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An Econometric Analysis of Bilateral Import Demand in South Africa

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AN ECONOMETRIC ANALYSIS OF BILATERAL IMPORT DEMAND IN SOUTH AFRICA

by

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ABSTRACT

AN ECONOMETRIC ANALYSIS OF BILATERAL IMPORT DEMAND IN SOUTH AFRICA

by Christopher B. Smith

One of the most significant challenges facing any society is the allocation of scarce economic resources that have alternative uses. Though imports can streamline the allocation of scarce resources in an economy, the potency of a country's import policies are subject to the magnitude of import elasticities with respect to income, domestic prices, foreign prices, and exchange rates. This research estimates the bilateral income, domestic price, import price, and exchange rate elasticities between South Africa and its five largest trading partners: China, Germany, the United States, India, and Saudi Arabia using quarterly data from 1998 – 2017. The bounds testing approach to cointegration tests for a long run relationship among the variables and an autoregressive distributed lag model is used to estimate short and long run bilateral elasticity estimates. An error-correction model is used to estimate the rate at which short run shocks are absorbed and equilibrium reestablished.

This research contributes to the literature in four ways. First, this research estimates bilateral import demand elasticities as opposed to aggregate elasticities. The range of elasticity estimates suggest tailored policy decisions based on the unique characteristics of each bilateral trade relationship may be beneficial instead of a single policy ascertained from aggregate elasticity estimates. Second, this research separates the relative price variable, typically expressed as a ratio of import price to domestic prices, into distinct independent variables. When the relative price variable is used, the effects

of the two variables used to construct the relative price variable are assumed to be of equal and opposite magnitude. This research provides evidence that this assumption merits reconsideration in the literature. Third, this research includes the real effective exchange rate variable and a control variable for periods of recession. Fourth, this research uses an error correction model that estimates the rate at which short run shocks are absorbed and equilibrium reestablished.

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I would not have made it through this process were it not for the support and encouragement of two classmates: Dave Davis and Richard Baker. I am fortunate to have gone through this program with you two and I am thankful to call you friends.

DEDICATION

This dissertation is dedicated to the family and friends that made it possible. This dissertation was not written in isolation and I am thankful to my wife, Jennifer, for the support and sacrifice of time and resources. She took the journey with me and did not waver even though I did. She was there every step of the way and endured with me through the low and high points. I love you.

My mother, Suzanne, and father, Carey, dedicated their lives to education and instilled in me the importance of education at a young age. I hope this dissertation in some way pays them back for the sacrifices they made for me and the others whose lives they have touched. I am blessed to have parents who trained up their child in the way he should go.

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Max and Dylan sat in my office a lot of nights and fell asleep in their beds while I wrote. Man’s best friend indeed.

Finally, this work is dedicated to my Savior, Jesus Christ. May this work be evidence of your glory.

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CHAPTER I - INTRODUCTION

One of the most significant challenges facing any society is the allocation of scarce economic resources that have alternative uses. The presence of scarcity means the collective wants of a society's population is greater than the society's collective productive capacity. International trade is one of the methods used to mitigate the problem of scarcity. Through specialization, a country may produce a surplus of some goods and trade them with other countries for goods that can be produced relatively cheaper by other countries. Since trade has become an increasingly large portion of the world economy, a country's demand for imports has become a topic of interest to researchers.

Economic theory suggests that a country should import those goods and services where no comparative advantage is present and export those goods and services where a comparative advantage is present. Comparative advantage is the ability to produce a good or service at a relatively lower opportunity cost than another country. By importing goods and services where there is no comparative advantage, scarce economic resources can be allocated to the production of goods and services where a comparative advantage does exist. A country may also import goods and services that cannot be produced domestically given a country's endowment of economic resources.

Though imports can streamline the allocation of scarce resources in an economy, the potency of a country's import policies are subject to the magnitude of import elasticities with respect to income, domestic prices, foreign prices, and exchange rates. Therefore, estimation of bilateral import demand elasticities is important from a policy perspective. At the macro level, income means national income and is typically represented by gross domestic product (GDP). Prices, at the macro level, means aggregate prices and is typically represented by a price index such as the consumer price index (CPI).

In the last half of the twentieth century, world trade activity increased significantly and became an integral part of the world economy. According to the World Bank's National Accounts Data (2017) database, trade contributed nearly 25% to the world's economic output in 1960 and 51% by 2000. For many developing countries, increased trade activity has resulted in persistent current account deficits; for example, South Africa has been facing expanding current account deficits since 2003 (Balance of Payments Statistics Yearbook 2017). Just as the world economy has seen a significant increase in trade activity, so too has the South African economy.

Protectionist policies pursued throughout the Apartheid era (1948-1991) meant import and export opportunities were limited and economic growth was dependent upon favorable commodity prices in the world economy. The 1990s were characterized by a liberalization of trade policies, and South Africa saw import demand increase as a result (Edwards and Lawrence 2008). As part of trade liberalization initiatives, the South African currency, the Rand, began floating in March 1995.

South Africa has the second largest economy in Africa based on Purchasing Power Parity (PPP) GDP, following Egypt and Nigeria, and it is a member of the G-20 international forum. In addition, South Africa formally joined an economic association of emerging market economies known as BRICS (Brazil, Russia, India, China, and South Africa) in 2010. South Africa is a regional economic power in Africa's sub-Saharan region, and its currency is the currency of the Common Monetary Area between South

Africa, Swaziland, Lesotho, and Namibia. Given South Africa's importance as a regional economic power in a developing region of the world, an understanding of the dynamics that influence import demand is of interest. Therefore, the main objective of this study is to estimate bilateral import demand elasticity functions for each of South Africa's five largest trading partners: China, Germany, Saudi Arabia, the United States, and India from Q1 1998 through Q4 2017. Combined, these countries account for nearly half of South African import demand in 2017.

Statement of the Problem

Though the literature related to import demand is significant, there are still issues that need to be addressed. The following issues warrant further research with respect to import demand elasticity estimation:

1) Much of the current literature is focused on aggregate import demand functions, leaving a lack of elasticity estimates for bilateral trade relationships.
2) Sawyer and Sprinkle (1999) state "our knowledge of responsiveness of the exchange rate variable is small at best," and therefore, more research is necessary to better understand how the real exchange rate influences import demand.
3) Many contributions to the literature combine the effect of foreign and domestic prices on import demand while "non-trivial differences between the responsiveness of trade flows to foreign and domestic prices" exist (Sawyer and Sprinkle 1999). Since the differences between foreign price elasticity and domestic price elasticity may be significantly different, more empirical

research is needed where the impact of foreign prices and domestic prices are separate.

4) There is often a lag between the time one or more variables influencing import demand changes and when the impact on import demand is actually realized. Therefore, more research including the lag structure of each independent variable is necessary.

5) Finally, elasticity estimates may change over time, and an array of time periods must be analyzed to better understand how changes to prices and income influence import demand over time.

Purpose of the Study

This study addresses the preceding issues in the following way:

1) This dissertation estimates bilateral import demand elasticity estimates for South Africa and its five largest trading partners.

2) This dissertation includes the real exchange rate as an independent variable in the analysis.

3) This dissertation includes the split-price specification for foreign and domestic prices in order to isolate the independent effects of both on bilateral import demand.

4) This dissertation builds lag structure into the analysis since the effects of changes in income and prices often do not immediately impact import demand.

5) This dissertation covers a period of time not previously studied. The period of time considered is unique because all years included are after the Apartheid era and are years where a floating exchange rate regime was used.

Research Questions

The main purpose of this dissertation is to contribute to the empirical literature concerning import demand price and income elasticity estimation. As such, this dissertation will address the following research questions:

1) What are the bilateral income, domestic price, and foreign price elasticities of import demand between South Africa and its five largest trade partners?
2) What is the effect of the real exchange rate on import demand for South Africa?
3) What is the lag structure associated with income, domestic prices, foreign prices, and the real exchange rate?

The initial analysis for this research is OLS regression using the imperfect substitutes model of import demand, where quantity of imports demanded is the dependent variable (Goldstein and Khan 1985). The imperfect substitutes model customarily includes income, domestic prices, and foreign prices as independent variables (Stern, Francis, and Schumacher 1976). Since this research is concerned with the period of time in which South Africa pursued a floating exchange rate regime, a fourth independent variable, real exchange rate, is included in the analysis. Regression analysis following the general model described above will be conducted for South Africa's five largest trading partners.

Economic theory suggests that higher real gross domestic product has a direct relationship with the demand for imports, while the real relative price of imports has an inverse relationship with the demand for imports (Sawyer and Sprinkle 1999). Assuming the real exchange rate is quoted in the convention of domestic currency per unit of foreign currency, the relationship between real exchange rate and demand for imports has a direct relationship (Sawyer and Sprinkle 1999). Economic theory suggests that a rise in real income would stimulate the consumption of domestically produced goods as well as good produced abroad (Stern, Francis, and Schumacher 1976). Should significant divergence in bilateral import elasticities be present, South Africa would be better off implementing specific trade policies for each bilateral trade partner as opposed to pursuing a centralized trade policy applicable to all trading partners. In addition, each trading partner introduces specific political and security risk that, in some cases, may be addressed through economic sanctions related to trade policy.

Organization of the Study

The remainder of this dissertation proceeds in the following manner. Chapter II chronologically reviews the relevant literature related to the proposed research questions. Specifically, Chapter II surveys the development of international trade theory within the discipline of economics and examines the foundational works in the estimation of import demand elasticities. Finally, Chapter II reviews those empirical works estimating import demand elasticities for South Africa.

Chapter III details the methods used to answer the aforementioned research questions. The general and specified regression models are presented and the data used in the regression analysis is described. Chapter IV provides the results of the regression analysis as well as a discussion of these results. Chapter V summarizes the study's results, contributions, and conclusions, and discusses recommendations for future research.

CHAPTER II – LITERATURE REVIEW

Within the trade literature, this research contributes to the strand concerned with the estimation of income and price elasticities of import demand. Elasticity estimates are of interest to researchers and policymakers because they characterize how demand for imports changes with respect to a change in a related economic variable. Nations find importing desirable because importing goods allows more efficient allocation of resources to the production of goods and services that are produced cheaper domestically. By specializing in the production of those goods and services where comparative advantage exists, nations can produce more of those goods and services than needed domestically, then trade the excess for other goods and services.

This chapter divides into two main sections: the historical development of the import demand elasticity literature and a review of the literature estimating import demand elasticities for the country of South Africa. The historical development section then divides into four subsections: Elasticity Pessimism, Orcutt's Challenge, Econometric Advancement, and Estimates of Import Demand Elasticity for Developing Nations.

Within the historical development section, the Elasticity Pessimism subsection reviews the theoretical precedents informing the literature and surveys a series of papers written from 1937 to 1950 estimating import demand elasticities during the interwar period. This era was later termed the "Elasticity Pessimism" era because of the downward bias of the elasticity estimates (Leamer and Stern 1970). The Orcutt's Challenge subsection reviews the contribution of Orcutt (1950) whose challenges catalyzed a new research agenda within the field. The Econometric Advancement subsection surveys the manner in which improvements in the field of econometrics ameliorated the import demand elasticity literature. The final subsection examines the studies estimating import demand elasticities for developing countries.

Historical Development

The study of import demand elasticity began at an intersection between two major economic theories that found their beginnings in the work of Adam Smith: international trade theory and business cycle theory. From the late eighteenth century and through the nineteenth century, the body of knowledge in the field of economics was developed by a group, that included Smith, now known as the classical economics. Classical economists view the economy as a self-regulating mechanism that maintained desirable levels of unemployment and inflation by its own efficacy, a phenomenon Smith (1776) described as the "invisible hand." In addition, Smith was one of the first to recognize the benefits of international trade.

Business Cycle Theories: Smith to Keynes

Building on Smith's concept of the invisible hand, Say (1803) argues that overproduction in an economy is an impossibility. Say (1803) supported this claim explaining that suppliers would be eager to sell their goods as quickly as possible so their goods would not lose value sitting idly. The producer's desire to quickly sell their goods would be matched by an equal desire to rid themselves of the cash generated from the sale of the good. Thus, with every sale of a finished good, a market for other goods would immediately open. This concept was refined into the aphorism "supply creates its own demand," and is known as Say's Law (Thweatt 1978).

Say's Law informed economic thought related to business cycles throughout the nineteenth century until the Great Depression of the 1930s forced economists to rethink much of the classical economic orthodoxy. Keynes (1936) challenged Say's Law specifically claiming that decreases in aggregate demand lead to undesirable economic outcomes such as high unemployment or inflation. In challenging the ideas of the classical economists, Keynes developed a theory to explain the relationship between various macroeconomic variables such as consumption and income, investment and interest rates, and interest rates and the supply of money.

Theories of International Trade: Smith to Heckscher-Ohlin

Smith (1776) challenged the Mercantilist view that economic growth was best generated through the accumulation of gold and other precious metals. The Mercantilists saw engagement in international trade as a deterrent to economic growth since the import of goods required payment to other countries in the form of gold or other precious metals. Smith countered this assertion, claiming engagement in international trade could positively contribute to economic growth so long as each trading partner exports goods in which they possess an absolute advantage. Absolute advantage is defined as a situation where a country can produce more of a good given its endowment of economic resources than another country can produce of the good with its endowment of economic resources.

Ricardo (1817) proved the theory of comparative advantage on the foundation of Smith's original contributions. The comparative advantage states that countries that can produce a good with lower opportunity cost than another country could trade the relatively cheaper product for the goods with higher opportunity cost. Trade in this manner would mutually benefit both countries, and thus, lead to economic growth, assuming the factors of production are in a fixed location and only final goods are traded. Ricardo however, fails to identify the source of comparative advantage. Nearly onehundred years after Ricardo, Heckscher (1919) and Ohlin (1933) developed the factor proportions theory, which states the source of a nation's comparative advantage is the endowment of the factors of production, namely capital and labor.

Elasticity Pessimism

Early investigations into the estimation of import demand elasticities tested the efficacy of currency devaluation policies (Hinshaw and Metzler 1945; Chang 1948). During the interwar period, a number of advanced economies initiated currency devaluation policies in order to address balance of trade issues. The balance of trade is defined as the difference between exports and imports. When the balance of trade is negative, countries import more than they export and vice versa. When the combined price elasticity coefficients for import demand and export demand are greater than unity, the Marshall-Lerner conditions are said to be satisfied and currency devaluation policies alleviate balance of trade pressure (Robinson 1947, Polak 1947). Research concerned with testing the satisfaction of the Marshall-Lerner conditions has spawned a separate literature (Bahmani *et al.* 2013).

Building on the work of Keynes (1936), Tinbergen (1937) provides one of the earliest works in the import demand elasticity literature. Frustrated with the ambiguity of the verbal debate surrounding the origin of economic fluctuations, Tinbergen introduces the rigor of econometric modeling. Brown (1938) calls Tinbergen's work "a union of theoretical analysis and statistical observation," and states the goal of Tinbergen's work was to separate those macroeconomic variables that are vulnerable to business cycles from those that are not. Tinbergen estimates twenty-two regression models whose dependent variables represent various measures of the economy. Of these twenty-two models, two are concerned with the demand for imports.

Tinbergen's (1937) two models estimate partial demand elasticities for imported consumer goods and imported capital goods in the Netherlands for the period of 1923-35. The dependent variable in the consumer goods model is quantity of imported consumer goods and the independent variables are the prices of domestic goods and the prices of imported goods. The elasticity coefficient for domestic prices is -0.42 and the elasticity coefficient for foreign prices is 0.39. The dependent variable in the capital goods equation is the quantity of imported goods and the independent variable is the difference between price index of imported capital goods and the price index of domestically produced capital goods. The elasticity coefficient for the independent variable in the capital goods model is 0.86. No tests of statistical significance are provided.

de Vegh (1941) provides one of the earliest estimates of bilateral import demands elasticities for the United States and its imports from Canada for the period of 1922 through 1937 and Canadian imports from the United States for the period of 1929-1940. de Vegh explores how changes in import demand are influenced by changes in income and disregards the effect of price changes and supply side effects. de Vegh estimates the bilateral income elasticity for the United States' imports from Canada to be 1.35. The bilateral income elasticity for Canada's imports from the United States is estimated to be 1.8. No tests of statistical significance are provided.

Adler (1945) estimates import demand elasticities for the United States for the period of 1922 through 1937 as a linear relationship between the dependent variable, import volume, and the independent variables, income and relative prices. Relative price in the import demand elasticity literature refers to the price of imports divided by domestic prices with both prices represented by a price index. Adler's model estimates a constant of 8.23, the average income elasticity to be 1.0 and statistically significant, and the average relative price elasticity to be 0.09 and statistically insignificant. Adler claims the insignificance of relative prices is due to the effects of tariffs imposed in 1930 which decreased import demand. To test this hypothesis, Adler regresses income and relative prices on only duty-free imports and finds both independent variables to be significant.

Hinshaw and Metzler's (1945) estimates for import demand elasticities are motivated by need to assess the potency of currency depreciation policies considered by the British government in the presence of balance of payment issues in the post-war period. Hinshaw and Metzler regress income on import volume and estimate the elasticity coefficient to be 0.83. No tests of significance are reported, but a correlation coefficient is provided and is 0.92.

Chang (1945-46) estimates aggregated import demand elasticities for twenty-one countries across a spectrum of development. The most developed countries such as the United States or United Kingdom are termed "industrialized" countries. The least developed countries such as South Africa and Chile are termed "mining countries." The income elasticity coefficients for industrialized nations range from 0.94 to 1.74 and relative price elasticities range from -0.26 to -0.97. For mining countries, the income elasticity coefficients range from 2.3 to 3.25 and relative price elasticities range from -0.32 to -0.64. Chang attributes the difference between the income elasticity coefficients to the "relative composition of their imported manufactures." Import demand is regressed on income and relative prices for each country. For South Africa, the income elasticity coefficient equals 2.3 and the relative price elasticity coefficient equals -0.64.

Chang (1946) regresses aggregate import demand on national income and relative prices for the period of 1924-38 in the United Kingdom using logarithmic functional form. Chang estimates the coefficient for income to be 1.43 and the coefficient for relative prices to be -0.64. In addition to regressing import demand on national income, Chang (1946) regresses import demand on the domestic employment index, an estimate of employment in the United Kingdom. Though the results of the regression are unremarkable, the exercise introduces the concept of lagged variables to the import elasticity literature. Noting that employment acts as leading indicator of import demand, Chang calculates correlation coefficients not only according to the same time period, but also when the variables are shifted forward or backward over multiple time periods. Although lags were not explicitly included in the model, the concept of lagging variables is introduced to the import demand literature.

The literature of the Elasticity Pessimism era continues to influence import demand elasticity research today. During the Elasticity Pessimism era, the model's functional form began to transition from level to logarithmic. The use of logarithmic functional form means the coefficients are interpreted as constant elasticities, which explain the proportional response of the dependent variable to a change in the independent variable (Wooldridge 2009). The works of the Elasticity Pessimism era also use two variables that appear in recent research: income and relative prices.

Although the works of the Elasticity Pessimism made lasting contributions to the literature, some characteristics of these early works have been abandoned or refined, mainly due to the advancement of econometric techniques. The Elasticity Pessimism era works rarely include tests for statistical significance, a staple of modern research. In addition, the research of the Elasticity era focused on the estimation of short-run elasticity coefficients instead of long-run coefficients and did not account for the potential of lagged responses from the dependent variable in the model. Finally, the Elasticity Pessimism era failed to recognize econometric issues pertaining to time series data.

Orcutt's Challenge

The 1950s began with researchers questioning previous estimates of import demand elasticities (Orcutt 1950; Harberger 1953). Orcutt (1950) disputes the validity of previous elasticity estimates based on the presence of bias in the estimation techniques. Orcutt asserts the techniques, namely OLS regression using time-series data, biased price elasticity estimates downward. Downward biased elasticity estimates meant policymakers might view currency devaluation as an ineffective means of addressing balance of trade issues.

Orcutt claims the source of elasticity pessimism in previous empirical research originates from five sources:

1. simultaneous equation bias – the assumption of independence between the relative price variable and the error term in the equation which contains additional factors that affect demand as well as factors that affect supply
2. errors in observation due to falsification, misclassification, or index construction
3. historical price and quantity indices gave greater weight to goods with low elasticities, thus biasing elasticity estimates downward

4. short-run instead of long-run price elasticities have been estimated and short run elasticities are typically lower than long-run elasticities

5. quantum effect where elasticity estimates is probably much larger for large price changes than for small price changes.

In addition to these, Orcutt recognizes the possibility that the observations used in the literature are not independent observations but observations that are dependent upon the previous observation. Thus, the possibility of autocorrelation in elasticity estimates using time-series data was understood. When using time-series data, the presence of autocorrelation means there is correlation between errors across time and the use of OLS standard errors and statistics can be deceiving (Wooldridge 2009).

While the models of the Elasticity Pessimism era contain a spectrum of independent variables, the income and relative price variables emerge as the foundation of import demand elasticity models. Orcutt's first challenge involves the estimation of the relative price coefficient. Orcutt (1950) claims the low relative price elasticities estimated in the Elasticity Pessimism era are the result of simultaneity. Simultaneity means that one or more independent variables jointly determine the dependent variable (Wooldridge 2009). If simultaneity is present, use of OLS produces estimated parameters that are biased and inconsistent. Since price and quantity are simultaneously determined through the supply and demand equilibrium model, the issue of simultaneity must be addressed when estimating demand elasticity equations.

One method that may be used to address simultaneity is to utilize simultaneous equation models. Simultaneous equation models have been estimated within the literature, but have met little success (Magee 1970; Richardson 1973; Afzal 2000). The estimation of simultaneous equation models is typically not practiced in the literature and the supply side is resolved by assuming perfectly elastic supply (Goldstein and Khan 1985; Dutta and Ahmad 1999; Hibbert, Thaver, and Hutchinson 2012). Leamer and Stern (1970) claim the assumption of a perfectly elastic supply curve is reasonable for smaller countries that do not contribute a large proportion of world exports. The advantage of assuming perfectly elastic supply is that single-equation models may be used to accurately estimate demand elasticities.

Orcutt's second point claims that downward bias results from errors within the data itself such as data misclassification, data falsification, and faulty price index construction. While these errors may impact parameter estimates, Leamer and Stern (1970) recognize the difficulty in substantiating such a claim. However, the push to address Orcutt's second challenge has had a positive influence on the ability to research developing countries. Triplett and Thaver (2015) claim that as data for developing countries has become more accessible, the literature estimating bilateral import demand elasticities for developing countries has grown.

Orcutt's third challenge highlights the use of aggregate data in the Elasticity Pessimism era. Use of aggregate import data means price and quantity data for all imported goods are used to estimate price elasticities. Since low elasticity goods, such as raw materials or agricultural products, account for a relatively large portion of price variation within the price indexes, their inclusion would bias elasticity estimates downward (Orcutt 1950).

Orcutt's fourth critique states that studies of the Elasticity Pessimism era estimate short-run elasticities instead of long-run elasticities. The inability to distinguish short-run elasticity estimates from long-run elasticity estimates was one of the major issues within the literature throughout the 1970s and 1980s (Hooper and Marquez 1993). In the 1990s, the use of error-correction models allows for the separation of short and long-run effects. The Engle-Granger Two-Step method and the Johansen technique were widely used until the bounds testing approach developed by Pesaran, Shin, and Smith (2001). The Pesaran, Shin, and Smith (2001) technique is commonly used in recent works (Tang 2003; Narayan and Narayan 2005; Arize and Nippani 2010; Thaver, Ekanayake, and Plante 2012).

Orcutt's final point argues that the price elasticity of demand will be larger for larger price changes and smaller for smaller price changes. Orcutt termed this concept the "quantum effect." Empirical investigation into the existence of the quantum effect has yielded mixed results, but the preponderance of studies indicates little support for the presence of the quantum effect (Liu 1954; Khan 1974; Magee 1975).

Orcutt's (1950) seminal work catalyzed further investigation into the viability of OLS regression techniques in the estimation of import demand elasticities. The import demand literature of 1960s, 1970s, and 1980s is characterized by attempts to settle the questions first proposed by Orcutt in 1950.

Econometric Advancements

Throughout the next four decades, researchers continued to build on the foundation set by the works of the Elasticity Pessimism era and Orcutt (1950) and also addressed empirical issues unique to time-series data such as general model selection, functional form, model specification, lags, and stationarity. This section examines these issues and considers how these issues contribute to the import demand literature.

General Model Selection

Two general models are used for estimating import demand functions: the perfect substitutes model and the imperfect substitutes model. The perfect substitutes model is often used when estimating disaggregated import demand functions. The imperfect substitutes model is often used when estimating aggregate import demand functions. Although theoretical justifications for use of the perfect substitutes model exist, the imperfect substitutes model has been the most frequently used model throughout the literature (Arize *et. al*. 2004; Ozturk and Acaravci 2009).

Empirical support for the perfect substitutes model is lacking in the literature. At the aggregate level, the assumption of perfect substitutes is questionable due to the relative size of non-standardized goods in most countries' import portfolios and the perfect substitutes model should not be used. Even at disaggregated levels, when traded goods may be perfect substitutes, the "law of one price," the theory advocating the same price for the same goods in different countries, should hold. However, the literature suggests the "law of one price" does not typically hold for non-standardized goods (Kreinen and Officer 1978; Isard 1977; Kravis and Lipsey 1978).

The theoretical framework underpinning import demand models can be traced back to the economic theory of consumer demand (Labys 1973). The theory of consumer demand claims that consumers maximize total utility within the constraints of a budget (Labys 1973). Miller and Fratianni (1974) support the validity of the import demand function as seen in the import demand elasticity literature on both a theoretical and empirical basis. The imperfect substitutes model of imports builds on the foundation of consumer demand theory whereby consumers are assumed to maximize utility subject to a budget constraint (Goldstein and Khan 1985).

The main assumption underlying the imperfect substitutes model is that neither exports nor imports serve as perfect substitutes for domestically produced goods. Rhomberg (1973) supports this underlying assumption arguing that a country may be either an importer or an exporter of a good, but not both simultaneously. Magee (1975) further supports this claim arguing that if traded goods were perfect substitutes, then one should observe domestic markets alternately saturated by imports and domestically produced goods as the costs of production are driven downward. In addition, the imperfect substitutes model assumes that changes in consumer income are equally matched by a change in price level so that demand is constant (Goldstein and Khan 1985). Finally, the imperfect substitutes model assumes the absence of inferior goods (Goldstein and Khan 1985).

The imperfect substitutes model, at its core, describes import demand as a function of income, domestic prices of substitute goods, and import prices and is presented theoretically as follows:

$$M = f(Y, PD, PM) \qquad (1)$$

where M represents import demand, Y represents income, PD represents domestic prices, and PM represents import prices (Magee 1975). The income variable is typically represented by real gross domestic product. Domestic prices are represented by the consumer price index and foreign prices are represented by an import price index.

Functional Form

Although the imperfect substitutes model became the preferred general model during the post-Orcutt era, the question of proper functional form remained a central point of debate. The questions of level versus logarithmic measurement of variables, the specification of the price variable, and which control variables to include in the model in addition to income, domestic prices, and import prices were all explored during the period of econometric advancements. This section explores the literature surrounding these debates.

Houthakker and Magee (1969) modified the functional form of Equation 1 by expressing all variables as logarithmic instead of level. Altering the functional form changes the interpretation of the estimated regression model. When variables are expressed in level form, the regression coefficients relay the constant linear effect of the independent variables on the dependent variable. Coefficients estimated using variables in logarithmic form express the proportional changes of the dependent variable with respect to a change in an independent variable, which results in elasticities (Wooldridge 2009). The shift from linear functional form to logarithmic functional form persists in the literature today (Hye and Mashkoor 2010; Triplett and Thaver 2015).

Houthakker and Magee's (1969) model presents the price variable as a ratio of foreign prices to domestic prices as seen below:

$$M = f(Y, PM/PD) \qquad (2)$$

where Y is real GDP, PM is the price of imports typically represented by an import value index, and PD is domestic prices typically represented by the importing country's consumer price index. Dividing the price of imports by the price of domestic prices is referred to as the relative price variable.

Murray and Ginman (1976) argue the use of the relative price variable leads to questionable elasticity results when applied in studies where aggregate import demand is used as the dependent variable. These findings led Murray and Ginman (1976) to question the validity of price as a ratio of foreign prices to domestic prices and favor the use of the split-price form of the price variable as shown below:

$$M = f(Y, PM, PD) \qquad (3)$$

where the variables are the same as defined above, but the price variable is split into two separate variables. In order for the relative price specification to be valid, the elasticity of the domestic price variable and the import price variable must be of equal magnitude but opposite in sign. Murray and Ginman (1976) dispute this claim based on two arguments. First, prices of goods are weighted differently in the domestic and import price indexes. Second, consumers may show a preference for domestically produced goods due to patriotism or greater knowledge or local markets. Treating import and domestic prices as separate independent variables allows for the differences in consumers response to changes in these variables to be observed. However, studies conducted in the last ten years continue to use relative prices as an independent variable to reduce the likelihood of multicollinearity (Alam and Ahmad 2010; Hye and Mashkoor 2010; Khan, Khan, and Shah 2014).

According to Sawyer and Sprinkle (1996), use of the split-price form is useful when the real exchange rate variable is included in the model as shown below:

$$M = f(Y, PM, PD, REER) \qquad (4)$$

where Y, PM, and PD are the same as above and REER is equal to the real exchange rate. Bahmani-Oskooee (1986) estimates an import demand function for seven developing countries including Brazil, Greece, Korea, Pakistan, Philippines, Thailand, and Turkey using the real exchange rate as explanatory variable, which is statistically significant. Bahmani-Oskooee and Payesteh (1993) estimate import demand functions for six less developed countries including Greece, Korea, Pakistan, Philippines, Singapore, and South Africa and found significant effects for both income (positive) and the real exchange rate variable (negative) for Pakistan, Philippines, Singapore, and South Africa.

The inclusion of more independent variables increases the risk of multicollinearity, but researchers continue to examine additional independent variables in addition to the income and price variables (Abbott and Seddighi 1996; Narayan and Narayan 2005). Price and Thornblade (1972) encourage conducting research aimed at identifying variables other than income and prices influencing import demand. Khan (1974) endorses the inclusion of variables such as trade restrictions, economic conditions, and historical political characteristics as dummy variables, especially in the case of developing countries. Mutti (1977) claims there is no "correct" functional form but contends more general functional forms with fewer variables are favorable due to their ease of use and broad application. Thursby and Thursby (1984) suggest the inclusion of control variables for macroeconomic shocks such as exchange rate regime, import price shocks, and prolonged global recession. Therefore, the current study incorporates a dummy variable to control for the effects of the global recession of the late 2009-10:

$$M = f(Y, PD, PM, REER, REC) \qquad (5)$$

where REC is a dummy variable for the global recession of 2009-10 and the other variables are the same as previously defined.

Time Lags and Dynamics

Consumer response towards changes in income, prices, and other variables that influence demand do not transpire instantly in practice (Yadav 1975; Goldstein and Khan 1985). In the 1970s, the import demand model was augmented to account for the lag in response time of the demand for imports to the independent variables. Using data from 1957 – 1971, Wilson and Takacs (1979) present evidence from six developed nations supporting the hypothesis that trade flows do not respond instantly to changes in income, prices, and exchange rates. The findings of Wilson and Takacs (1979) are supported throughout the literature (Bahmani-Oskooee 1986; Tegene 1991; Oyinlola, *et al.* 2010).

Stationarity

Until the 1990s, the presence of stationarity in the variables was assumed and, therefore, untested (Dutta and Ahmed 1999). Stationarity is a feature of time series data whereby changes to an independent variable are due to a random process instead of trend, seasonality, or business cycles (Wooldridge 2009). Stationary data exhibit a constant mean and variance through time.

Granger and Newbold (1976) question the validity of elasticity estimates when the presence of stationarity is assumed. If stationarity is assumed and the variables are non-stationary, the results could be spurious and therefore invalid. Within the import demand elasticity literature, stationarity was first tested for using the Augmented Dickey-Fuller test or the Johansen technique. The development of the bounds testing approach by Pesaran, Shin, and Smith (2001) provides a more powerful test for stationarity due to its positive attributes for small sample sizes (Narayan and Narayan 2005; Thaver and Ekanayake 2010). Since data related to developing countries is scarce compared to developed countries, researchers favor statistical techniques, like the bounds testing approach, suitable for small sample sizes (Narayan and Narayan 2005).

After Orcutt's Challenge, researchers sought to increase the precision of import demand elasticity estimates. As a result, researchers debated econometric issues unique to the estimation of trade elasticities, namely the merits of the imperfect substitutes model versus the perfect substitutes model, the proper functional form of the model, and which independent variables to include in the model. The precision of import demand elasticities was further enhanced by the advancement of econometric techniques with respect to time series data; specifically, the inclusion of time lags and tests for stationarity. These advancements, coupled with greater access to data for developing countries towards the end of the twentieth century, led to greater interest in the estimation of import demand elasticities for developing countries.

Estimates of Import Demand Elasticity for Developing Nations

During the latter part of the twentieth century, the literature began to include elasticity estimates for developing countries. This section reviews the works concerned with the estimation of import demand elasticities for developing countries.

Arize and Afifi (1987) estimate import demand elasticities for thirty developing countries including twenty-seven African countries, Pakistan, Kuwait, and Israel using aggregate data for the period of 1960-1982. Four equations are estimated, two of which are equilibrium models containing no lagged variables and two are disequilibrium models containing one-period lagged variables for the dependent variable, quantity of import demand. The independent variables for the first model are trend level of real income, the ratio of real income to trend level income, price of imports, and price of domestic goods. The independent variables for the second model are the same as the first model plus the addition of the one-period lagged variable for import demand. The independent variables for the third model are trend level of real income, the ratio of real income to trend level income, and relative prices. The independent variables for the fourth model are the same as the third model plus the addition of the one-period lagged variable for import demand. The two stage least squares method of estimation is used instead of OLS because the authors presume correlation between the error term and the independent variables leading to simultaneity bias. Arize and Afifi (1987) report statistically significant price elasticity coefficients with negative signs for twenty-three of the thirty countries studied. Of those twenty-three countries, ten price elasticity coefficients were elastic.

Tang and Alias (2000) estimate an import demand function for Malaysia for the period of 1970-1998 using the Johansen approach to cointegration. The dependent variable is quantity of imports demanded and the independent variables are income and relative prices. Tang and Alias (2000) find an elasticity coefficient of 1.5 for the long run relationship between the quantity of imports demanded and income and a coefficient of -1.8 for relative prices.

Tang (2003) estimates an import demand function for China using the bounds testing approach for cointegration for the period of 1970-1999. The dependent variable is the quantity of imports demanded and the independent variables are relative prices and disaggregated components of expenditure: final consumption, export spending, and investment expenditure. The results include import demand elasticity coefficients is 0.17

for final consumption, 0.51 for export spending, 0.40 for investment expenditure, and -0.6 for relative prices.

Narayan and Narayan (2005) estimate import demand elasticities for Fiji using annual data from 1970-2000. The dependent variable is the quantity of imports demanded and the independent variables are relative prices and disaggregated components of expenditure: total consumption, investment expenditure, and export expenditure with all variables in log form. Narayan and Narayan claim the use of disaggregated expenditure components provides two advantages: the mitigation of aggregation bias and greater forecasting power via the elimination of aggregation bias. The bounds testing approach to test for cointegration and an autoregressive distributed lag model is used to find short and long run elasticities. The long run model estimates a coefficient of 0.68 for consumption, .017 for investment, 0.69 for export expenditure, and -0.38 for relative prices. In the short run, the model estimates a coefficient of 0.52 for consumption, 0.13 for investment, 0.53 for export expenditure, and -0.29 for relative prices. The error correction term included in the short run model is -0.76 and statistically significant indicating Fijian import respond rapidly to economic shocks. All dependent variables are statistically significant at the 1% level.

Alam and Ahmad (2011) estimate bilateral import demand elasticities between Pakistan and its six largest trading partners: The United States, the United Kingdom, Japan, Saudi Arabia, the United Arab Emirates, and Germany. The study uses quarterly data from 1982-2008. The dependent variable is quantity of imports demanded and the independent variables are real gross domestic product, relative prices, real effective exchange rate, and exchange rate volatility with all variables in log form. An autoregressive distributed lag model is used in conjunction with the bounds testing approach to test for the presence of cointegration. Alam and Ahmad find statistically significant income elasticities for the United States (0.75), the United Kingdom (0.68), Japan (1.41), and Germany (1.11); statistically significant, but wrong-sided price elasticities for Saudi Arabia (2.31) and the United Arab Emirates (1.70); and statistically significant real exchange rate elasticities for Saudi Arabia (2.91), the United Arab Emirates (2.99), and Germany (-0.97). The positive sign for Saudi Arabia and the United Arab Emirates indicates a depreciation of local currency would reduce demand for goods from Saudi Arabia and the United Arab Emirates. The negative sign for Germany indicates a depreciation of local currency would increase imports from Germany. No significant results were found for the real exchange rate volatility variable.

Hibbert, Thaver, and Hutchinson (2012) estimate a bilateral import demand function for Jamaica and two trading partners, the United States and the United Kingdom. The elasticity coefficients are estimated for the United States and the United Kingdom using quarterly data from 1996-2010 and employing the bounds approach to cointegration and an error correction model. The dependent variable is the quantity of bilateral imports demanded from the United States and the United Kingdom. The independent variables for both bilateral models are real gross domestic product, relative prices, real foreign exchange reserves, and real exchange rate volatility. The long run elasticities for the Jamaica-United States relationship indicate a statistically significant, elastic (5.86) relationship between real gross domestic product and import demand and a statistically significant, inelastic (0.68) relationship between real gross domestic product and import demand. The price elasticity is wrong-signed but no explanation is provided.

The short run elasticities for the Jamaica-United States relationship indicate a statistically significant, elastic (-4.99), but wrong-signed, relationship between real gross domestic product and import demand. Relative prices are also statistically significant, elastic (2.07), and wrong-signed. Neither foreign reserves nor volatility was statistically significant in the short-run model. The long run elasticities for the Jamaica-United Kingdom relationship indicate a statistically significant relationship between import demand and relative prices (0.93), real foreign exchange reserves (0.44), and exchange rate volatility (0.11). The short run elasticities for the Jamaica-United Kingdom relationship indicate a statistically significant relationship between import demand and income (11.63) and foreign exchange reserves (-0.9). Neither relative prices nor volatility was statistically significant in the short-run model.

The literature estimating import demand elasticities for developing countries generally utilizes the imperfect substitutes model, with all variables in logarithmic form, and estimates of both long and short run elasticities. Income elasticities are consistently positive and elastic, but the price variable has yielded inconsistent results. Separating the price variable into the split-price form could provide insight into these inconsistent estimates.

Import Demand Elasticities for South Africa

This section reviews empirical works in the estimation of import demand elasticities for the country of South Africa. All empirical works on South Africa before 1975 are surveyed in Stern, Francis, and Schumacher (1975), so this section updates their work by considering empirical studies since 1975.

Studies Estimating Aggregate Import Demand Elasticities for South Africa

Erasmus (1978) estimates aggregate import demand elasticities for South Africa for the time period of 1965 to 1976 using quarterly data. The independent variables in this study are income and prices. Prices are modeled using the ratio of import prices to domestic prices. The elasticity coefficient of income is 0.886 and the elasticity coefficient of relative prices is -1.525. Both independent variables are found to be significant at the 5% level.

Bahmani-Oskooee (1984) estimates aggregate import demand elasticities for the time period of 1975 to 1978 using quarterly data for South Africa. The independent variables in this study are income and prices. Prices are modeled using the ratio of import prices to domestic prices. The elasticity coefficient of income is 1.889 and the elasticity coefficient of relative prices is -0.467. Neither of the independent variables is found to be significant at the 5% level.

Bahmani-Oskooee (1986) estimates aggregate import demand elasticities for South Africa for the time period of 1973 to 1980 using quarterly data. The independent variables in this study are income, relative prices, and the real exchange rate. The elasticity coefficient of income is 2.499, the elasticity coefficient of relative prices is -2.46, and the elasticity coefficient of the real exchange rate is -0.1092. All three independent variables are found to be significant at the 5% level.

Kahn (1987) estimates disaggregated import demand elasticities for South Africa for the time period of 1974 to 1987 using quarterly data. Imports are disaggregated into agricultural, chemical, machinery and transport, and manufacturing imports. The independent variables in this study are income and relative prices. The elasticity coefficients of income range from 0.19 for agriculture to 2.96 for machinery and transport. The elasticity coefficients of relative prices range from -1.37 for chemicals to -0.14 for machinery and transport. All independent variables for all import categories are found to be significant at the 5% level with the exception of the coefficient for relative prices in the machinery and transport category.

Bahmani-Oskooee and Niroomand (1998) estimate aggregate import demand elasticities for South Africa for the time period of 1960 to 1992 using annual data. The independent variables in this study are income and prices. Prices are modeled using the ratio of import prices to domestic prices. The elasticity coefficient of income is 1.29 and the elasticity coefficient of relative prices is -0.83. Neither of the independent variables is found to be significant at the 5% level.

Gumede (2000) uses quarterly data from 1960 through 1996 to estimate an aggregate import demand equation for South Africa. The dependent variable is the quantity of real imports demanded and the independent variables are real income and relative prices. The Engle-Granger two-step approach is used to test for cointegration and a cointegrated relationship among the variables is confirmed. The long-run elasticity coefficients are 1.06 for real income and -1.56 for relative prices. Real income is statistically significant at the one percent level and relative prices is significant at the five percent level. The short-run elasticity coefficients are 1.63 for real income and -1.00 for relative prices. The coefficient for real income is statistically significant at the one percent level and the coefficient for relative prices is statistically insignificant.

Narayan and Narayan (2010) estimate aggregate import demand elasticities for Mauritius and South Africa using annual data from 1960 through 2005. The bounds t-test developed by Pesaran, Shin, and Smith (2001) is used to test for long-run cointegration and an error correction model developed by Banerjee, Dolado, and Mestre (1998) is used to estimate the long and short-run import demand elasticity coefficients. The dependent variable in the model is the quantity of real imports demanded. The independent variables are real income and relative prices. The long-run elasticity coefficients are 1.64 for real income and -1.00 for relative prices and both are statistically significant at the one percent level. The short-run elasticity coefficients are 4.00 for real income and -0.31 for relative prices and both are statistically significant at the one percent level. The coefficient for the error correction term is -0.31 indicating thirty percent of the shock to import demand is absorbed in the first year.

Thaver and Ekanayake (2010) estimate an aggregate import demand function for South Africa using annual data from 1950 through 2008. The authors test for cointegration among the variables using the bounds testing approach. An autoregressive distributed lag model is used to estimate the short and long-run import demand elasticities. The dependent variable is the quantity of real import volume demanded. The independent variables are real income, relative prices, level of foreign reserves, a dummy variable for the Apartheid era (1950-1994), and a dummy variable representing a period of economic sanctions against South Africa (1981-1994). The long-run elasticity coefficients are 1.07 for real income, -0.09 for relative prices, 0.15 for level of foreign reserves, -0.02 for the Apartheid dummy variable, and -0.13 for the economic sanctions dummy variable. Real income and level of foreign reserves are significant at the one percent level; the dummy variable for economic sanctions is statistically significant at the five percent level; the rest of the independent variables are statistically insignificant. In the short-run, the import demand elasticities are 2.86 for real income, -0.32 for relative prices, 0.04 for level of foreign reserves, -0.07 for the Apartheid dummy variable, and 0.05 for the economic sanctions dummy variable. Real income and the dummy variable for economic sanctions are statistically significant at the one percent level and the rest of the variables are statistically significant at the five percent level. The coefficient on the error correction term is -0.36 indicating 36% of the shock to import demand is absorbed in less than one year.

Zhou and Dube (2011) estimate an aggregate import demand function for South Africa using annual data from 1970 through 2007. The dependent variable is the quantity of imports demanded. The independent variables are national cash flow and relative prices. A cointegrated relationship among the variables is confirmed using the bounds test developed by Pesaran, Shin, and Smith (2001). The long-run elasticities are 1.36 for national cash flow and -0.13 for relative prices. The national cash flow variable is statistically significant at the 1% level and the relative price level is statistically insignificant. The short-run elasticities are 0.3 for national cash flow and 1.17 for relative prices. The error correction variable is lagged one year and is -0.22 indicating 22% of the shock to import demand is absorbed within one year. Zhou and Dube (2011) posit that the inelastic demand with regard to relative prices is due the import of capital goods necessary to support economic growth in South Africa.

Studies Estimating Bilateral Import Demand Elasticities for South Africa

Thaver, Ekanayake, and Plante (2012) estimate a bilateral import demand function between South Africa and Nigeria using quarterly data for the period of 1992 through 2010. The dependent variable is quantity of imports demanded by South Africa from Nigeria. The independent variables are relative prices, level of foreign reserves, exchange rate volatility, consumption plus government expenditure, investment, real exports, and a dummy variable representing South Africa's participation in initiatives aimed at increasing intra-African trade. Using the bounds testing approach developed by Pesaran, Shin, and Smith (2001), a long-run cointegrated relationship among the variables is established. The long-run elasticity coefficients are 3.32 for relative prices, 0.03 for level of foreign reserves, 0.14 for exchange rate volatility, 3.36 for consumption plus government expenditure, -3.15 for investment, 1.77 for real exports, and 1.14 for the dummy variable. The relative price variable is statistically significant at the 1% level and the investment variable is significant at the 10% level. All other variables are statistically insignificant in the long-run. The short-run elasticity coefficients are -8.43 for relative prices, 0.77 for level of foreign reserves, -0.21 for exchange rate volatility, -0.12 for consumption plus government expenditure, 2.61 for investment, -1.91 for real exports, and -0.67 for the dummy variable. The coefficient of the error correction term is -0.59, lagged on quarter, and statistically significant at the 1% level indicating 59% of the shock to import demand is absorbed in one quarter.

Triplett and Thaver (2015) estimate a bilateral import demand function between South Africa and China for the period of 1993 through 2012. The dependent variable is the quantity of imports to South Africa from China. The independent variables are real income, relative prices, foreign exchange reserves, exchange rate volatility, industrial productivity, and a dummy variable to account for periods in which China is a member of the World Trade Organization. A long-run cointegrated relationship among the variables is established using the bounds testing procedure. The estimated long-run elasticities are

2.10 for real income, 1.67 for relative prices, 0.05 for foreign exchange reserves, 0.07 for exchange rate volatility, 1.29 for industrial productivity, and 0.2 for the dummy variable. Real income, relative prices, industrial production, and the dummy variable are statistically significant at the 1% level; exchange rate volatility is statistically significant at the 10% level; and foreign exchange reserves is statistically insignificant. The theoretically counter intuitive result of the relative price variable means a devaluation of the Rand would widen the trade deficit between South Africa and China. The estimated short-run elasticities based on an error-correction model are 3.65 for real income, -3.52 for relative prices, -0.24 for foreign exchange reserves, -0.09 for exchange rate volatility, -2.27 for industrial productivity, 0.2 for the dummy variable. All variables are statistically significant at the 1% level in the short-run. The parameter estimate for the correction term is lagged one quarter, statistically significant at the 1% level, and estimated to be -0.99 meaning any shock to import demand is absorbed in one quarter 99% of the time.

This research adds to the literature by estimating bilateral import demand elasticities between South Africa and its five largest trading partners. The literature estimating bilateral import demand elasticities is small relative the size of the literature devoted to estimating aggregate import demand elasticities. In addition, this research splits the relative price variable into its component parts and includes both import prices and domestic prices as independent variables. Finally, this research incorporates lags into the model and estimates both short-and long-term elasticities.

CHAPTER III - METHODOLOGY

This chapter establishes the procedures used to estimate the bilateral trade elasticities for South Africa and each of its five largest trading partners: China, Germany, the United States, India, and Saudi Arabia. This study uses time-series data so tests for stationarity and cointegration are performed to establish the validity of the regression models. This study uses the bounds testing approach to cointegration, developed by Pesaran, Shin, and Smith (2001). The bounds testing approach develops an autoregressive distributed lag (ARDL) model that may be used to test for cointegration and estimate short and long run elasticities. The procedural framework established in this chapter is applied to all five bilateral trade models. Stata is used for all statistical analysis. This chapter divides into seven sections:

a) Research Questions

b) Hypotheses

c) Import Demand Model

d) Data

e) Pre-estimation Statistical Tests

f) Parameter Estimation

g) Post-estimation statistical tests

Research Questions

1) What are the bilateral income, domestic price, and foreign price elasticities of import demand between South Africa and its five largest trade partners?

2) What is the effect of the real exchange rate on import demand for South Africa?

3) What is the lag structure associated with income, domestic prices, foreign prices, and the real exchange rate?

Hypotheses

The imperfect substitutes model specified below will be used to test the following hypotheses:

Claim #1

H_O: β_1: Real income has no effect on import demand

H_a: β_1: Real income is directly related to import demand

Claim #2

H_O: β_2: Price of Domestic Goods has no impact on import demand

H_a: β_2: Price of Domestic Goods is directly related to import demand

Claim #3

H_O: β_3: Price of Imported Goods has no impact on import demand

H_a: β_3: Price of Imported Goods is inversely related to import demand

Claim #4

H_O: β_4: Real effective exchange rate has no impact on import demand

H_a: β_4: Real effective exchange rate is directly related to import demand

Claim #5

H_O: β_5: Recession has no impact on import demand

H_a: β_5: Recession is inversely related to import demand

The expected signs for elasticity estimates are positive for income (Y), the price of domestic goods (PD), and the real exchange rate; and negative for the price of imported goods (PM), and recession (REC).

Import Demand Model

Since the South African import portfolio is composed of a myriad of goods that includes but is not limited to commodities, the imperfect substitutes model is used in this research. The imperfect substitutes model for import demand assumes import demand is a function of income, domestic prices, and foreign prices (Goldstein and Khan 1985). The model is typically presented in log form and the resulting coefficients for each variable are interpreted as elasticity estimates for income and prices (Houthakker and Magee 1969).

At its core, the imperfect substitutes model describes import demand as a function of income, domestic prices of substitute goods, and import prices and is presented theoretically as follows:

$$M = f(Y, PD, PM) \qquad (1)$$

where M represents import demand, Y represents income, PD represents domestic prices, and PM represents import prices. The current study includes the real exchange rate variable and a dummy variable for periods of recession in the estimation of South Africa's import demand function, yielding the following theoretical presentation of the imperfect substitutes model that will be used in this study:

$$M = f(Y, PD, PM, REER, REC) \qquad (2)$$

where REER represents the real exchange rate and REC is a dummy variable for periods of recession and the other variables are the same as defined earlier.

Therefore, the import demand model for South Africa used in this research is specified as:

$$lnM_{it} = \beta_0 + \beta_1 lnY_t + \beta_2 lnPD_t + \beta_3 lnPM_t + \beta_4 lnREER_t + \beta_5 REC_t + u_t \qquad (3)$$

The variables used in the regression model are defined as follows:

(1) Total Quantity Imports Demanded *(lnM_{it})*: Real bilateral import demand for South Africa from country i at time t.

(2) Gross Domestic Product *(lnY_t)*: Real income or real gross domestic product of South Africa at time t.

(3) Price of Domestic Goods *($lnPD_t$)*: Price of domestic goods produced in South Africa at time t.

(4) Price of Imported Goods *($lnPM_t$)*: Price of goods imported by South Africa at time t.

(5) Real Effective Exchange Rate ($lnREER_t$): Real Effective Exchange Rate at time t.

(6) Dummy Variable for Recession (REC_t)

Data

Dependent Variable

Real Bilateral Import Demand. The model's dependent variable is real bilateral import demand and is defined as the quantity of goods imported by South Africa from each of its top five trading partners. Data for aggregate bilateral import demand is available from the International Monetary Fund's Direction of Trade Statistics, or DOTS (2019). The database reports total value of imports in current U.S. Dollars (USD). The total value of imports is deflated by South Africa's unit value index and rebased to 2010 to arrive at real bilateral import demand. The level data is then converted into logarithmic form.

Independent Variables

Real Income. Income is represented by real gross domestic product. Nominal gross domestic product figures are sourced from the South African Reserve Bank, or

SARB (2019). The nominal figures are converted to USD using the average nominal exchange rate for each quarter as provided by the International Monetary Fund's International Financial Statistics, or IFS (2019) database. Finally, the figures are converted from nominal to real using the Consumer Pricing Index sourced from Statistics South Africa, or SSA (2019). The base year is 2010. The level data is then converted into logarithmic form.

Import Prices. Import prices are represented by the South African import unit value index. Data for the import unit value index is sourced from the SARB (2019) database. The database reports import unit value index using 2000 as the base year. The level data is rebased to 2010 and converted into logarithmic form.

Domestic Prices. Domestic prices are represented by the South African consumer price index. Data for the consumer price index is sourced from the SSA statistical database (SSA 2019). The database reports the consumer price index using 2010 as the base year. The level data is then converted into logarithmic form.

Real Effective Exchange Rate. Real effective exchange rate data is available from the International Monetary Fund's IFS (2019) database. The database reports the real effective exchange rate using 2010 as the base year. The level data is then converted into logarithmic form.

Recession. A dummy variable for periods of recession is used to control for the effects of a downturn in the business cycle. Quarters in which there was no recession are coded as "0", and quarters in which there was a recession are coded as "1."

Pre-Estimation Statistical Tests

This research estimates both short and long run import demand elasticities using an ARDL model based on Equation 3. In order to estimate valid elasticities in the long run, the data must be stationary and the variables cointegrated. In order to estimate valid elasticities in the short run, the data must be stationary. This section describes the statistical methods used to test for stationarity and cointegration.

Stationarity

When using time series data, the data must be stationary in order to validate the regression results. The use of non-stationary data may result in spurious results (Dickey and Fuller 1979). Non-stationary variables may be made stationary by taking the variable's first difference. When a series is stationary without differences, the series is considered to be integrated of order zero, or I(0). When data becomes stationary by taking the first difference, the data is integrated of order one, or I(1). Although the bounds approach to cointegration does not require the variables to be integrated of the same order, stationarity tests are necessary to ensure the data is not integrated of order two. Data integrated of order two invalidates the bounds testing approach (Pesaran, Shin, and Smith 2001).

Non-stationary data is often characterized by the presence of a unit root. To test for the presence of unit root, this study employs the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test. The null hypothesis for both tests is that the data is non-stationary.

Augmented Dickey-Fuller. The ADF test is an autoregressive process so before conducting the test, the optimal lag length for the model is established. The lag length is selected based on the Akaike Information Criterion (AIC), the Schwarz-Bayesian Information Criterion (SBIC), and the Hannan-Quinn Information Criterion (HBIC). Should these criterions disagree, the criterion with the lowest number of lags is chosen to alleviate multicollinearity.

The ADF test is run on the dependent variable and each of the independent variables. The ADF test is run the first time without controlling for trend and run a second time controlling for trend. The ADF test is initially run with and without trend on the log form of the variables without differencing. If the test fails to reject the null hypothesis, the ADF test is conducted using the first difference of each variable.

Phillips-Perron. The second test for stationarity is the Phillips-Perron test. Whereas the ADF test controls for the presence of serial correlation through additional lags, the PP test controls for the presence of serial correlation by adjusting the test statistic (Philips and Perron 1988).

The PP test is run on the dependent variable and each of the independent variables. The PP test is run the first time without controlling for trend and run a second time controlling for trend. The PP test is initially run with and without trend on the log form of the variables without differencing. If the test fails to reject the null hypothesis, the PP test is conducted using the first difference of each variable.

Cointegration

After the ADF and PP tests are run, the data is tested for the presence of a long-run cointegrated relationship among the variables. Following Narayan and Narayan (2005), Alam and Ahmad (2010), and Triplett and Thaver (2015) the bounds testing approach developed by Pesaran, Shin, and Smith (2001) is used to test for cointegration.

The bounds testing approach offers three advantages in comparison to other methods for testing cointegration. First, the bounds test for cointegration may be used with I(0), I(1), or any combination of I(0) and I(1) variables (Pesaran, Shin, and Smith 2001). Second, the bounds testing approach is more robust in the case of small sample sizes (Narayan and Narayan 2005). Third, the bounds testing technique obtains long run unbiased elasticity coefficients (Belloumi 2014).

To initiate the bounds test for cointegration, an ARDL model is specified. For Equation 3, the model ARDL model used to test for cointegration in this research is specified below:

$$\Delta lnM_t = \beta_0 + \beta_1 lnM_{t-i} + \beta_2 lnY_{t-i} + \beta_3 lnPD_{t-i} + \beta_4 lnPM_{t-i} + \beta_5 lnREER_{t-i} + \beta_6 REC_{t-i} + \sum_{i=1}^{p} \beta_7 \Delta lnM_{t-i} + \sum_{i=1}^{q1} \beta_8 \Delta lnY_{t-i} + \sum_{i=1}^{q2} \beta_9 \Delta lnPD_{t-i} + \sum_{i=1}^{q3} \beta_{10} \Delta lnPM_{t-i} + \sum_{i=1}^{q4} \beta_{11} \Delta lnREER_{t-i} + \sum_{i=1}^{q5} \beta_{12} \Delta lnREC_{t-i} + u_t \quad (4)$$

where β_1 through β_6 are the coefficients for the long run elasticity coefficients, β_7 through β_{12} are the short run elasticity coefficients, *p* is the optimal lag length for the dependent variable, and *q1, q2, q3, q4, and q5* are optimal lag lengths for the independent variables.

The bounds test for cointegration evolves from the Wald test (Pesaran, Shin, and Smith 2001). Two critical values are provided: a lower bound critical value which assumes the variables are all integrated of order zero and an upper bound critical value which assumes the variables are all integrated of order one. If the calculated F-statistic is less than the lower bound critical value, the null hypothesis of no cointegration among the variables cannot be rejected. If the calculated F-statistic is greater than the upper bound critical value, the null hypothesis is rejected in favor of the alternative. If the calculated F-statistic is between the lower and upper bound critical values, the bounds test is inconclusive.

The null hypothesis for the bounds cointegration test is no cointegration among the variables against the alternative of cointegration, or:

$$\mathrm{H_O}: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$$

$$\mathrm{H_a}: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 = 0$$

If the null hypothesis is rejected in favor of the alternative, the long run import demand elasticities are estimated using the ARDL model and the short-run elasticities are estimated using the ECM. If no cointegrated relationship is present, only the short-run elasticities using the ECM are estimated.

Parameter Estimation

Once cointegration is established, the long run and short run parameters may be estimated using Equation 4. Prior to parameter estimation, the dependent variable and the independent variables are tested to determine the optimal number of lags to include in the ARDL model. Lag selection is based on the AIC, SBIC, and HBIC criterion. Finally, an error correction model (ECM) is estimated to capture the speed of adjustment back to a long run equilibrium after a short run shock. The ECM is specified as:

$$\Delta lnM_t = \beta_0 + \sum_{i=1}^{p} \beta_1 \Delta lnM_{t-i} + \sum_{i=1}^{q1} \beta_2 \Delta lnY_{t-i} + \sum_{i=1}^{q2} \beta_3 \Delta lnPD_{t-i} + \sum_{i=1}^{q3} \beta_4 \Delta lnPM_{t-i} + \sum_{i=1}^{q4} \beta_5 \Delta lnREER_{t-i} + \sum_{i=1}^{q5} \beta_6 \Delta lnREC_{t-i} + \lambda ECT + u_t \quad (5)$$

where all variables are the same as previously defined and λ is the parameter estimating the speed of adjustment back to long run equilibrium.

Post-Estimation Statistical Tests

After estimating the ECM, diagnostic checks are conducted to address potential econometric issues in the model. These diagnostic checks include the Durbin-Watson and Breusch-Godfrey tests for serial correlation, the White test for heteroscedasticity, and the Jarque-Bera test for normality.

CHAPTER IV – RESULTS

This chapter applies the econometric strategy set forth in the previous chapter. The variables are tested for stationarity using the Augmented Dickey-Fuller test and the Phillips-Perron test. Once the stationarity properties are determined, the variables are tested for cointegration using the bounds testing approach developed by Pesaran, Shin, and Smith (2001). After conducting the bounds test, the diagnostic tests enumerated in the previous chapter are applied. The necessary econometric adjustments are made based on the results of the diagnostic tests and the elasticity coefficients are then estimated. If cointegration is established, the ARDL model is used to estimate the long and short run elasticities and the ECM is used to estimate the speed of adjustment to short run shocks. If no cointegration is present, the ARDL model is used to estimate only short run elasticities.

Pre-Estimation Statistical Tests

Before conducting the formal tests for stationarity, subjective analysis is conducted based on line graphs of each variable against time. Figures 1 through 4 provide such information. Figure 1 combines all of the dependent variables in log form, Figure 2 combines all of the independent in log form, Figure 3 combines the first difference of all dependent variables in log form, and Figure 4 combines the first difference of all independent variables in log form.

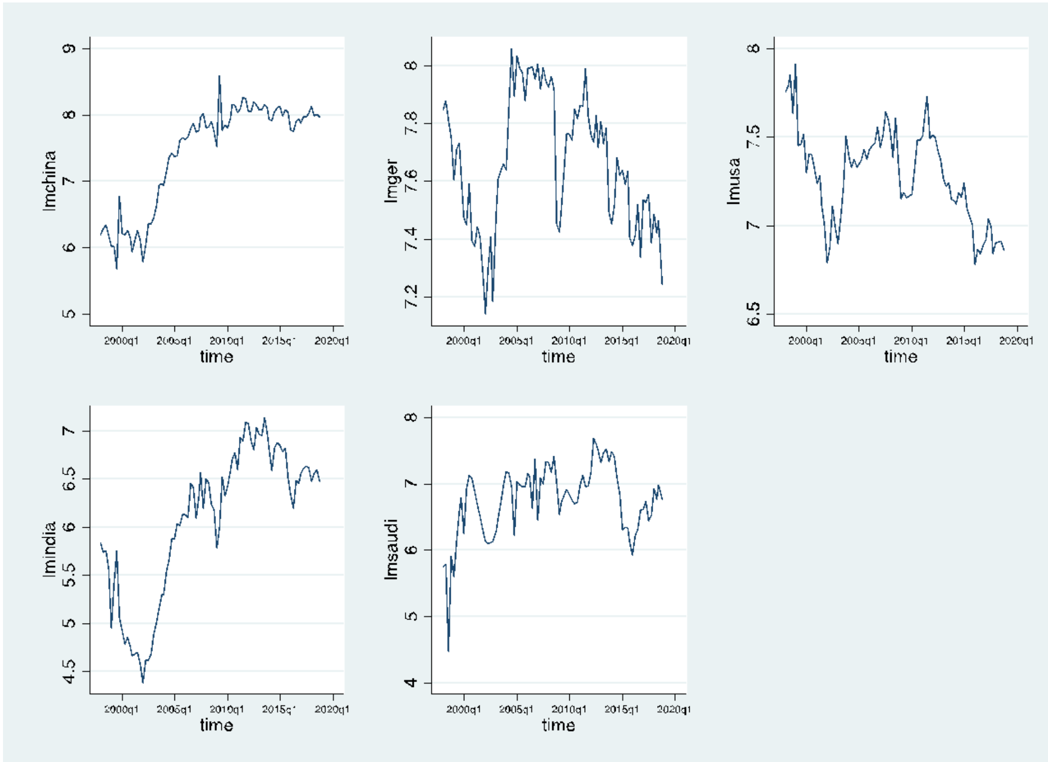

Figure 1. *Line Graphs for Dependent Variables in Log Form*

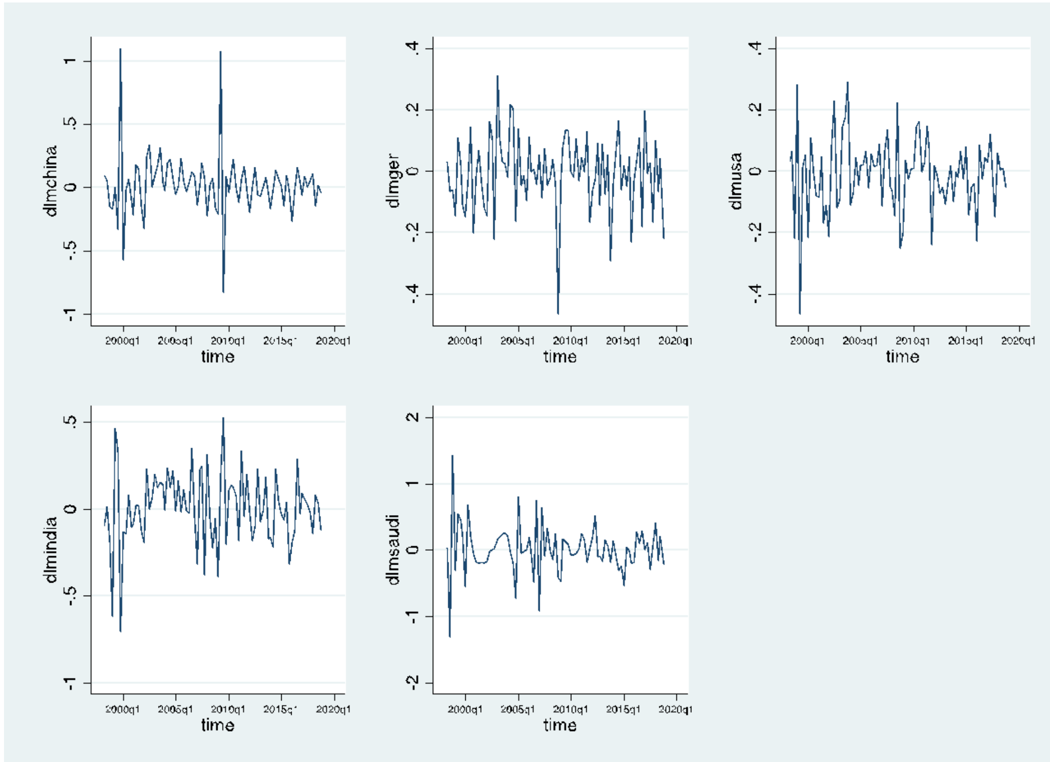

Figure 2. *Line Graphs for Dependent Variables in Log Form – First Difference*

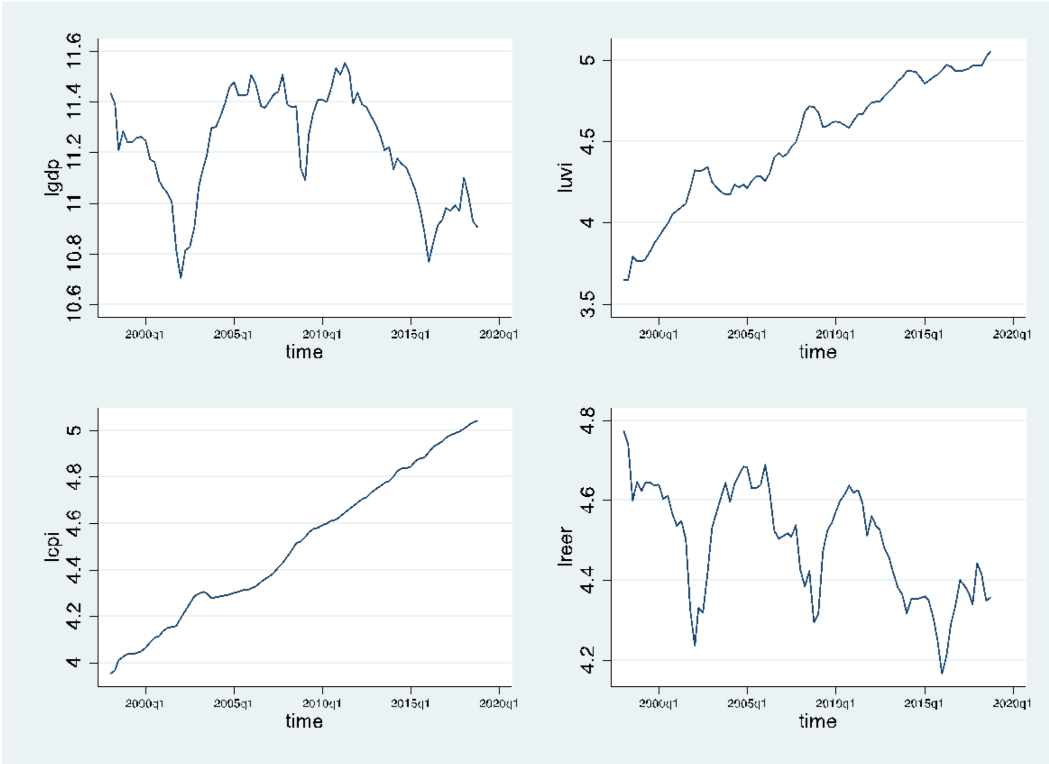

Figure 3. *Ling Graphs for Independent Variables in Log Form*

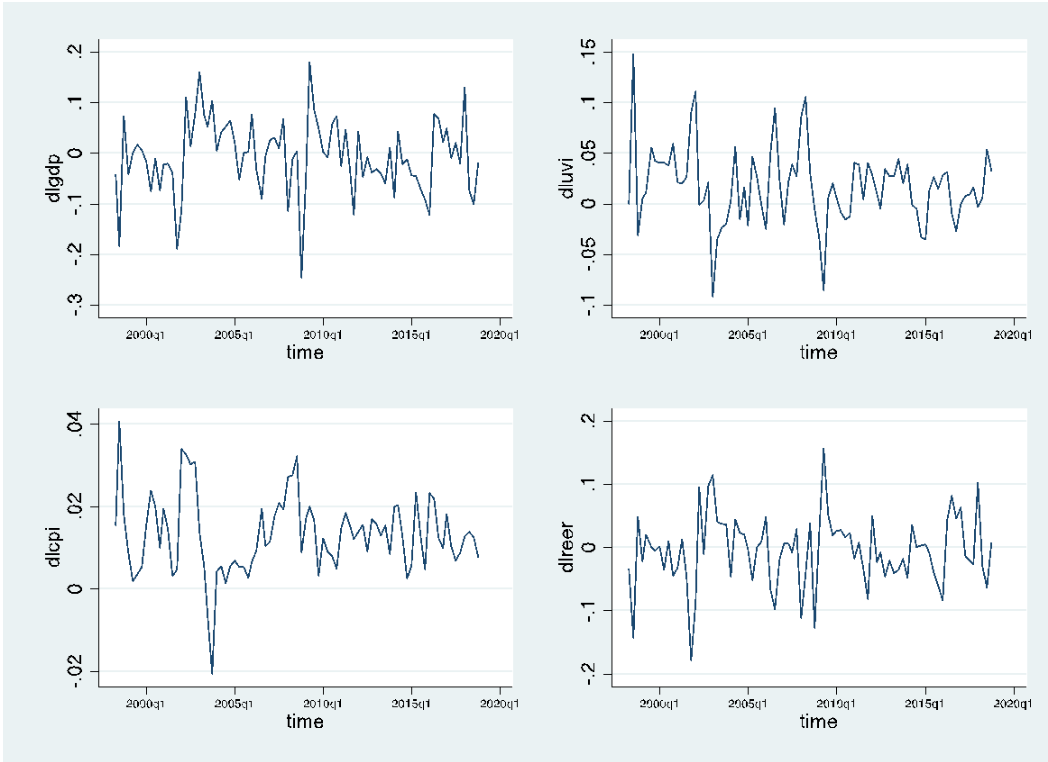

Figure 4. *Line Graphs for Independent Variables in Log Form – First Difference*

Figures 1 through 4 indicate all variables are either I(0) or I(1) processes. The bounds test accommodates both I(0) and I(1) variables, but I(2) variables invalidate the bounds test (Pesaran, Shin, and Smith 2001). The presence of trend is noted in the dependent variables LMCHINA and LMINDIA, as well as the independent variables LUVI and LCPI. In the formal stationarity tests below, all variables will be controlled for trend.

In order to perform the Augmented Dickey-Fuller test, the number of lags used in the test must be determined. Results for the dependent and independent variables are presented below in Tables 1 and 2. The lag selection order criteria details are included in Appendix A Tables A1 through A10. The maximum number of lags allowed for each variable is four. The number of lags is chosen based on the AIC, HQIC, or SBIC criteria. When the criteria disagree, the fewest number of lags is chosen to alleviate multicollinearity.

Table 1 *Lag Order Selection – Dependent Variables*

Variable	**Lags**
LMCHINA	3
LMGER	1
LMUSA	1
LMINDIA	1
LMSAUDI	2

Table 2 *Lag Order Selections – Independent Variables*

Variable	Lags
LGDP	2
LUVI	2
LCPI	2
LREER	2
REC	4

The results of the Augmented Dickey-Fuller test for the dependent variables and their first difference are presented in Table 3. The null hypothesis for the Augmented Dickey-Fuller test assumes the presence of a unit root.

With the exception of LMSAUDI, all non-differenced data contains a unit root. The LMSAUDI variable is significant at the 1% level. All first difference variables were significant at the 1% level. The Augmented Dickey-Fuller tests therefore suggest all dependent variables are I(0) or I(1). When controlling for trend, the results of the Augmented Dickey-Fuller test indicate the same stationarity properties as not controlling for trend.

Table 3 *Augmented Dickey-Fuller Test – Dependent Variables*

Variable	**Intercept Only**	**Intercept and Trend**
LMCHINA	-1.399 (0.5827)	-0.616 (0.9781)
LMCHINA_D1	-5.363 (0.0000)***	-5.587 (0.0000)***
LMGER	-1.939 (0.3139)	-1.968 (0.6190)
LMGER_D1	-7.215 (0.0000)***	-7.181 (0.0000)***
LMUSA	-2.068 (0.2575)	-2.256 (0.4587)
LMUSA_D1	-7.339 (0.0000)***	-7.303 (0.0000)***
LMINDIA	-1.058 (0.7316)	-2.017 (0.5924)
LMINDIA_D1	-8.481 (0.0000)***	-8.429 (0.0000)***
LMSAUDI	-4.537 (0.0002)***	-4.165 (0.0050)***
LMSAUDI_D1	-5.335 (0.0000)***	-5.396 (0.0000)***

P-values in parenthesis.

* p < 0.10, ** p < 0.05, *** p < 0.01

The results of the Augmented Dickey-Fuller test for the independent variables and their first difference are presented in Table 4. With the exception of the dummy variable, REC, all level independent variables contain a unit root. The first differences for every other independent variable is significant at the 1% level. The Augmented Dickey-Fuller tests therefore indicate all independent variables are I(0) or I(1). When controlling for trend, the results of the Augmented Dickey-Fuller test indicate the same stationarity properties as not controlling for trend.

Table 4 *Augmented Dickey-Fuller Test – Independent Variables*

Variable	**Intercept**	**Intercept and Trend**
LGDP	-1.493 (0.5370)	-1.634 (0.7789)
LGDP_D1	-4.135 (0.0008)***	-4.131 (0.0057)***
LUVI	-1.084 (0.7213)	-2.456 (0.3501)
LUVI_D1	-4.648 (0.0001)***	-4.786 (0.0005)***
LCPI	0.303 (0.9775)	-2.578 (0.2902)
LCPI_D1	-4.035 (0.0012)***	-4.015 (0.0084)***
LREER	-2.026 (0.2752)	-2.698 (0.2368)
LREER_D1	-4.447 (0.0002)***	-4.416 (0.0021)***
REC	-3.755 (0.0034)***	-4.168 (0.0050)***

P-values in parenthesis.

* p < 0.10, ** p < 0.05, *** p < 0.01

The results of the Phillips-Perron test for the dependent variables and their first difference are presented in Table 5. The null hypothesis for the Phillips-Perron test assumes the presence of a unit root.

The results of the Phillips-Perron tests echo the results of the Augmented Dickey-Fuller tests. All level variables, with the exception of LMSAUDI, are I(1) at the 1% significance level. The test indicates LMSAUDI is I(0) at the 1% level for intercept only and at the 5% level when controlling for trend. Controlling for trend for all other dependent variables suggest the variables are I(1) at the 1% level.

Table 5 *Phillips-Perron Test – Dependent Variables*

Variable	Intercept Only	Intercept and Trend
LMCHINA	-1.482 (0.5425)	-1.908 (0.6506)
LMCHINA_D1	-15.818 (0.0000)***	-15.991 (0.0000)***
LMGER	-2.049 (0.2656)	-2.101 (0.5456)
LMGER_D1	-10.589 (0.0000)***	-10.531 (0.0000)***
LMUSA	-2.185 (0.2118)	-2.515 (0.3207)
LMUSA_D1	-10.586 (0.0000)***	-10.793 (0.0000)***
LMINDIA	-1.031 (0.7417)	-2.131 (0.5286)
LMINDIA_D1	-10.251 (0.0000)***	-10.180 (0.0000)***
LMSAUDI	-3.482 (0.0085)***	-3.518 (0.0375)**
LMSAUDI_D1	-13.282 (0.0000)***	-13.322 (0.0000)***

P-values in parenthesis.

* p < 0.10, ** p < 0.05, *** p < 0.01

The results of the Phillips-Perron test for the independent variables and their first difference are presented in Table 6. The results of the Phillips-Perron tests echo the results of the Augmented Dickey-Fuller tests. All level variables, with the exception of the dummy variable (REC), contain a unit root. The test indicates REC is I(0) and the test is significant at the 1% level. All other independent variables are I(1) and the tests are significant at the 1% level for each variable. Controlling for trend did not change the stationarity properties of any dependent variables.

Table 6 *Phillips-Perron Test – Independent Variables*

Variable	**Intercept**	**Intercept and Trend**
LGDP	-1.716 (0.4228)	-1.776 (0.7160)
LGDP_D1	-7.400 (0.0000)***	-7.360 (0.0000)***
LUVI	-1.859 (0.3516)	-2.781 (0.2038)
LUVI_D1	-6.690 (0.0000)***	-6.800 (0.0000)***
LCPI	-0.340 (0.9196)	-2.203 (0.4882)
LCPI_D1	-5.035 (0.0000)***	-5.008 (0.0002)***
LREER	-2.553 (0.1030)	-2.993 (0.1518)
LREER_D1	-7.463 (0.0000)***	-7.429 (0.0000)***
REC	-5.329 (0.0000)***	-5.442 (0.0000)***

P-values in parenthesis.

* p < 0.10, ** p < 0.05, *** p < 0.01

The stationarity tests indicate a mixture of I(0) and I(1) variables. When variables are a mixture of I(0) and I(1), the bounds test for cointegration is appropriate (Pesaran, Shin, and Smith 2001). Bounds tests results for each of the five bilateral trade relationships are presented below in Table 7. The upper and lower bound critical values for models with five regressors are presented in Table 8. The critical values are provided by Narayan (2005), and are appropriate for models with fewer than eighty observations. The null hypothesis for the bounds test is no cointegration.

If the F-statistic is greater than the critical value for the upper bound, the null hypothesis is rejected and the error correction model (ECM) is used to estimate the long-run import demand elasticity coefficients. If the F-statistic is less than the critical value for the lower bound, we fail to reject the null hypothesis and the short-run import demand elasticities are estimated using the autoregressive distributed lag (ARDL) model. The bounds test is inconclusive if the F-statistic falls between the lower and upper bounds.

The results of the bounds test indicate a cointegrated relationship among the variables for China, Germany, the United States, and India at the 1% level and for Saudi Arabia at the 5% level. The bounds test provides sufficient evidence of a unique, long run cointegrated relationship among the variables.

Table 7 *ARDL Bounds Test for Cointegration – SBIC*

Import Partner	**Lag Structure**	**F-Statistic**	**Result**
China	1, 0, 1, 0, 0, 1	9.402	Cointegrated @ 1%
Germany	1, 1, 0, 0, 0, 0	5.582	Cointegrated @ 1%
United States	1, 3, 0, 0, 0, 0	7.219	Cointegrated @ 1%
India	3, 0, 0, 0, 0, 0	9.112	Cointegrated @ 1%
Saudi Arabia	2, 0, 0, 0, 0, 0	4.851	Cointegrated @ 5%

Table 8 *Bounds Test Critical Values from Narayan (2005)*

	10%		**5%**		**1%**	
# of regressors	**I(0)**	**I(1)**	**I(0)**	**I(1)**	**I(0)**	**I(1)**
5	2.38	3.52	2.80	4.07	3.77	5.21

Diagnostics

After cointegration is established, the ARDL model is subjected to a series of diagnostic tests for serial correlation, heteroskedasticity, and normality of the residuals. The results of these tests are presented below in Table 9. The diagnostic tests for all five models are acceptable with three exceptions. First, the White test detected heteroskedasticity in the China model; second, the Jarque-Bera test detected non-normally distributed residuals in the China model; and third, the Jarque-Bera test detected non-normally distributed residuals in the Saudi Arabia model.

To address the issue of heteroskedasticity in the China model, a robust model was estimated using Newey-West robust standard errors. Although the normality assumption is not upheld in the case of China and Saudi Arabia, the estimates remain unbiased and represent the best linear unbiased estimators (Wooldridge 2009). The non-normally distributed residuals diminish the inferential power of the estimates and is a limitation of results.

Table 9 *Diagnostic Checks on the ECM*

	China	**Germany**	**United States**	**India**	**Saudi Arabia**
A	0.543 (0.4612)	0.530 (0.4667)	0.116 (0.7329)	1.926 (0.1652)	1.202 (0.2729)
B	0.605 (0.4368)	0.590 (0.4424)	0.135 (0.7138)	2.140 (0.1435)	1.332 (0.2484)
C	76.28 (0.0000)	37.02 (0.2885)	54.80 (0.2975)	47.09 (0.2373)	23.24 (0.8963)
D	63.22 (0.0000)	1.155 (0.5612)	3.239 (0.198)	0.9784 (0.6131)	239.1 (0.0000)
A: Durbin-Watson Alternative for serial correlation B: Breusch-Godfrey for serial correlation C: White for heteroskedasticity D: Jarque-Bera for normality					

P-values in parenthesis

Long Run Import Demand Elasticity Estimates

The results in Table 10 indicate a direct long run relationship between the quantity of import demanded and real income for China, Germany, the United States, and India. Each of these results is significant at the 1% level. The results indicate an inverse relationship between the quantity of imports demanded and real income for Saudi Arabia though the result is statistically insignificant.

The results in Table 10 indicate a direct long run relationship between the quantity of import demanded and the price of domestic goods for China, Germany, the United States, and India. The results are significant at the 5% level for China, the 10% level for Germany, the 1% level for India, and statistically insignificant for the United States. The results indicate an inverse long run relationship between the quantity of imports demanded and real income for Saudi Arabia though the result is statistically insignificant.

The results in Table 10 indicate an inverse long run relationship between the quantity of import demanded and the price of imported goods for Germany, the United States, and India. The results are significant at the 10% level for Germany and the United States and statistically insignificant for India. The results indicate a direct long run relationship between the quantity of imports demanded and the price of imported goods for China and Saudi Arabia. The result for China is statistically insignificant while the result for Saudi Arabia is statistically significant at the 10% level.

The results in Table 10 indicate an inverse long run relationship between the quantity of import demanded and the real effective exchange rate for China, Germany, the United States, and India. The results are significant at the 10% level for China, the 5% level for Germany, and statistically insignificant for the United States and India. The results indicate a direct long run relationship between the quantity of imports demanded and the real effective exchange rate for Saudi Arabia. The result for Saudi Arabia is statistically significant at the 5% level.

The results in Table 10 indicate an inverse long run relationship between the quantity of import demanded and periods of recession for China, Germany, the United

States, and India. The results are significant at the 5% level for Germany and the United States and statistically insignificant for Germany and India. The results indicate a direct long run relationship between the quantity of imports demanded and periods of recession for Saudi Arabia though the result is statistically insignificant.

Table 10 *ARDL Long-Run Import Demand Elasticities – SBIC*

	China	**Germany**	**United States**	**India**	**Saudi Arabia**
Lags	1, 0, 1, 0, 0, 1	1, 1, 0, 0, 0, 0	1, 3, 0, 0, 0, 0	3, 0, 0, 0, 0, 0	2, 0, 0, 0, 0, 0
GDP	2.4466 (0.2937) [0.000]***	1.3704 (0.2105) [0.000]***	1.2808 (0.2122) [0.000]***	3.0101 (0.5045) [0.000]***	-0.2397 (1.0628) [0.822]
CPI	1.3086 (0.5466) [0.019]**	0.5423 (0.3201) [0.094]*	0.4319 (0.3388) [0.207]	2.8528 (0.8448) [0.001]***	-2.4460 (1.8081) [0.180]
UVI	0.6371 (0.6146) [0.303]	-0.6084 (0.3386) [0.076]*	-0.6745 (0.3698) [0.072]*	-0.6639 (0.9503) [0.487]	3.4100 (1.8513) [0.069]*
REER	-1.3820 (0.7790) [0.080]*	-1.0380 (0.5050) [0.043]**	-0.7139 (0.5358) [0.187]	-1.7002 (1.3588) [0.215]	4.8529 (2.4989) [0.056]**
REC	-0.0787 (0.1261) [0.535]	-0.1542 (0.0739) [0.040]**	-0.1615 (0.0766) [0.039]**	-0.0236 (0.1511) [0.876]	0.2868 (0.3727) [0.444]
Constant	-17.0535 (2.6465) [0.000]***	-1.6793 (0.7046) [0.020]***	-1.7723 (0.7304) [0.018]**	-14.9163 (2.2345) [0.000]***	-6.6092 (2.2608) [0.005]***

Standard errors in parenthesis and P-values in brackets.

* p < 0.10, ** p < 0.05, *** p < 0.01

Short Run Import Demand Elasticity Estimates

The results in Table 11 indicate a direct short run relationship between the quantity of import demanded and real income for China, Germany, and India. Each of these results is significant at the 1% level. The results indicate an inverse short run relationship between the quantity of imports demanded and real income for the United States and Saudi Arabia. Both of these results are statistically significant at the 1% level.

The results in Table 11 indicate a direct short run relationship between the quantity of import demanded and the price of domestic goods for China, Germany, the United States, India, and Saudi Arabia. The results are significant at the 10% level for China and at the 5% level for Germany, the United States, India, and Saudi Arabia.

The results in Table 11 indicate an inverse short run relationship between the quantity of import demanded and the price of imported goods for China, Germany, the United States, and India. The results for each model are statistically insignificant. The results indicate a direct short run relationship between the quantity of imports demanded and the price of imported goods for Saudi Arabia. The result for Saudi Arabia is statistically insignificant.

The results in Table 11 indicate an inverse short run relationship between the quantity of import demanded and the real effective exchange rate for China, Germany, the United States, and India. The results are significant at the 10% level for Germany, the United States, and India and statistically insignificant for China. The results indicate a direct short run relationship between the quantity of imports demanded and the real effective exchange rate for Saudi Arabia. The result for Saudi Arabia is statistically significant at the 10% level.

The results in Table 11 indicate a direct short run relationship between the quantity of import demanded and periods of recession for China, Germany, the United States, India, and Saudi Arabia. The results are statistically insignificant for all five countries.

In addition to the long and short run elasticity coefficients, the model also estimates an error correction term. The error correction term estimates the rate at which short run shocks are absorbed and equilibrium reestablished. China's error correction coefficient is -0.7571 meaning 75.7% of disequilibrium is rectified in the first quarter. The remaining coefficients are -0.6123 for Germany, -0.6328 for the United States, -0.2983 for India, and -0.3969 for Saudi Arabia. Each of these results is statistically significant at the 1% level.

Table 11 *ECM Short-Run Import Demand Elasticities – SBIC*

	China	**Germany**	**United States**	**India**	**Saudi Arabia**
Lags	1, 0, 1, 0, 0, 1	1, 1, 0, 0, 0, 0	1, 3, 0, 0, 0, 0	3, 0, 0, 0, 0, 0	2, 0, 0, 0, 0, 0
ΔLGDP	1.8523 (0.5751) [0.002]***	1.2320 (0.2513) [0.000]***	-0.5708 (0.1617) [0.001]***	1.4998 (0.4525) [0.001]***	-0.0952 (0.4219) [0.822]***
ΔLCPI	0.9907 (0.5358) [0.069]*	0.3320 (0.2032) [0.106]**	02733 (0.2303) [0.239]**	1.4214 (0.5933 [0.019]**	0.9712 (0.8490) [0.256]**
ΔLUVI	-0.6676 (0.9261) [0.473]	-0.3726 (0.2173) [0.091]	-0.4268 (0.2644) [0.111]	-0.3308 (0.5096) [0.518]	1.3537 (0.9108) [0.141]
ΔLREER	-1.0462 (0.7307) [0.156]	-0.6356 (0.3354) [0.062]*	-0.452 (0.3662) [0.221]*	-0.8471 (0.7853) [0.284]*	1.9266 (1.0127) [0.061]*
ΔREC	0.1336 (0.1517) [0.381]	0.09439 (0.0459) [0.043]	0.1022 (0.0471) [0.033]	0.0118 (0.0757) [0.877]	0.1139 (0.1407) [0.421
ΔECM	-0.7571 (0.0984) [0.000]***	-0.6123 (0.1069) [0.000]***	-0.6328 (0.1037) [0.000]***	-0.4983 (0.0928) [0.000]***	-0.3969 (0.1156) [0.001]***
Obs.	83	83	81	81	82
R^2	0.4744	0.4856	0.5371	0.4804	0.3493
Adj. R^2	0.4176	0.4376	0.4784	0.4227	0.2877

P-values in parenthesis.

* p < 0.10, ** p < 0.05, *** p < 0.01

CHAPTER V – CONCLUSIONS

This research estimates bilateral import demand elasticities between the country of South Africa and its five largest trading partners: China, Germany, the United States, India, and Saudi Arabia. This research employs the bounds testing approach to cointegration in order to test for a long run relationship between the dependent variable, quantity of imports demanded and five independent variables: real income, domestic prices, import prices, the real effective exchange rate, and a dummy variable for periods of recession. Upon establishing a long run cointegrated relationship among the variables, the long run and short run elasticity estimates are obtained using an ARDL model and an error correction model is estimated to capture the speed of adjustment back to a long run equilibrium after a short run shock. This chapter summarizes the findings relative to the previously stated research questions and hypotheses, enumerates the research's contributions, notes the limitations, and suggests directions for future research.

Research Questions and Hypotheses

Research Question #1

What are the bilateral income, domestic price, and foreign price elasticities of import demand between South Africa and its five largest trade partners?

The alternative hypotheses claim real income and domestic prices have a direct relationship with import demand while foreign prices have an inverse relationship with import demand. The results of this study indicate a direct relationship between real income and import demand in the China, Germany, United States, and India models. This result is in line with theoretical prediction. Bilateral import demand income elasticities tend to be higher than income elasticities using aggregate imports and the estimates in this research affirm this expectation (Alam and Ahmad 2010; Hibbert, Thaver, and Hutchinson 2012; and Triplett and Thaver 2015). In the Saudi Arabia model, and inverse relationship between real income and import demand is estimated. The result is contrary to the theoretical prediction but is in line with other estimates of bilateral import demand income elasticities between developing countries and oil exporting nations (Alam and Ahmad 2010).

The results of this study indicate an inverse relationship between foreign prices and import demand for the Germany, United States, and India models, affirming the theoretical expectation. The China and Saudi Arabia models estimate a direct relationship between foreign prices and import demand, a result countering the theoretical expectation.

Research Question #2

What is the effect of the real exchange rate on import demand for South Africa?

The alternative hypotheses claim the real exchange rate has a direct relationship with import demand. The Saudi Arabia model indicates a direct relationship between the real exchange rate and import demand, a result that affirms the theoretical expectation. The results indicate an inverse relationship between the real exchange rate and import demand for the China, Germany, United States, and India models. The results for these four models counter the theoretical expectation.

Research Question #3

What is the lag structure associated with income, domestic prices, foreign prices, and the real exchange rate?

Based on the ARDL bounds test for cointegration, the lag structure associated with income, domestic prices, foreign prices, and the real exchange rate is estimated for the bilateral trade relationships between South Africa and China, Germany, the United States, India, and Saudi Arabia. The lag structure for all five models uses the Schwarz-Bayesian Information Criterion to determine appropriate lags. The presence of lags in an autoregressive model suggests a delayed effect on import demand for each of the dependent variables (Wooldridge 2009). Since this research uses quarterly data, all lags are measured in quarters.

The lag structure for the China model includes a one-quarter lag for the dependent variable, real import demand, as well as a one quarter lag for domestic prices and recession with no lag for all other variables. The Germany model includes a one quarter lag for import demand and real income with no lag for all other variables. The United States model includes a one quarter lag for import demand and a three quarter lag for real income with no lag for all other variables. The India model contains a three quarter lag for import demand with no lag for all other variables. The Saudi Arabia model includes a two quarter lag for import demand with no lag for all other variables.

Contributions of Research

This research contributes to the literature concerned with estimating import demand elasticities, a literature that dates back to the interwar period. The literature is largely focused on the estimation of aggregate import demand elasticities. The first contribution of this research is the estimation of bilateral import demand elasticities as opposed to aggregate elasticities. Previous investigations into the nature of bilateral trade relationships demonstrate a range of income and relative price elasticities (Alam and

Ahmad 2010; Hibbert, Thaver, and Hutchinson 2012). The range of elasticity estimates suggest tailored policy decisions based on the unique characteristics of each bilateral trade relationship may be beneficial instead of a single policy ascertained from aggregate elasticity estimates (Triplett and Thaver 2015).

The second contribution of this research is the separation of the relative price variable, typically expressed as a ratio of import price to domestic prices, into distinct independent variables. When the relative price variable is used, the effects of the two variables used to construct the relative price variable are assumed to be of equal and opposite magnitude. This research provides evidence that this assumption merits reconsideration in the literature.

The third contribution of this research is the inclusion of the real effective exchange rate variable and a control variable for periods of recession. The real exchange rate variable was significant in the China, Germany, and Saudi Arabia long run models though the results for the China and Germany model are of incorrect signs. The wrong-sided results imply a decrease in the demand for imports while the domestic currency is strengthening relative to other currencies. The dummy variable for periods of recession is significant in the Germany and United States models. The coefficient is negative indicating a decrease in import demand from Germany and the United States during recessionary periods.

The fourth contribution of this research is the estimation of the error correction model which includes an error correction term that estimates the rate at which short run shocks are absorbed and equilibrium reestablished. The error correction terms for all five models are significant. The coefficients of the error correction terms suggest equilibrium is restored fastest in the China trade partnership and slowest in the Saudi Arabia partnership.

Limitations of Research

There are three limitations in this research: the use of proxy variables which may not effectively represent their corresponding variables, the dedicated use of the imperfect substitutes model, and diagnostic weaknesses in the China and Saudi Arabia models.

The potential shortcoming of using proxies to represent the variables is well documented within the literature (Goldstein and Khan 1985; Narayan and Narayan 2005). Though the data may not fully represent the variables, the data used in this research is analogous to the data used throughout the import demand elasticity literature.

For consistency and comparability purposes, the imperfect substitute model is applied to all five bilateral relationships in this research. Given the unique relationship between South Africa and each trading partner, variables not typically included in the imperfect substitutes model could have a significant impact on demand. Further, the perfect substitutes model may be a more viable model for bilateral partners where a single product makes up a large portion of the import portfolio such as the import of oil from Saudi Arabia.

The Jarque-Bera test for normality indicates the residuals of the China and Saudi Arabia models are not normally distributed. Though the elasticity estimates for both of these models are unbiased, the inferential power of these models is limited.

Implications of Future Research

Based on this study, there are three areas future research in bilateral import demand elasticities should consider. First, the volume of bilateral import demand literature is small compared to the literature dedicated to the estimation of aggregate import demand elasticities. In order to strengthen the potency of bilateral import demand estimates with respect to policymaking, more studies are needed to identify the true elasticity coefficients. Second, the replication of existing research in bilateral import demand elasticities should be pursued as data gathering techniques improve and proxies become more suitable. This is especially true with regard to the price variables representing baskets of goods that may not adequately represent the nature of the imported goods. Third, researchers should continue to seek other variables that influence import demand. The variables included in this research explained anywhere from 35% to 54% of the variation in import demand so other factors influence import demand that have not been identified.

APPENDIX– Lag Selection Order Criteria

Table A1. *Lag Order Selection - lmchina*

Lags	Df	p-value	AIC	HQIC	SBIC
0			2.3273	2.3392	2.3570
1	1	0.000	0.0352	0.05910	0.0948
2	1	0.000	-0.1104	-0.0746	-0.0211
3	1	0.012	-0.1636*	-0.1158*	-0.0445*

Table A2. *Lag Order Selection - lmger*

Lags	Df	p-value	AIC	HQIC	SBIC
0			-0.0676	-0.0556	-0.0378
1	1	0.000	-1.3164*	-1.2926*	-1.2569*

Table A3. *Lag Order Selection - lmusa*

Lags	Df	p-value	AIC	HQIC	SBIC
0			0.0750	0.0869	0.1048
1	1	0.000	-1.3373*	-1.3141*	-1.2777*

Table A4. *Lag Order Selection - lmindia*

Lags	Df	p-value	AIC	HQIC	SBIC
0			2.3824	2.3944	2.4122
1	1	0.000	-0.2225	-0.1987*	-0.1630*
2	1	0.356	-0.2082	-0.1724	-0.1189
3	1	0.029	-0.2427	-0.1949	-0.1236
4	1	0.118	-0.2483*	-0.1886	-0.0994

Table A5. *Lag Order Selection - lmsaudi*

Lags	Df	p-value	AIC	HQIC	SBIC
0			1.2147	1.2266	1.2445
1	1	0.000	0.3689	0.3927	0.4284
2	1	0.029	0.3344	0.3702*	0.4237*
3	1	0.155	0.3341*	0.3818	0.4532

Table A6. *Lag Order Selection - lgdp*

Lags	Df	p-value	AIC	HQIC	SBIC
0			-0.1910	-0.1791	-0.1612
1	1	0.000	-2.4048	-2.3810	-2.3453
2	1	0.019	-2.4482*	-2.4123*	-2.3588*

Table A7. *Lag Order Selection - luvi*

Lags	Df	p-value	AIC	HQIC	SBIC
0			0.7479	0.7598	0.7777
1	1	0.000	-3.8397	-3.8156	-3.7802
2	1	0.000	-4.0023*	-3.9665*	-3.9130*

Table A8. *Lag Order Selection - lcpi*

Lags	Df	p-value	AIC	HQIC	SBIC
0			0.4633	0.4752	0.4931
1	1	0.000	-6.5382	-6.5143	-6.4787
2	1	0.000	-6.8598	-6.8239*	-6.7704*

Table A9. *Lag Order Selection - lreer*

Lags	Df	p-value	AIC	HQIC	SBIC
0			-1.1819	-1.1700	-1.1521
1	1	0.000	-2.9840	-2.9601	-2.9244
2	1	0.017	-3.0306*	-2.9948*	-2.9413*

Table A10. *Lag Order Selection - rec*

Lags	Df	p-value	AIC	HQIC	SBIC
0			0.1946	0.2066	0.2244
1	1	0.000	-0.0175	0.0064	0.0421
2	1	0.001	-0.1400	-0.1042	-0.0507*
3	1	0.063	-0.1583	-0.1106	-0.0392
4	1	0.027	-0.1947*	-0.1350*	-0.0458

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