the regressors is allowed. This requires orthogonal opposition between the individual effects and the regressors in order to ensure the use of random effects so that the unobserved heterogeneous constituent is distributed randomly, with a particular mean and variance, and is presumed to be meticulously exogenous (Hill et al., 2011).

Under this model, the intercept is not treated as fixed variable but as a random variable with a mean value. In this case, the intercept parameter comprises two parts and is expressed as follows:

$$\alpha_{0i} = \alpha_0 + \mu_i \quad (48)$$

A random error term with a zero mean value and a confined variance is symbolized by  $\mu_i$  indicating individual heterogeneity selected randomly from an average population. The fixed part is represented by  $\alpha_0$ , standing for the standard population (Gujarati, 2009).

It follows that the gravity equation for the trade flows between South Africa and the BRIC nations is denoted by:

$$\ln X_{ijt} = \alpha_{0i} + \alpha_t + \beta_1 \ln GDP_{it} + \beta_2 \ln GDP_{jt} + \beta_3 \ln N_{it} + \beta_4 \ln N_{jt} + \beta_5 \ln D_{ij} + \beta_6 ER_{ijt} + \beta_7 Open_{it} + \beta_7 Open_{jt} + \beta_8 lang_{ij} + \beta_9 Time_{ij} + \varepsilon_{ijt}, \quad t = 1, \dots, T \quad (49)$$

#### 4.4.2 Panel tests procedures

Diverse panel tests used for empirical results in this study are described in this section. Tests to check for fixed effects, random effects, poolability, Hausman specification, serial correlation, heteroskedasticity, and panel unit root as well as their hypotheses are specified in the following sub-sections.

##### 4.4.2.1 Fixed effects or individual effects test

Testing for fixed effects with panel data means checking whether precise individual effects are present in the model used for the study, that is, across cross-sections or

through a time period (Baltagi, 2008). The imperceptible particular individual effect is signified by  $\mu_i$ .

Fixed effects test combines the pooled OLS model with a null hypothesis and the fixed effects model with an alternative hypothesis. Under the pooled OLS model, the null hypothesis indicates that all dummy variables are equivalent to zero, except for one for the dropped, expressed as follows:  $H_0 = \mu_1 = \mu_2 = \dots = \mu_{N-1} = 0$ . This implies that individual effects are absent and the intercept is the same for all cross sections.

In the case of the fixed effects model, the alternative hypothesis shows that at least one dummy variable is different from zero. This is denoted by:  $H_A$ : not all equal to 0.

An F-statistic test or a simple rendition of the chow test is applied to test the null hypothesis of no individual effects, incorporating the Residual Sum of Squares for both regressions with restraints (subject to the null hypothesis) and without constraints (under the alternative hypothesis) respectively. In addition, this test scrutinizes the magnitude of changes for the goodness-of-fit measures, for instance,  $RSS$  or  $R^2$  (Wooldridge, 2012).

The F-statistic is computed with the following formulation:

$$F = \frac{(RSS_{pooled} - RSS_{LSDV}) / (N-1)}{RSS_{LSDV} / (NT - N - K)} \stackrel{H_0}{\sim} F_{(N-1), (NT - N - K)} \quad (50)$$

The Residual Sum of Squares for the pooled and the fixed effects models are represented by  $RSS_{pooled}$  and  $RSS_{LSDV}$  respectively.  $N$ ,  $T$ , and  $K$  stand for the number of individuals, time, and the number of parameters of slope coefficients. The null hypothesis is symbolized by  $H_0$ .

It is important to note that the Within estimation can be used in preference to LSDV computation for the residual sum of squares, provided that  $N$  is large enough. In the case of the Within regression, the residual sum of squares with restrictions remains from the pooled OLS model. However the unrestricted residual sum of squares is now obtained from this regression instead of LSDV regression (Baltagi, 2008). Moreover, the joint significance of individual effects ( $\mu_i$ ) and time effects ( $\lambda_T$ ) is tested in this context by means of a null hypothesis, denoted by  $H_0: \mu_1 = \dots = \mu_{N-1} = 0$  and  $\lambda_1 = \dots = \lambda_{T-1} = 0$ .

Therefore, the F-statistic is found as follows:

$$F = \frac{(RSS_{pooled} - RSS_{WITHIN}) / (N+T-2)}{RSS_{WITHIN} / (N-1)(T-1) - K} \stackrel{H_0}{\sim} F_{(N+T-2), (N-1)(T-1) - K} \quad (51)$$

It follows that when the null hypothesis  $H_0$  is rejected, this implies that fixed effects are authentic and significant, which suggests that cross-sections are heterogeneous and should not be pooled. In other words, there is a significant rise in goodness-of-fit in the fixed effects model, implying that this model is better than the pooled OLS model.

#### 4.4.2.2 Random effects test

Testing for random effects by means panel data intends to examine whether any individual effects or time effects occur in the random effects model in this study. In other words, individual or time specific variance components are assessed to test if they are equal to zero (Greene, 2012). In addition, random effects test combines the pooled OLS model with a null hypothesis and the random effects model with an alternative hypothesis. A Lagrange multiplier (LM) test derived by Breusch and Pagan (1980) is employed to test the null hypothesis of no individual effects or time effects of the OLS pooled model and relies generally upon the OLS residuals.

Following Greene's (2012) approach, random individual effects, the null hypothesis, and the alternative one, based on the work of Breusch and Pagan (1980), are displayed by:  $H_0 = \sigma_{\mu}^2 = 0$  and  $H_A = \sigma_{\mu}^2 \neq 0$ .

As above-mentioned, it is also important to note that the LM statistic appears to follow the limiting chi-squared distribution with one degree of freedom under the null hypothesis. Therefore, the LM test statistic is obtained as follows:

$$LM_{\mu} = \frac{NT}{2(T-1)} \left[ \frac{T^2 \bar{e}' \bar{e}}{e' e} - 1 \right] \stackrel{H_0}{\sim} \chi^2(1) \quad (52)$$

The  $n \times 1$  vector of the pooled regression residuals and the residual sum of squares are signified by  $\bar{e}$  and  $e' e$  respectively.

The similar LM test statistic is presented by Baltagi (2008) in a distinct way with the following formulation:

$$LM_1 = \frac{NT}{2(T-1)} \left[ \frac{\sum(\sum e_{it})^2}{\sum \sum e_{it}^2} - 1 \right]^2 = \frac{NT}{2(T-1)} \left[ \frac{\sum(T \bar{e}_t)^2}{\sum \sum e_{it}^2} - 1 \right]^2 \stackrel{H_0}{\sim} \chi^2(1) \quad (53)$$

In fact, when the null hypothesis is rejected, this implies that there are substantial random effects in panel data and the random effects model is better than the OLS pooled model in terms of its ability to cope with heterogeneity across cross-sections.

In the case of the random two-way error component model, a LM test is used to test the null hypothesis of no individual effects and time effects, given by  $H_0: \sigma_\mu^2 = \sigma_\lambda^2 = 0$ .

This suggests the absence of the two variance parameters. The LM test statistic is usually found by summing  $LM_1$  and  $LM_2$ , that is,  $LM = LM_1 + LM_2 \stackrel{H_0}{\sim} \chi^2(2)$  (54)

$LM_2$  ensures the validity of the period random effects under the null hypothesis  $H_0: \sigma_\lambda^2 = 0$  and the alternative one assigned by  $H_A: \sigma_\lambda^2 \neq 0$ .

$$\text{In this case, } LM_2 = \frac{NT}{2(N-1)} \left[ \frac{\sum(\sum e_{it})^2}{\sum \sum e_{it}^2} - 1 \right]^2 = \frac{NT}{2(N-1)} \left[ \frac{\sum(T\bar{e}_i)^2}{\sum \sum e_{it}^2} - 1 \right]^2 \stackrel{H_0}{\sim} \chi^2(1) \quad (55)$$

For this reason, rejecting the null hypothesis here demonstrates that adjustment over time occurs in the panel data, and time effects should be incorporated in the specification since they are valid.

#### 4.4.2.3 Poolability test

Testing for poolability along with panel data aims to calculate whether all coefficients (intercepts and slopes) or just the slopes are the same among cross-sections or over a period of time in the model adopted for this study.

An extension of the Chow test or F-statistic test (Chow,1960) is constructed and implemented as the general poolability test to check the null hypothesis, surmising that all coefficients (intercept and slopes) for each cross-section are the same, irrespective of individual regressions for all different parameter values across cross-sections or time (Baltagi, 2008). For each cross-section or each period of time, the null hypothesis is denoted by:

$H_0: \delta_1 = \delta_2 = \dots = \delta_N = \delta$  for all  $i$  and  $H_0: \delta_1 = \delta_2 = \dots = \delta_T = \delta$  respectively, together with the alternative hypothesis  $H_A$ : not all equal. It should also be noted that intercept and slopes remain constant in the fixed effects and the random effects models. Moreover, the main issue to deal with in this case is the error variances. The following F-statistic is measured as:

$$F = \frac{(e'e - (e_1'e_1 + \dots + e_N'e_N)) / (N-1)K'}{(e_1'e_1 + \dots + e_N'e_N) / N(T-K')} \quad H_0 \sim F_{(N-1)K', N(T-K'); \alpha} \quad (56)$$

$$\text{Or } F = \frac{(e'e - (e_1'e_1 + \dots + e_T'e_T)) / (T-1)K'}{(e_1'e_1 + \dots + e_T'e_T) / T(N-K')} \quad H_0 \sim F_{(N-1)K', N(T-K'); \alpha} \quad (57)$$

$e'e$  stands for the residual sum of squares of the pooled model (the restricted model). The residual sum of squares of the unrestricted model (fixed effects or random effects) is represented by  $(e_1'e_1 + \dots + e_N'e_N)$ , for each cross-section, or  $(e_1'e_1 + \dots + e_T'e_T)$ , for each time period. In addition, individual estimations are allowed by the model without restraints.

In the Chow test (Chow, 1960) assumption, it seems that individual error variance components are normally distributed subject to  $\mu \sim N(0, \sigma^2 I_{NT})$ , binding the below test to a very rigid restriction (Baltagi, 2008).

Following this assumption, the poolability of data is done by means of the Chow test, using an F-statistic, specified by:

$$F = \frac{(e'e - (e_1'e_1 + e_2'e_2 + \dots + e_N'e_N)) / (N-1)K'}{(e_1'e_1 + e_2'e_2 + \dots + e_N'e_N) / N(T-K')} \quad H_0 \sim F_{((N-1)K', N(T-K'))} \quad (58)$$

As a result, when the null hypothesis is rejected, panel data does not appear to be poolable, and each individual possesses its specific intercept and slopes for all regressors. However, this does not imply that individual regressions should be performed for every cross-section or every period of time. In that case, fixed effects or random effects may possibly be valid.

#### 4.4.2.4 Hausman specification test

Testing for the Hausman specification aims to compare coefficient estimates of the fixed effects and random effects models employed in this study and to check whether or not the specific effects are correlated with the independent variables so that the appropriate estimation technique for the gravity model is selected (Gujarati, 2009). This test is conditioned by the null hypothesis, stating that neither correlation seems to exist between individual effects and any regressors in the model or any misspecification (exogeneity) of any regressors (Hausman, 1978).

For the consistency of the regressions' estimates, the null hypothesis and the alternative one are illustrated as follows:  $H_0: E(u_{it}/X_{it}) = 0$  and  $H_A: E(u_{it}/X_{it}) \neq 0$ .

Individual and/or time effects may be represented by  $u_{it}$  and  $X_{it}$  stands for any regressors in the model.

Based on both models' estimators, the Hausman test statistic can be described by:

$$m_1 = \hat{q}'_1 [\text{var}(\hat{q}_1)]^{-1} \hat{q}_1 \stackrel{H_0}{\sim} \chi^2_K \quad (59)$$

The dimension of  $\hat{q}$ , which is the number of slope coefficients vector  $\beta$ , is designated by  $K$ . This test relies on  $\hat{q} = \hat{\beta}_{GLS} - \hat{\beta}_{Within}$ . Clearly then, in order to compute this test and make it functional,  $\Omega$  should be replaced by  $\hat{\Omega}$  –a consistent estimator in this case. In addition, this test appears to be asymptotically distributed as  $\chi^2_K$  is subject to the null hypothesis.

Moreover, an alternative equivalent test exists and checks whether  $\gamma = 0$ . This test depends on  $\hat{\gamma} = \hat{\beta}_{Within} - \hat{\beta}_{Between}$  and can be constructed using  $\hat{\gamma}'(\text{var}(\hat{\gamma}))^{-1}\hat{\gamma}$ . Although there are many other equivalent tests which also exist, according to Hausman and Taylor (1981), they are not used in this study.

Based on the theory of the Hausman specification test (Hausman, 1978), both the fixed effects model and the random effects model may possibly generate consistent estimate parameters if there is no correlation between the random individual effect and any of the independent variables. However, the random effects model should be employed in order to furnish more efficient estimators in this case, owing to result differences expected in the estimates from the two models (Hill et al., 2011).

When there is correlation between individual effects and any of the regressors, the fixed effects model should be considered to be more appropriate and selected to reveal the heterogeneity across country pairs and generate consistent estimators (Greene, 2012). In fact, the fixed effects model (slope coefficients) is coherent whether the null hypothesis is rejected or not.

#### 4.4.2.5 Serial correlation test

Testing for serial correlation through panel data investigates whether the error component disturbances, given by this model  $u_{it} = \mu_i + v_{it}$  (60), are correlated across cross-sections or from different periods of time (Baltagi, 2008). This model is usually referred to as a one-way error component model for the disturbances, where the unobservable individual specific effect is symbolized by  $\mu_i \sim IDD(0, \sigma_\mu^2)$ , being

independent of  $u_{it}$  and identically distributed, and the remnant disturbance denoted by  $v_{it} \sim IDD(0, \sigma_v^2)$  with the same interpretation as  $\mu_i$ . In fact, this model is applied by many panel data applications and is also implemented for this case study (Baltagi, 2008). In addition, the presence of the same individual effects in panel data regressions make the error serially correlated, leading to the inefficiency of the OLS estimates and the bias of the standard errors. Furthermore, serial correlation may possibly be caused by random effects across cross-sections or correlated residuals across time periods.

It is also important to note that the correlation coefficient is generally exhibited as

$$Correl_{(u_{it}, u_{is})} = \frac{\sigma_\mu^2}{(\sigma_\mu^2 + \sigma_v^2)} \quad \text{for } t \neq s. \quad (61)$$

There are different tests for serial correlation in panel data context such the Durbin-Watson (DW) statistic for the fixed effects model (Bhagarva et al., 1982) and the Lagrange Multiplier (LM) statistic for the first order serial correlation (Baltagi and Li, 1991 and 1995; Baltagi and Wu, 1999).

The DW statistic scrutinizes the null hypothesis of no serial correlation as  $H_0 = \rho =$

0. The D-W is then found as follows: 
$$DW = \frac{\sum_{i=1}^N \sum_{t=2}^T (\hat{u}_{it} - \hat{u}_{i,t-1})^2}{\sum_{i=1}^N \sum_{t=1}^T \hat{u}_{it}^2} \quad (62)$$

The least square dummy variable or even within-estimation is indicated by  $\hat{u}_i$ . The test statistic above lies within the 0-4 range. No first order serial correlation is displayed with a value near 2, and DW values above 2 or below 2 designate negative or positive serial correlation respectively (Dougherty, 2011). However, the main issue with this test is that the critical values to be found depend on  $N$  and  $T$  in big tables provided by Bhargava et al. (1982), making it difficult for unbalanced panel data.

The LM statistic inspects the null hypothesis of no joint serial correlation with individual effects, denoted by  $H_0 = \sigma_\mu^2 = 0; \rho = 0$  or  $H_0 = \sigma_\mu^2 = 0; \lambda = 0$ , since the remainder disturbances ( $v_{it}$ ) may follow either the AR(1) process, where  $|\rho| < 1$ , or the MA(1) process, where  $|\lambda| < 1$  (Baltagi, 2008).

In the case of the AR(1) process (autoregressive),  $v_{it} = \rho v_{i,t-1} + \epsilon_{it}$  and the  $\epsilon_{it}$  seems to be independent of the  $v_{it}$  and identically distributed, signified by  $\epsilon_i \sim IID(0, \sigma_\mu^2)$ .

In the case of the MA(1) process (moving average),  $v_{it} = \epsilon_{it} + \epsilon \lambda_{i,t-1}$  and the  $\epsilon_{it}$  appears to be independent of the  $v_{it}$  and normally distributed suggested by  $\epsilon_i \sim IIN(0, \sigma_\epsilon^2)$ .

Therefore, the LM statistic test for this study is computed as follows:

$$LM = \frac{NT^2}{2(T-1)(T-2)} [A^2 - 4AB + 2TB^2] \stackrel{H_0}{\sim} X_2^2 \quad (63)$$

$A = [\hat{u}'(I_N \otimes J_T)\hat{u}/(\hat{u}'\hat{u})] - 1$  and  $B = (\hat{u}'\hat{u}_{-1}/\hat{u}'\hat{u})$ . In this case, the distribution is asymptotic, especially for large  $N$ , due to the fact that  $X_2^2$  is under  $H_0 = \sigma_\mu^2 = 0; \lambda = 0$  (Baltagi, 2008). In addition, this LM test is sometimes used to test structures of the variance-covariance matrix of the disturbances.

Furthermore, the joint test adjustment is represented by  $4AB$  and the OLS pooled residuals are symbolized by  $\hat{u}$ .

Consequently, rejecting the null hypothesis points out that there is serial correlation across cross-sections or over periods of time, making the estimators unbiased and should remedied using a generalized least squares estimator.

#### 4.4.2.6 Heteroskedasticity test

Testing for heteroskedasticity with panel data intends to check whether the disturbances of a regression given by the same one-way error component model above (see equation (60)) are homoscedastic by means of the same variance among individuals and across periods of time. The homoskedastic error component model was proffered by Mazodier and Trognon (1978). This model was subject to the one-way disturbance term  $u_{it}$  which consists of two components: individual specific error term  $\mu_i \sim (0, \sigma_\mu^2)$  and the remnant error term  $v_{it} \sim (0, \sigma_v^2)$ . The pioneering work of Mazodier and Trognon (1978) was extended by Baltagi and Griffin (1988) in the case of balanced panel data. In addition, heteroskedasticity is considered to appear in the regression through the unit specific error component where the variance of  $\mu_i$  appears to be heteroskedastic and the remainder

disturbance term where, according to Baltagi and Griffin (1988), the variance of  $v_{it}$  seems to be heteroskedasticity.

A Lagrange multiplier (LM) test developed by Verbon (1980) is utilized to test the null hypothesis of homoscedasticity against the heteroskedastic alternative, where  $\mu_i \sim (0, \sigma_{\mu_i}^2)$  and  $v_{it} \sim (0, \sigma_{v_i}^2)$ , implying that  $\mu_i$  and  $v_{it}$  are independent of one another and amongst themselves. It is important to note that heteroskedasticity can only emerge from  $v_{it}$  for the fixed effects model as opposed to the random effects model, where it can result from either  $\mu_i$  or  $v_{it}$  (Baltagi, 2008).

Following Greene (2012), the null and the alternative hypothesis are given by:  $H_0: \sigma_i^2 = \sigma^2$  for all  $i$  where the errors are homoskedastic and  $H_A$ : not equal for all  $i$ .

The LM test statistic is thus obtained with the formulation below:

$$LM = \frac{T}{2} \sum_{i=1}^N \left[ \frac{\hat{\sigma}_i^2}{\hat{\sigma}^2} - 1 \right]^2 \sim \chi_{(N-1)}^2 \quad (64)$$

The residual sum of squares of individual regressions is expressed by:

$$\hat{\sigma}_i^2 = \left( \frac{1}{T} \right) (e_i' e_i) \quad (65)$$

And the residual sum of squares resulting from the OLS pooled model is displayed by

$$\hat{\sigma}^2 = [1/NT] (e' e) \quad (66)$$

It follows that when the null hypothesis means that heteroskedasticity is present in the model (residuals). This may possibly yield misleading regression results. Therefore, heteroskedasticity should be corrected by taking standard errors' rectification into consideration through the white coefficient covariance method (White, 1980).

#### 4.4.2.7 Unit root test

Testing for unit root in panel data aims to check the stationarity of data in this study. It should be noted that the panel root test is not identical with the unit root test in time series. When testing for unit root in panel data, two types of processes such as common unit root and individual unit root are generally used (Baltagi, 2008).

From a common unit root perspective, the persistence parameters are common across all cross-sections. For instance, Levin, Lin, and Chu (LLC) (2002) make use of this assumption to test for unit root. However, in the case of individual unit root tests, the persistent parameters seem to move freely across all cross-sections. This form of text is usually employed by Im, Pesaran, and Shin (IPS) (2003). These two methods are implemented in this study.

The LLC tests the null hypothesis of a unit root contained by each individual time series against an alternative one. The null hypothesis and the alternative one are denoted as follows:

$H_0$  : Each individual time series encompasses a unit root

$H_A$ : Each time series is stationary

A three-step procedure is proposed by Levin, Lin, and Chu (2002), so that their test is implemented. They first start by running separate augmented Dickey-Fuller (ADF) regressions for each  $i$  (each cross-section), expressed by:

$$\Delta y_{it} = \rho_i y_{i,t-1} + \sum_{L=1}^{p_i} \theta_{iL} \Delta y_{i,t-L} + \alpha_{mi} d_{mt} + \varepsilon_{it} \text{ for } m=1, 2, 3 \quad (67)$$

The lag order for each cross section,  $p_i$ , is obtained and orthogonalized residuals are generated. Then, the long-run variance is estimated through non-parametric methods, based on individual cross-section, as follows:

$$\hat{\sigma}_{yi}^2 = \frac{1}{T-1} \sum_{t=2}^T \Delta y_{it}^2 + 2 \sum_{L=1}^{\bar{K}} w_{\bar{K}L} \left[ \frac{1}{T-1} \sum_{t=2+L}^T \Delta y_{it} \Delta y_{i,t-L} \right] \quad (68)$$

The ratio of long-run to short-run deviations is also found. This is estimated by

$$\hat{s}_i = \hat{\sigma}_{yi} / \hat{\sigma}_{\varepsilon i} \quad (69)$$

for each cross-section. In average, this standard deviation is assigned by

$$\hat{S}_N = \frac{1}{N} \sum_{i=1}^N \hat{s}_i \quad (70)$$

Finally, the panel statistic test is computed by running the pooled regression, given by

$$\tilde{e}_{it} = \rho \tilde{v}_{i,t-1} + \tilde{\varepsilon}_{it} \quad (71)$$

in order to find an estimate for  $\rho$ .

Under the null hypothesis,  $H_0: \rho = 0$ , the conventional t-statistic is obtained as follows:

$$t_\rho = \frac{\hat{\rho}}{\hat{\sigma}(\hat{\rho})} \quad (72)$$

$$\hat{\rho} = \frac{\sum_{i=1}^N \sum_{t=2+p_i}^T \hat{v}_{i,t-1} \hat{e}_{it}}{\sum_{i=1}^N \sum_{t=2+p_i}^T \hat{v}_{i,t-1}^2} \text{ and } \hat{\sigma}(\hat{\rho}) = \frac{\hat{\sigma}_{\hat{\rho}}}{[\sum_{i=1}^N \sum_{t=2+p_i}^T \hat{v}_{i,t-1}^2]^{1/2}}.$$

After some adjustments, the t-statistic is computed with the formulation below:

$$t_\rho^* = \frac{t_\rho - N\tilde{T}\hat{S}_N\hat{\sigma}_{\hat{\rho}}^{-2}\hat{\sigma}(\hat{\rho})\mu_{m\tilde{T}}^*}{\sigma_{m\tilde{T}}^*} \sim N(0,1) \quad (73)$$

The average number of observations per cross-section is represented by  $\tilde{T} = T - \tilde{p} - 1$  and the lag order of individual ADF regressions is described in average by  $\tilde{p} = \sum_{i=1}^N p_i / N$ . The mean and standard deviation modifications are symbolized by  $\mu_{m\tilde{T}}^*$  and  $\sigma_{m\tilde{T}}^*$  respectively. In addition, the adjusted t-statistic appears to be distributed asymptotically. Furthermore, potential correlation and heteroskedasticity are allowed by this test.

The IPS checks the null hypothesis against the alternative one denoted respectively by:

$H_0$ : Each individual series in the panel comprises a unit root, that is,  $\rho_i = 0$  for all  $i$ .

$H_A$ : Some (but not all) of the individual series seem to have unit roots implying that  $\rho_i < 0$  for at least one  $i$ .

Im, Pesaran, and Shin (2003) continue by specifying and performing separate augmented Dickey-Fuller regressions for each cross-section with the similar model used for the LLC test. Based on the individual ADF statistics' average, the IPS t-bar statistic is then constructed and expressed by  $\bar{t} = \frac{1}{N} \sum_{i=1}^N t_{\rho_i}$ , where the individual t-statistics for testing the null hypothesis is displayed by  $t_{\rho_i}$ . In addition, this is the case when a heterogeneous coefficient of  $y_{it-1}$  is allowed and different serial correlation characteristics among cross-sectional units exist (Baltagi, 2008).

Following the asymptotic distribution, a standardised test statistic can be computed as follows:

$$t_{IPS} = \frac{\sqrt{N}(\bar{t} - \frac{1}{N} \sum_{i=1}^N E[t_{iT} / \rho_i = 0])}{\sqrt{\frac{1}{N} \sum_{i=1}^N var[t_{iT} / \rho_i = 0]}} \Rightarrow N(0,1) \quad (74)$$

Where  $E[t_{iT}/\rho_i = 0]$  and  $var[t_{iT}/\rho_i] = 0$  refer to means and variances respectively, based on Monte Carlo simulations with different lag orders  $\rho_i$ , values of  $T$ , and the ADF test being performed in a deterministic structure.

Rejecting the null hypothesis for both tests above implies that cross-sections do not have a unit root, therefore panel data is stationary.

#### **4.5 Data Description and Analysis**

A description of data and time period used in this study as well as variables incorporated in both the general and extended gravity models are presented in this section. The empirical analysis of this study uses a dataset for 5 countries, which consists of Brazil, Russia, China, India, and South Africa (the BRICS countries). The exporter country is represented by South Africa, and the rest of BRICS refer to the importer country.

The data collection consists of annual export flows, real GDPs, population, real exchange rate, distance, openness to trade, and language and time dummies designed for BRICS flows of trade analysis. To evaluate South African trade flows with the BRICs, based on data availability, this study is conducted on a sample period 2000-2012. This gestures towards a new epoch in the economy of South Africa, characterized by the absence of apartheid. There have been questions raised on the position of South Africa within the BRIC economies, given its economic size, location, population, and other relevant economic fundamentals. To address this matter, the study attempts to demonstrate how the increased export flows of South Africa are important in the economic growth of the BRIC countries.

Following most previous empirical literature on gravity models, the dependent variable used in this study is the value of bilateral exports measured in U.S. dollars from South Africa to the BRIC nations. They are obtained from the Organization for Economic Co-operation and Development (OECD, 2014). Additionally, there are also independent variables chosen for this study.

A measure of economic size is reflected in the GDPs of South Africa and other BRICS nations. Gross domestic product measures the economic magnitude of each country, which expresses the sum of gross value added by all producers within the geographic boundaries of a country adding any product taxes and subtracting any

subsidies not encompassed in the value of the products. This is relevant because, owing to country's boom or recession, the international trade is affected, thus disturbing the overall revenue of the country (Feenstra et al., 2001).

The gross domestic products of the BRICS economies are obtained from the International Monetary Fund (IMF, 2014). This variable is in constant U.S. dollars and computed on different base years. As a result, the base years of the GDPs are given as follows 1990, 1995, 2004-05, 2005 and 2008 for China, Brazil, India, South Africa and Russia respectively (IMF, 2014). In addition, this variable is expected to be positively and considerably related to the flows of exports in accordance with the gravity model. This illustrates that the volume of trade between two nations is precisely proportional to the economic size of both the exporter and the importer countries. Moreover, population is also contained within the set of explanatory variables in order to estimate the market size, which is directly associated with trade. For instance the bigger the market, the greater its trade, and this variable is presumed to have a positive sign. Data on BRICS' population is obtained from the International Monetary Fund (IMF, 2014), and this variable is in millions persons.

On the empirical front, previous studies have displayed that exchange rates added in the gravity equation significantly describe trade fluctuations among trading countries (Bergstrand, 1985; Dell' Ariccia, 1999; Maradiaga et al., 2012). The incorporation of exchange rate as an explanatory variable in this analysis is important because an appreciation of a country's currency decreases its exports by making them more expensive and increases its imports since they are cheaper. A depreciation of the country's currency will cause the opposite effects. This variable refers to the bilateral real exchange rate between South Africa and each BRIC country, and is expected to have a positive sign.

The variable distance between two counties is also included in the gravity equation, in line with the simple gravity model, and is specified as the geographical distance in kilometers between countries' economic centers, also acknowledged as the capitals. International costs of transaction, which may influence or even impede flows of trade, are represented by this variable. In compliance with the gravity model, this variable is expected to have a negative coefficient since the volume of trade between two countries appears to be inversely proportionate to the geographical distance

between them. The data on distance between South Africa and other BRICS countries was derived from the centre d'etudes prospectives et d'informations internationales (CEPII) and calculated by Mayer and Zignago (2011), and designates distance between the biggest cities of South Africa and other BRICS nations in kilometers. This variable will remain constant over the entire period of the estimation.

The variable openness to trade exhibits the economic integration of a country in the global economy and this is computed as the total trade (the sum of exports and imports) of a nation along with the world economy divided by its GDP. For instance, countries have a tendency to trade more with trading partners that are highly merged with the global economy, revealing an overall propensity of nations for external trade (Head and Ries, 1998). Subsequently, this variable is deemed to have a positive coefficient. Data for BRICS exchange rates and openness to trade are obtained from International Monetary Fund (IMF, 2014).

The dummy variables in this study refer to the common language, taking the value of one if the same language is spoken or shared by the BRICS countries, and zero otherwise, and the time dummy, taking the values between one and the number of observations.

## **4.6 Conclusion**

Although many previous studies highlighted the importance of trade among BRICS economies, a small number of studies have investigated the patterns and magnitude of trade flows between South Africa and the BRIC economies with regards to the economic integration of South Africa into the BRICs. In addition, some authors such as Hongna and Zengfeng (2011), among others, reveal that trade has been rising among BRICS countries, also influencing global trade by the use of the revealed comparative advantage method and trade indicators or indices, instead of the gravity model. In order to address this lacuna, this study aims to estimate the flows of trade between South Africa and other BRICS nations. The gravity model is the preferred framework to conduct an empirical analysis of trade flows among the BRICS economies. The gravity model serves a very effectual and prominent tool in international economics and bilateral trade flows modelling. As it has often been utilised in international trade for empirical studies, theories of the gravity model have been discussed in this chapter, illustrating weak theoretical groundwork and poor

micro-basis from Tinbergen (1962) in the literature. Thus, a number of theoretical developments appear to justify the specifications of the gravity model. Anderson (1979) was the first to try give a general notion of a trade model in which the utility of tradable goods is maximized, products are differentiated, and preferences are homothetic. Herewith, the gravity equation can be derived. There has been a growing interest by Bergstrand (1985, 1989) in investigating theories behind the gravity model, in determining bilateral flows of trade within monopolistic competition models and traded differentiated products and increasing returns to scale perceptions. In their papers, gravity equations were obtained under these assumptions.

From two cases of the Heckscher-Ohlin framework, which consist of frictionless trade and the production of different goods by a single country, Deardorff (1998) indicated that the resultant gravity equations may possibly assess expected bilateral flows of trade among trading partners and describe a great range of models as well. In order to have a successful gravity equation, based on a consistent theory, the examination of a model identification problem was done by Evenett and Keller (2002) to explore principles of the Heckscher-Ohlin model and increasing returns to scale in a specified sample data.

A Ricardian model generated by Eaton and Kortum (2002) was implemented to derive the gravity equation, owing to potential benefits from trade through the principle of comparative advantage. Their gravity equations considered technological differences in production, constant returns to scale, and homothetic preferences. A method, which pertinently and proficiently estimates a theoretical gravity equation, was applied to solve the border puzzle of McCallum with the use of comparative statics analysis by Anderson and Wincoop (2003), revealing that border barriers have a negative impact on national trade and its production.

After finding that the gravity model is the appropriate framework, the generalised model, as well as the augmented model, has been specified. Data and variables included in these models have been discussed and the panel data methodology implemented in this study to check the validity of the framework adopted for the study was described. To investigate the BRICS' trade flows, the data range covers the period of time 2000-2012.

Given that the econometric analysis of panel data is used in this study, both a fixed effects model and a random effects model will examine bilateral trade flows among the BRICS countries. In addition, various tests such as fixed effects, random effects, Hausman specification, heteroskedasticity, serial correlation, and panel unit root will be performed in the next chapter in order to select the right estimator so that the gravity models being assessed will use the appropriate method(s).

# CHAPTER FIVE

## EMPIRICAL ANALYSIS

### 5.1 Introduction

This chapter presents and analyses the estimated results of the specifications of bilateral trade flows between South Africa and other BRICS countries discussed in the previous chapters. This is done by conducting several diagnostic tests such as fixed effects, random effects, poolability, Hausman specification, Heteroskedasticity, serial correlation and panel unit root for checking the adaptability and effectiveness of the gravity models estimated in this study. In addition, these tests serve to choose the most effectual methodology between the pooled, fixed, and random effects procedures, and rectify any biases faced by the models so that the estimated results from regressions carried out below are well received.

Before moving on to the performance of the diagnostic tests, flows of exports' equations are first estimated using the three procedures (pooled OLS, fixed effects, and random effects). This is done due to the lack of an obvious answer in previous empirical studies with regard to which estimation technique offers the most efficient results. Thereafter, the above-mentioned diagnostic tests are carried out, following the approaches discussed in the methodology section (chapter four).

It follows that after obtaining the diagnostic test results, the appropriate model's findings using the best valuation approach will be also discussed and analysed. In addition, the panel regression analysis in this study depends on the value of total exports from South Africa to the rest of the BRICS nations, covering four cross-sections over a period of time 2000-2012 by reason of data accessibility. The independent variables are the real GDP, population, openness to international trade, real exchange rate, and dummy variables (language and time). Moreover, four cross-sections are examined through the 13-year period, producing a total of 52 observations for BRICS' balanced panel data analysis. It is important to note that the dependent variable and the explanatory variables are both expressed in natural logarithms, except for the dummy variables, and their coefficient estimators should be interpreted as the elasticity – or even the approximated percentage change – in bilateral exports from South Africa to the other BRICS economies when each of the independent variables under consideration rises by one percent. The purpose behind

investigating those regressions is to provide a general idea of how bilateral trade flows between South Africa and the rest of the BRICS nations are determined.

The rest of the chapter is structured as follows: section 5.2 reports on and outlines results examining bilateral flows of trade between South Africa and the BRICs from the OLS pooled estimation, fixed effects, and random effects methods, using equations of the standard gravity model and the augmented one (see table one and two respectively). The next section (5.3) provides panel procedures tests as described in the previous chapter. Section 5.4 presents and analyses the best estimation technique with respect to the panel regression analysis in the case of South Africa and the rest of the BRIC countries. The last section (5.5) concludes the chapter.

## 5.2 Results Based on OLS Pooled, Fixed Effect, and Random Effect Models

Results from both the standard and the augmented gravity models are reported in tables 5.1 and 5.2 respectively, presenting the coefficient estimators obtained from the three estimation techniques.

Table 5.4. Estimated results for the standard gravity model

Variables	Pooled model	Fixed effects model	Random effects model
Constant	-586.740 (-3.96) ***	-179.24 (-5.49) ***	-586.740 (-3.96) ***
South Africa's GDP	0.066 (0.31)	-0.056 (-0.28)	0.066 (0.309)
BRIC's GDP	1.046 (4.25) ***	1.077 (4.46) ***	1.046 (4.25) ***
South Africa's Population	30.627(4.20) ***	14.163 (7.11) ***	30.627 (4.20) ***
BRIC's population	-2.304 (-1.53)*	-3.273 (-2.02) **	2.304 (-1.53)*
Distance	10.868 (1.98) **		10.868 (1.98) **
Language dummy	5.654 (2.19) **		5.654 (2.19) **
Time dummy	-0.204 (-2.67) ***		-0.204 (-2.67) ***
<b>R-Squared</b>	<b>0.97</b>	<b>0.97</b>	<b>0.97</b>
<b>Adjusted R-squared</b>	<b>0.96</b>	<b>0.96</b>	<b>0.96</b>

Notes: \*\*\*/\*\*/\* significant at 1%/ 5%/ 10% level. The T-statistics are in parentheses.

Source: Author's calculation from Eviews 8.

Table 5.5. Estimated results for the augmented gravity model

Variables	Pooled model	Fixed effects model	Random effects model
Constant	-1134.963 (-6.80) ***	-80.035 (-2.76) ***	-1134.963 (6.80) ***
South Africa's GDP	-0.451 (-1.68) *	-0.686 (-2.73) ***	-0.451 (-1.68) *
BRIC's GDP	1.558 (5.85) ***	1.540 (6.19) ***	1.558 (5.85) ***
South Africa's population	58.671 (7.08) ***	16.010 (9.26) ***	58.671 (7.08) ***
BRIC's population	-8.187 (-4.80) ***	-9.953 (-5.67) ***	-8.187 (-4.80) ***
Real exchange rate	-0.443 (-1.94) *	-0.334 (-1.54) *	-0.443 (-1.94) *
South Africa's openness	-0.554 (-1.37)	-0.515 (-1.37)	-0.554 (-1.37)
BRIC'S openness	1.580 (5.27) ***	1.626 (5.89) ***	1.580 (5.27) ***
Distance	29.627 (4.85) ***		29.627 (4.85) ***
Language dummy	15.771 (5.29) ***		15.771 (5.29) ***
Time dummy	-0.526 (-5.98) ***		-0.526 (-5.98) ***
<b>R-Squared</b>	<b>0.98</b>	<b>0.98</b>	<b>0.98</b>
<b>Adjusted R-squared</b>	<b>0.98</b>	<b>0.98</b>	<b>0.98</b>

Notes: \*\*\*/\*\*/\* significant at 1%/ 5%/ 10% level. The T-statistics are in parentheses.

Source: Author's calculation from Eviews 8.

Following the three assessment methods above, which analyse bilateral trade flows between South Africa (exporter country) and the BRIC countries (importer countries), both flows of exports' equations display coherent coefficient estimators. These coefficients have practically all the expected signs, apart from distance and both GDP and openness to international trade in South Africa. In addition, the significance of the coefficients in the pooled model tends to be similar to those in the random effect method, yet prominently different from those in the fixed effects estimation technique. This may possibly be biased results, due to the fact that country individual effects are disregarded in pooled estimation procedure, and the random effects are non-existent. Moreover, all coefficients, except for South Africa's openness to trade, appear to be statistically significant at 1% and 10% levels. Considering their significance, these coefficients seem to have an impact on bilateral flows of trade

between South Africa and the rest of the BRICS nations. As significant results are exhibited – which are certainly related to their volumes of trade as they have strong effect on the BRICS’ export flows – this implies that flows of trade between South Africa and the BRIC countries are likely determined by economic size, market size, real exchange rate, distance, the importer countries’ openness to trade, and the dummy variables.

### 5.3 Diagnostic Tests

Before selecting the most efficient method and examining the estimated results of the panel regression in accordance with the best appraisal technique in this study, numerous diagnostic tests are required. Adhering to this requirement ensures that the estimated regressions portraying bilateral trade flows between South Africa and other BRICS countries will no longer be biased and their coefficient estimators accurately elucidated.

#### 5.3.1 Fixed effects or individual effects test

The F-statistic test follows the approach employed by Wooldridge (2012) and Baltagi (2008). It is requisite to compare the F-statistic tests conducted with the F-critical value in order to decide whether or not individual effects exist in both gravity models.

The value of the critical F-statistic is computed as follows:  $F_{(N-1),(NT-N-K)}$  when precise individual effects are tested.  $[(N - 1), (NT - N - K)]$  represents the degree of freedom (d.f), the number of cross sections, time, and parameters are denoted respectively by  $N, T$ , and  $K$ . In addition, when both individual and time effects are tested, the critical F-value is obtained with the following formulation:  $F_{(N+T-2),(N-1)(T-1)-K}$ . The degree of freedom is now described by:  $[(N + T - 2), (N - 1)(T - 1) - K]$ , while the rest remains the same.

Table 5.6. Test cross section fixed-effects for the standard gravity equation

Effects Test	Statistic	d.f	Prob.
Cross-section F	35.0437	(3,44)	0.0000

Source: Author’s own calculations from Eviews 8.

F-critical=  $F_{(N-1),(NT-N-K)} = 2.62, 1.98$  and  $1.70$  at 1%, 5% and 10% significance levels respectively.

Table 5.7. Test cross section fixed-effects for the augmented gravity equation

Effects Test	Statistic	d.f	Prob.
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to the chi-square (2) value (critical value), in order to reject or accept the null hypothesis.

Table 5.10. The Breusch-Pagan Test for the standard gravity equation

<b>Effects Test</b>	<b>Statistic</b>
<i>Cross-section LM<sub>1</sub></i>	2.1662
<i>Period LM<sub>2</sub></i>	1.9412
<i>LM = LM<sub>1</sub> + LM<sub>2</sub></i>	4.1079

Source: Author's own calculations from Eviews 8.

Table 5.11. The Breusch-Pagan Test for the augmented gravity equation

<b>Effects Test</b>	<b>Statistic</b>
<i>Cross-section LM<sub>1</sub></i>	2.1652
<i>Period LM<sub>2</sub></i>	1.1458
<i>LM = LM<sub>1</sub> + LM<sub>2</sub></i>	3.3125

Source: Author's own calculations from Eviews 8.

Given the chi-square (2) value [ $\chi^2(2)$ ] equals to 9.21, 5.99, and 4.61 at 1%, 5%, and 10% levels of significance respectively, the LM statistic test for random effects reveals that there is no heterogeneity among the BRICS countries. The null hypothesis is not rejected in support of the nonexistence of random effects in both gravity equations, as that the LM statistic goes below the critical value  $\chi^2(2)$  (Tables 5.7 and 5.8). Therefore, the random effects seem to not be valid in this study.

### 5.3.3 Poolability Test

Following the structure of the Chow test's extension or F-statistic test (Chow, 1960), the null hypothesis – inferring that all coefficients are identical across cross-sections and over a period of time – is tested. It is important to note that individual regressions for each BRICS cross-section are performed, and the F-statistic obtained is compared, along with the critical value, calculated as follows:  $F_{((N-1)K', N(T-K'))}$ . The degrees of freedom of the numerator and denominator refer to  $((N - 1)K', N(T - K'))$ .

Table 5.12. Extension of Chow test or F-statistic test for the standard gravity equation

<b>Poolability Test</b>	<b>Statistic</b>	<b>d.f</b>
<i>Cross-section F</i>	3.0791	(15,32)

Source: Author's own calculations from Eviews 8.

F-critical=  $F_{((N-1)K',N(T-K'))}$  = 2.65, 1.99 and 1.71 at 1%, 5% and 10% significance levels respectively.

Table 5.13. Extension of Chow test or F-statistic test for the augmented gravity equation

<b>Poolability Test</b>	<b>Statistic</b>	<b>d.f</b>
<i>Cross-section F</i>	2.1310	(24,20)

Source: Author's own calculations from Eviews 8.

F-critical=  $F_{((N-1)K',N(T-K'))}$  = 2.86, 2.08 and 1.77 at 1%, 5% and 10% levels of significance respectively.

Tests conducted on poolability exhibit that the resolved F-statistics exceed the critical values at all significance levels, and at least a 5 percent level of significance for both the basic and augmented gravity models (Tables 5.9 and 5.10). For this reason, the null hypothesis is rejected. This implicates that common intercept and slope coefficients are not pertinent analysing for BRICS' trade flows. Therefore, both models used for this study should not be pooled on account of the heterogeneity's existence among the BRICS cross-sections. Thus, the suitable model that should be assessed using the two equations in this case could be either the fixed effects model or the random effects model.

### 5.3.4 Hausman specification test

To select the most appropriate model – either the fixed effects model or the random effects model – in this study, the Hausman test for regressors' exogeneity or misspecification is performed. In addition, it is imperative to compare the test statistics calculated against the chi-square ( $K$ ) critical value.

Table 5.14. Correlated random effects – Hausman test for the standard gravity equation

<b>Test summary</b>	<b><math>\chi^2</math> Statistic</b>	<b><math>\chi^2</math> d.f</b>	<b>Prob</b>
<i>Cross-section <math>m_1</math></i>	0.4130	7	0.9814

Source: Author's own calculations from Eviews 8.

With  $K= 4$ , chi-square (4) critical value = 13.28, 9.49 and 7.78 at 1%, 5% and 10% levels of significance respectively.

Table 5.15. Correlated random effects – Hausman test for the augmented gravity equation

Test summary	$\chi^2$ Statistic	$\chi^2$ d.f	Prob
Cross-section $m_1$	0.2297	7	1.0000

Source: Author's own calculations from Eviews 8.

With  $K=7$ , chi-square (7) critical value = 18.48, 14.07 and 12.02 at 1%, 5% and 10% significance levels one after another.

The results of the Hausman specification test carried out in Table 5.11 and Table 5.12 demonstrate that the test statistics are lower than the critical values at the significant levels mentioned above, suggesting exogeneity or no misspecification of the BRICS regressors. The null hypothesis thus could not be rejected. In other words, there is no correlation between individual effects and any regressors in both gravity equations analyzing BRICS flows of trade. In addition, when the null hypothesis is not rejected, it is important to note that the random effects model is favored over the fixed effects model, even though both models seem to be appropriate in generating consistent estimates of the regression's parameters. However, in this study the random effects are absent in both gravity equations analyzing the BRICS' export flows. Therefore, the fixed effects model is preferred over the random effects model, because of the heterogeneity across BRICS cross-sections acknowledged by this model when estimating these countries' specific effects. For that reason, in this case study, the fixed effects model appears to be relevant for BRICS analysis in view of consistent parameter regressions' estimation.

### 5.3.5 Serial correlation test

In order to detect serial correlation in the error component disturbances, the Durbin-Watson statistic (DW) and the Lagrange Multiplier (LM) statistic test the null hypothesis of no serial correlation across BRICS cross-sections in the period of time covered in this study. It follows that the LM statistic test and the DW statistic are compared, together with the chi-square (2) critical value and the critical values proposed by Bhargava et al. (1982).

Table 5.16. Serial correlation test for the standard gravity equation

Effects Test	Statistic
$LM$	12.9232
$D_p$	1.2864

Source: Author's own calculations from Eviews 8.

Where  $D_p$  stands for the Durbin-Watson statistic generalized to panel data.

The chi-square (2) critical value [ $\chi^2(2)$ ] = 9.2103, 5.9915 and 4.6052 at 1%, 5% and 10% levels of significance one-to-one.

Critical values obtained from table II in Bhargava et al (1982) indicate that  $D_{PL} = 1.8421$  and  $D_{PU} = 1.8688$ .

Besides, it should be noted that the same critical values given above are also used for the augmented gravity equation.

Table 5.17. Serial correlation test for the augmented gravity equation

Effects Test	Statistic
<i>LM</i>	2.1681
$D_p$	1.9459

Source: Author's own calculations from Eviews 8.

The outcomes of the tests for serial correlation among the residuals conducted in Table 5.13 and Table 5.14 reveal existing positive first-order serial correlation in only the standard gravity model. This is owing to the fact that the obtained LM statistic is higher than the chi-square (2) critical value and the  $D_p$  statistic lies between 0 and 1.8421, leading to the rejection of the null hypothesis. The above test suggests that there is no serial correlation when the basic gravity model is augmented because of the non-rejection of the null hypothesis, since the LM statistic is less than the chi-square (2) critical value and  $D_{PL} = 1.8421 < D_p < 2$ .

With respect to the standard gravity model, correction for the existent serial correlation is required, so that this matter is removed from this trade equation's residuals. It is thus necessary to determine the serial correlation parameter given by  $\rho$  so that all BRICS data series are altered by means of this parameter. As a consequence, the converted series will be now denoted as follows:  $Y_{it}^* = Y_{it} - \rho Y_{i,t-1}$  for the dependent variable and  $X_{it}^* = X_{it} - \rho X_{i,t-1}$  for the explanatory variables. However, an observation is lost due to the difference in the data set. The serial correlation parameter  $\rho$  is found by running another regression, with the residuals from the pooled model as the dependent variable and the lagged value of these residuals as the independent variable. The result is displayed in Table 5.15 below.

Table 5.18. Serial correlation parameter: regression on residuals

Variable	Standard gravity model
<i>Residuals (-1)</i>	0.339063 (2.56) ***

Notes: \*\*\*/\*\*/\* significant at 1%/ 5%/ 10% level. The T-statistics are in parentheses

Source: Author's calculation from Eviews 8.

Therefore, as evident in Table 5.15, the appraised parameter for serial correlation ( $\rho$ ) equals 0.339063 for the standard gravity equation. This implies that the transformed series assessed are expressed now with the following formulations:  $Y_{it}^* = Y_{it} - 0.339063Y_{i,t-1}$  and  $X_{it}^* = X_{it} - 0.339063X_{i,t-1}$  for the standard gravity equation. After changing all BRICS data series, the test for serial correlation is once more performed and scrutinised.

Table 5.19. Serial correlation for the standard gravity equation with transformed data series

Effects Test	Statistic
<i>LM</i>	2.3122
<i>D<sub>p</sub></i>	1.9570

Source: Author's own calculations from Eviews 8

The results of the serial correlation displays that the problem is solved and there is no more first order serial correlation present in the simple gravity equation analyzing BRICS trade flows, since the  $D_p$  statistic lies between  $D_{PL} = 1.8421$  and 2. In addition, the LM statistic is lower than the chi-square (2) critical value (Table 5.16).

### 5.3.6 Heteroskedasticity test

This test follows the technique used by Greene (2012) and Baltagi (2008), based on the work of Verbon (1980). By the means of the Lagrange Multiplier (LM) statistic test, the null hypothesis of the disturbance terms' homoscedasticity is examined. In addition, the LM statistic found is compared with the chi-square ( $N - 1$ ) critical value. This study consists of 4 cross-sections ( $N$ ).

Table 5.20. Heteroskedasticity test for the standard gravity equation

Test outline	statistic
<i>Cross-section LM</i>	9.5025

Source: Author's calculation from Eviews 8. Chi-square ( $N - 1$ ) critical value =  $\chi^2(3) = 11.3449, 7.8147$  and  $6.2514$  at 1%, 5% and 10% significance levels respectively. This critical value is also similar to the case of the augmented gravity model.

Table 5.21. Heteroskedasticity test for the augmented gravity equation

Test outline	statistic
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Source: Author's own calculations from Eviews 8.

The test on Heteroskedasticity performed in Tables 5.17 and 5.18 discloses the presence of Heteroskedasticity in both gravity equations used for BRICS analysis, due to the rejection of the null hypothesis, suggesting that errors are homoscedastic. In addition, the null hypothesis is rejected, given that the LM statistic tests are higher than the critical values at 5 percent for the standard gravity model and all levels of significance for the augmented gravity model. This implies that the results or regression will be biased, generating inconsistent estimates. Given this, the correction of the Heteroskedasticity should be done by virtue of the white cross-section covariance method before running regressions for this study.

### 5.3.7 Panel Unit root test.

To investigate the stationarity of panel data in each BRICS cross-section, Levin, Lin, Chu (LLC) (2002) and Im, Pesaran, Shin (IPS) (2003) unit root tests are performed, following the procedure described by Baltagi (2008). In addition, these tests are operated on all the variables by means of the test regression, encompassing only individual intercepts or constants with trend specification. In addition, these tests are required to investigate whether or not there is a feasibly cointegrated relationship between variables. Moreover, the panel unit root test could not check the stationarity of distance and common language referring to dummy variables, as they are fixed and time unresponsive. It follows that both tests are compared with the critical values, based on the p-value, given as follows: 0.01, 0.05, and 0.1 at 10%, 5%, and 1% levels of significance respectively.

Table 5.22. Panel unit root test for the standard and augmented gravity models

<i>Series</i>	<i>LLC</i>	<i>IPS</i>
Exports	-5.023 (0.00) ***	-3.711 (0.00) ***
South Africa's GDP	-9.096 (0.00) ***	-5.188 (0.00) ***
BRIC's GDP	-4.173 (0.00) ***	-2.677 (0.00) ***
South Africa's population	-3.836 (0.00) ***	-2.060 (0.02) **
BRIC's population	-4.695 (0.00) ***	-2.700 (0.00) ***
Real exchange rate	-9.719 (0.00) ***	-4.326 (0.00) ***

South Africa's openness	-3.975 (0.00) ***	-2.612 (0.00) ***
BRIC's openness	-2.206 (0.01) ***	-3.267 (0.00) ***

Notes: \*\*\*/\*\*/\* significant at 1%/ 5%/ 10% level. In addition, probabilities of the panel unit root test are assigned in parentheses. Source: Author's calculation from Eviews 8.

When executing both the LLC and the IPS tests, the results of these tests display that all variables are stationary owing to the refusal of the null hypothesis in support of the alternative hypothesis. This suggests that at least one individual series does not embrace a unit root since their p-value is less than the critical p-value and, for that reason, it may possibly be concluded that the panel data used for BRICS analysis is stationary (Table 5.19). Therefore, this implies that it is not necessary to perform a co-integration test and both the standard and augmented gravity equations exploring flows of trade between South Africa and the rest of BRICs can be assessed utilising the ordinary least square process.

#### **5.4 Empirical Results: Fixed Effects Estimation Results**

After performing the diagnostic tests presented above, a panel of trade analysis with a fixed effects model for BRICS countries is conducted. This is because of the fact that the random effects model did not acknowledge heterogeneity in the BRICS cross-sections when performing the LM test. The fixed effects model thus is preferred in this study. The interpretation of the results will be centered on both standard and augmented fixed effects models. It is important to note that the evaluated time period changes and, at the moment, is from 2001 to 2012 in consequence of serial correlation's correction, leading to a deficit in an observation for the standard gravity model only. In addition, 48 observations in total are currently used for BRICS panel data analysis for the basic gravity equation. However, the period of time (2000-2012) as well as the number of observations remains the same when the standard gravity model is augmented. In addition, both gravity equations are corrected, owing to the presence of Heteroskedasticity in the error terms. The results of the fixed effects regression for both equations (the standard and the augmented) are estimated and are reported in Table 5.20 below.

Table 5.23. Estimated results for the standard and augmented gravity equations

Variables	Standard fixed effects model	Augmented fixed effects model
Constant	-150.248 (-5.19) ***	-80.035 (-3.34) ***
South Africa's GDP	-0.094 (-0.78)	0.686 (-3.15) ***
BRIC's GDP	0.694 (3.16) ***	1.540 (7.09) ***
South Africa's Population	15.977 (8.83) ***	16.010 (10.98) ***
BRIC's population	-2.036 (-0.84)	-9.953 (-6.15) ***
Exchange rate		-0.334 (-1.73) *
South Africa's Openness		-0.516 (-1.35)
BRIC's openness		1.626 (6.67) ***
<b>Adjusted R-squared</b>	<b>0.92</b>	<b>0.98</b>
<b>F-statistic test</b>	<b>35.04</b>	<b>32.12</b>

Notes: \*\*\*/\*\*/\* significant at 1%/ 5%/ 10% level. The T-statistics are in parentheses

Source: Author's calculation from Eviews 8.

The result of the standard gravity model as reported in column 1 of Table 5.20, revealing that all coefficients, aside from South Africa's GDP and the population of the BRIC countries, are found to be statistically significant at the 1% level. In other words, they have a strong effect in bilateral flows of trade between South Africa and the BRIC nations, as they do play a significant role in explaining patterns of trade among BRICS economies. The estimated coefficient on the BRIC's GDP has a positive influence on the flows of exports between South Africa and the rest of the BRICS countries. This suggests that an increase by 1% in the GDP of the BRIC economies will lead to an increase in the South African export flows of 0.69%. This is in accord with the expected theories. The positive and significant sign of the population's coefficient in South Africa displays that the country expands its exports when its population rises by reason of economies of scale. For instance, South Africa's bilateral exports with the BRIC countries increase by approximately 16% as South Africa's population grows by 1%. This result is coherent with the gravity model assumption that states that volumes of trade rise together with an increase in market

size. In addition, bigger markets tend to produce more goods and services for exports, which, in turn, lead to the increase of demand for importing goods.

It follows that when the basic gravity equation is augmented, the result of this regression, as exhibited in column 2 of Table 5.20, indicates all coefficients are statistically significant, apart from only the openness to international trade variable in South Africa. This means that they have an impact on the flows of trade between South Africa and the BRIC nations. In addition, as reported by the regression results, all coefficients appear to have the expected signs, which do not contradict with the theory of the gravity model, except for the real GDP variable in South Africa. The positive and significant sign of the GDP in the BRIC economies has the similar explanation as above-mentioned but, in this case, a 1% growth in the BRIC's GDP also increases exports flows from South Africa to the BRIC nations by 1.54%. South African GDP has a negative and significant coefficient on the export flows between the country and the BRIC economies. This is not in agreement with the theoretical expectations and this may possibly be attributed to the fact that there has been an accelerated economic growth in South Africa, especially during 2003-2006, which reached more than 5 percent in 2006. In addition, its domestic market was also increasing. Therefore, the expansion of economic growth, together with the local market, can raise consumption and reduce South Africa's exports flows to the BRIC economies. With regards to the population variable, the coefficient in South Africa exhibits a positive and significant sign on trade flows, following the same explanations for the basic gravity model described above. The BRIC's population has a negative and significant coefficient, displaying that they are negatively related to the bilateral flows of exports between South Africa and the remaining BRICS countries. This implies that the growth in the BRIC's population will lead to the expansion of their local markets, thus creating a greater magnitude of self-sustenance and, as a consequence, there will be no exigency to trade between them. These results are in conformity with the expected theories and correspond favourably to those computed by Eita and Joordan (2007), amongst others.

As can be seen from the estimated results in Table 5.20 in column 2, the coefficient value of real exchange rate is found to be statistically significant at the 10% level only, and carries a negative sign (not the expected sign), which is in agreement with some papers, namely that of Dell' Ariccia (1999). The negative coefficient of

exchange rate might be attributed to the fact that South Africa's bilateral flows of exports with other BRICS nations rely upon its currency appreciation, which is described by an increase in its real exchange rate. This implies that the appreciation of the South African Rand against the BRIC's currencies discourages bilateral exports from South Africa to the BRIC countries and worsens their trade relations to a maximum level. For instance, South Africa tends to import more from the BRICs, given that imports become cheaper than exports, which, in turn, results in the depreciation of the Rand during the period time under study. In addition, South Africa had a trade surplus with only Russia. From this estimated regression's outcome, it is clear that 1% currency appreciation leads to (while holding other explanatory variables constant) a 0.334% decline in South African exports to the BRIC countries. As above-mentioned, it is important to note that the South African Reserve Bank should make an effort in stabilising the exchange rate with the BRIC economies, since the Rand has been growing weaker against most main currencies in the global economy. In addition, price competitiveness should be substantial for bilateral flows of trade between South Africa and the BRIC nations.

As shown in Table 5.20, the South African openness variable does not have the expected positive sign, but is found to be statistically insignificant. This means that this variable seems not to have an effect on the flows of trade between South Africa and the BRIC countries. The coefficient of the openness variable for the BRIC countries has the expected positive sign and is found to be statistically significant at the 1% level. This implies that South Africa trade with all other BRICS nations is presumably going to considerably improve, together with trade barriers' liberalisation in the BRIC countries. In addition, the regression's result suggests that a 1% increase in the trade openness in the BRIC countries could also increase South Africa exports with these countries by about 1.63%.

Furthermore, the overall performance of both models, for instance the goodness of these models' fit, appear to be extremely positive, with an R-squared of 0.92 and 0.98 for the standard and the augmented gravity equations respectively. This means that both gravity equations used in this study are proficient in explaining more than 90% of the variances in bilateral exports between South Africa and the rest of the BRICS nations (the dependent variable).

Moreover, it is evident that the fixed effects model does not seem to be able to administrate time-invariant variables by reason of perfect multicollinearity and lack of variations inside of these variables. As acknowledged in previous studies, this is owing to time insensitivity. Because of this, a separate regression, with individual fixed effects as the dependent variable and distance and dummy variables as the explanatory variables, needs to be conducted, so that these variables may be estimated in the second step (Zarzoso and Lehmann, 2003). The results of the second-stage estimation are presented in Table 5.21, below describing both the standard and augmented regressions.

Table 5.24. Second stage results: fixed effects regressed on dummies

Variables	Standard fixed effects model	Augmented fixed effects model
Constant	-121.761 (-22.57) ***	-307.979 (-24.36) ***
Distance	13.787 (22.90) ***	34.792 (24.65) ***
Language dummy	7.123 (21.71) ***	18.391 (23.92) ***
Time dummy	-0.232 (-21.82) ***	-0.562 (-22.57) ***
<b>Adjusted R-squared</b>	<b>0.95</b>	<b>0.95</b>

Notes: \*\*\*/\*\*/\* significant at 1%/ 5%/ 10% level. The T-statistics are in parentheses

Source: Author's calculation from Eviews 8.

From both estimated results of Table 5.21, the variable distance has a significant and positive effect on South African trade flows with the BRIC countries. This is not in line with the theory of the gravity model, because the long geographical distance between South Africa and the BRICs should raise transportation costs and therefore affect flows of trade negatively. This positive coefficient can be attributed to the fact technological innovation and progress has been promoted in South Africa, making the geographical distance less important. For instance, the development of information and communication technology as well as the use of internet amplifies the flows of exports among BRICS economies, since they diminish all transaction and transportation costs involved by South African trade with the BRIC nations. Additionally, this may possibly be owing to the geographical closeness of China, India, and Russia, which is beneficial to increasing South African exports with the BRIC countries and reducing the influence of distance.

The language dummy variable displays the expected positive sign and is found to be significant at the 1% level. This implies that the BRIC nations, where English is the official language, is influential in increasing South African flows of exports to the rest

of the BRICS group. The significant and negative value of time dummy's coefficient suggests that export flows from South Africa to other BRICS economies decreases during the time period under this study. This also indicates that South African exports do change in respect of time. For instance, it is important to note that South Africa tends to import more from than export to China, Brazil, and India denoting a trade deficit. However, Russia had a trade surplus with South Africa from 2000-2012.

Regarding specific fixed cross-sectional effects, a positive sign or a negative sign is an indicative of a positive or negative effect of each BRIC country on the South African trade pattern. It follows that, apart from Brazil and Russia, there is a positive impact on South African pattern of trade with China and India. It is evident that growing bilateral flows between South Africa and the BRICs nations are probably going to be driven more by China's and India's economies, followed by Brazil's and Russia's.

## **5.5 Conclusion**

The purpose of this chapter was to investigate BRICS bilateral flows of trade regressions using both the standard and the augmented gravity models of trade. Regarding the analysis of the results, the augmented gravity model has been estimated by means of a balanced panel data of BRICS trading pairs along with 52 observations over the period 2000-2012. The standard gravity equation was assessed with 48 observations for the time period 2001-2012. In addition, the number of observations and time period has changed for the simple model, in consequence of serial correlation's rectification. Conclusions drawn from empirical results in this study are subject to diagnostic tests conducted. Based on the outcome of the diagnostic tests, the fixed effects estimation technique is chosen due to the absence of random effects and is used in this study in order to examine export flows from South Africa to the BRIC economies. In addition, diagnostic test results disclose that there are fixed individual effects, together with time effects, present in both gravity equations, implying that both models of trade should not be pooled. Moreover, there are problems of heteroskedasticity and serial correlation in the sample panel data employed in this study, which have been corrected in order to avoid misleading results. Furthermore, panel unit root test demonstrates that all variables are stationary and could not provide results for time-invariant variables such as distance and dummy variables.

From the regression results demonstrated, both gravity models of trade properly fit the data and explain more than 90 percent of the variation in bilateral exports across BRICS countries. According to the regression's results, all independent variables except for the openness of trade in South Africa are found to be significant in determining the level of exports flows from South Africa to the rest of the BRICS economies. This implies that they have greater influence on bilateral export flows across BRICS countries. The South African openness to trade variable is found insignificant, having no impact on trade flows between South Africa and the BRIC nations. As reported by the results, it has been shown that South Africa's exports is positively related to the economic size (GDP) as well as the openness of the BRIC trading countries, the population of South Africa, distance, and language dummy. This implies that the BRIC countries should increase their real GDPs to a greater extent and must loosen their trade barriers. In addition, market size should grow more and technological communication, information, as well as infrastructure should be further improved in South Africa. Moreover, South Africa's exports with the BRIC countries are promoted when the same official language (English, in this case) is spoken. However, the exchange rate, along with South Africa's GDP and time dummy, has a negative effect on the South Africa's exports. This suggests that South Africa's currency requires imperative depreciation against of the currencies of the BRIC nations to enhance South Africa's flows of exports with the BRIC economies and eradicate the current trade deficit amongst them (except for Russia). The negative effect time dummy has been explained by the tendency of South Africa importing more than exporting to BRIC nations during time period under consideration. Furthermore, the high growth and consumption in South Africa reduces exports, as reflected in the negative impact of GDP on exports.

## **CHAPTER SIX**

### **CONCLUSIONS POLICY RECOMMENDATIONS AND AREAS FOR FURTHER RESEARCH**

#### **6.1 Conclusions**

This study examines the magnitude of trade flows between South Africa and the BRIC countries. A comparative analysis is conducted in Chapter Two in terms of these countries' performance in economic growth, trade flows, exchange rate, and distance, in order to observe changes they have created in the global economy and how they have contributed in the main sectors of their economies. Among BRICS countries, China is found to be the most prominent in this group in terms of economic growth and trade flows. In addition, China represents an emerging economic market with a high rate of economic growth and a great prospective for imports and exports. China is the largest partner of trade for Brazil, Russia, and South Africa, while the value of real GDP per capita is found to be high in Russia, followed by South Africa, as compared with China. However, South African economic performance is lower than that of other BRICS countries. South Africa imports more from than exports to the BRIC countries. In addition, the Chinese Renminbi appears to be the strongest currency performing against the U.S. dollar since 1994, due to its higher rate of appreciation as contrasted with the currencies of the rest of the BRICS, which have been fluctuated and mostly depreciated, especially in the case of the Russian Rupee (weakest currency). In terms of the real effective exchange rate, the BRICS countries experienced real depreciation over both periods of time 1994-1998, and 2004-2011 (except for South Africa). Several exchange controls are regulated by each of BRICS government for all transactions performed in the exchange market. In terms of distance, Russia, India, and China are closer, as compared with South Africa and Brazil. Moreover, BRICS economies are found to be mainly driven by services followed by industry, then manufacturing sectors. Additionally, the agriculture sector is growing slower than other sectors, contributing less to these countries.

With respect to international trade flows, theories such as the absolute advantage theory, comparative advantage theory, the Heckscher-Ohlin model, the new trade

theory and the gravity model have been reviewed and evaluated to understand the pattern of trade flows among countries and determine the best theoretical configuration in Chapter Three. Considering the weaknesses of the classical and modern theories, the gravity model reveals its capacity to explore the magnitude of trade flows between two or more countries, regardless of its unsatisfactory theoretical foundation. Empirically, most studies have used the gravity model to determine factors and potential of trade (exports) flows. However, few studies have examined the patterns and magnitude of trade flows between South Africa and the BRIC economies. This study thus addressed this deficit in the existing literature by applying the gravity model for BRICS empirical analysis. With reference to Chapter Four of this thesis, the gravity model is chosen to be the preferred theoretical framework, rather than other theories of international trade which were adopted in the literature, describing trade flows between South Africa and the BRICs. Furthermore, in view of many previous empirical studies, this model represents a successful tool in correctly explaining bilateral trade flows for developing and African countries, not only developed countries. For that reason, the application of the gravity model is theoretically justified at the current moment after many attempts by many authors (such as Anderson (1979), Bergstrand (1985, 1989), Deardorff (1995, 1998), as well as Anderson and Wincoop (2003) amongst others) to provide a sound theoretical foundation of the gravity model of trade.

Furthermore, the study uses panel data econometrics technique, in preference to cross-section data technique, due to biased results and lack of heterogeneity's control that the latter may produce in the context of the gravity model. In addition, the generalised and augmented gravity models of trade used for this study has been specified and estimated. With reference to these gravity models, data used in this study is as follows: annual export flows, real GDPs, populations, real exchange rate, distance, language, time, and openness to trade. These variables are chosen to specify how bilateral trade flows are determined between South Africa and other BRICS countries in view of the South African economic integration into the BRICs. Based on data availability, this analysis covers a sample period of time 2000-2012. Among these variables, GDPs, populations, language, exchange rate, and openness to trade were expected to be positively related to export flows, while the rest of the variables were expected to have a negative sign.

The empirical part of this study is presented in Chapter Five, which represents and analyses the main findings of the study. Moreover, the fixed effects model approach is employed as suggested by the results of the diagnostic tests, instead of the pooled method, as it prevents the omission of appropriate variables (for instance, the heterogeneity bias). It is also important to note that this estimation technique allows for the acknowledgement of BRICS countries' specific effects, controlling for unobserved meaningful variables. As a result, the country-pair effects are examined to determine how high bilateral trade exposure is among BRICS nations, as they capture factors involved in the volume of trade.

By using both the standard and the augmented gravity equations, the empirical findings were consistent with the previous studies such as Eita and Jordaan (2011), amongst others. The main determinants of trade flows between South Africa and the BRIC nations are exchange rate, distance, language, time and BRIC's openness and GDP, as well as population for both the exporter and the importer countries. In addition, the overall performance of both gravity equations is extremely good in describing on average 95 percent of the variation in bilateral exports among BRICS emerging economies. It follows that South African population, distance, language dummy, and BRIC's GDP and openness are found to be positively related to bilateral exports from South Africa to the BRIC emerging economies. This implies that the rise in the above-mentioned factors is the reasons, which contribute to the increase in trade flows during the time period under study.

## **6.2 Policy Recommendations**

As a consequence, South Africa should promote policies that permit necessary and increased labour market flexibility as its population should be expected to increase. Policies that lead to the exceptional advancement of the domestic economy through trade liberalisation are indispensable in each BRIC country. South Africa should improve policies that make distance less important in its trade flows with the BRIC countries by investing more on advanced and efficient communication devices as well as infrastructure in the country. Nevertheless, GDP in South Africa, real exchange rate, and time dummy have not been favourable as they have affected negatively trade flows in this context. For this reason, South Africa should encourage policies that facilitate the country to gain more access to international markets such as other the BRICS countries, in order to accelerate its economic development

progress, regardless of the consumption market or market size's growth. In addition, market access for exports should be extended in South Africa so that its trade with the BRIC economies would be strengthened. South Africa should adopt further policies that liberalise trade by reducing many restrictions in the regulations related to trade, such as the exchange control regulation. Policy makers in South Africa need to pay particular attention to the export-oriented trade system so that the country would tend to export more than import from BRIC nations, leading to the positive effect of the time dummy. In addition, policies that result in the depreciation of the Rand against the BRIC's currencies are required, in order to promote these countries' exports. However, this will be successful if the embedded structural constraints in the South African economy are eradicated.

It is also important to note that because of the BRIC countries' large populations, policies that restrain population's growth should be promoted in these countries, otherwise, if the population grows, there would be no need to trade between South Africa and the BRIC countries.

Moreover, these findings provide information that may be employed by BRICS policy makers to generate pragmatic trade policies for further economic growth and investment prospects. This might contribute to the analysis of how trade flows between South Africa and the BRIC countries have altered after the period of time used in this study and how this has affected primary sectors of their economies as well as the global economy. It would also be interesting to scrutinise how these bilateral trade flows have influenced trade relationships for different parts of their respective regions. The type of research could be of great interest for policy makers from the BRICS countries who may have the intention to expand rate of exports in the future.

### **6.3 Areas for Further Research**

Future research may also focus on estimating trade flows between South Africa and the BRICs by using longer time periods, dynamic gravity equations, and specifying more economic variables. For instance, the inflation rate, price, and other data should be included in the augmented gravity model to observe how these additional variables may affect the trading volume between South Africa and the BRICs. A longer period of time would be advantageous in deriving more accurate estimation

results for the regressions under consideration in the future. It would also be interesting to use GDP per capita, instead of population, to evaluate gross bilateral trade flows across BRICS countries in order to check whether different results will be generated in terms of the sign of the coefficients. In addition, the investigation of bilateral trade flows between South Africa and BRICs could be further developed by incorporating other variables as a substitution of distance, such as communication, transportation, transaction and synchronisation costs, amongst others. This could contribute to the future analysis of how, in consideration of these costs, trade flows have changed in the BRICS economies.

Generally, the dynamic gravity model suggests that bilateral trade between two countries relies upon the economic size of each country, the prevailing trade costs, and the past trade costs (Campbell, 2010). In addition, the dynamic gravity model would be very informative as it would facilitate in determining trade patterns among BRICS economies based on their lagged trade flows as well as their historic trade shocks, culture, tastes of local consumers, and precise market productivity characteristics.

Furthermore, it would be interesting to analyse the dynamic gravity model to discover how the history of all past trade costs, as determinants of relative prices, can affect trade flows between South Africa and the BRIC nations, following the empirical work of Feenstra (2004), Anderson and Wincoop (2003), and Novy (2008). For instance, these past costs have been reasons of economic inadequacy in many regions of the world especially in Africa.

## REFERENCES

- Adekunle, B. & Gitau, C. W. 2013. "Illusion or Reality: Understanding the Trade Flow between China and Sub-Saharan Africa", *Journal of African Business*, 14(2): 117-126.
- Afonso, O. 2001. "The Impact of International Trade on Economic Growth", Working Paper 106. University of Porto.
- Anaman, K. A. & Atta-Quayson, A. 2009. "Determinants of Bilateral Trade between Ghana and Other Members of the Economic Community of West African States", *IJUM Journal of Economics and Management*, 17(2): 231-259.
- Anderson, J. E. 1979. "A Theoretical Foundation for the Gravity Equation", *The American Economic Review*, 69(1):106-116.
- Anderson, J. E. 2011. "The Gravity Model", *The Annual Review of Economics*, 3(1): 133-160.
- Anderson, J.E. & Wincoop E. V. 2003. "Gravity with Gravitas: a Solution to the Border Puzzle", *The American Economic Review*, 93(1): 170-92. Nashville.
- Anderson, J.E. & Wincoop E. 2004. "Trade Costs", *Journal of Economic Literature*, 42(3): 691-751.
- Arkhangelskaya, A. A. 2011. "IBSA – BRICS: Rivals or Allies", paper for the international workshop on South-South Cooperation and new forms of Southern Multilateralism. Institute for African Studies, Uppsala, June 13-14.
- Armington, P. S. 1969. "A Theory of Demand for Products distinguished by Place of Production", *Staff Papers – International Monetary Fund*, 16(1): 1159-178.
- Arora, V. & Vamvakidis, A. 2005. "The Implications of South Africa Economic Growth for the Rest of Africa", *South African Journal of Economics*, 73(2): 229-242.
- Azzarelli, S. & Putnam, B. 2012. "BRIC Country Update: Slowing Growth in the Face of Internal and External Challenges", Market Insights, CME group. Available from <http://www.cmegroup.com/marketinsights>.

- Aziz, N. 2008. "The Role of Exchange Rates in Trade Balance: Empirics from Bangladesh", University of Birmingham, United Kingdom.
- Bacchetta, P. & Wincoop, E. V. 2000. "Does Exchange-Rate Stability increase Trade and Welfare?" *American Economic Review*, 90(5): 1093-1109.
- Baldwin, R. & Taglioni, D. 2006. "Gravity for Dummies and Dummies for Gravity Equations", Working Paper 12516, National Bureau of Economic Research. Cambridge, MA.
- Baltagi, B. H. 2008. *Econometric Analysis of Panel Data*. United Kingdom: John Wiley and Sons, Ltd.
- Baltagi, B. H. & Griffin, J. M. 1988. "A Generalized Error Component Model with Heteroscedastic Disturbances", *International Economic Review*, 29(4): 745-753.
- Baltagi, B. H. & Li, Q. 1991. "A Joint Test for Serial Correlation and Random Individual Effects", *Statistics and Probability Letters*, 11(3): 277-280.
- Baltagi, B. H. & Li, Q. 1991. "A Transformation that will circumvent the Problem of Autocorrelation in An Error Component Model", *Journal of Econometrics*, 48: 385-393.
- Baltagi, B. H. & Wu, P. X. 1999. "Unequally Spaced Panel Data Regressions with AR (1) Disturbances", *Econometric Theory*, 15: 814-823.
- Batra, A. 2004. "India's Global Trade Potential: The Gravity Model Approach", Working Paper 151, Indian Council for Research on International Economic Relations, New Delhi, India.
- Baumann, R. & Ceratti, R. 2012. "Trade among BRICS: Still a Bumping Road from a Brazilian Perspective", Instituto de Pesquisa Economica Aplicada (IPEA), University of Brasilia.
- Bergstrand, J. H. 1985. "The Gravity Equation in International Trade: Some Micro-economic Foundations and Empirical Evidence", *Review of Economics and Statistics*, 67: 474-481.

- Bergstrand, J. H. 1989. "The Generalized Gravity Equation, Monopolistic Competition and the Factor-Proportions Theory in International Trade", *Review of Economics and Statistics*, 71: 143-153.
- Bhagwati, J. 1959. "Protection, Real Wages and Real Incomes", *The Economic Journal*, 69(276): 733-748.
- Bhargava, A., Franzini, L. & Narendranathan, W. 1982. "Serial Correlation and Fixed Effects Model", *The Review of Economic Studies*, 49(4): 553-549.
- Borgatti, L. 2008. "Pacific Islands' Bilateral Trade: the Role of Remoteness and of Transport Costs", *Journal of International Development*, 20(4): 486-501.
- Breusch, T. S. & Pagan, A. R. 1979. "A Simple Test for Heteroskedasticity and Random Coefficient Variation". *Econometrica* 47(5): 1287-94.
- Breusch, T. S. & Pagan, A. R. 1980. "The Lagrange Multiplier Test and its Applications to model Specification in Econometrics", *The Review of Economic Studies*, 47(1): 239-253.
- Breuss, F. & Egger, P. 1999. "How Reliable are Estimations of East-West Trade Potential Based on Cross-Section Gravity Analysis?" *Empirica* 26(2): 81-94.
- Cairns, A. P. & Meilke, K. D. 2012. "Canadian Agrifood Export Performance and the Growth Potential of the BRICs and NEXT-11.", Working Paper 5, Canadian Agricultural Trade Policy and Competitiveness Research Network (CATPRN).
- Çakir, M. Y. & Kabundi, A. 2011. "Trade Shocks from BRIC to South Africa: A Global VAR Analysis", Working paper, 250, Department of Economics and Econometrics, University of Johannesburg.
- Campbell. D.L. 2010. "History, Culture and Trade: A Dynamic Gravity Approach", MPRA Paper 24014, University of Munich, Germany.
- Carim, X. 2011. "South Africa's Trade Relations: EU, IBSA and BRICS", International Trade and Economic Development Division, the DTI.
- Chan-Hyun, S. 2001. "A Gravity Model Analysis of Korea's Trade Patterns and the Effects of a Regional Trading Agreement", Korea Institute for International Economic Policy, Working Paper Series, 2001-09.

- Cheng, I. H. & Wall, H. J. 1999. "Controlling for Heterogeneity in Gravity Models of Trade and Integration", Federal Reserve Bank of St Louis Working Paper Series, 010: 1-29.
- Cheng, I. H. & Wall, H. J. 2005. "Controlling for Heterogeneity in Gravity Models of Trade and Integration", *Federal Reserve Bank of St. Louis Review*, 87(1): 49-63.
- Chipman, J.S. 1965. "A survey of the Theory of International Trade: Part 1, the Classical Theory", *Econometrica*, 33(3): 477-519.
- Cortes, M. 2007. "Composition of Trade between Australia and Latin America: Gravity Model", Working Paper 07-19, Department of Economics, University of Wollongong.
- Daumol, M. & Özyurt, S. 2011. "The Impact of International Trade Flows on Economic Growth in Brazilian States", *Review of Economics and Institutions*, 2(1): 1-25.
- Davis, D. R. 1995. "Intra-industry trade: "A Heckscher-Ohlin-Ricardo Approach", *Journal of International Economics*, 39: 201-226, Department of Economics, Harvard University, Cambridge, MA.
- De Almeida, P. R. 2009. "The Brics' Role in the Global Economy". *Trade and International Negotiations for Journalists*, 146-154.
- Deardorff, A. V. 1995. "Determinants of Bilateral Trade: Does Gravity Work in a Neoclassic World?" *National Bureau of Economic Research, Working Paper 5377*, Department of Economics, University of Michigan.
- Deardorff, A. V. 1998. "Determinants of Bilateral Trade: Does Gravity Work in a Frictionless Model?" *In The Regionalisation of the World Economy*, 1: 7-28. University of Chicago.
- De Castro, T. 2012. "Trade Cooperation Indicators: Development of BRIC Bilateral Trade Flows", *International Review of Business, Research Papers*, 8(1): 211-223.
- Dell' Ariccia, G. 1999. "Exchange Rate Fluctuations and Trade Flows: Evidence from the European Union", *IMF Staff Paper*, 46(3): 315-334.
- Deloitte. 2008. "Exchange Control and Foreign Investment", Brazil upstream taxation and foreign investment.

- De Paula, L. F. 2007. "Financial Liberalization, Exchange Rate Regime and Economic Performance in BRICs Countries", proceedings of the 35<sup>th</sup> Brazilian Economics Meeting, 98.
- Disdier, A. C. & Head, K. 2008. "The Puzzling Persistence of the Distance Effect on Bilateral Trade", *The Review of Economics and Statistics*, 90(1): 37-48.
- Distancefromto. 2013. "Measure Distance between Cities. City to city, Place to Place Distance Calculator". Available from <http://www.distancefromto.net>.
- Dixit, A. & Stiglitz, J. 1977. "Monopolistic Competition and Optimum Product Diversity", *American Economic Review*, 67(3): 297-308.
- Dornbusch, R., Fischer, S. & Samuelson, P. A. 1977. "Comparative Advantage, Trade, and Payments in a Ricardian Model with a Continuum of Goods", *American Economic Review* 67 (5): 823–839.
- Dougherty, C. 2011. *Introduction to Econometrics*. New York: Oxford University Press Inc.
- Duncan, F. 2013. "Next up: A Post-BRICS World. Looking for the Next Big Thing as BRICS Growth slows", The burning question, Money web. Available from <http://www.moneyweb.co.za>.
- Eaton, J. & Kortum, S. 2002. "Technology, Geography and Trade", *Econometrica*, 70: 1741-1779.
- Edwards L. J. & Garlick R. 2008. "Trade Flows and the Exchange Rate in South Africa", MPRA Paper Series (36666), University of Munich.
- Egger, P. 2000. "A Note on the Proper Econometric Specification of the Gravity Equation", *Economic Letters*, 66: 25-31.
- Egger, P. 2002. "An Econometric View on the Estimation of Gravity Models and the Calculation of Trade Potentials", *World Economy*, 25(2): 297-312.
- Endoh, M. 2000. "The Transition of Post-War Asia-Pacific Trade Relations", *Journal of Asian Economics*, 10(4): 571-589.

- Eita, J. H. & Jordaan, A. C. 2007. "South Africa's Wood Export Potential Using a Gravity Model Approach", Working Paper 23, Department of Economics, University of Pretoria.
- Eita, J. H. & Jordaan, A. C. 2011. "Identifying South Africa's Wood Exports Potential using a Gravity Model", *International Conference on E-business, Management and Economics*, 3: 159-164.
- Evenett, S. J. & Keller, W. 2002. "On Theories Explaining the Success of the Gravity Equation", *Journal of Political Economy*, 110: 281–316.
- Farrell, G.N. 2001. "Capital Controls and the Volatility of South African Exchange Rates", South African Reserve Bank Working Paper, 15.
- Farrell, G. N. & Todani, K. R. 2004. "Capital Flows, Exchange Control Regulations and Exchange Rate Policy: The South African Experience", Paper prepared for OECD seminar, Bond exchange of South Africa, March 25-26.
- Feenstra, R. C., Markusen, J. R. & Rose, A.K. 2001. "Using the Gravity Equation to differentiate among Alternative Theories of Trade", *Canadian Journal of Economics*, 34(2): 430-447.
- Feenstra, R. C. 2004. *Advanced International Trade: Theory and Evidence*. Princeton: University Press.
- Frankel, J.A. 1997. *Regional Trading Blocs in the World Economic System*. Washington, D.C.: Institute of International Economics.
- Genberg, H. 2009. "Currency Internationalisation of Analytical and Policy Issues", HKIMR Working paper, 31, Hong Kong Institute for Monetary Research.
- Georgieva, K .2006. "BRIC Countries in Comparative Perspective". World Bank.
- Geraci, V. J. & Prewo, W. 1977. "Bilateral Trade Flows and Transport Costs", *Review of Economics and Statistic*, 59: 67-74.
- Glick, R. & Rose, A. K. 2001. "Does a Currency Union affect Trade? The Time Series Evidence", *NBER Working Paper* (8396): 1-28.
- Golberg, L. S. & Tille, C. 2008. "Vehicle Currency Use in International Trade", *Journal of International Economics*, 76(2): 177-192.
- Greene, W. H. 2012. *Econometric Analysis*. New York: Pearson Education edition.

- Greytak, D. & McHugh, R. 1977. "Linder's Trade Thesis: An Empirical Examination", *Southern Economic Journal*, 43(3): 1386-1389.
- Groot, S. P. T., De Groot, L. F. H., Lejour, M. A. & Möhlmann, J. 2011. "The Rise of the BRIC Countries and its Impact on the Dutch Economy", CPB Background document, The Hague.
- Grubel, H. G. & Lloyd, P. J. 1975 *Intra-industry Trade: The Theory and Measurement of International Trade in Differentiated Products*. London: Macmillan.
- Gujarati, D. N. 2009. *Basic Econometrics*. New York: McGraw Hill International edition.
- Hanink, D. M. 1990. "Linder, Again", *Weltwirtschaftliches Archiv*, 126(2): 257-267.
- Head, K. & Ries, J. 1998. "Immigration and Trade Creation: Econometric Evidence from Canada", *Canadian Journal of Economics*, 31(1): 47-62.
- Hausman, J. A. 1978. "Specification Tests in Econometrics", *Econometrica*, 46(6): 1251-71.
- Hausman, J. A. and Taylor, W. E. 1981. "Panel Data and Unobservable Individual Effects", *Econometrica*, 49(6): 1377-98.
- Havlik, P. & Stöllinger, R. 2009. "EU's Trade with the BRICs and Competitiveness Challenges", The Vienna Institute for International Economic Studies (wiiw), Austria.
- Havlik, P., Pindyuk, O. & Stöllinger, R. 2009. "Trade in Goods and Services between the EU and the BRICs", Research Reports, 357, The Vienna Institute for International Economic Studies.
- Head, K. 2003. "Gravity for Beginners". Mimeography, Faculty of commerce, University of British Columbia, Canada.
- Heckscher, E. 1919. *The Effects of Foreign Trade on the Distribution of Income*, reprinted in Flam, H. and Flanders, M. J., 1949, *Heckscher-Ohlin Trade Theory*, Massachusetts: MIT Press.
- Hellvin, L. & Nilsson, L. 2000. *Trade Flows between Trading Blocs: The Case of the EU's Trade with Asia and NAFTA*. Stockholm: Ministry of Foreign Affairs, Sweden.
- Helpman, E. 1981. "International Trade in the Presence of Product Differentiation, Economies of Scale and Monopolistic Competition - A Chamberlin- Heckscher-Ohlin Approach", *Journal of International Economics*, 11 (3): 305- 340.

Helpman, E. & Krugman, P. 1985. *Market Structure and Foreign Trade: Increasing Returns, Imperfect Competition and the International Economy*. Cambridge, MA: MIT Press.

Helpman, E., Melitz, M. & Rubinstein, Y. 2008. "Estimating Trade Flows: Trading Partners and Trading Volumes", *The Quarterly Journal of Economics*, 83(2).

Henderson, D. R. 1993. "David Ricardo", *The Fortune Encyclopedia of Economics*.

Hill, R. C., Griffiths, W. E. & Lim, G. C. 2011. *Principles of Econometrics*. New York: John Wiley and Sons, Inc.

Hongna, Y. & Zengfeng, L. 2011. "Comparative Analysis on Foreign Trade of the BRICs", College of Economics and Trade, Agricultural University of Hebei, China.

Hosein, R. & Khadan, J. 2012. "The impact of Emerging Markets (BRICs) on CARICOM", *Bank of Valette Review* (45), Department of Economics, University of Malta.

Hummels, D. & Levinsohn, J. A. 1995. "Monopolistic Competition and International Trade: Reconsidering the Evidence", *Quarterly Journal of Economics*, 110: 799-836.

Huot, N. & Kakinaka, M. 2007. "Trade Structure and Trade Flows in Cambodia: A Gravity Model", *ASEAN Economic Bulletin*, 24(3): 305-319.

Im, K. S., Pesaran, M. H. & Shin, Y. 2003. "Testing for Unit roots in Heterogeneous Panels", *Journal of Econometrics*, 115: 53-74.

IMF. 2013. International Monetary Fund. *World Economic Outlook*, April. Available from <http://www.imf.org> or [www.quantec.co.za](http://www.quantec.co.za).

IMF. 2013. International Monetary Fund. *International financial Statistics*, June. Available from <http://www.imf.org> or [www.quantec.co.za](http://www.quantec.co.za).

IMF. 2014. International Monetary Fund. *World Economic Outlook*, April. Available from <http://www.imf.org> or [www.quantec.co.za](http://www.quantec.co.za).

IMF. 2014. International Monetary Fund. *International financial Statistics*, March. Available from <http://www.imf.org> or [www.quantec.co.za](http://www.quantec.co.za).

Ito, T. 2011. "The Internationalisation of the RMB Opportunities and Pitfalls", Working Paper, Council on Foreign Relations, New York.

Jaeger, M. 2012. "Brazil: Fair Economic Prospects", Deutsche Bank Research Management.

Hills, J. 2012 "Russia Tax Guide 2012" PKF Worldwide Tax Guide.

Judson, R. A & Owen, L. A. 1999. "Estimating Dynamic Panel Data Models: A Practical Guide for Macroeconomists", *Economic Letters*, 65(1): 9-15.

Kepaptsoglou, K., Karlaftis, G.M. & Tsamboulas, D. 2010. "The Gravity Model Specification for Modelling International Trade Flows and Free Trade Agreement Effects: A 10-Year Review of Empirical Studies", *The Open Economics Journal*, 3: 1-13.

Krugman, P. 1979. "Increasing Returns, Monopolistic Competition, and International Trade", *Journal of International Economics*, 9(4): 469-479.

Krugman, P. R. & Obstfeld, M. 2000. *International Economics Theory and Policy*. New York: Addison-Wesley Longman.

Krugman, P. R. & Obstfeld, M. 2005. *International Economics: Theory and Policy*. Boston: Pearson Addison-Wesley.

Krugman, P. R. & Obstfeld, M. 2009. *International Economics: Theory and Policy*. Boston: Pearson Addison-Wesley.

Kusi, N. K. 2002. "Trade Liberalization and South Africa's Export Performance", Trade and Industrial Policy Strategies (TIPS) Annual Forum, Muldersdrift.

Laverty, A. 2011. "Globalisation in Emerging Markets: How South Africa's Relationship to Africa serves the BRICS", The African File.

Leamer, E. E. 1995. "The Heckscher-Ohlin in Theory and Practice", *International finance section*, (77): 1-50. Department of Economics, Princeton University, New Jersey, USA.

Levin, A., Lin, C. F. & Chu, C. S. J. 2002. "Unit Root Test in Panel Data: Asymptotic and Finite Sample Properties", *Journal of Econometrics*, 108: 1-24.

- Linder, S.B. 1961. *An Essay on Trade and Transformation*. New York: John Wiley and Sons.
- Linders, G., De Groot, H. L. F. & Florax, R. J. G. M. 2005. "Distance Decay in International Trade Patterns: a Meta-Analysis", ERSA conference paper, 05, Department of Spatial Economics, Vrije Universiteit, Amsterdam.
- Linnemann, H. 1966. *An Econometric Study in International Trade Flows*. Amsterdam: North Holland.
- Lwin, N. N. 2009. "Analysis on International Trade of CLM Countries", IDE Discussion Paper, 215.
- Maradiaga, D.I., Zapata, H. O., & Pujula, A. L. 2012. "Exchange Rate Volatility in BRICS Countries", paper presented at the Southern Agricultural Economics Association Annual Meeting, Alabama (119726), Birmingham, February 4-7.
- Markusen, J. R., Melvin, J. R., Kaempfer, W. H. & Maskus, E. K. 1995. *International trade theory and evidence*. Boston: McGrawHill.
- Matyas, L. 1997. "Proper Econometric Specification of the Gravity Model". *The World Economy*, 20 (3): 363-368.
- Matyas, L. 1998. "The Gravity Model: Some Econometric Considerations". *The World Economy*, 21 (3): 397-401.
- Mayer, T. & Zignago, S. 2011. "Notes on CEPII's Distances Measures: The GeoDist Database", CEPII Working Paper 2011-25.
- Maziad, S., Farahmand, P., Wang, S., Segal, S. & Ahmed, F. 2011. "Internationalization of Emerging Market Currencies: A Balance between Risks and Rewards", IMF Staff Discussion Note 11/17. Washington: International Monetary Fund.
- Mazodier, P. & Trognon, A. 1978. "Heteroskedasticity and Stratification in Error Components Models", *Annales de l'INSEE* (30/31): 451-482.
- McCallum, J. 1995. "National Borders Matter: Canada-US Regional Trade Patterns". *The American Economic Review* 85(3): 615-623.

- Melitz, J. 2007. "North, South and Distance in the Gravity Model", *European Economic Review*, 51(4): 971-991.
- Micco, A., Stein, E. & Ordoñez, G. 2003. "The Currency Union Effect on Trade: Early Evidence from EMU", *Economic Policy*, 18(37): 315-356.
- Mill, J.S. 1844. *Essay on Some Unsettled Questions in Political Economy*. London: John W. Parker.
- Mjema, G., Mahona, B. & Bagumhe, P. 2012. "Determinants of East African Community Trade: A Gravity Model Analysis of Trade Flows between Tanzania and Kenya", paper presented at the 5th International Conference organized by the Institute of Finance Management, 23rd -25th August 2012, Department of Economics, Institute of Finance Management, Dar es salaam, Tanzania.
- Moghadam, R. 2011. "New Growth Drivers for Low-Income Countries: The Role of BRICs", Department of Strategy, Policy and Review, International Monetary Fund.
- Morazán, P., Knoke, I., Knoblauch, D. & Schäfer, T. 2012. "The Role of BRICS in the Developing World". Policy Department, Directorate General for External Policies, European Union.
- Myint, H. 1977. "Adam Smith's Theory of International Trade in the Perspective of Economic Development", *Economica*, 44 (175): 231-248.
- Nayyar, D. 2008. "China, India, Brazil and South Africa in the World Economy. Engines of Growth?" Discussion Paper 2008/05, United Nations University, World Institute for Development Economics Research.
- Newton, I. 1687. "Philosophiæ Naturalis Principia Mathematica". University of Cambridge, Cambridge Digital Library: <http://cudl.lib.cam.ac.uk>.
- Novy, D. 2008. "Gravity Redux: Measuring International Trade Costs with Panel Data", Warwick Economic Research Papers, 861.
- OECD. 2009. Organisation for Economic Co-Operation and Development. "Globalisation and Emerging Economies. Brazil, Russia, India, Indonesia, China and South Africa", OECD, Paris.

OECD. 2010. Organisation for Economic Co-Operation and Development. "OECD Economic Outlook, 87, Summary of Projections", Paris.

OECD. 2013. Organization for Economic Co-operation and Development. *Economic Surveys: South Africa*. Available from <http://www.oecd.org>

OECD. 2013. Organization for Economic Co-operation and Development. *Bilateral Trade in Goods by Industry and End-use Category*. The STAN Bilateral Trade Database by industry and end-use. Available from <http://www.oecd.org>

OECD. 2014. Organization for Economic Co-operation and Development. *Bilateral Trade in Goods by Industry and End-use Category*. The STAN Bilateral Trade Database by industry and end-use. Available from <http://www.oecd.org>

Oehler-Şincail, I. M. 2011. "Trends in Trade and Investment Flows between the EU and the BRIC Countries", *Institute of World Economy, the Romanian Academy*. University of Sao Paulo.

Ohlin, B. 1933. *Interregional and International Trade*, Cambridge, Mass: Harvard University Press.

O'Neill, J. 2001. "Building Better Global Economic BRICs", Goldman Sachs: Global Economics Paper (66).

O'Neill, J., Lawson, S., Wilson, D., Purushothamn, R., Buchanan, M. & Griffiths, L. 2004. "Growth and Development: The Path to 2050". London: Goldman Sachs.

O'Neill, J., Wilson, D., Purushothaman, R. & Stupnytska, A. 2005. "How Solid are the BRICs?" Goldman Sachs: Global Economics Paper, 134.

Petersson, L. 2005. "Export Diversification and Intra-Industry Trade in South Africa", *South African Journal of Economics*, 73(4):785-802.

Petersen, J. 2012. "Chinese Currency Controls and the Liberalization of the Renminbi", China Briefing.

Polodoo, V., Seetanah, B., Sannasse, R. V. & Padachi, K. 2012. "Trade and Economic Growth-A perspective from BRICS nations and Implications for Developing World". University of Mauritius.

Pöyhönen, P. 1963. "A tentative model for the Volume of Trade between Countries". *Weltwirtschaftliches Archiv*, Band 90: 93-100.

Pöyhönen, P. 1963. "Toward a General Theory of International Trade", *Economiska Samfundets Tidskrift*, 16: 69-77.

Pulliainen, K. 1963. "A World Trade Study: An Econometric Model of the Pattern of the Commodity Flows of International Trade in 1948-60", *Economiska Samfundets Tidskrift*, 16: 78-91.

Rahman, M.M. 2003. "A Panel Data Analysis of Bangladesh's Trade: the Gravity Model Approach", the 5th European trade study group conference, Madrid, Spain, September 11-13, 2003. University of Sidney

Ranjan, R. & Prakash, A. 2010. "Internationalisation of Currency: The Case of the Indian Rupee and Chinese Renminbi", Reserve Bank of India Staff Studies, Department of Economic Analysis and Policy. New Delhi: Reserve Bank of India.

Rault, C.; Sova, R. & Sova, A. 2008. "Modeling international Trade Flows between CEEC and OECD Countries", CESifo working paper, 2282, Munich.

Reserve bank of India. 2013. "India Central Bank database". Available from [Http://www.rbi.org.in](http://www.rbi.org.in).

Ricardo, D. 1817. *Principles of Political Economy*. Reprinted New York, Penguin, 1971.

Ricardo, D. 2004. "On the Principles of Political Economy and Taxation", edited by Piero, S. *The Works and Correspondence of David Ricardo*, 1, Indianapolis: Liberty Fund.

Ricci, L. A. 2006. "South Africa's Real Exchange Rate Performance", International Monetary Fund (IMF) Paper.

Richardson, G. B. 1975. "Adam Smith on Competition and Increasing Returns", in *Essays on Adam Smith*, ed. Skinner, A. & Wilson, T. Oxford.

Rybczynski, T.M. 1955. "Factor Endowments and Relative Commodity Prices", *Economica*, 22: 336-41.

Samuelson, P. A. 1948. "International Trade and the Equalisation of Factor Prices", *The Economic Journal*, 58(230): 163-184.

Samuelson, P. A. 1949. "International Factor-Price Equalisation Once Again", *The Economic Journal*, 59(234): 181-197.

Sandrey, R. & Jensen, H.G. 2007. "Examining the India, Brazil and South African Triangular Trading Relationship", Tralac Working Paper, 1/2007. Available from <http://www.tralac.org>.

Sandrey, R. 2013. "BRICS: South Africa's Way Ahead? Summary", Trade law centre, Stellenbosch.

Schrooten, M. 2011. "Brazil, Russia, India, China and South Africa: Strong Economic Growth – Major Challenges", DIW Economic Bulletin, 4.

Seligman, E. R. A. & Hollander, J. H. 1911. "Ricardo and Torrens", *The Economic Journal*, 21(83): 448-468.

Sichei, M. M., Erero, J. L. & Gebreselasie, T. 2008. "An Augmented Gravity Model of South Africa's Exports of Motor vehicles, Parts and Accessories", *SAJEMS NS*, 11(4): 494-510.

Sidiropoulos, E. 2011. "Perspectives from the BRICs: Lessons for South Africa", South African Institute of International Affairs Report.

Simwaka, K. 2006. "Dynamics of Malawi's Trade Flows: A Gravity Model Approach", MPRA Paper 1122, University Library of Munich, Germany.

Singh, A., Dhania, R., Upasani, R. & Mathur, S.K. 2010. "Analyzing the Trade Flows for Brazil, Russia, India, China and South Africa (BRICS)". Available from <http://www.scribd.com>.

Singh, S. P. & Dube, M. 2013. "The BRICS and the New World Order: A Beginner's Guide." *South African Institute of International Affairs*, African perspectives, Global insights. Available from [http://www. Saiia.org.za](http://www.Saiia.org.za) or [www.gegafrika.org](http://www.gegafrika.org).

Slobodníková, O. & Nagyová, R. 2011. "Global Influence of the BRIC Countries", Ostrava: University of Ostrava.

Smith, A. 1776. *An Enquiry into the Nature and Cause of Wealth of Nation*. London: Oxford University Press.

Stigler, G. J. 1952. "The Ricardian Theory of Value and Distribution", *Journal of Political Economy*, 60(3): 187-207.

Szirmai, A., Naude, W. and Haraguchi, N. 2012. "Structural Change, Poverty Reduction and Industrial Policy in the BRICS", Vienna: United Nations Industrial Development Organisation.

Thapa, S. B. 2012. "Nepal's Trade Flows: Evidence from Gravity Model", *Economic Review*, 24(1): 16-27. Tribhuvan University, Kitipur.

The BRICS Report. 2012. "A Study of Brazil, Russia, India, China and South Africa with Special Focus on Synergies and Complementarities", Oxford: Oxford University.

Tinbergen, J. 1962 *Shaping the World Economy – Suggestions for an International Economic Policy*. New York: Twentieth Century Fund.

Todaro, M. P. 2000. *Economic Development*. New York: Addison-Wesley.

Torrens, R. 1815. *Essay on the External Corn Trade*. London: J. Hatchard.

UNCTAD. 2013. United Nations Conference on Trade and Development. *Unctad Statistics*. Available from <http://www.unctad.org>.

Van der Merwe, E.J. 1996. "Exchange Rates Management Policies in South Africa: Recent Experience and Prospects", occasional Paper, 9, paper prepared for the United Nations Economic Commission for Africa, South Africa Reserve Bank.

Venables, A. J. 2001. "Regionalism and Economic Development". London School of Economics and CEPR.

Venkatesan, T. 2011. "Emerging Trends in Forex Markets in India." *Journal of South Asian Academic Research*, 1(2): 9-17.

Verbon, H. A. A. 1980. "Testing for Heteroscedasticity in a Model of Seemingly Unrelated Regression Equations with Variance Components (SUREVC)", *Economics Letters*, 5(2): 149-153.

West, E.G. 1990. *Adam Smith and Modern Economics: From Market Behaviour to Public Choice*. England: Edward Elgar Publishing.

White, H. 1980. "A Heteroscedasticity Consistent Covariance Matrix Estimator and a Direct Test of Heteroscedasticity", *Econometrica*, 48: 817-838.

Wilson, D. & Purushothaman, P. 2003. "Dreaming with BRICs: The Path to 2050". Goldman Sachs: Global Economics Paper, 99.

Wilson, D., Burgi, C. & Carlson, S. 2011. "The BRICs Remain in the Fast Lane", Goldman Sachs Global Economics, BRICs Monthly (11/06).

Wooldridge, J. M. 2012. *Introductory Econometrics: A Modern Approach*. USA: South-Western, Cengage learning.

World Bank. 2011. World Development Indicators. The World Bank group. Available from <http://www.data.worldbank.org>.

World Bank. 2012. World Development Indicators. The World Bank group. Available from <http://www.data.worldbank.org>.

World Bank. 2013. World Development Indicators. The World Bank group. Available from <http://www.data.worldbank.org>.

Xu, X. & Sheng, Y. 2009. "Trade Potential between Mainland China and Taiwan", paper prepared for the PAFTAD Conference, Taipei, 5-8 Oct 2009.

Zannou, A. 2010. "Determinants of Intra-ECOWAS Trade Flows", *African Journal of Business Management*, 4(5): 678-686.

Zarzoso, I M. & Lehman, F. N. 2003. "Augmented Gravity Model: An Empirical Application to Mercosur-European Union Trade Flows", *Journal of Applied Economics*, 6(2): 291-3.