ABSTRACT

KAMARA, ALIMAMY. Essays in Regional Integration and International Macroeconomics. (Under the direction of Dr. Barry K Goodwin and Dr. Ivan T Kandilov.)

This dissertation provides an analysis of international trade flows and investigates the effects of exchange rate fluctuations on trade prices and inflation for a group of industrialized and emerging economies in Latin America and Southeast Asia. The study also investigates the relationship between the real exchange rate and productivity differential of tradables relative to nontradables for one of the fastest growing economies in Sub-Saharan Africa, South Africa. In particular, the dissertation comprises three independent essays on international trade and international macroeconomics.

In the first essay, I investigate the effects of institutional failures, political risks and regional integration agreements on bilateral trade for a group of 46 countries in three distinct regional trade blocs *viz* the EU, ECOWAS and NAFTA. To carry out this investigation, I develop an augmented gravity model from a monopolistic competition model of product differentiation. Using the *Poisson Quasi Maximum Likelihood (PQML)*, the *Heckman two-stage*, *Tobit* and *Negative Binomial* estimation techniques on the augmented gravity model, I argue that stronger institutions of trading partners leads to an increase in trade. This is so because stronger institutions of both the exporting and importing countries in the form of good regulatory and legal frameworks reduce the uncertainty in contract enforcement, lower transactions costs and ultimately increase trade. I also find that regional integration boosts bilateral trade, but there is evidence of trade diversion in WAMZ and MRU trading blocs. The proposition that geographically proximate partners traded more is supported according to the results, but there is little empirical support for the hypothesis that differences in factor endowment predict patterns of trade in the sample of countries.

The second essay employs quarterly time series data to examine the dynamic response of trade prices and inflation to exchange rate shocks for three OECD countries and a group of emerging economies in Southeast Asia and Latin America. The study begins by decomposing the exchange rate pass-through into 'First-Stage pass-through' and the 'Second-Stage pass-through' with the help of a simple optimization of the exporting firm's profit function in a partial equilibrium framework. To examine this dynamic behavior of prices, I used a structural vector autoregression (SVAR) model to derive the impulse response functions to exchange rate shocks for the different group of prices. From the structural and accumulated impulse responses, it is evident that pass-through is incomplete in each of the nine countries. However,

pass-through to trade prices and inflation are much higher in emerging economies than OECD economies.

In the final essay I provide evidence on how real exchange rates respond to changes in productivity differential between the tradable and nontradable goods sectors for South Africa using quarterly data for the period 1993 through 2015. In the study I decompose the Balassa-Samuelson's effect into two separate effects —domestic and foreign effects—and propose a structural cointegrated VAR with weakly exogeneous foreign variables (VECX*) in the spirit of Garrett *et al.* (2003) to outline the relationship between the real exchange rates and sectoral productivity differential. This type of model is regarded as an augmented form of the vector error correction model (VECM). In order to obtain estimates of the equilibrium long run relationships between the variables of both the domestic and international B-S model, I employ the standard autoregressive distributed lag (ARDL) estimation method. In general, the results support the prediction of the productivity bias hypothesis that increases in productivity differential result in an increase in the price of nontradables in both South Africa and the US and an appreciation of the real exchange rate. Our results are consistent with those of Lewis (2007), Berka *et al.* (2012) and the productivity differential hypothesis. Terms of trade, trade liberalization and the real interest rate differential also play a major role in creating movements in the real exchange rate.

Essays in Regional Integration and International Macroeconomics

by
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DEDICATION

This dissertation is dedicated to my late parents, Pa Sheku Kamara and Yan Bomwara Kamara, and Pa Abu Conteh, my guardian, for helping me acquire an education.

BIOGRAPHY

Alimamy Kamara was born in Port Loko, Sierra Leone. He received his Bachelor of Science with honors in Economics from Fourah Bay College, University of Sierra Leone, in 1993. After completing his undergraduate studies, he was employed by the Central Statistics Office as the lead Statistician in the National Accounts and Consumer Price statistics department. In 1994, Alimamy was awarded an AERC scholarship to pursue graduate studies in economic policy in Addis Ababa University, Ethiopia and graduated with a Master of Science degree in economics in July 1996. Upon graduation, he returned to Sierra Leone to head the National Accounts Statistics division at the Central Statistics Office in Sierra Leone. During his tenure at the Central Statistics Office, he also taught quantitative economics, microeconomics, macroeconomics and statistics at Fourah Bay College (University of Sierra Leone) and the Institute of Public Administration and Management in Sierra Leone.

Alimamy migrated to the United States during the rebel war in Sierra Leone and began to work in the planning department at Rutgers University in New Jersey in 2002 as a Data Analyst. He later joined Devereux Foundation, a non-profit organization, in 2005 and served as Program Manager until 2008. After working for three years at Devereux, he gained admission into the International Development graduate program at Duke University in 2008 and graduated with a Master of Arts degree in Applied Economics in September 2009. In recognition for his outstanding performance in the graduate program, he was appointed as a Teaching Fellow in the Executive Education program at the Duke Center for International Development in Durham, North Carolina. In 2010, after serving for one year as a Teaching Fellow, he was admitted into the PhD program in economics at North Carolina State University. While pursuing doctoral studies, he taught project appraisal, microeconomics and economics of taxation at the Duke Center for International Development. He was also a graduate Teaching Assistant at North Carolina State University in Raleigh, North Carolina. His research is at the intersection of international trade, international macroeconomics, finance, applied econometrics and economic development. His works mainly employ gravity models to analyze international trade flows and time series models to investigate the effects of exchange rate fluctuations on prices. He lives in Chapel Hill with his family.

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To the Director of the graduate program in economics at North Carolina State University, I would like to express my sincere gratitude for providing me with funding to complete my studies. I also want to thank all my professors, especially Professors Ivan Kandilov and Nora Traum for sharing with me their vast knowledge in International Trade and International Macroeconomics. I would also like to extend my sincere thanks and appreciation to all my classmates and friends in the economics department for all the fruitful academic discussions that eventually resulted in the framing of my dissertation topic.

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It would be remiss of me not to mention the invaluable contribution of my wife—Mrs. Isatu Kamara—towards my graduate studies. Her role in managing the home and simultaneously serving as a source of encouragement when the going gets tough is second to none. I remain forever indebted to her.

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Chapter 1

Introduction

1.1 General Overview

Trade economists and policy analysts have acknowledged the role of regional integration in economic development and the degree to which exchange rate fluctuations are reflected in trade prices and inflation on the one hand; and the degree to which productivity differential across sectors and countries is reflected in the real exchange rate on the other. This dissertation attempts to contribute to the growing literature on this subject by providing a comprehensive analysis on issues related to international trade and international macroeconomics. This research comprises three fully-fledged essays on a mixture of topics in international trade and international macroeconomics. In each of the three essays, economic theory was used to motivate the empirical analysis.

In the first essay, I explore the effects of institutional failures, type of political regime and regional integration agreements on bilateral trade flows for a group of 46 countries in three distinct regional trading blocs *viz* the EU, ECOWAS and NAFTA for the period 1996 through 2012. Specifically, I address the question of whether institutional quality and political stability of trading partners play any major role in bilateral trade. Institutional quality and political risks are important latent trade costs that have not been incorporated into the modeling of the gravity model of trade until recently by Mansfield, Milner and Rosendorff (2000), Anderson and Marcouiller (2002), Levchenko (2007) and Yu (2010). They used models ranging from structural import demand to game theoretic and gravity to analyze the effects of institutional failures and political risks on transaction costs and international trade. In my own research, I took a different approach by embedding an index of quality of the product variety into a utility maximization problem of consumers in the exporting and importing countries. The index of quality of the product variety is itself affected by institutional quality and political conditions of the trading partners. In the final analysis, I used these arguments to derive a novel augmented gravity model of bilateral trade to address the issue at hand. The augmented gravity model was developed from a monopolistic competition model of product differentiation and estimated by using *Poisson Quasi Maximum Likelihood*, *Heckman two-step*, *Tobit* and *Negative Binomial* tehniques in order to address potential problems of overdispersion, heteroscedasticity and zero trade flows. Using a panel data of 36,150 observations for 46 countries, I was able to arrive at results that corroborate the hypothesis that strong institutions and less political risks of trading partners increases bilateral trade. This is so because stronger institutions and less political risks reduce the uncertainty in contract enforcement and transactions costs. The reduction in transactions costs and uncertainty in contract enforcement ultimately leads to an increase in bilateral trade. In the study, I also find that regional integration leads to an improvement in trade, but there was evidence of trade diversion in some of the small trading blocs like WAMZ (West African Monetary Zones) and MRU (Mano River Union). The results of the study also provide support for the *Natural Trading Partner Hypothesis* by arguing that geographically proximate partners trade more than distant partners because the costs of transporting goods between proximate partners tend to be lower than for distant partners, all else remaining equal. However, there was little support that differences in factor endowments between countries predict patterns of trade.

The second essay employs quarterly time series data on the macroeconomic variables of interest to investigate how trade prices and inflation respond to exchange rate fluctuations for a group of OECD, Southeast Asian and Latin American countries. In this paper, I propose a Structural Vector Autoregression-AB (SVAR-AB) model to estimate first stage and second stage pass through elasticities for the sample of nine countries from the OECD, Asia and Latin America. The motivation for this study is deeply rooted in an understanding of the exchange rate pass-through mechanism in mainly inflation targeting countries. The main idea here is that understanding the exchange rate pass-through process is crucial to the success of any inflation targeting policy because knowing the magnitude of exchange rate pass-through will assist the monetary authorities to determine how much interest rate adjustment—a higher exchange rate pass-through requires a bigger interest rate adjustment while a lower exchange rate pass-through requires a smaller interest rate adjustment to meet the inflation target—to make in order to maintain their inflation targets. In the study, I decompose the exchange rate pass-through into *First Stage Pass-Through* and *Second Stage Pass-Through* via the use of a simple optimization of the exporting firm's profit function in a partial equilibrium framework. In the first stage, I quantify the effect of exchange rate fluctuations on trade prices while in the second stage I analyze the effects of import prices on consumer prices and producer prices. The main result of the study is that exchange rate pass-through to import prices is lower for OECD and Southeast Asian economies and higher for economies in Latin America. I also find a weak correlation between exchange rate movements and prices for Argentina, Mexico, Sweden and the UK. This result was attributed to the fact that trade prices and consumer prices remain stable in most OECD and some Latin American countries following exchange rate depreciation between 1992 and 2003. In contrast, there was a strong correlation between exchange rate movements and prices in all the Southeast Asian countries in the sample.

In the final essay I provided evidence on how productivity increases in the tradable sector affect the real exchange rates in South Africa via the use of quarterly data for the period 1993 through 2015. In the study I decompose the Balassa-Samuelson's effect into both domestic and foreign effects in order to provide evidence on the effect of productivity differential on the internal and external real exchange rate in South Africa. In addition, dynamic least square (DOLS) estimation was used to obtain the inputs shares and total factor productivity for the tradable and nontradable sectors. Using a structural cointegrated vector autoregressive model with weakly exogeneous variables (VECX*), I find that differences in productivity between the tradable and nontradable sectors in South Africa resulted in an appreciation of the internal and external real exchange rate. The results also indicate that an improvement in the terms of trade leads to an appreciation of the internal and external real exchange rate through the income effect. Both the interest rate differential and the degree of openness to trade are responsible for real exchange rate appreciation in South Africa.

1.2 Organization of Dissertation

This dissertation is apportioned into five chapters. Following this introductory chapter, the second chapter constitutes the first essay on the effects of hidden trade costs and regional trade agreements on bilateral trade in three regional trading blocs. In this chapter, an augmented gravity model of trade was specified in order to further examine the effect of Regional Trade Arrangements (henceforth RTAs) on bilateral trade. The third chapter provides cross-country evidence on how trade prices and consumer prices respond to exchange rate fluctuations for a set of OECD and emerging economies in Latin America and Southeast Asia. Chapter 4 consititute the final essay of the dissertation and it investigates the relationship between real exchange rate movement and productivity differential of tradable relative to nontradable goods for South Africa. Chapter 5 summarizes the entire dissertation.

Chapter 2

Regional Trade Agreements and Bilateral Trade: An Eclectic View of the Hidden Trade Costs

2.1 Introduction

After the Tokyo and Uruguay rounds of trade negotiations, the world trading system went through a considerable amount of changes. One of these changes include, *inter alia*, the spectacular increase in the number of regional trade agreements[1]. This proliferation in regional trade agreements can be explained by the failure of the old regionalism[2] autarkic or anti-market development policy, the stalemate in WTO/GATT—World Trade Organization/General Agreement of Trade and Tariffs—multilateral trade negotiations and the perceived success of regional trade agreements in facilitating tariff reduction or trade liberalization in Europe[3]. Regional trade agreements which represent a subset of members of the WTO departs from the MFN (Most Favored Nations) priniciple of non-discrimination. The violation of the MFN principle arises because members of an RTA grant trade concessions like lower tariffs on imports to RTA

[1]In the International Trade literature, the rapid expansion of trade agreements over the last decade is referred to as "*The New Regionalism*" or the *Third Wave of Regionalism*. The third wave of regionalism, spearheded by Asia, is characterized by a deep form of regional integration in which all preferential tariffs barriers were removed and RTAs proliferated around the globe (See Figure 2.1).

[2]In this context old regionalism simply refers to the wave of regional integration agreements in the 1960s and 1970s. During the "*Old Regionalism*" or *First Wave of Regionalism* period, trade policies adopted by countries in regional agreements were inward-oriented, distortive and prevented the free flow of goods and services.

[3]NAFTA (North American Free Trade Agreements) also experienced remarkable success after liberalizing trade in North America. Baldwin and Venables (1995) pointed out that NAFTA and the EU (European Union) disproportionately liberalized their regional trade relative to liberalization at the multilateral level. This policy of trade liberalization help these regional trade blocs to boost their trade shares relative to other regional trade blocs in the world.

members without extending similar concessions to members outside the regional trade bloc. Although RTAs contravene the WTO MFN principle, there is growing evidence of an increase in trade regionalization in some developed regions of the world (Spilimbergo and Stein, 1998). Krugman (1991) attributed the increasing trade regionalization to the lower transport costs. Transport related costs are higher for distant partners and lower for geographically proximate partners.

Apart from the growing trade regionalization among developed countries, many other countries around the world have been enthusiastic in negotiating trade agreements with geographically proximate countries and, in some instances, distant partners. This is especially true for developing and emerging economies. For instance, in the early 70s and the period that ensued a myriad of bilateral and regional trade agreements are in force in the southern cone (Latin America), Sub-Saharan Africa, the Middle East, Asia, the Maghreb, the Caribbean and Pacific regions[4]. RTAs in these regions are appealing for the following reasons. First, many developing countries, especially those in Sub-Saharan Africa, regard the formation of RTAs as the best way to enhance policy credibility. Second, because of the fragmentation of many developing economies, RTAs are perceived as a catalyst for promoting trade since they help to overcome the problems associated with fragmented economies[5].

In addition to the aggressive pursuit of regional integration by developing countries, some existing RTAs went through a series of transformations after the second oil price shock in the late 70s. For instance, the former Preferential Trade Area in Southern Africa was transformed into a single common market in which trade was liberalized and factors of production and services allowed to move freely across member countries in the region. Elsewhere in Africa, ECOWAS has evolved into a customs union where members adopt a common external tariff among themselves and maintain their individual tariffs with the rest of the world.

Research on regional trade liberalization and the effect of trade agreements on bilateral trade have dominated other areas of research in international economics and current trends indicate that this dominance will continue for many more years to come. Despite this development, theoretical and empirical studies on the impact of regional integration on bilateral trade have focused primarily on the welfare effects of regional trade agreements. That is, whether the

[4]The RTAs in these regions include CARICOM (Caribbean Community Secretariat), MERCOSUR (Mercado Comun del Sur or Southern Common Market), AFTA (ASEAN Free Trade Area), ECOWAS (Economic Community of West African States), WAEMU (West African Economic and Monetary Union), WAMZ (West African Monetary Zone) to mention just a few.

[5]See Omilola (2007) for details on this.

formation of a regional trade bloc results in trade creation or trade diversion[6]. While the trade creating and trade diverting effects are well understood in the literature, previous theoretical and empirical studies on regional trade agreements and bilateral trade have failed to account for all the hidden trade costs associated with international trade. The neglect of these latent trade costs—level of democratization, institutional quality—in the old and new trade theories is surprising considering their importance in explaining patterns of trade.

This paper attempts to address this issue by providing evidence on the effects of these hidden trade costs—institutional quality, democratization and autocratization—on bilateral trade via the use of an augmented gravity model of trade. It is widely believed that these unobserved trade costs impede trade in the same way as tariffs, Non-tariffs barriers (NTBs) and other traditional trade costs. In addition to the trade impediment of these latent trade costs, they are also responsible for the famous *Home Bias Puzzle* or the so called *mystery of the missing trade* in international macroeconomics (Obstfeld and Rogoff (2000); McCallum (1995)). Recently, a few researchers have been able to control for the impact of latent trade costs on trade. For instance, Anderson and Macouiller (2002) used a structural import demand model of trade to examine the link between unobserved trade costs and bilateral trade. They argued that countries with strong and quality institutions like good legal systems for the enforcement of contracts trade more than those with weaker institutions. On similar sentiments, Deardorff (2014) also emphasized the significance of unobserved trade costs in explaining the patterns of trade rather than the Ricardian argument of differences in technology or the H-O (Heckscher-Ohlin) theory of differences in factor endowments.

In this paper I examine whether these latent trade costs affect bilateral trade between countries in regional trade agreements. Specifically, I hypothesize that bilateral trade increases with an improvement in the quality of institutions of both the exporting and importing country in a trade agreement. Countries with stronger institutions are more likely to prevent criminals or corrupt officials from engaging in predatory activities because they have the required regulatory and legal framework to enforce business contracts[7]. To the extent that exporting and importing countries are able to prevent predation, transaction costs will be lowered, trade costs reduced and bilateral trade volumes increased by a significant amount. François and Manchin (2013)

[6]Trade creation is said to occur when imported goods from an efficient producer of member country within the RTA displaced goods produced by a high cost producer outside the RTA. On the other hand, trade deflection or diversion occurs when inefficient firms within the RTA displace low cost or efficient producers outside the RTA.

[7]Anderson and Marcouiller (2002) underscored the importance of a country having stronger institutional framework in their paper. They argued that for countries with weaker institutional framework the risk of predation is very high which implies imperfect enforcement of contracts. Imperfect enforcement of contracts has a negative effect on bilateral trade because it increases transactions as well as trade costs.

provided support for this argument by predicting a lower volume of trade between countries in a 'South-South' trade agreement than those in a 'North-North' trade agreement because the former is characterized by lower or poor quality institutions and infrastructure. There is growing evidence that poor quality institutions and infrastructure in ECOWAS, WAEMU, WAMZ and MRU (Mano River Union) countries have been regarded as one of the factors responsible for the rise in uncertainty of contract enforcement, an increase in trade costs and decline in trade volumes in regional trade. This explains why excluding these hidden trade costs in the analysis of trade flows results in omission bias and hence clouds inference. In order to resolve this issue, I derive a gravity equation from a monopolistic competition model of product differentiation that implicitly embeds institutional quality and type of political regime into a CES utility function. The resulting gravity model is then fitted to bilateral trade data for 46 countries in three distinct trade blocs.

Aside from investigating the effects of trade policy and hidden trade costs on bilateral trade, this paper also addresses the question of whether the patterns of trade between countries is based on differences in relative factor endowment as the H-O factor endowment theory predicts. According to this theory, the pattern of trade is determined by differences in productive resources across countries. Assuming constant returns to scale and perfect competition, these differences in resources or relative factor endowments across countries generate some gains in trade. The main idea behind the H-O trade theory is that differences in factor endowments or resources between countries result in convergence in factor prices which in turn affect trade between trading partners (Feenstra, 2003).

Put in a rather succinct way, the H-O model predicts that countries endowed with an abundant supply of labor should specialize in the production of labor-intensive goods for export to capital abundant countries and import the goods that employ their scarce factors. Similarly, capital abundant countries should specialize in the production of capital-intensive goods for exports and import labor-intensive goods from labor-abundant countries. If the prediction of the H-O model were correct then a North-South trade agreement is expected to result in a greater improvement in economic welfare because of asymmetry in relative factor endowment or incomes between the North and the south. In contrast, South-South trade agreements like CARICOM, ECOWAS, WAEMU, MERCOSUR and others with symmetric relative factor endowments are expected to realize little or no improvement in economic welfare. One reason advanced by Evenett and Keller (2002) for the apparent small trade in South-South trade agreements is the high risk of having trade diversion surpassing trade creation since South-South trade agreements are usually characterised by less efficient methods of production, smaller markets, inadequate research and development and less innovation. This paper tests the validity of this prediction and extends the models developed by Bergstrand (1985, 1990) and Helpman (1987) by incorporating a variable that controls for institutional quality. I employ the new trade theory and model of product differentiation to derive the standard gravity model of trade in the spirit of Anderson and van Wincoop (henceforth AvW) (2003).

In order to address the aforementioned research questions and test the stated hypothesis, I estimate the derived gravity model via the Poisson-Quasi Maximum Likelihood (PQML) estimation procedure[8]. This econometric approach has been regarded by many researchers as the most appropriate technique in resolving the problem of heteroscedasticity and the zero trade flows inherent in bilateral trade data. Silva and Tenreyro (2006) were the first to recommend this estimation approach in gravity models.

This paper builds on this literature by using the new trade theory of product differentiation to analyze the consequence of institutional failures and political risks on bilateral trade. However, my paper completely departs from the work of Silva and Tenreyro and other previous studies in three main respects. First, this paper is the first to incorporate countries in *North-North*, *North-South* and *South-South* trade agreements into a single sample in the analysis of bilateral trade flows. Second, to the best of my knowledge, this paper is the first to incorporate the quality of institutions implicity into a utility function in the derivation of the gravity model of trade. Finally, I conduct sensitivity analysis to check for the robustness of the parameters of interest. This is done by adopting minor changes to the specification of the baseline model and applying a different estimation procedure to handle the problem of overdispersion of the dependent variable in the PQML estimation technique.

My paper is also related to the papers written by Helpman (1987) and Egger *et al.* (2011). However, I use a different approach to measure relative factor endowment. In this paper I use the absolute difference of capital-labor ratios between the exporting and importing country instead of the absolute difference of the GDP per capita ratio between the exporting and importing countries as a measure of the relative difference in factor endowments between countries. The use of GDP per capita is more appropriate in measuring differences in consumer preferences between two countries in a trade agreement than measuring differences in factor endowment between countries. In this paper, the Poisson Quasi Maximum likelihood method was conducted by exploiting data drawn from the World Bank WDI, IMF Direction of Trade Statistics, EUROSTAT and WTO-RTA website. I construct a dataset of about 35,190 observations describing

[8]The Poisson estimation technique is applicable to bilateral trade flow data regardless of whether the data is distributed as a poisson or not. Silva and Tenreyro (2006) argued that the Poisson Quasi Maximum Likelihood (PQML) estimator yield consistent estimates of the gravity model of trade under weak assumptions.

bilateral trade for a set of 46 countries in ECOWAS, EU and NAFTA. The richness of the data enables me to provide a thorough analysis on the effects of institutional failures and other hidden trade costs on regional trade.

To provide a synopsis of the empirical results, I argue that trading partners characterized by higher levels of development traded more than those in less developed trading blocs. This is not surprising since developed countries tend to have better institutions for enforcing contracts and securing property rights than less developed countries. One other interesting conclusion of this paper is that geographically proximate partners traded more than distant partners. My findings corroborate those of Rose (2004), Helpman *et al.* (2008), McCallum (1995), AvW (2003) and a host of others in the literature. My results show little evidence that differences in factor endowment across countries explain pattern of trade. However, hidden trade costs associated with institutional quality and type of political regime of trading partners have a strong effect on trade.

The rest of the paper is organized as follows. Section 2.2 embodies a summary of key findings in previous research on the effects of trade policy and institutional quality on bilateral trade. In Section 2.3 I use a model of product differentiation as the theoretical foundation for the derivation of the canonical gravity model of trade that embodies both bilateral and multilateral trade resistance terms. The empirical strategy and estimation procedure are presented in Section 2.4. Section 2.5 provides the empirical analysis of the regression results. Section 2.6 constitutes sensitivity analysis and robustness checks. Finally, Section 2.7 summarizes the paper and recommends areas for further research.

2.2 Survey of Related Literature

Following the pioneering work of Viner (1950) on customs union and Tinbergen (1954) and Balassa (1961) on regional integration, both the theoretical and empirical literature on the role of regional integration in international trade has been enormous. The large body of research in the area of regional integration and bilateral trade has explored various strands in the literature. One major strand focused on the welfare implication of trade agreements. A particular study that focused on the welfare implications of trade agreements is the work of Krishna (1998). Using an imperfect competition and market segmentation model like the reciprocal dumping model of Brander and Krugman (1983), Krishna (1998) argued that politically favored trade diverting RTAs are more likely to erode incentives for multilateral trade liberalization. His conclusion was based on a political economy framework in which the role of interest groups appears to be crucial in determining whether a country enters a regional trade agreement because trade policy is purely driven by the welfare gains and losses of these interest groups. Other trade economists like Krugman (1987, 1991), Krugman and Helpman (1985), Debaere (2005), Deardorff (1998, 2014), Eaton and Kortum (2002), Helpman *et al.* (1998, 2008), to mention a few, have used different models ranging from monopolistic competition to the Ricardian technological difference model to explain the welfare implication of trade agreements. Krugman (1991) used a model of monopolistic competition to argue that in a world of three regional blocs with zero transport cost, regional integration is both trade diverting and welfare decreasing.

In the extant literature, some trade economists also used the Vinerian approach to further explain the welfare implication of regional trade agreements. For instance, Viner (1950) was the first to use this approach to analyse the effects of customs union. He elegantly introduced the famous concepts of trade creation and trade diversion in his analysis of the effects of customs unions. Prior to Viner's (1950) customs union theory, proponents of trade liberalization and trade protection based their arguments on the benefits of trade liberalization and trade protection without considering the harmful effects of these two different trade policies on an RTA member or global welfare. This failing was mentioned by Viner (1950) in his customs union theory. He argued that regional trade blocs, whether of the 'North-North' or 'North-South' type, can be both trade creating and trade diverting. RTAs are trade creating if imports from lower-cost or efficient producers from a partner country are substituted for the products of high-cost domestic producers within the RTA. In contrast, RTAs are trade diverting if imports of high-cost producers within the RTA displace those from more efficient or lower-cost firms in countries outside the RTA. Therfore, the question of whether RTAs improve or worsens welfare of member countries or the rest of the world depends on the relative magnitude of trade creation and trade diversion. According to Viner, welfare of an RTA member and the rest of the world will improve if trade creation exceeds trade diversion and worsens if trade diversion outweighs trade creation. Wonnacott and Lutz (1989); Summers (1991) and Krugman (1991) corroborated Viner's argument in their papers on the effects of RTAs on economic welfare of RTA members.

On the determinants of trade integration, Aitken (1973) used a gravity model of trade to isolate the main factors that have contributed to the European trade integration for the period 1951 through 1967. Using a temporal cross-section analysis of European trade integration and the gravity model, he arrived at results that corroborate the *customs union theory.* He argued that both the EEC and EFTA experienced tremendous improvement in gross trade creation during their periods of economic integration with improvement in trade creation for EEC greater than for EFTA. Bergstrand (1985) also provided strong support for the trade creating hypothesis of regional trade agreements. Ghosh and Yamarik (2004) used the extreme bounds test approach to test the validity of the trade creation hypothesis of regional trade arrangements. They expressed concern on the fragility of the trade creation coefficients in the gravity model of trade for a group of RTAs.

Another strand of the literature on regional integration and bilateral trade focused on the *Natural Trading Partner Theory* first articulated in Lipsey's (1960) paper on the theory of customs union. His argument was based on the fact that economic welfare of countries in a regional trade agreement will improve if they decide to trade disproportionately with each other and less with the rest of the world. This argument used the intial volume of trade as a measure for the determination of a country's natural partner in trade. Wonnacott and Lutz (1989) provided a different measure to determine a country's natural trading partner. According to them, geographically proximate countries trade disproportionately with each other rather than with distant countries. The basic idea here is that if trading partners are closer to each other there is the likelihood for transport cost to be lower and trade to increase substantially between them than with other distant trading partners. Krugman (1991) and Deardorff and Stern (1994) reinforced this argument in their paper. They contend that the possibility of having trade diversion is greatly reduced if geographically proximate countries enter into a regional trade agreement. Other researchers used trade complementarity as a measure to determine natural trading partners.

In a recent study by Krishna (2003), the natural trading partner hypothesis was rejected on empirical grounds. He used a general equilibrium model of preferential trade agreement and the Rotterdam model estimation to derive own price and cross price elasticities for a welfare function with the aid of data for the US and other 24 OECD and developing countries. Empirical results from his estimation failed to provide support for the natural trading partner hypothesis since the geographic proximity and volume of trade measures have no effect. Other opponents of the natural trading partner hypothesis, like Bhagwati (1993) and Panagariya (2000) regarded the argument of the proposition as untenable because the volume of trade criterion of the natural trading partner theory is both asymmetric and intransitive. They also argued that trade agreements with geographically proximate partners are trade diverting and welfare decreasing.

Regarding the role of regional integration on trade, growth and development, there is a growing debate on whether the formation of an RTA helps to generate incentives for potential trading partners to stifle or promote the growth and development of multilateralism. For instance, critics of regionalism like Bhagwati (1993) and Panagariya (2000) argued that the rise in regionalism results in a reduction in global welfare as well as contributes towards stifling the momentum of free trade by undermining multilateralism[9]. On the other hand, proponents of regional integration, like Ethier (1998), Summers (1991) and Fernández and Portes (1998), view the growth in RTA as a blessing since it helps to stimulate investment flows between members within the RTA and nonmembers. The growth in investment occur because the formation of RTAs leads to an increase in the size of the market and a reduction in distortions within the regional trading bloc. The dismantling of the tariff wall and the increase in the size of the market act as incentives for investors to increase investment (Fernández and Portes, 1998). In addition to the increased access to a wider market, the formation of regional trade agreements is regarded as an impetus for promoting world trade and sustainable growth by securing economies of scale for large-scale production. This means that RTAs are *building blocks*' to multilateralism and the achievement of free trade.

While this paper uses the new trade theory of product differentiation as the bedrock for the empirical anaylsis, it also contributes to the virgin literature on the effects of trade policy, institutional failures and political risks on bilateral trade. Anderson and Macouiller (2002) used a structural import demand function to analyse the effect of predation by corrupt public officials on transactions costs and international trade. They argued that international trade will decline because of hidden trade costs associated with trading partners' weak institutional framework. According to them, corruption of customs officials, government ineffectiveness to enforce contracts, poor regulatory quality and overall poor governance result in increased insecurity in international transactions and hence a decline in trade. This implies that ignoring the effects of hidden trade costs on international trade will lead to biased empirical results. In a nutshell, the Anderson and Marcouiller (2002) results appear to be consistent with the argument that an improvement in institutional quality results in an increase in bilateral trade volume. Levchenko (2007) also provided theoretical and empirical evidence to support the argument that variations in institutional quality across countries is a source of comparative advantage and major determinant of international trade. François and Manchin (2013) later corroborated this argument in their study on North-North, North-South and South-South trade.

Yu (2010) used an augmented gravity model of trade to analyze the effect of trading partners' levels of democracy and international trade. Using panel data and a battery of estimation techniques and robustness checks, he argued that trade between countries increases as they

[9]Based on this argument we can say that the formation of a regional trade agreement is a '*stumbling block*' to multilateralism and the achievement of free trade. Saggi and Yildiz (2010), however expressed concern about GATT's or WTO's ambiguous rules or regulatory framework as enshrined in Article I and Article XXIV of its charter. The ambiguity arises because GATT's Article I allows all its members to liberalize trade without discrimination. At the same time, Article XXIV allows member countries to form RTAs and engage in mutual trade liberalization by granting tariff concessions to each other member within the RTA without extending that same preference to a third country.

become more democratic. The main thrust of his argument is that democratic regimes are more likely to have better institutions that limit the scope for rent extraction by the bureaucrats. This helps to minimize bureaucratic inefficiencies, reduce transaction and trade costs and ultimately increase trade. Mansfield *et al.* (2000) used a game theoretic and a gravity-type model to determine whether democracies are in a better position to liberalize trade than autocracies. Their findings provided a resounding 'yes' to this question. They argued that trade barriers or trade costs are lower between democratic trading partners than between mixed pairs, that is, between democracies and autocracies.

My paper is also part of the growing literature on the relevance of factor proportion theory in explaining bilateral trade. Some of the earlier studies in this area of research include the works by Deardorff (1998), Evenett and Keller (1998) and Bergstrand (1985, 1989). Bergstrand (1985) used the factor proportions theory or the H-O framework to provide a theoretical basis for the gravity model. He obtained a generalized gravity equation in a general equilibrium setting by assuming frictionless trade between the exporting and importing country. This implies perfect or rather costless substitutability of products across countries. He later on extended this model in Bergstrand (1989) to incorporate non-homothetic preferences in the spirit of the Linder theory and differences in relative factor endowments across countries.

In another study conducted by Baier and Bergstrand (2004), a general equilibrium monopolistic model akin to the Krugman (1980) framework was used to identify the economic determinants of bilateral trade agreements. In their study, they provided a comprehensive analysis of the economic determinants of free trade agreements via the use of a qualitative choice model in a general equilibrium framework. Helpman (1987) used a monopolistic competition model to explain why countries with increasing similarity in GDP trade disproportionately with each other and less with those whose GDPs are dissimilar. Helpman's (1987) theoretical and geometric analysis of bilateral trade flows in developed or OECD countries provided evidence that supported his prediction that differences in relative factor endowments play a partial role in determining patterns of trade between countries.

To conclude this review of the literature, the main contributions of the paper are as follows:

- First, this paper uses a theory-driven approach to motivate the empirical analysis rather than just fitting the traditional gravity model to data as most researchers do[10]. This approach will help to further our understanding of the possible linkages that exist between the variables in the specified model and isolate the effects of bilateral trade.

[10] Many economists believe that for an empirical research to be compelling it must be guided by an appropriate theory. Similarly, compelling theoretical research is based on appropriate empirical observations.

- Second, I use a novel approach to model trade costs by identifying the most important hidden trade costs that have eluded previous researchers interested on studies related to regional integration and bilateral trade. In this paper, I also use a battery of estimation methods to check for the sensitivity of our parameters and resolve the issue of overdispersion inherent in PQML estimation. In particular, I use the Tobit, truncated OLS regression, negative binomial for overdispersion in the regressand and Heckman's sample selection techniques to correct for sample selection bias arising from the dropping of zero trade flows.

- Third, I use the new trade theory to analyse the effect of trade policy on bilateral trade in three regional trade blocs and test the validity of the H-O theory of differences in factor endowments across countries in the context of 'North-North', South-South' and North-South' regional trade. In particular, a model of product differentiation was used to provide some micro foundations of the gravity model.

2.3 Theoretical and Analytical Framework

In this section I discuss the theoretical and analytical framework related to the linkages among bilateral trade, regional trade and hidden trade costs. The framework is based on a simple derivation of an augmented gravity model of trade flows from a monopolistic competition model of product differentiation. To begin with the analytical framework, I define the preferences and characterize the optimal strategies of both consumers and firms for a hypothetical economy in a general equilibrium framework[11]. In each country of a regional trade bloc, it is assumed that firms produce varieties of differentiated goods and that trade between countries is purely driven by consumers love of variety. However, all firms are identical with regards to marginal cost. To this end, the structural gravity model is derived and presented in the following section.

2.3.1 The Structural Model

In order to examine the effects of the latent trade costs and RTA membership on bilateral trade, I develop a model of trade that implicitly embeds institutional quality of the exporting country in a utility maximization problem. The model is a variant of the Anderson-van Wincoop (2003), Egger *et al* (2011) and Helpman (1987) models in the sense that it incorporates a variable to account for institutional quality in the resulting gravity equation. This is important for analyzing the effects of hidden trade costs on bilateral trade. In this model I assume that there is a set $\mathbb{R} \equiv [1, ...L]$ countries in the world with a continuum of consumers and firms. To

[11] See Anderson van Wincoop (2003) for an elaboration of this.

simplify the model further, I assume that there are only two countries i and j. Each country, $i \in \mathbb{R}$ and $j \in \mathbb{R}$, comprises consumers with identical and homothetic preferences who wish to have a variety of goods in their consumption baskets. However, commodities consumed and produced in these countries are differentiated not only by country of origin but by type of firm. This ensures that each firm in a particular country specializes in the production of a single commodity[12]. Firms in each economy incur both fixed and variable costs for the production of a unique variety. Country $i \in \mathbb{R}$ engages in trade with country $j \in \mathbb{R}$ and consumers in each of these countries derive utility from the consumption of varieties of goods. The quality of a product variety produced in a particular country is assumed to be a function of the quality of institutions and index of democratization or autocratization of that country. To proceed with the modelling, the consumer optimization problem in this economy is presented in the following subsection.

2.3.2 Consumers

Since countries are free to trade with each other, export and import of varieties can occur in each country and consumers can improve their welfare by consuming varieties. Following Anderson and van Wincoop (2003) and Chaney (2008), I assume that preferences of consumers over goods are of the Cobb-Douglas type with a fix supply of each good. On the other hand, preferences of consumers over varieties of goods is approximated by CES (Constant Elasticity of Substitution) preferences. It is also assumed for the time being that there are no impediments like transport costs or "*iceberg*" trade costs to trade flows between regions or countries suggesting no trade frictions[13]. This means that the product variety fetches the same price in country i and country j. Although this sounds unrealistic, for tractability of the model I am going to hold on to this assumption for the time being. Accordingly, the representative consumer in country $i \in \mathbb{R}$ maximizes utility subject to the budget or expenditure constraint according to:

$$\underset{q_i^j(a)}{\text{Max}} \quad U_i = \left(\int_{a \in \Omega_i} (G_i)^{1-\rho} (q_i^j(a))^\rho da \right)^{\frac{1}{\rho}} \tag{2.1}$$

subject to

$$\int_{a \in \Omega_i} p_i^j(a) q_i^j(a) da = Y_i \tag{2.2}$$

From the above consumer optimization problem, $q_i^j(a)$ represents the quantity produced in

[12]This assumption is in line with Helpman and Krugman (1985) and later Anderson and van Wincoop (2003) model of product differentiation.

[13]Later on in the modelling, this assumption will be relaxed in order to accomodate the effects of bilateral trade costs.

country i of the given variety of goods, a, and exported to country j. Consumers in country j therefore consume the goods imported from country i, country i being the exporter and country j the importer in this model. The price associated with this quantity is p_i^j, Ω_i is a set of product varieties produced in country i and a denotes the product variety of goods produced in country i and exported to country j for consumption in that country. The variable G_i is an index of quality that captures the exporting country's quality of the product variety. Following Yu (2010), I specify this quality index as

$$G = F(s_i, d_i, z_i) = \phi_i \exp(s_i, d_i, z_i) \tag{2.3}$$

where ϕ_i is a measure of how the quality of the product responds to variations in institutional quality, level of autocratization and degree of democratization. The variables s_i, d_i and z_i are indices of institutional quality, democratization and autocratization of the exporting country respectively. It is expected that a country's product quality responds positively to the strength of its institutions and level of democratization and negatively to the degree of autocratization so that $F'_s > 0$, $F'_d > 0$ and $F'_z < 0$. The quality of a country's institutions affects the quality of the goods produced and traded by that country because better quality institutions implies better regulatory and legal framework for the proper maintenance of the rule of law, increased ability to enforce contract and secure property rights. It is argued that these factors help to create an enabling environment for free and healthy competitive industries for the production of quality goods. Based on these arguments, I incorporate an index that captures the effect of institutional quality, democratization and autocratization implicitly into the consumer's utility function. The total expenditure on goods or aggregate output in country i is represented as Y_i and the substitution parameter, ρ, is denoted as $\rho = \frac{\sigma-1}{\sigma}$, where $\sigma > 1$ is the elasticity of substitution across product varieties[14]. If a particular variety of good is not consumed in country i, that is, $a \notin \Omega_i$, then $q_i^j(a) = 0$. On the other hand, if consumers in country j develop a taste for the given variety, a, then $a \in \Omega_i$ and so the quantity demanded by country j consumers of the given variety of goods produced will be positive, that is, $q_i^j(a) > 0$. Based on the representative consumer optimization problem, the Langrangean function is given by

$$\mathcal{L}(q_i^j, \mu) = \left(\int_{a \in \Omega_i} [\phi_i \exp(s_i, d_i, z_i)]^{1-\rho} (q_i^j(a))^\rho da \right)^{\frac{1}{\rho}} + \mu \left(Y_i - \int_{a \in \Omega_i} p_i^j(a) q_i^j(a) da \right) \tag{2.4}$$

where μ is the Lagrange multiplier and all the other terms carry the usual meaning. Solving for

[14]This restriction ensures that marginal revenue is not negative since $\sigma > 1$ when $\eta_D > 1$, where η_D is the price elasticity of demand (Helpman and Krugman, 1985).

the optimal value of $q_i^j(a)$ or the demand function yields the first order condition as

$$\frac{\partial \mathcal{L}(q_i^j(a),\mu)}{\partial q_i^j(a)} = \frac{\left(\int_{a\in\Omega_i}[\phi_i \exp(s_i,d_i,z_i)]^{1-\rho}(q_i^j(a))^{\rho}da\right)^{\frac{1}{\rho}-1} \times [\phi_i \exp(s_i,d_i,z_i)]^{1-\rho}(q_i^j(a))^{\rho-1}}{\int_{a\in\Omega_i}[\phi_i \exp(s_i,d_i,z_i)q_i^j(a)]^{\rho}da} - \mu p_i^j(a) = 0 \tag{2.5}$$

Since the substitution parameter $\rho = \frac{\sigma-1}{\sigma}$, we can rewrite equation (2.5) as

$$\frac{\partial \mathcal{L}(q_i^j(a),\mu)}{\partial q_i^j(a)} = \frac{\left(\int_{a\in\Omega_i}[\phi_i \exp(s_i,d_i,z_i)]^{\frac{1}{\sigma}}(q_i^j(a))^{\frac{\sigma-1}{\sigma}}da\right)^{\frac{1}{\sigma-1}} \times (\phi_i \exp(s_i,d_i,z_i)^{\frac{1}{\sigma}}(q_i^j(a))^{-\frac{1}{\sigma}}}{\int_{a\in\Omega_i}[\phi_i \exp(s_i,d_i,z_i)]^{\frac{1}{\sigma}}(q_i^j(a))^{\frac{\sigma-1}{\sigma}}da} - \mu p_i^j(a) = 0 \tag{2.6}$$

Rearranging equation (2.6) and solving for μ gives

$$\frac{Q^{-\sigma} \times [\phi_i \exp(s_i,d_i,z_i)]^{-1}q_i^j(a)}{\left(\int_{a\in\Omega_i}[\phi_i \exp(s_i,d_i,z_i)]^{\frac{1}{\sigma}}(q_i^j(a))^{\frac{\sigma-1}{\sigma}}da\right)^{-\sigma}} = \mu^{-\sigma}p_i^j(a)^{-\sigma} \tag{2.7}$$

where $Q = \left(\int_{a\in\Omega_i}[\phi_i \exp(s_i,d_i,z_i)q_i^j(a)]^{\frac{\sigma-1}{\sigma}}da\right)^{\frac{1}{\sigma-1}}$. Since the expenditure on the variety of goods consumed in country i is needed in the derivation of the gravity equation, it is necessary to multiply equation (2.7) throughout by prices to obtain

$$p_i^j(a)q_i^j(a) = Q^{\sigma}\left(\int_{a\in\Omega_i}[\phi_i \exp(s_i,d_i,z_i)]^{\frac{1}{\sigma}}(q_i^j(a))^{\frac{\sigma-1}{\sigma}}da\right)^{-\sigma} p_i^j(a)^{1-\sigma}[\phi_i \exp(s_i,d_i,z_i)]\mu^{-\sigma} \tag{2.8}$$

Aggregating over all product varieties equation (2.8) can be expressed as

$$\int_{a\in\Omega_i}p_i^j(a)q_i^j(a)da = Q^{\sigma}\left(\int_{a\in\Omega_i}[\phi_i \exp(s_i,d_i,z_i)]^{\frac{1}{\sigma}}(q_i^j(a))^{\frac{\sigma-1}{\sigma}}da\right)^{-\sigma}[\phi_i \exp(s_i,d_i,z_i)]\int_{a\in\Omega_i}p_i^j(a)^{1-\sigma}da\mu^{-\sigma} \tag{2.9}$$

Differentiating the Lagrangean function with respect to μ yields

$$\frac{\partial \mathcal{L}(q_i^j(a),\mu)}{\partial \mu} = Y_i - \int_{a\in\Omega_i}p_i^j(a)q_i^j(a)da = 0 \tag{2.10}$$

From equation (2.10) it is easy to see that the aggregate income of country i spent on all product varieties from country j in the domestic economy can be expressed as

$$Y_i = \int_{a \in \Omega_i} p_i^j(a) q_i^j(a) da \tag{2.11}$$

Plugging equation (2.11) into equation (2.9) and solving for the lagrangean multiplier yields

$$\mu = \left(\frac{[\phi_i \text{exp}(s_i, d_i, z_i)] \displaystyle\int_{a \in \Omega_i} p_i^j(a)^{1-\sigma} da}{Y_i} \right)^{\frac{1}{\sigma}} \times \frac{Q}{\displaystyle\int_{a \in \Omega_i} [\phi_i \text{exp}(s_i, d_i, z_i)]^{\frac{1}{\sigma}} (q_i^j(a))^{\frac{\sigma-1}{\sigma}} da} \tag{2.12}$$

Applying some algebraic manipulation to equation (2.7) gives

$$\frac{Q \times [\phi_i \text{exp}(s_i, d_i, z_i)]^{\frac{1}{\sigma}} [q_i^j(a)]^{-\frac{1}{\sigma}}}{\displaystyle\int_{a \in \Omega_i} [\phi_i \text{exp}(s_i, d_i, z_i)]^{\frac{1}{\sigma}} (q_i^j(a))^{\frac{\sigma-1}{\sigma}} da} = \mu p_i^j(a) \tag{2.13}$$

Substituting for the lagrangean multiplier (equation(2.12)) into equation (2.13) and solving for country's j demand for the imported product variety from country i yields

$$q_i^j(a) = \frac{p_i^j(a)^{-\sigma}}{\displaystyle\int_{a \in \Omega_i} p_i^j(a)^{1-\sigma} da} \times Y_i [\phi_i \text{exp}(s_i, d_i, z_i)]^{\sigma-1} \tag{2.14}$$

From equation (2.14) we can introduce the Dixit-Stiglitz price index by rewriting the equation as

$$q_i^j(a) = \left(\frac{p_i^j(a)}{P_i} \right)^{-\sigma} \left(\frac{Y_i}{P_i} \right) [\phi_i \text{exp}(s_i, d_i, z_i)]^{\sigma-1} \tag{2.15}$$

where $P_i = \left(\displaystyle\int_{a \in \Omega_i} p_i^j(a)^{1-\sigma} da \right)^{\frac{1}{1-\sigma}}$ is the Dixit-Stiglitz general consumer price index of country i. $q_i^j(a)$ in equation (2.15) is the volume of exports of the given variety of product to country j. Clearly, the volume of exports is a decreasing function of the price and an increasing function of real income.

From equation (2.15), the following comparative static results can be obtained

$$\frac{\partial q_i^j(a)}{\partial p_i^j(a)} = -\sigma \left(\frac{p_i^j(a)}{P_i} \right)^{-(\sigma+1)} \times \frac{Y_i}{P_i^2} [\phi_i \text{exp}(s_i, d_i, z_i)]^{\sigma-1} < 0 \tag{2.16}$$

$$\frac{\partial q_i^j(a)}{\partial Y_i} = \left(\frac{p_i^j(a)}{P_i}\right)^{-\sigma} [\phi_i \exp(s_i, d_i, z_i)]^{\sigma-1} P_i^{-1} > 0 \tag{2.17}$$

Intuitively, equation (2.16) suggests that an increase in the cost of producing the product variety in the exporting country i will, *ceteris paribus*, result in an increase in the price of the product variety in country j. The rise in the price of the unique product variety relative to the average price over all varieties in turn leads to a decline in the quantity of the unique product variety consumed in the importing country j. Equation (2.17) of the comparative static results reveal that a rise in real incomes of consumers in both the importing and exporting countries, *ceteris paribus*, will stimulate consumption of the product variety and import volumes in country j.

2.3.3 Firms

As in the consumption side of the economy, it is assumed that there is a large number of firms each of which produces a unique variety of product given the existing resources. Each country $i \in \mathbb{R}$ and $j \in \mathbb{R}$ comprises N number of potential firms combining inputs to produce a unique variety of product. That is, country i has N_i firms and country j has N_j active firms. Moreover, firms in country i incur both variable and fixed costs in the production and export of the unique variety. As in Krugman (1980), I assume that labor is the only input used in the production of the given variety so that

$$L_i(a) = k_i + v_i q_i^j(a) \tag{2.18}$$

where $L_i(a)$ is labor used by firms in country i to produce the product variety a, v_i is the marginal product of labor cost and k_i is the fixed costs. The production of all the product varieties in this economy is based on the same cost function so that there is fixed cost and constant marginal cost everywhere. Since the consumer price is represented as p_i, then the revenue from the sale of the variety of product is denoted by $p_i q_i^j(a)$. Given this revenue, each firm in country i faces the following profit function

$$\pi_i = p_i(a) q_i^j(a) - w v_i q_i^j(a) - w k_i \tag{2.19}$$

where π_i denotes the profit obtained by a particular firm from the production and sale of the product variety in country i, w is the wage rate, p_i is the price associated with the product variety and $q_i^j(a)$ is the quantity of product variety a produced in country i. Monopolistic competition among firms ensures that the high profits enjoyed by existing firms in the short run are eroded as new firms enter the market in the long run. This free entry of new firms into the market results in the introduction of new varieties, displacement of the old varieties and a decline in profits to zero in equilibrium. Accordingly, the zero profit condition is represented as

$$\pi_i = p_i(a)q_i^j(a) - wv_iq_i^j(a) - wk_i = 0 \tag{2.20}$$

From the optimization problem in equation (2.19), the Bertrand-Nash price-setting equilibrium for each firm yields

$$p_i(a) = \left(\frac{\sigma}{\sigma - 1}\right) wv_i \tag{2.21}$$

where σ is the price elasticity of substitution between varieties, wv_i is the marginal cost of producing the variety of the unique commodity and the term in parenthesis represents the so called price-marginal cost markup. Based on the initial assumption of no trade frictions, it is expected that price of the product variety in the importing country is the same as the price of the product in the exporting country regardless of where the good is produced. It is very easy to see that a positive wedge exists between the factory gate price and the marginal cost since the price-marginal cost markup exceeds unity[15]. Since it was assumed previously that the production cost is the same for all product varieties in country i, it follows that each product variety exported to country j commands the same price..

2.3.4 Patterns of Bilateral Trade

Having successfully obtained the price and demand functions from the foregoing analysis, I now proceed with the arduous task of determining the patterns of bilateral trade. To determine the patterns of bilateral trade in this setup, it is important to introduce some trade costs. This is done by relaxing our earlier assumption of 'No Trade Frictions' or trade costs. Trade barriers in the form of transport costs, tariffs, NTBs, costs associated with contract enforcement and other hidden trade costs drive a wedge between relative production costs and relative prices across borders. This means that the presence of trade costs or rather trade frictions increases the price consumers paid for the product in country j. As in Anderson and van Wincoop (2003), I model the effects of these trade frictions as *iceberg* trade costs. The iceberg formulation here means that when country i trades with country j, firms in the exporting country are expected to ship $\tau_{ij} > 1$ units in order for one unit of the product variety to arrive in country j. In this case, the excess amount $\tau_{ij} - 1$ melts away in transit during shipment and this constitute our trade costs in the model. How large these trade costs are in international trade depends, to a large extent, on the value of the goods shipped. The higher the value of the goods shipped the greater will

[15]For more on this see Shepherd (2012) "The Gravity Model of International Trade: A User Guide" *United Nations Economic and Social Commission for Asia and the Pacific* UN Manual 2012.

be the trade costs and vice versa.

As I mentioned earlier, the marginal cost of producing the product variety in the exporting country is wv_i. If the product is consumed in the importing country (country j), international trade costs are incorporated so that the marginal costs becomes $\tau_{ij}wv_i$. It is easy to see here that if there are no trade costs, the value of the trade costs term equates to unity. With trade costs the price paid by consumers for the product variety in the importing country will be

$$p_j(a) = \left(\frac{\sigma}{\sigma - 1}\right)\tau_{ij}wv_i \tag{2.22}$$

Equation (2.22) can be rewritten as

$$p_j(a) = \tau_{ij}p_i(a) \tag{2.23}$$

where $p_j(a)$ is the import price of the product variety in country j and $p_i(a)$ denotes the price of the product in country i[16]. So far we have identified the trade costs, price of imports, price of exports and the volume of exports. The value of exports or bilateral trade between country i and country j is required in order to obtain the complete gravity model of trade. Accordingly, the value of exports for one product variety is $x_{ij}(a) = p_i^j(a)q_i^j(a)$. Using this formulation, bilateral exports of the product variety between country i and country j yields

$$x_{ij}(a) = \tau_{ij}p_i(a)\left(\frac{p_i^j(a)}{P_i}\right)^{-\sigma}\left(\frac{Y_i}{P_i}\right)[\phi_i\text{exp}(s_i, d_i, z_i)]^{\sigma-1} \tag{2.24}$$

Because of trade frictions, $p_i^j(a) = \tau_{ij}p_i(a)$. Plugging for $p_i^j(a)$ into equation (2.24) and solving gives

$$x_{ij}(a) = \left(\frac{\tau_{ij}(s_i, d_i, z_i)p_i(a)}{P_i}\right)^{1-\sigma} Y_i[\phi_i\text{exp}(s_i, d_i, z_i)]^{\sigma-1} \tag{2.25}$$

Equation (2.25) represents bilateral exports between the exporting country and importing country of a single consumption variety. For the gravity equation we need the bilataral exports for the sum of all the consumption varieties in the economy. Following Shepherd (2012), I assume that all firms in a particular exporting or importing country are identical with regards to prices and marginal cost. Based on this assumption and with the presence of N_i firms in the exporting country, the total bilateral trade between country i and country j for all consumption varieties

[16]With no trade frictions $p_j(a) = p_i(a)$ since $\tau_{ii} = 1$. The price $p_j(a)$ can be regarded as c.i.f while $p_i(a)$ is f.o.b since the former includes trade costs (cost, insurance, freight) and the latter is free on board.

in the economy can be expressed as

$$X_{ij} = N_i \left(\frac{\tau_{ij}(s_i, d_i, z_i) p_i(a)}{P_j} \right)^{1-\sigma} Y_i [\phi_i \exp(s_i, d_i, z_i)]^{\sigma - 1} \tag{2.26}$$

2.3.5 Market Clearing Condition and the Gravity Equation

In this model, all product varieties produced by firms in country i are expected to be sold to country j so that the total income earned by country i equates to the value of all exported product varieties in equilibrium. Therefore, the production and sale of all product varieties satisfy the market clearing condition according to

$$Y_i = \sum_{j=1}^{T} X_{ij} \tag{2.27}$$

where Y_i is total income and X_{ij} is bilateral export value between country i and country j. Plugging equation (2.26) into equation (2.27) and solving gives

$$X_{ij} = \frac{Y_i Y_j}{\sum\limits_{j=1}^{T} \left(\frac{\tau_{ij}(s_i, d_i, z_i)}{P_j} \right)^{1-\sigma} Y_j} \left(\frac{\tau_{ij}(s_i, d_i, z_i)}{P_j} \right)^{1-\sigma} [\phi_i \exp(s_i, d_i, z_i)]^{\sigma - 1} \tag{2.28}$$

As in Anderson and van Wincoop (2003), let world income be represented as $Y^G \equiv \sum_i Y_i \equiv \sum\limits_j Y_j$ so that the relative income shares in each country yield $\varphi_i = \frac{Y_i}{Y^G}$ and $\varphi_j = \frac{Y_j}{Y^G}$. Dividing equation (2.28) throughout by Y^G and solving gives a microfounded gravity equation in the spirit of Anderson-van Wincoop (2003) as

$$X_{ij} = \frac{Y_i Y_j}{Y^G} \left(\frac{\tau_{ij}(s_i, d_i, z_i)}{\Pi_i P_j} \right)^{1-\sigma} [\phi_i \exp(s_i, d_i, z_i)]^{\sigma - 1} \tag{2.29}$$

where τ_{ij} denotes the bilateral trade resistance or the magnitude of the barrier to trade between the exporting country and importing country. As in Anderson and van Wincoop (2003), this bilateral trade resistance is assumed to be symmetric so that $\tau_{ij} = \tau_{ji}$. The outward multilateral resistance term, $\Pi_i \equiv \left(\sum\limits_{j=1}^{T} \left(\frac{\tau_{ij}(s_i, d_i, z_i)}{P_j} \right)^{1-\sigma} \varphi_j \right)^{\frac{1}{1-\sigma}}$ $\forall i$ captures all trade impediments or barriers that the exporting country faces with all its trading partners and $\mathrm{P}_j \equiv \left(\sum\limits_{j=1}^{T} \left(\frac{\tau_{ij}(s_i, d_i, z_i)}{\Pi_i} \right)^{1-\sigma} \varphi_i \right)^{\frac{1}{1-\sigma}}$ $\forall j$ is the inward multilateral trade resistance term which represents the trade barrier or trade resistance that the importing country faces with all its trading partners. Notice that the bilateral trade resistance term is a function of institutional quality, the level of democratization and autocratization. These embedded variables affect trade costs and hence bilateral trade. Therefore, the inclusion of these institutional variables in bilateral trade resistance together with the multilateral trade resistance variables suggest the striking difference between the gravity model of this paper and the traditional gravity model of trade.

The gravity equation in equation (2.29) can be further expressed as

$$X_{ij} = \frac{Y_i Y_j}{Y^G} \tau_{ij}^{1-\sigma}(s_i, d_i, z_i) \Pi_i^{\sigma-1} P_j^{\sigma-1} [\phi_i \exp(s_i, d_i, z_i)]^{\sigma-1} \tag{2.30}$$

Loglinearizing equation (3.30) gives

$$\ln X_{ij} = \ln(Y_i Y_j) + \ln\tau_{ij}^{1-\sigma}(s_i, d_i, z_i) + \ln\Pi_i^{\sigma-1} + \ln P_j^{\sigma-1} + (\sigma-1)\ln\phi_i + (\exp(s_i, d_i, z_i))^{\sigma-1} - \ln Y^G \tag{2.31}$$

In the next section, I will use this expression to specify the baseline gravity equation for analyzing the effects of the hidden trade costs and RTA membership on bilateral trade.

2.4 Empirical Methodology and Estimation Procedure

The empirical approach used in this study to analyze the effects of the hidden trade costs and regional integration on bilateral trade is the gravity model of trade. This is the standard procedure used by many researchers ever since it was first introduced in 1962 by Tinbergen. For the two-country case, i and j, the basic gravity model of trade shows bilateral trade between country i and country j as being directly proportional to the sizes of the two countries, as measured by their GDPs and inversely to the distances between them. This traditional gravity model is augmented to incorporate direct as well as 'hidden' trade costs variables and other variables to control for institutional quality and type of political regime of country-pair. The augmented model also includes binary variables that control for RTA membership, contiguity, landlockness and common currency. An econometric specification of the augmented gravity model is specified in subsection 2.4.1.

2.4.1 Baseline Gravity Model Specification

In Section 3 the canonical gravity model in the spirit of Anderson and van Wincoop (2003) model was developed. This model is different from the traditional model of gravity in the sense that it incorporates other variables to control for RTA membership, institutional quality, the degree of democratization and autocratization of the exporting and importing countries. I specify the baseline gravity equation in this section using our earlier derived gravity model in Section 3. This is done by first specifying the bilateral trade resistance (τ_{ij}) in equation (2.30) as

$$\tau_{ij}^{1-\sigma}(s_i, d_i, z_i) = DIST_{ij}^{\theta}\exp^{W'_{ij}\alpha} \tag{2.32}$$

where $DIST_{ij}$ is the bilateral distance between the exporting and importing country measured as the great circle distance between the major business cities of country i and country j, $W_{ij} = \begin{bmatrix} COMLANG_{ij} & COMBORD_{ij} & \dots & \dots & RTA_{ij} \end{bmatrix}$ is a vector of RTA membership variables and country characteristics like landlockedness, adjacency or common border, historical link, ethnicity and common currency, to mention a few. The country characteristics and RTA membership varibles include $COMBORD_{ij}$, $COMLANG_{ij}$, $COMCUR_{ij}$, $LANDLOCK_{ij}$ and RTA_{ij}. $COMLANG_{ij}$ denotes the common official language widely spoken by people in country i and country j, $COMBORD_{ij}$ is the common border shared between country i and country j, $COMCUR_{ij}$ denotes the common currency shared by the exporting and importing country, $LANDLOCK_{ij}$ indicates that both exporting and importing countries are landlocked and RTA_{ij} indicates whether both countries are members of the same regional trade agreement. The parameter $\alpha = \begin{pmatrix} \alpha_1 & \alpha_2 & \dots & \alpha_5 \end{pmatrix}$ is a vector of coefficients associated with the country characteristics and RTA membership variables. In addition, the outward and inward multilateral resistance terms can be represented as $\ln\Pi_i^{\sigma-1} = \gamma_i$ and $\ln P_j^{\sigma-1} = \gamma_j$. Plugging the bilateral trade and multilateral trade resistances terms into equation (2.31) yields

$$\ln X_{ij} = \ln(Y_iY_j) + \theta\ln DIST_{ij} + W'_{ij}\alpha + (\sigma-1)\ln\phi_i + \ln(\exp(s_i, d_i, z_i))^{\sigma-1} - \ln Y^G + \gamma_i + \gamma_j \tag{2.33}$$

Notice that the term representing the quality of the product, $\ln(\exp(s_i, d_i, z_i))$, in equation (2.33) is a function of exporter and importer institutional quality, the level of democratization and autocratization. This can the expressed as

$$(\exp(s_i, d_i, z_i))^{\sigma-1} = \exp^{V'_{i(j)}\delta} \tag{2.34}$$

$$\delta = \begin{bmatrix} \delta_1 & \delta_2 & \dots & \delta_6 \end{bmatrix}; \; V'_{i(j)} = \begin{bmatrix} INSTQ_i \\ \vdots \\ \vdots \\ DEMOC_i \\ \vdots \\ AUTOCRAT_j \end{bmatrix}$$

where $INSTQ_i$ denotes institutional quality of the exporting country, $INSTQ_j$ is the institutional quality of the importing country, $DEMOC_i$ denotes the degree of democratization of the exporting country, $DEMOC_j$ is the degree of democratization of the importing country and $AUTOCRAT_i(AUTOCRAT_j)$ denote the degree of autocratization of the exporting and importing countries respectively. The parameter $\delta = \begin{pmatrix}\delta_1 & \delta_2 & \dots & \delta_6\end{pmatrix}$ is a vector of coefficients associated with the institutional quality and governance indicators. Substituting for equation (2.34) into equation (2.33) and solving gives

$$\ln X_{ij} = \ln(Y_iY_j) + \theta \ln DIST_{ij} + W'_{ij}\alpha + (\sigma-1)\ln\phi_i + V'_{i(j)}\delta - \ln Y^G + \gamma_i + \gamma_j \tag{2.35}$$

Augmenting the above specification to incorporates variables that capture levels of economic development of the trading partners and the Linder or H-O effects gives the multiplicative and stochastic form of the model as

$$X_{ijt} = \beta_0 Y_{it}^{\beta_1} Y_{jt}^{\beta_2} PCY_{it}^{\beta_3} PCY_{jt}^{\beta_4} RFD^{\beta_5} DIST_{ij}^{\beta_6} \exp^{W'_{ij}\alpha} \exp^{V'_{i(j)}\delta} \exp^{\gamma_i} \exp^{\gamma_j} \eta_{ijt} \tag{2.36}$$

where $\beta_0 = -\ln Y^G$, PCY_{it} denotes GDP per capita of the exporting country, PCY_{jt} is the GDP per capita of the importing country, RFD represents the relative differential of factor endowment between the exporting and importing country, γ_i and γ_j are nuisance parameters and capture the effects of the inward and outward multilateral trade resistances (Π_i and P_j). Accounting for these multilateral trade resistances does make sense because it helps to eliminate the upward bias of the parameter estimates of the baseline gravity equation that would result if they were ignored. The error term $\eta_{ijt} \sim_{iid} N[0, \sigma^2]$ and it is expressed as $\eta_{ijt} = (\sigma-1)\ln\phi_i$. Loglinearizing the multiplicative and stochastic form of the gravity equation in equation (2.36) gives our resulting baseline gravity equation as

$$\begin{aligned} \ln X_{ijt} = \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln PCY_{it} + \beta_4 \ln PCY_{jt} \\ + \beta_5 RFD + \beta_6 \ln DIST_{ij} + Z'\beta + \gamma_i + \gamma_j + \eta_{ijt} \end{aligned} \tag{2.37}$$

where Z' is a vector of RTA membership variables, various country characteristics and variables that capture institutional quality, democratization and autocratization of the exporting and importing countries and β is a vector of parameters associated with the vector of variables Z'. The vector, Z', comprises all the variables of the vectors W' and V'. As in Anderson and van Wincoop (1979, 2003), the extant literature on the specification of the gravity model encompasses a large amount of excellent theoretical explanation to support the gravity model. For instance, Eaton and Kortum (2002) specified a gravity model based on the standard Ricardian trade model of differences in technologies between countries. Deardorff (1989) used the H-O differences in factor endowments between countries to provide a theoretical rational for the gravity model. I have provided in Table 2.1 the hypothesized signs and a thorough description of both the regressand and regressors included in the baseline gravity model. The regressors include the hidden trade cost variables that are the main focus of my attention in this study.

Table 2.1: Description of Variables in the Baseline Gravity Model

Variable	Description	Hypothesized Sign
Dependent Variables		
X_{ijt}	Exports of country i to country j (in Million US$) in time t	None
Explanatory Variables		
Y_{it}	Exporting country's GDP (in Million US$) in time t	+
Y_{jt}	Importing country's GDP (in Million US$) in time t	+
PCY_{it}	Exporting country's GDP per Capita (in Million US$) in time t	+
PCY_{jt}	Importing country's GDP per Capita (in Million US$) in time t	+
$DIST_{ij}$	Distance (in miles) between country i and country j major cities	-
RFD_{ijt}	Factor Endowment Differential between country i and country j	±
$COMLANG_{ij}$	Dummy variable =1 if both country i and country j share a common official language and 0 otherwise	+
$COMCUR_{ij}$	Dummy variable=1 if both country i and country j share a common currency and 0 otherwise	+
$COMBORD_{ij}$	Dummy variable=1 if both country i and country j share a common border and 0 otherwise	+
$LANDLOCK_{ij}$	Dummy variable=1 if both country i and country j are landlocked and 0 otherwise	-
RTA_{ij}	Dummy variable=1 if both country i and country j belong to the same RTA and 0 otherwise	+
$INSTQ_{it}$	Institutional quality of exporting country (six variables) regulatory quality, rule of law, control of corruption etc.	+
$INSTQ_{jt}$	Institutional quality of importing country (six variables) regulatory quality, rule of law, control of corruption etc.	+
$DEMOC_{it}$	Degree of democratization of exporting country	+
$DEMOC_{jt}$	Degree of democratization of importing country	+
$AUTOCRAT_{it}$	Level of Autocratization of exporting country	-
$AUTOCRAT_{jt}$	Level of Autocratization of exporting country	-

Notes: This table reports the description and expected signs of all the variables—including the binary or dichotomous variables—used to carry out the empirical analysis in this paper. INSTQ, DEMOC and AUTOCRAT are the proxy variables for institutional failures and political risks.

2.4.2 Data Sources and Description

The empirical and econometric analysis of the effects of hidden trade costs and RTA membership on bilateral trade require data on a large amount of statistical information. Therefore, a panel of bilateral trade flows, RTA characteristics, institutional quality indicators, income, geographic characteristics of the exporting and importing countries, factor inputs and Polity IV data on democratization and autocratization was collected from a variety of sources. In particular, the two principal sources of the data used in the study are the IMF *Direction of Trade Statistics* (IMF DOTS) CD-ROM and the World Bank World Development Indicators (WDI) database. These useful sources contain comprehensive statistical data on 95% of the variables of interest for each of the countries in the trade blocs under consideration. The study comprises a sample of 46 countries (15 countries in ECOWAS, the 3 countries in NAFTA and the EU (28) countries) for the period 1996 through 2012[17]. This means that a total of (46 x 45 x 17) 35190 observations of bilateral trade flows was considered in the study. There are a total number of 5804 zero trade flow observations in the data. The presence of zero trade flows is a serious problem for the estimation of our model but will be fully addressed later on in the econometric estimation.

Data on GDP at constant prices or real GDP and per capita real GDP were extracted from the World Bank WDI 2013 database. In addition to controlling for the economic sizes of the exporting and importing countries, I also control for differences in factor endowments across countries. Data on differences in factor endowments as proxied by the absolute difference of capital-labor ratio of the exporting and importing countries was generated by taking absolute difference of the logarithms of the capital-labor ratios between the exporting and importing countries. The following equation was used to generate differences in relative factor endowment

$$RFD = |ln(K/L)_{it} - ln(K/L)_{jt}| \tag{2.38}$$

where $(K/L)_{it}$ denotes capital-labor ratio of country i in period t, $(K/L)_{jt}$ is the capital-labor ratio of country j in period t and RFD is the absolute differential of factor endowment between the exporting and importing countries. Capital is proxied as gross fixed capital formation and the data was drawn from the World Bank WDI. Statistical data on labor for both the exporting and importing country was drawn from the World Bank WDI database of 2013.

Bilateral trade data on exports and imports were extracted from the IMF *Direction of Trade Statistics* CD-ROM. To ensure consistency of our data, all exports (f.o.b) and imports (c.i.f) including real GDP data are expressed in millions of US dollars for all the 46 countries in the sample. The data is supplemented by obtaining statistical information from other sources like the WTO-RTA website and "*http://www.distancefromto.net*" . The distance data, expressed in miles and computed from great circle distances using longitudes and latitudes between the ma-

[17]For a complete list of countries see Table A.1 in the appendix.

jor cities of each country, serves as proxy for geographic barrier to international trade. All the distance data were sourced from the website "*http://www.distancefromto.net*". To construct data on landlockness, common border or contiguity, common language, I extracted information from maps of the regional trade blocs and the CIA world factbook via the CIA's website (*https://www.cia.gov/library/publications/the-world-factbook/docs/profileguide.html*). This website contains comprehensive information from which data related to geographic location can be constructed.

Since my primary goal in this paper is to analyze the effects of RTA membership and hidden trade costs, that is the effect of institutional quality and political regime type, on bilateral trade flows, I extracted data on governance from the World Bank governance indicators homepage "*http://info.worldbank.org/governance/wgi/index.aspx#home*". These indicators were compiled by Kaufmann, Kraay and Mastruzzi (2010) and later updated by the World Bank in 2014. Their governance or institutional quality indicators were based on a comprehensive survey of a large number of respondents (professionals, private practitioners, public and private sector employees etc.) in 215 countries around the world. Fortunately, the countries considered in my dataset were all covered in the survey and so the question of having governance data for all the 46 countries in this study is irrelevant.

Kaufmann *et al.* (2010) developed a total of six governance indicators to measure the quality of institutions for various countries around the globe. Each of the six governance indicators constitute six independent clusters which are then aggregated to obtain a single composite governance indicator. According to Kaufmann *et al.* (2010), each of the six governance indicators represents a different dimension of institutional quality. In particular, the first of the six indicators, *voice and accountability*, is a measure of the freedom of the citizens of a country to exercise their franchise and voice their opinions freely without arbitrary arrests by government officials. It also includes freedom of the press, freedom of association and freedom to participate in the decision making process of the state. The second indicator is *political stability and absence of violence* and it is a measure of the political risk of the country. Therefore, it captures the probability of government in power being toppled by violence, coup d'état or unconstitutional means, civil unrest and terrorism.

The third institutional quality indicator is *government effectiveness* and it captures the quality of government policy formulation and its commitment to implement those sound policies. It is also a measure of the quality of public service delivery, the competence of the civil or public service and its independence in policy formulation and execution. *Regulatory quality* is the fourth governance indicator and it measures economic freedom of the private sector. This indicator measures the incidence of government to formulate policies that are unfriendly to private sector development. Policies like rationing, price control and excessive regulation of businesses are detrimental to the smooth functioning of the free market enterprise and therefore impede private sector development. The fifth indicator is *Rule of Law* which is a measure of the confidence economic agents, firms and other agents, have in the country's legal system to enforce contracts and secure property rights (**http://info.worldbank.org/governance/wgi/index.aspx#home**). The final institutional quality indicator considered in this study is *Control of Corruption* . This measures the incidence of public servants to levy bribes or engage in predation for personal gain. Anderson and Marcouiller (2002) discussed the negative effect of graft on trade extensively in the literature.

Data on WGI (World governance indicators) is available for the period 1996 through 2013 with the exception of 1997, 1999 and 2001. Since the missing data are not many an imputation method was used to obtain the data. This approach has been regarded as standard in many research works in which there are few missing data. The imputation method involves replacing the missing data with the average of the preceding and subsequent data. In the data each of the WGI ranges between -2.5 and +2.5, with the lowest number suggesting weak or poor institutional quality and the highest denoting better institutions.

One important point to note about these institutional quality indicators is that they are highly correlated and so having all of them as explanatory variables in a gravity regression results in multicollinearity (See Table 2.2) and impair the estimates of our coefficients. Therefore, to avoid the problem of multicollinearity, a composite indicator that measures the overall institutional quality of the importing and exporting country was used. To do this, I obtain the average of the individual scores for all of the six governance indicators.

Finally, in order to capture the effect of political regime type of the exporting and importing countries, I used the indices of democratization and autocratization developed by Marshall *et al.* (2014). These data were reported in the POLITY IV project in May 2014 for the Center for Systemic Peace and Societal Systems Research Inc. The POLITY IV project data was compiled for 185 countries for the period 1800 through 2013 and has been a vital source of statistical information for my empirical analysis. Two political regime indicators were considered (DEMOCRACY and AUTOCRACY). Democracy in this case is regarded as institutionalized democracy. That is, the establishment of structures or institutions through which citizens are able to choose their leaders, participate in the political process unhindered and the presence of contraints that limit the exercise of power of the executive. The democracy indicator is on an eleven point scale, that is, 0 through 10 with 0 indicating zero democracy and 10 indicat-

Table 2.2: Correlation Matrix for Governance or Institutional Quality Indicators

Variable	GovEff	RLaw	ContCrrp	PolStab	RegQlt	VAcct
GovEff	1					
RLaw	0.9426	1				
ContCrrp	0.9259	0.9492	1			
PolStab	0.7791	0.8526	0.7622	1		
RegQlt	0.9390	0.9496	0.9063	0.8109	1	
VAcct	0.9104	0.9373	0.8808	0.8449	0.9275	1

Notes: The variables are defined as GovEff = Government Effectiveness, RLaw= Rule of Law, ContCrrp = Control of Corruption or Graft, PolStab = Political Stability, RegQlt = Regulatory Quality and Vacct= Voice and Accountability.

ing complete democracy. The autocracy index also ranges between 0 and 10, with 0 indicating zero authoritarian political regime, that is, complete political accountability and existence of constraint to limit the exercise of power by the executive and 10 suggesting totally autocratic. Some of the countries included in the sample, such as Sierra Leone and Liberia have experienced periods of total collapse of central authority between 1996 and 2012 (periods in which there was no functioning central government). In order to account for this period of *interregnum*, the DEMOCRACY and AUTOCRACY variables are coded as -77 and -88 for periods of transition from collapse of state authority to periods of proper functioning of state authority. I have also provided some supplementary notes on the governance and political regime data sources in the appendix for the interested reader.

2.4.3 Poisson Quasi Maximum Likelihood Estimation

As was mentioned in the introductory section of this paper, the poisson estimation method was used to estimate the baseline gravity model specified in subsection 2.4.1. This estimation procedure is appropriate because our dataset has a couple of zero bilateral trade flows. In previous studies, it has been the common practice by many researchers to use OLS to estimate the gravity model of trade. However, OLS estimation of the gravity model is both inefficient and inconsistent. Silva and Tenreyro (2006) argued that using logarithms in the OLS estimation poses two major econometric problems. First, using logarithms on bilateral export leads

Table 2.3: Summary Statistics of Variables in the Baseline Model

Variables	N	Mean	Std. Dev.	Min	Max
Economic Variables					
Exports	35,190	1,895.41	11335.2	0	354,677
Exporter GDP	35,190	10.8659	2.5014	4.7596	16.4710
Importer GDP	35,190	10.8237	2.5337	4.7596	16.4710
Exporter GDP Per Capita	35,190	8.6462	1.8689	3.9722	11.3819
Importer GDP Per Capita	35,190	8.6462	1.8689	3.9722	11.3819
Relative Factor Endowment	35,190	2.1351	1.6983	0.00002	9.9270
Direct Trade Costs Variables					
Distance	35,190	7.3993	0.9141	3.5264	8.9299
Landlockness	35,190	0.0271	0.1622	0	1
Common Language	35,190	0.1130	0.3167	0	1
Common Border	35,190	0.0642	0.2452	0	1
Common Currency	35,190	0.1923	0.3941	0	1
RTA or Trade Policy Variables					
ECOWAS	35,190	0.1025	0.3021	0	1
EU28	35,190	0.3652	0.4815	0	1
NAFTA	35,190	0.0029	0.0538	0	1
WAEMU	35,190	0.0271	0.1622	0	1
WAMZ	35,190	0.0145	0.1195	0	1
MRU	35,190	0.0291	0.0538	0	1
Hidden Trade Costs and Political Risk Variables					
Exporter Control of Corruption	35,190	0.4987	1.1031	-1.74	2.59
Importer Control of Corruption	35,190	0.4987	1.1031	-1.74	2.59
Exporter Rule of Law	35,190	0.4706	1.0716	-2.23	2.00
Importer Rule of Law	35,190	0.4707	1.0717	-2.23	2.00
Exporter Regulatory Quality	35,190	0.5785	0.9685	-2.11	2.08
Importer Regulatory Quality	35,190	0.5785	0.9685	-2.11	2.08
Exporter Government Effectiveness	35,190	0.5190	1.1096	-1.98	2.36
Importer Government Effectiveness	35,190	0.5190	1.1096	-1.98	2.36
Exporter Political Stability	35,190	0.3459	0.8818	-2.56	1.67
Importer Political Stability	35,190	0.3458	0.8818	-2.56	1.67
Exporter Voice and Accountability	35,190	0.5828	0.9026	-1.82	1.82
Importer Voice and Accountability	35,190	0.5830	0.9024	-1.83	1.83
Exporter DEMOCRACY	35,190	5.2186	15.9227	-88	10
Importer DEMOCRACY	35,190	5.2033	15.9191	-88	10
Exporter AUTOCRACY	35,190	-1.9486	14.4443	-88	9
Importer AUTOCRACY	35,190	-1.9412	14.4479	-88	8

Notes: This table reports the summary statistics of the data.All the variables used in the regressions are apportioned into three categories *viz* economic, trade policy and hidden trade costs variables.

Source: International Monetary Fund *Direction of Trade Statistics*, World Bank *World Development Indicators* and *World Governance Indicators* to bias estimates of the parameters in the gravity model. This is so because the logarithm of zero values is indeterminate which implies that loglinearization of the dependent variable results in the random elimination of observations from the regression. Second, in the presence of heteroscedasticity, the OLS method yields inconsistent estimates of the parameters[18]. Some researchers used the robust covariance matrix estimation technique to resolve the issue of heteroscedasticity, but this approach has been criticized by Shepherd (2012) on the grounds that it affects both the standard errors and parameters.

To circumvent all these estimation issues and preseve the bilateral trade flows in the regression, I have used the PQML approach proposed by Silva and Tenreyro (2006). This approach involves estimating the baseline gravity model in multiplicative form in which the conditional expectation of bilateral trade flows given its determinants is regressed on the explanatory variables. I modeled the endogenous variable—in this case bilateral exports—according to the poisson distribution or probability mass function as

$$Pr(X_{ijt} \mid \mu = M) = \frac{e^{-\mu}\mu^{X_{ijt}}}{X_{ijt}!}, \quad \mu > 0 \quad X_{ijt} = 0, 1, 2, 3, ... \tag{2.39}$$

where X_{ijt} is bilateral export flows in period t, M represents the explanatory variables in the baseline gravity model and embodies all the determinants of bilateral trade including trade costs and all other variables that control for economic development, RTA membership, type of political regime and institutional quality. The conditional expectation of bilateral trade flows given the regressors is represented as $E[X_{ijt} \mid M) = \mu = \exp(\mathrm{M}'\beta)$.

From equation (2.39), M is expressed as

$$\begin{aligned} M = \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln PCY_{it} + \beta_4 \ln PCY_{jt} \\ + \beta_5 RFD + \beta_6 \ln DIST_{ij} + Z'\beta + \gamma_i + \gamma_j \end{aligned} \tag{2.40}$$

[18]In the presence of heteroscedasticity, the overall predicted bilateral exports will exceed the sum of actual export for each country. This is the so called *Jensen's Inequality* pointed out by Silva and Tenreyro (2006) and, later by Arvis and Shepherd (2013).

Using the multiplicative and stochastic form of the gravity model obtained earlier, the PQML can be applied to the resulting equation according to

$$\begin{aligned} X_{ijt} = \exp(&\beta_0 + \beta_1 \text{ln} Y_{it} + \beta_2 \text{ln} Y_{jt} + \beta_3 \text{ln} PCY_{it} + \beta_4 \text{ln} PCY_{jt} \\ &+ \beta_5 RFD + \beta_6 \text{ln} DIST_{ij} + Z'\beta + \gamma_i + \gamma_j) + \eta_{ijt} \end{aligned} \tag{2.41}$$

This is the standard equation on which the PQML estimator is used. According to Silva and Tenreyro (2006); Cameron and Trivedi (2005) and many other econometricians, the PQML estimator is robust in the presence of heteroscedasticity and to "distributional misspecification" if the conditional mean of trade flows is correctly specified. Therefore, regardless of whether we are dealing with count data or continuous data, the PQML yields consistent estimates. The beauty of the PQML is the way zero trade flows are treated in the estimation of gravity regressions. The PQML naturally incorporates all zero trade flow observations instead of dropping them from the regression. In addition to being a consistent estimator for both count and continuous data regressions, the PQML estimator performs very well in fixed effects and nonlinear gravity regressions.

2.5 Empirical Results and Analysis

So far I have been able to show that the gravity model can be estimated by a poisson distribution estimator. In this section I test the validity of the underlying hypothesis of this study and provide empirical evidence to support or refute it using the available data. In particular, I use the poisson regression and other estimation analysis to isolate the effects of hidden trade costs, regional integration, institutional quality, democratization and autocratization on bilateral trade. This will help to rid our resulting parameter estimates of any potential biasedness arising from the use of a single econometric estimation technique. The regression results are reported in Tables 2.4 and 2.5. Before I get to the interpretation and discussion of the key results, it is important to start with the analysis of the traditional estimates of the baseline gravity model. Apart from the PQML approach, I have estimated the baseline gravity model with zero trade flows included and excluded with three other econometric estimation techniques. These estimation approaches include, OLS, Truncated OLS and Tobit estimations[19]. The Tobit estimation method was used by Martin and Pham (2008) to handle the problem of zeros trade flows. They provided a justification for using the Tobit estimation method in gravity models when zero trade flows are common. They argued that the Tobit estimation method perform better than the PQML estimation technique if the issue of heteroscedasticity is properly addressed. The results of the Tobit and the other estimation methods are reported in four separate columns. The OLS results are in column 1 of Tables 2.4 and 2.5, the truncated OLS regression in column 2, the PQML in column 3 and the Tobit regression in column 4. Notice that for the OLS, Truncated OLS and Tobit estimations 1 was added to the bilateral trade flows data before taking the logarithms for the baseline gravity model estimation with zero trade flows. Therefore the regressand in columns 1 and 2 of Table 2.5 is $\log(1 + X_{ijt})$. I also used exporter and importer fixed effects in all the regressions to control for multilateral trade resistance.

From a cursory look at the results of the baseline gravity model, it appears that the coeffi-

[19]Both the Tobit and Truncated regressions are explained in detail in Cameron and Trivedi (2005).

cients of the income variable that measures the size of the exporting and importing countries have the expected positive sign in all the regressions, including the OLS and the truncated OLS econometric approaches. This finding appear to be consistent with the findings of Rose (2004) in his study on the effect of WTO on trade. However, the estimated coefficients obtained in this study are not very close to those obtained by McCallum (1995) and Anderson-van Wincoop (2003) but are consistent with theory[20]. Each of the econometric approaches recorded varying elasticities of export supply and import demand. Whereas the OLS estimates recorded higher export elasticities for the baseline regression model, the truncated OLS, PQML and Tobit estimations recorded higher import demand elasticities. Interestingly, the estimated coefficients of GDP per capita turned out to higher than those of income and are significantly positive in all the regressions of the baseline gravity model. This implies that economically wealthy countries like UK, USA, Germany, to name but a few, trade more than poor countries. In other words, the more developed the exporting and importing countries are the higher will be the volume of trade between them and vice versa. Intuitively, the more developed the exporting and importing countries are the better will be the quality of their institutions in enforcing contracts and the higher the volume of trade between them. In contrast, the lower the level of development of the trading partners, the lower will be the volume of trade between them. This explains why countries in *South-South* trade agreements trade less with each other. For instance, intra-regional trade share for ECOWAS, WAEMU, WAMZ and MRU appears to be very low relative to intra-regional trade shares in EU28 and NAFTA.

2.5.1 Effects of Trade Costs and Regional Integration

Having discussed the traditional estimates of the baseline gravity model, I now address the primary goal of the paper which is to analyze the effects of trade costs and regional integration on bilateral trade. In this paper I have divided trade costs into direct trade costs and latent or

[20]Both McCallum (1995) and Anderson-van Wincoop (2003) obtained unitary elasticities for both export supply and import demand elasticities in their studies of the border puzzle and solution to the border puzzle respectively.

unobserved trade costs for ease of analysis. The direct trade costs include transport costs, cost associated with language, landlockedness, border currency and trade policy barriers. I have used geographical distance between the exporting and importing country as a proxy for transport costs and binary variables for common border or contiguity, common language, common currency and trade policy to control for these trade barriers. The regression results are presented in Tables 2.4 and 2.5. The coefficient of the geographical distance variable is overwhelmingly negative and significant in all the battery of econometric estimation procedures. This result suggests the significance of transport costs as a driver of bilateral trade. Trade is higher the smaller the distance separating the trading partners. This means that two countries that are geographically proximate partners in trade do trade more than distant countries because distance increases transport costs and lowers the volume of trade. In the NAFTA trading bloc, trade volumes are higher among the three member countries primarily because of proximity. Canada and US trade more because they are geographically proximate partners and most of their trade policies provide the enabling environment for the private sector to thrive.

Moreover, the results of the coefficient associated with not having access to a seaport or a coastline seem to be ambiguous, to say the least. Both the Tobit and Truncated OLS regression results indicate that trading partners landlockedness boost bilateral trade. This is in contradiction with the OLS and PQML results and theory. It is a well established fact that landlocked countries tend to trade less as landlockedness poses a big barrier to trade by increasing trade costs. If two trading partners are landlocked, trade costs are higher because for one of these countries to export its goods to the other landlocked trading partner it would mean transporting the goods overland which results in huge costs. These trade costs are lower if at least one of the trading partners has access to a seaport. Since the landlockedness coefficient is significant in all the regression we can safely say that this covariate affects trade costs and hence bilateral trade. According to the OLS and PQML regression results reported in Tables 2.4 and 2.5, the baseline gravity model estimates suggest that if both country i and country j are landlocked bilateral trade between them will decline by approximately 13% and 27% respectively than if both of them have access to a seaport[21]. This finding corroborates the conclusion reached by Carrère (2006) that landlocked countries trade about 28% less than those that are not landlocked.

The coefficients associated with all the country characteristics save common currency have the expected signs and are significant in all the regression estimation procedures. Interestingly, the common language coefficient of the OLS, Truncated OLS and Tobit estimations were astronomically higher than the PQML estimate. According to the OLS, Truncated and Tobit estimates a pair of countries i and j sharing a common language, traded 100% more than a pair of countries with different languages. The PQML estimate suggests that if both exporting and importing countries share a common language, trade between them is bound to increase by approximately 37%. This finding is consistent with the estimates obtained by Rose (2004) and Helpman *et al.* (2008). Clearly sharing a common language does facilitate trade between countries. This is arguably evident in the trade relations between France and Ivory Coast; Germany and Austria; UK and Sierra Leone; US and Canada, to name but a few.

The estimated coefficient of the common border variable appear with the expected sign and is significant in all save the PQML regression. On average, the estimated coefficients suggests that sharing a common border does facilitate trade in the trading blocs under investigation. Bilateral trade is expected to increase by approximately 40% ($(\exp^{0.337} - 1) \times 100$) if the exporting and importing countries share a common border than if they do not. In other words, the result suggests that countries that are closer to each other or share a common border are likely to trade more regardless of the distance separating them. High volume of trade between adjacent countries could also occur because of different regulatory framework or good roads and communication network that facilitate the free flow of goods and services [22]. The common currency effect on bilateral trade, though exhibiting ambiguous results, does play a role in facilitating trade between trading partners. Having a single currency in a trading bloc as in the

[21] These values were obtained from the regression estimates according to the following exponential equation: $e^{-0.138} - 1 = -0.1289 \approx 13\%$ and $e^{-0.318} - 1 = -0.2724 \approx 28\%$.

[22] See De Groot *et al.* (2004) for details on this.

case of WAEMU and EU28 trade blocs helps to reduce transaction costs and therefore trade costs in the trade bloc. Various economists have empirically investigated the effects of currency unions on trade, but their documented results appear to be conflicting at best.

Thus far, I have provided a thorough analysis of the effects of trade costs on bilateral trade. My final task in this subsection is to show the effects of regional integration on bilateral trade. As I mention earlier, binary variables were used as proxies to determine countries membership in a regional trade bloc. The results of the regressions are reported in Tables 2.4 and 2.5. Membership in the Free Trade Agreement, NAFTA has a very large effect on trade. The OLS regression result in column (1) of Table 2.4 indicates that a pair of countries in NAFTA traded 425% more than a pair countries outside the trade agreement. In contrast, the PQML estimate suggests that a pair of countries in NAFTA traded 74% less than a pair of countries outside a trade agreement. This is an indication of trade diversion in NAFTA. The ECOWAS trade bloc, like the NAFTA trade bloc show some interesting results for all the regressions. The OLS, Truncated OLS and Tobit regressions coefficients show a very large discrete effect on bilateral trade whilst the PQML show a relatively smaller effect. According to the PQML results, a pair of countries in ECOWAS is expected to trade about 53% ($\exp^{0.424} - 1$) more than a pair outside the regional trade agreement. WAEMU variable is a significant predictor of trade in all the regressions of the baseline gravity model and the coefficients turned out the expected signs. The PQML results indicate that a pair of countries in WAEMU traded approximately 63.3% more than a pair of countries outside the RTA. Similar results were obtained for the three other econometric techniques. However, WAMZ and MRU returned ambiguous results for the coefficients in all the regressions. According to the PQML results, a pair of countries in WAMZ and MRU will trade about 52% and 40% less than a pair of countries outside these RTAs. Clearly there is considerable amount of trade diversion in these regional trade blocs.

Results of the European Union integration indicate that EU28 is a significant predictor of trade. All the regression methods report the expected signs and the coefficients are significant at conventional levels of significance. According to the Tobit estimates, approximately 116% increase in trade was observed when a pair of countries decides to integrate into the EU than a pair of countries outside the RTA.

In a nutshell, the findings on the effects of trade costs on bilateral trade can be summarized as follows. First, bilateral distance contributes immensely towards increasing trade costs and decreasing trade. Trade volumes increases between geographically proximate partners and declines for distant trading partners. Second, landlockedness, common language, common currency and common border are major trade barriers and they increase trade costs. Finally, I conclude that membership in a regional trade agreement does help boost bilateral trade. These results are consistent with those of Rose (2002), Helpman *et al.* (2008) and many other researchers.

2.5.2 Effects of Hidden Trade Costs and Political Regimes

For the purpose of analysis in this study, hidden trade costs are all those trade costs associated with institutional quality and type of political regimes of the exporter and importer. Governance indicators such as voice and accountability, control of corruption, political stability, government effectiveness, rule of law and regulatory quality for the exporting and importing countries have been used as proxies to control for institutional quality. To avoid possible multicollinearity in our regression estimates, I have used the average of the six indicators for the exporting and importing countries to control for institutional quality. I rely on the governance indicators developed by Kaufmann *et al.* (2010) to do the analysis here. Each of these indicators ranges between -2.5 and 2.5 with -2.5 denoting bad governance of poor institutional quality and 2.5 representing good governance or institutional quality. I also control for political regime type by adding the democracy and autocracy variables into our baseline gravity model. All the proxies to control for type of political regime are not included in one regression because of multicollinearity. The results are presented in Tables 2.4 and 2.5. The coefficient of institutional quality has the expected sign in all the estimation methods except the OLS. According to the

OLS estimate in the nonzero trade flow regression, a pair of countries traded about 15.6% more if both of them have strong and quality institutions than a pair with weak institutions. However, the results of the truncated OLS, PQML and Tobit are consistent with the theory in the literature. I find strong evidence that exporter and importer institutional quality positively increase trade. According to the truncated OLS, PQML and Tobit regressions, a pair of countries are expected to trade 37%, 60% and 52% more if both have quality institutional framework, the rule of law, control of corruption and an effective government for sound policy formulation than a pair without all these good qualities. Better institutions reduce the risk of predation and the uncertainty about contract enforcement. This directly reduces transaction costs and trade costs which in turn result in increased trade. François and Manchin (2013), De Groot *et al.* (2004) , Levchenko (2007) also underscore the importance of institutions in trade facilitation.

Finally, our estimates suggest that political liberalization is a significant predictor of trade. Democratic countries are characterized by very good institutional frameworks for the enforcement of contracts and securing property rights. This reduces the risk of predation, reduces trade costs and increases bilateral trade..

2.5.3 Relative Factor Endowment and the Linder Effect

As was mentioned in the introduction, this paper also endeavors to isolate the H-O and Linder effect in the augmented gravity equation. To do this, I augment the traditional gravity model by incorporating the absolute differential in capital-labor ratio. The coefficient of this variable is either positive or negative. If the coefficient is positive, then the H-O theory is supported. That is, countries that produce capital-intensive goods (cars, microwaves, washing machines, to name but a few) efficiently trade more with those that produce labor-intensive goods (clothing and textiles) efficiently. On the other hand, if the coefficient is negative, then the Linder effect that countries with similar endowment or preferences trade more than those with disimilar endowments is supported. The results are reported in Tables 2.4 and 2.5. According to the regression results, there is overwhelming evidence to support the Linder effect because the coefficient of the RFD variable is negative in all the estimation methods, but Tobit and Truncated OLS. Based on the results, an increase in relative factor differential between country i and country j, *ceteris paribus*, results in less trade between the trading partners. Therefore, we can conclude that the H-O theory is not supported. This results corroborate the findings of Deardorff (1998).

2.6 Sensitivity Analysis

In the previous section, I provided empirical evidence on the effect of both direct and hidden trade costs on bilateral trade. My task in this current section is to perform sensitivity analysis on the parameters of interest in the baseline gravity model to determine if slight changes to our default estimation method or specification of the baseline gravity model have an effect on the estimated parameters. In particular, I check for the robustness of the estimated results of the key parameters. The sensitivity checks are carried out along two dimensions. First, I re-estimate the gravity model by correcting for sample selection bias arising from censored observations. Second, I resolve the issue of overdispersion in the PQML estimation procedure. These robustness checks are done in the subsequent subsection.

2.6.1 Robustness Checks

As was mentioned in the foregoing section, I conduct a series of robustness checks to ensure that the underlying parameter estimates of the baseline gravity specification are insensitive regardless of which approach is used to estimate the gravity model. One major concern about the poisson quasi maximum likelihood (PQML) estimation technique is that it failed to handle the zero trade flows problem because of the inherent overdispersion problem associated with the estimator. To allay the fears of skeptics regarding this issue I have used an alternative estimation method proposed by Heckman (1979) to handle the zero trade flows problem in the data. Because of the large number of zero trade flows or censored observations in the data there is the potential for heteroscedasticity if OLS is used. I have discussed this issue earlier and this is just a way to recap. As in Helpman *et al.* (2008), the censored observations (the zero trade flows) are considered as a sample selection problem and so the Heckman two-step estimation procedure was used in re-estimating the gravity model. The Heckman selection method is performed in two stages. The first stage represents the *selection equation* and the second stage is the *outcome equation.* As a standard procedure, I first define a latent variable of trade relationship in which all the positive trade flow observations are assigned a value of 1 and all the zero trade flows or censored observations are assigned a value of zero. Now suppose the latent variable is X^L_{ijt}, the first stage regression equation in the Heckman procedure can be represented as

$$\begin{aligned} X^L_{ijt} &= \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln PCY_{it} + \beta_4 \ln PCY_{jt} \\ &\quad + \beta_5 RFD + \beta_6 \ln DIST_{ij} + Z'\beta + \gamma_i + \gamma_j + \eta_{ijt} \end{aligned} \tag{2.42}$$

$$X^L_{ijt} = \begin{cases} 1 & \text{if } X_{ijt} > 0 \\ 0 & \text{if } X_{ijt} = 0 \end{cases}$$

This regression is a probit model because the dependent variable or regressand is a binary variable. The predicted values of this regression are then used to generate the Mills ratio. The estimated Mills ratio is then used with the predicted values as another regressor in the baseline gravity model. This result in the outcome equation which is represented as

$$\begin{aligned} X^L_{ijt} &= \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln PCY_{it} + \beta_4 \ln PCY_{jt} \\ &\quad + \beta_5 RFD + \beta_6 \ln DIST_{ij} + Z'\beta + \gamma_i + \gamma_j + \lambda \hat{X}^L_{ijt} + \eta_{ijt} \end{aligned} \tag{2.43}$$

In addition to using the Heckman method to robustify our original estimates, I re-estimate the baseline gravity equation to correct for overdispersion in the regressand of the PQML approach by using another member of the family of poisson estimation methods, the negative binomial. Since the PQML requires the equidispersion property as a necessary condition for implementing this estimation method, it becomes a problem when this is violated. One of the dangers is that the dependent variable X_{ijt} is overdispersed because its conditional variance exceeds its conditional mean. Therefore, using the PQML method might impair the estimates of our results because in the presence of overdispersion, the PQML estimator is inefficient. The negative binomial and Heckman regression estimates are presented in Table 2.6. All our parameters of interest stood the onslaught of all these battery of estimation methods. The proxies for institutional quality, and political liberalization are all significant and carry the expected signs. In the Heckman results, I observe that the Mills ratio is positive and significant implying that the Heckman selection procedure is appropriate. Similar positive results were reported for the negative binomial. The coefficient of overdispersion, α, is positive and significant at the conventional level of significance. From the likelihood ratio test for α, the result suggest that the overdispersion coefficient is not equal to zero meaning that the negative binomial performs better than the PQML ($\chi^2_{(1)}$=980.6).

Although the re-estimation procedures perform better than the the PQML, the resulting parameter estimates obtained in the sensitivity checks are not that different from our original PQML estimates. This implies that our estimates for the baseline gravity model are robust regardless of the econometric estimation procedure employed in the regressions.

2.7 Concluding Remarks

This paper analyzes the effects of hidden trade costs—institutional failures and political risks—and regional integration on bilateral trade by estimating an augmented gravity equation in the spirit of Anderson and van Wincoop (2003). In this paper I refer to hidden trade costs as those costs that are very difficult to observe which means that institutional quality and type of political risk fall under this category. My approach is based on the fact that there exist trade frictions associated with institutional quality and political risks and that these hidden trade costs affect bilateral trade in the same way as tariffs and NTBs. Using a microfounded gravity model derived from a monopolistic competition model of product differentiation and a battery of estimation methods, this paper concluded that stronger institutions of trading partners leads to an increase in trade. This is so because stronger institutions of both the exporting and importing countries in the form of good regulatory and legal frameworks reduce the uncertainty in contract enforcement, transactions costs and ultimately increase trade. Differences in political regimes of trading partners also have a strong effect on trade. Results indicate that regional integration boosts bilateral trade, but there is evidence of trade diversion in WAMZ and MRU trading blocs. The proposition that geographically proximate partners trade more is supported according to the results, but there is little support for the theory that differences in factor endowments predict patterns of trade in the sample of countries.

In addition to the PQML estimation procedure, this paper also conducted an extensive sensitivity analysis to robustify the results of the baseline gravity model of trade. This sensitivity analysis is carried out by subjecting the model to various estimation techniques. The results of the sensitivity tests suggest that both the regional integration and hidden trade costs effects are robust—the results of the Negative Binomial, Heckman two-step, Tobit and Truncated OLS are not different from the PQML estimates—to the different estimation procedures. My results further suggest that regional trade involving countries that share a common language and land border—Canada and USA, Liberia and Sierra Leone, Germany and Austria—tend to create more trade rather than less trade. This result appears to be consistent with the results obtained by Rose (2004) and Susanto *et al.* (2007), among others.

Before I wrap up, three important caveats of this study are worth mentioning. First, the hidden trade costs considered in this paper are by no means exhaustive. This is so because the large number of trade costs in international trade makes it difficult for a researcher to cover all these costs in a single study. Therefore, it is recommended that future research should also look at trade costs associated with administrative hurdles, contractual frictions, quality of seaports, customs procedures, communications networks and bribes or 'kickbacks'. These costs also carry the same weight—in terms of significance—as the hidden trade costs I have just discussed. Second, this paper did not use the double hurdle model for the analysis of international trade flows. It will be a good idea to employ this model in future research in order to enrich the analysis. Finally, the analysis carried here only focused on trade in goods and neglects trade in services. As an extension to the current work, it is recommended that future research should be structured around models that incorporate trade in services in order to enrich the analysis.

2.8 Tables and Figures

Table 2.4: Baseline Gravity Model Regression Results (Without Zero Trade Flows)

Econometric Procedure:	OLS	Truncated OLS	PQML	Tobit
Regressand:	logX_{ijt}	logX_{ijt}	X_{ijt}	log$(\alpha + X_{ijt})$
	(1)	(2)	(3)	(4)
Log Y_{it}	0.540**	0.139*	0.031*	0.246**
	(0.128)	(0.030)	(0.011)	(0.121)
Log Y_{jt}	0.235*	0488**	0.370**	0.506**
	(0.102)	(0.106)	(0.054)	(0.104)
Log PCY_{it}	2.342***	2.257**	0.568**	2.447***
	(0.125)	(0.140)	(0.066)	(0.134)
Log PCY_{jt}	1.213***	1.099**	1.987**	1.001***
	(0.107)	(0.121)	(0.258)	(0.121)
Log $DIST_{ij}$	-1.157^{**}	-1.219^{***}	-0.663^{**}	-1.282^{**}
	(0.017)	(0.173)	(0.018)	(0.188)
RFD_{ijt}	-0.127^{***}	-0.073^{**}	-0.142^{**}	0.002
	(0.009)	(0.011)	(0.019)	(0.010)
$COMLANG_{ij}$	0.783**	0.855***	0.313**	0.949**
	(0.026)	(0.026)	(0.029)	(0.027)
$COMCUR_{ij}$	-0.175^{**}	0.107***	0.139**	-0.069^{*}
	(0.027)	(0.027)	(0.033)	(0.029)
$COMBORD_{ij}$	0.353**	0.325***	-0.018^{***}	0.337**
	(0.033)	(0.033)	(0.009)	(0.036)
$LANDLOCK_{ij}$	-0.187^{**}	-0.212^{***}	-0.022^{**}	0.126**
	(0.041)	(0.054)	(0.017)	(0.054)
$ECOWAS_{ij}$	1.380**	1.371**	0.307**	2.196**
	(0.085)	(0.093)	(0.169)	(0.018)
$EU28_{ij}$	0.748$**$	0.635**	0.550**	0.685**
	(0.053)	(0.051)	(0.108)	(0.054)
$NAFTA_{ij}$	1.659**	1.261***	-0.306^{**}	1.093**
	(0.098)	(0.109)	(0.031)	(0.124)
$WAEMU_{ij}$	0.174**	0.329***	0.121**	0.213**
	(0.069)	(0.071)	(0.041)	(0.065)
$WAMZ_{ij}$	-1.422^{**}	1.725***	-0.991^{**}	-2.046^{**}
	(0.080)	(0.121)	(0.085)	(0.098)
MRU_{ij}	-1.194^{**}	-1.746^{**}	-0.062	-0.432^{**}
	(0.116)	(0.267)	(0.191)	(0.164)
$INSTQ_{i}$	0.485***	0.503**	0.321***	0.433**
	(0.059)	(0.058)	(0.074)	(0.059)
$INSTQ_{j}$	-0.397^{**}	0.344**	0.198**	0.295**
	(0.055)	(0.057)	(0.073)	(0.058)
$DEMOC_{i}$	-0.101^{**}		0.112***	
	(0.0001)		(0.001)	
$DEMOC_{j}$	0.121**		0.001	
	(0.006)		(0.001)	
$AUTOCRAT_{i}$		-0.005^{*}		-0.033^{**}
		(0.002)		(0.015)
$AUTOCRAT_{j}$		-0.014^{*}		-0.02^{**}
		(0.003)		(0.005)
Exporter Fixed Effects	Yes	Yes	Yes	Yes
Importer Fixed Effects	Yes	Yes	Yes	Yes
R^2	0.89		0.837	0.437
RMSE	1.031			
σ		0.957		-1.118
Left Censored Obs.				5,894
Uncensored Obs.				23,492
Number of Observations	29,386	23,492	29,386	29,386

Notes: Robust Standard errors are in parentheses, exporter and importer fixed effects were included in all the specifications, Pseudo-R^2 is reported for Tobit estimation, *** Significant at 1%, ** Significant at 5%, * Significant at 10%, RMSE is the root mean square error. Notice that the number of observations is smaller than the original sample size of 35,190 because all the zero bilateral trade flows were dropped.

Table 2.5: Baseline Gravity Model Regression Results (With Zero Trade Flows)

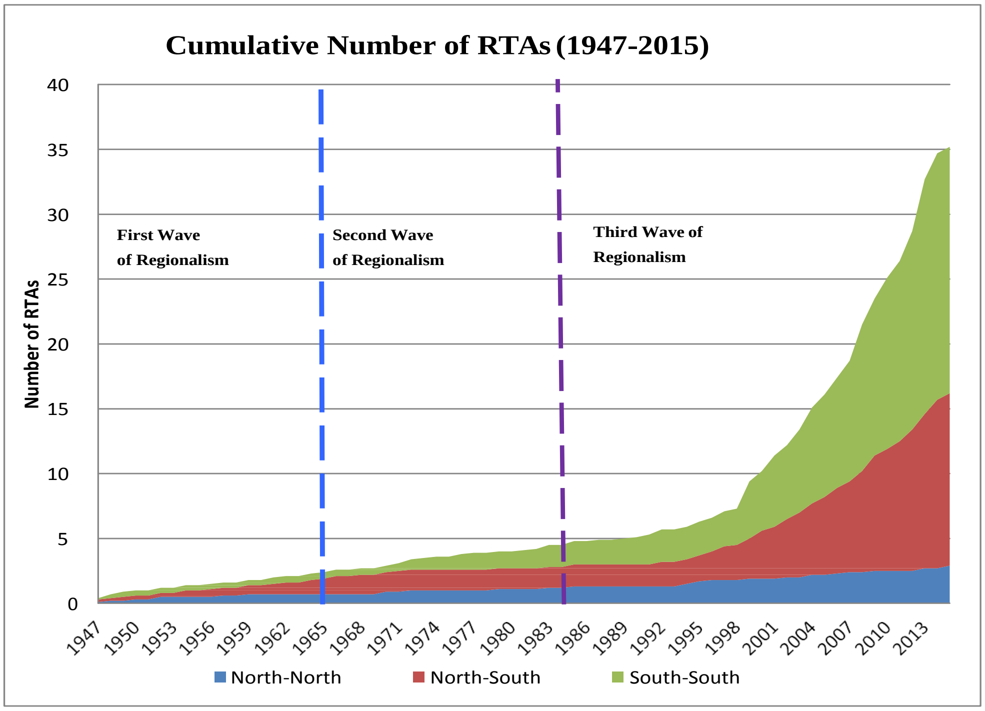
Econometric Procedure:	OLS	Truncated OLS	PQML	Tobit
Regressand:	$\log(1 + X_{ijt})$	$\log(1 + X_{ijt})$	X_{ijt}	$\log(\alpha + X_{ijt})$
	(1)	(2)	(3)	(4)
Log Y_{it}	0.735***	0.221**	0.129*	0.442**
	(0.092)	(0.116)	(0.040)	(0.087)
Log Y_{jt}	0.212*	0.651**	0.355**	0.352**
	(0.079)	(0.097)	(0.226)	(0.079)
Log PCY_{it}	2.180**	2.459**	1.968**	2.156**
	(0.093)	(0.127)	(0.258)	(0.099)
Log PCY_{jt}	1.074*	0.942**	1.502**	1.098***
	(0.039)	(0.112)	(0.237)	(0.094)
Log $DIST_{ij}$	−1.026**	−1.290***	−0.661**	−1.182**
	(0.015)	(0.017)	(0.018)	(0.008)
RFD_{ijt}	−0.144***	0.037**	−0.130**	−0.061
	(0.006)	(0.010)	(0.019)	(0.008)
$COMLANG_{ij}$	0.646**	0.965**	0.315**	0.754**
	(0.023)	(0.025)	(0.028)	(0.022)
$COMCUR_{ij}$	0.243**	0.082**	0.137**	−0.054*
	(0.023)	(0.026)	(0.033)	(0.024)
$COMBORD_{ij}$	0.503***	0.325***	0.485**	0.406**
	(0.031)	(0.033)	(0.024)	(0.031)
$LANDLOCK_{ij}$	−0.138**	0.119*	−0.318**	0.241**
	(0.034)	(0.051)	(0.065)	(0.042)
$ECOWAS_{ij}$	1.109***	2.160**	0.424**	1.549**
	(0.059)	(0.093)	(0.165)	(0.065)
$EU28_{ij}$	0.639**	0.593**	0.553**	0.844**
	(0.044)	(0.049)	(0.110)	(0.044)
$NAFTA_{ij}$	2.203**	0.909*	0.978**	1.917**
	(0.114)	(0.109)	(0.112)	(0.110)
$WAEMU_{ij}$	0.177**	0.316*	0.760**	0.346**
	(0.053)	(0.064)	(0.120)	(0.050)
$WAMZ_{ij}$	−1.312**	2.051*	−0.561**	−1.335**
	(0.061)	(0.103)	(0.144)	(0.064)
MRU_{ij}	−1.103**	−0.399**	−1.365**	−0.949**
	(0.095)	(0.207)	(0.202)	(0.124)
$INSTQ_i$	0.480***	0.436**	0.316***	0.412**
	(0.046)	(0.053)	(0.074)	(0.045)
$INSTQ_j$	0.443**	0.295**	0.193**	0.392**
	(0.045)	(0.052)	(0.073)	(0.045)
$DEMOC_i$	0.002***		0.001***	
	(0.001)		(0.000)	
$DEMOC_j$	0.001***		0.002	
	(0.0005)		(0.001)	
$AUTOCRAT_i$		−0.015**		−0.023***
		(0.002)		(0.012)
$AUTOCRAT_j$		−0.014**		−0.022***
		(0.003)		(0.011)
Exporter Fixed Effects	Yes	Yes	Yes	Yes
Importer Fixed Effects	Yes	Yes	Yes	Yes
R^2	0.895		0.435	0.474
RMSE	0.99			
σ		0.957		-1.017
Left Censored Obs.				5,804
Uncensored Obs.				29,386
Number of Observations	35,190	29,386	35,190	35,190

Notes: Robust Standard errors are in parentheses, exporter and importer fixed effects were included in all the specifications, Pseudo-R^2 is reported for Tobit estimation, *** Significant at 1%, ** Significant at 5%, * Significant at 10%, RMSE is the root mean square error.

Table 2.6: Resolving Zero Trade Flows and Overdispersion of X_{ijt}

Econometric Procedure:	Heckman Two-Step		Negative Binomial
Regressand:	X^L_{ijt} Selection	$\log X_{ijt}$ Outcome	X_{ijt}
Log Y_{it}	0.341^{***} (0.009)	0.256^{***} (0.135)	0.148^{***} (0.100)
Log Y_{jt}	0.430^{**} (0.009)	0.385^{*} (0.130)	0.995^{**} (0.088)
Log PCY_{it}	-0.021^{***} (0.002)	2.258^{***} (0.159)	1.863^{***} (0.119)
Log PCY_{jt}	-0.382^{**} (0.022)	1.089^{**} (0.157)	0.307^{***} (0.110)
Log $DIST_{ij}$	-1.079^{**} (0.038)	-1.332^{**} (0.028)	-1.387^{*} (0.019)
RFD_{ijt}	0.141^{***} (0.009)	0.023^{*} (0.014)	-0.004 (0.01)
$COMLANG_{ij}$	0.334^{**} (0.040)	0.934^{***} (0.039)	0.993^{**} (0.026)
$COMCUR_{ij}$	0.315^{**} (0.066)	0.104^{**} (0.042)	0.095^{**} (0.028)
$COMBORD_{ij}$	0.393^{**} (0.102)	0.380^{***} (0.055)	0.638^{***} (0.035)
$LANDLOCK_{ij}$	-0.605^{***} (0.065)	-0.039^{*} (0.018)	0.182^{**} (0.050)
$ECOWAS_{ij}$	-0.458^{**} (0.069)	1.970^{***} (0.115)	1.756^{***} (0.083)
$EU28_{ij}$	0.425^{**} (0.090)	0.665^{**} (0.077)	1.138^{***} (0.051)
$NAFTA_{ij}$	2.706^{**} (0.025)	1.131^{**} (0.195)	1.032^{**} (0.122)
$WAEMU_{ij}$	0.358^{***} (0.073)	0.403^{*} (0.086)	0.029 (0.063)
$WAMZ_{ij}$	0.457^{**} (0.081)	-1.035^{***} (0.113)	-2.411^{**} (0.090)
MRU_{ij}	-0.937^{***} (0.188)	-0.814^{*} (0.220)	-1.935^{***} (0.175)
$INSTQ_i$	0.494^{***} (0.033)	0.235^{*} (0.076)	0.718^{**} (0.053)
$INSTQ_j$	0.325^{**} (0.335)	0.229^{*} (0.075)	0.460^{**} (0.053)
$DEMOC_i$	-0.005^{***} (0.001)	0.004^{**} (0.001)	
$DEMOC_j$	-0.002^{**} (0.001)	0.001^{***} (0.0.000)	
$AUTOCRAT_i$			-0.004^{**} (0.001)
$AUTOCRAT_j$			-0.001^{***} (0.000)
Exporter Fixed Effects	Yes	Yes	Yes
Importer Fixed Effects	Yes	Yes	Yes
R^2			0.190
Mills Ratio(λ)		1.785^{*}	
α			1.184^{**}
Likelihood-Ratio Test of $\alpha(\chi^2_{(1)})$			980.6
Censored Obs.	5,804	5,804	
Uncensored Obs	29,386	29,386	
Number of Observations	35,190	35,190	35,190

Notes: Robust Standard errors are in parentheses, exporter and importer fixed effects were included in all the specifications, Pseudo-R^2 reported for Negative Binomial, *** Significant at 1%, ** Significant at 5%, * Significant at 10%, RMSE is the root mean square error.



Source: Author's own Depiction from http://rtais.wto.org/UI/PublicAllRTAList.aspx

Figure 2.1: Cumulative Number of RTAs in Force (1947-2015)
Notes: The figure shows the cumulative number of RTAs in force between 1947 and 2015 and the three waves of regionalism.

Chapter 3

Trade Prices and Inflation Response to Exchange Rate Fluctuations

3.1 Introduction

The issue of how trade prices and inflation respond to exchange rate fluctuations—exchange rate pass-through (ERPT)—has galvanised a considerable amount of interest amongst economists and policy analysts in the field of international macroeconomics for the past three decades. Earlier contributions to this debate include the works of Dornbusch (1976, 1987), Krugman (1987), Baldwin (1988) and Fisher (1989), to mention a few. These studies used microfounded models to explain the reason for the low pass-through in industrialized countries. Recent contributions—in which the majority of the studies use the open economy macroeconomic framework—include research conducted by Campa and Goldberg (2005), Taylor (2000), Ito and Sato (2008), Choudhri *et al.* (2005), McCarthy (2007), Betts and Devereux (2000) and many others.

The burgeoning interest on the pass-through process is expected because of the growing concern amongst policy makers and monetary authorities that large swings in the exchange rate could affect trade prices—import prices or export prices—and reverberate via the distribution chain to producer prices and finally to consumer prices or retail prices (McCarthy, 2007).

For instance, a depreciation in the domestic country's exchange rate results in an increase in import prices and a rise in production costs of final and intermediate imported goods. With an increase in price of imported goods, domestic consumers have an incentive to substitute imports for locally produced goods because prices of these domestic goods are lower relative to the foreign goods. This results in a decline in import volume and an increase in exports[1]. Consequently, the increase in export volumes and the decline in import volumes results in an improvement in the trade balance.

Many papers in the exchange rate pass-through literature found higher ERPT to import prices for emerging economies. However, a number of recent empirical studies on exchange rate pass-through have demonstrated a weak sensitivity, or rather low response, of import prices and inflation to exchange rate fluctuations. Gagnon and Ihrig (2004) attributed the low pass-through of exchange rate depreciation in 20 industrialized countries to the aggressive monetary policy pursued by these countries to stabilize inflation. Using quarterly data between 1971 and 2003 to estimate a simple empirical macroeconomic model, they arrived at an average long-run ERPT estimate of 0.23 for their entire sample. They argued that ERPT decreases when a country's central bank decides to aggressively target inflation.

Taylor (2000) used a staggered price setting model of the pricing behavior of firms to explain the declining ERPT in industrialized countries. He arrived at results that tend to corroborate those obtained by Gagnon and Ihrig (2004). In his analysis, Taylor (2000) argued that the low ERPT and declining *pricing power* of firms can be explained by the low inflation environment that prevailed in most industrialized countries. Ito and Sato (2008) and McCarthy (2008) also obtained results akin to Taylor (2000) and Gagnon and Ihrig (2004) for five Asian countries and nine industrialized countries respectively. With regards to ERPT to import prices, Ito and Sato (2008) obtained higher estimates for the five Asian countries in their study. Others like

[1]The fall in import volume occur because imports are denominated in foreign currencies so a depreciation of the exchange rates makes these goods to become more expensive. This expenditure switching effect was well-documented in Burstein *et al.* (2002).

Betts and Devereux (2000), Choudhri *et al.* (2005) attribute the low ERPT to import price rigidity. Import prices are sticky when the exporting firm decides to set prices in the currency of the importing firm. In the short run, this price rigidity prevents the smooth transmission of the effect of exchange rate depreciation to producer, consumer and retail prices implying that the ERPT will be low.

Although numerous researchers have conducted studies on the pass-through process in industrialized countries, less attention has been directed towards investigating this phenomenon for a control group and emerging economies in Latin America and Southeast Asia. I address this issue by studying ERPT to trade prices and inflation in OECD and emerging economies in Latin America and Southeast Asia. In the aftermath of the Asian currency crisis in 1997 and the global financial crisis in 2008, these economies witnessed periods of high exchange rate fluctuations. However, these exchange rate fluctuations were not fully reflected in trade prices and inflation in a large number of these economies, making them the perfect laboratory to study how prices adjust to exchange rate fluctuations. In particular, the study addressed the following research questions. First, how much of the exchange rate fluctuations in OECD, Latin America and Southeast Asia is passed on to trade prices and inflation? Second, which of the two stages of ERPT—'First Stage ERPT' and 'Second Stage ERPT'—has declined in the sample of countries? Finally, is the ERPT higher for emerging economies than for OECD economies? To this end, this study estimates the 'First Stage ERPT' and 'Second Stage ERPT' and examines the dynamic behavior of trade prices and inflation to exchange rate shocks with the aid of quarterly time series data.

This study is important for two main reasons. First, since the nine countries—Canada, Sweden, United Kingdom, Argentina, Colombia, Mexico, The Philippines, South Korea and Thailand—included in this study have adopted inflation targeting as their main monetary policy goal, achieving it requires a clear understanding of the exchange rate pass-through mechanism. This is so because knowing the size or magnitude of exchange rate pass-through to internationally traded goods prices will help the monetary authorities to determine how much interest rate adjustment to make in order to maintain their inflation targets. For instance, a higher exchange rate pass-through to trade prices would mean bigger interest rate adjustment in order to maintain the inflation target set by the central bank. In contrast, a lower exchange rate pass-through would require smaller interest rate adjustment by the central bank. This explanation suggests that an understanding of the exchange rate pass-through mechanism will help policy makers understand the transmission mechanism in the conduct of monetary policy. A thorough knowledge of the transmission mechanism does not only help the central bank to know how variability in exchange rate affects inflation forecasts in the economy, but also assists monetary authorities to make better decision on how to deal with an array of exogenous shocks (Junttila and Korhonen, (2012)).

A second rational for this study relates to the increasing global integration of many economies, especially those in Latin America and Southeast Asia, which make them more susceptible to wide swings in exchange rates. Wide swings in exchange rates have the tendency to create macroeconomic instability such as rising inflation, increased uncertainty in business undertakings and perennial balance of payments problems, among others. These problems in turn help to compromise with the economic decision-making process by individual economic agents and the design and implementation of economic policies by the central authorities. This means that a knowledge of exchange rate pass-through is necessary, if not, quintessential in explaining the persistent economic problems affecting emerging economies.

In order to provide answers to the aforementioned research questions, the analysis in this paper proceeds in two steps. In the first step, I use a graphical approach to document the correlation between exchange rate movement and trade prices. The plots in Figures 3.1 through 3.5 show the correlation between prices—trade prices, producer price and consumer price inflation—and the rate of nominal exchange rate fluctuations for all the countries under investigation. For instance, Figure 3.1 depicts a weak correlation between exchange rate movements and prices for Sweden and the UK. There is a small or no upward movement in import prices and inflation following a depreciation of the Swedish krona and the British pound between 1992 and 2008 [2]. In contrast, the correlation between exchange rate movements and prices appear to be stronger for Southeast Asian and Latin American countries—except for Mexico. Figure 3.3 shows the apparent disconnect between exchange rate movements and trade prices in Mexico. For instance, the 65% devaluation of the Mexican Peso that occurred between 1992 and 1996 resulted in little or no change in trade prices and a modest increase in consumer prices. This apparent disconnect between exchange rate fluctuations has important implications for the conduct of monetary policy because of its stifling effect on one of the main channels of the monetary policy transmission mechanism. Figure 3.4 shows the relationships between exchange rate movement, trade prices and inflation in Thailand and South Korea. The huge devaluation of the Thai Bhat and Korean Won in 1997 resulted in big increases in import prices and slight increases in inflation[3]. In the second step, I utilize a multivariate integrated estimation technique to derive the ERPT coefficients for the two stages of ERPT. This involves estimating a structural vector autoregression (SVAR) model for each of the countries under investigation with the help of quarterly time series data[4].

The multivariate integrated estimation approach used in this paper is more advantageous than the single equation estimation technique because the former resolves the issue of simultaneity often encountered in previous studies on exchange rate pass through. Because of the presence of a two-way causality between exchange rates fluctuation and aggregrate prices, using single equation estimation methods as in Campa and Goldberg (2005), Nakamura and Zerom (2010), Taylor (2000) and recently by Parsley (2012) results in the calculation of biased and

[2] Mishkin (2008) argued that the low pass-through in Sweden and the UK between 1992 and 2008 was due to the rigid anchoring of inflation expectations by the monetary authorities.

[3] This period coincides with the period of the Asian Financial crisis when a large number of *Zombie* banks were allowed to operate in these countries.

[4] The data was obtained from IMF *International Financial Statistics* CD-ROM, and national statistical databases of the respective countries. With the exception of Thailand, Philippines, Mexico, Argentina and Colombia, the period of study spans from 1980q1 through 2012q4 for all the countries in the sample. This period coincides with the periods of the *Asian currency crisis* of 1997 and the *Global Financial Tsunami* of 2008 when major business currencies in the OECD and Southeast Asia depreciated remarkably.

unstable ERPT estimates. This is so because with a two-way causality between exchange rates and aggregate prices, the dependent variable has the potential of being correlated with the error term. Hence, using a single equation estimation method to calculate the ERPT elasticities will lead to simultaneous equation bias or simultaneity[5].

To motivate the SVAR estimation methodology, I formulate an augmented mark-up model in which economic agents are assumed to operate in an imperfectly competitive world. My approach draws from models developed by Dixit and Stiglitz (1977), Yang (2007), Markusen and Venables (2000), and Pollard *et al.* (2004). In developing the model for this paper, I depart from the earlier models by decomposing the ERPT into two stages. In the first stage, I model the effect of exchange rate changes on import prices and in the second stage I explore the effect of import prices on consumer prices.

I capture the dynamic responses of trade prices and inflation to exchange rate shocks by obtaining the impulse response functions (IRFs) for each country in the sample. The resulting IRFs were used to calculate the ERPT elasticities and determine whether the pass-through falls across the pricing chain for Latin America, Southeast Asia and the OECD. To identify the structural shocks of the SVAR, I impose short run or zero contemporaneous restrictions on the parameters of the impact matrix rather than the random orderings of the variables—Choleski decompositon of the variance-covariance matrix—method used by previous researchers. I therefore conjecture that this approach of identifying the parameters of the SVAR signals one important contribution of this paper to the exchange rate pass-through literature, and separates it from the earlier contributions by Taylor (2000), Campa and Goldberg (2005), Choudhri *et al.* (2005), Ito and Sato (2008), Devereux and Yetman (2014) and McCarthy (2007) in the new open macroeconomics analysis of exchange rate pass-through.

This introduction is concluded with a preview of the results. My estimated SVAR-AB model

[5]For details on the issue of simultaneity and single equation estimation see Parsley (2012).

suggests that pass-through to trade prices, producer and consumer prices is incomplete in each of the countries in the three regional economies. However, the First Stage pass-through is much higher and more rapid than the Second Stage pass-through. The results of the impulse responses and pass-through elasticities indicate that pass-through declines along the distribution chain. This finding is consistent with the results obtained in earlier studies by Choudhri *et al.* (2005), McCarthy (2007) and Ito and Sato (2008).

The rest of the paper proceeds as follows. Section 3.2 embodies a review of the related theoretical and empirical literature on ERPT. In Section 3.3, I lay out the theoretical background that serves as a platform for the subsequent empirical analysis. Section 3.4 embodies the empirical strategy, specification of the SVAR-AB model, a description of the data and its sources and some identification issues for the underlying SVAR estimation method. Section 3.5 presents the 'First Stage' and 'Second Stage' ERPT elasticities and outlines a detailed analysis of the empirical results, time series characteristics of the variables for the benchmark or SVAR-AB model and a battery of other econometric test results. In section 3.6, I derive reciprocal VAR roots to determine the SVAR-AB model. Section 3.7 summarizes the paper and recommend areas for further research.

3.2 Review of the Literature

There is a vast amount of literature on the response of trade prices and inflation to changes in the exchange rate. This large amount of studies on exchange rate pass-through encompasses both theoretical and empirical works. The theoretical studies focused primarily on models related to market structure and the pricing behavior of firms in the industry. Dornbusch (1987) used a Cournot setup to analyse the pricing behavior of firms in the face of exchange rate variability. He argued that ERPT depends on the market structure, the degree of competition and product substitutability. For instance, the greater the degree of competition the lower will be the pass through since in a highly competitive market condition, firms are more willing to absorb a fraction of the change in exchange rate in order to preserve their market share. Under these conditions, pricing-to-market will be higher and exchange rate pass-through to traded goods prices lower. The opposite effect will occur if the degree of competition is lower.

Earlier studies on exchange rate pass-through concentrated on the role of market segmentation, industrial organization and the pricing behavior of exporting producers. If markets and products are segmented, there is the potential for exporting firms to charge different prices for their products to different importers in the product market following a change in the exchange rate. This phenomenon of charging different prices for the same product to different importers is what economists like Krugman (1987), Froot and Klemperer (1989) and others refer to as *pricing to market* (PTM)[6] . Apart from Krugman's (1987) seminal contribution to the ERPT literature, other influential economists have made an attempt to advance our understanding on how trade prices and inflation respond to exchange rate fluctuations. Dornbusch (1987), for instance, analyzed the short run effect of exchange rate changes from an industrial organization perspective.

In his theoretical and very influential paper, Dornbusch (1987) argued that pass-through from exchange rate changes to import prices occurs because of product differentiation, market segmentation, the structure of the markets and the strategic interaction of firms in the market. In another seminal paper on the relationship between exchange rate changes and prices, Krugman (1987) advanced cogent reasons for the incomplete exchange rate pass-through and the failure of the 'Law of One Price'(LOP)[7]. According to Krugman (1987) and Dornbusch (1987), the ability of firms to practice '*Pricing to Market*' implies that import prices do not respond completely to variations in the exchange rate. Incomplete exchange rate pass-through

[6]Bailliu and Bouakez (2004) argued that under conditions of PTM, economic agents are prevented from taking advantage of international arbitrage in the goods market because of certain economic and institutional constraints.

[7]It is important to note that, if producers are able to set prices in their own currencies then the LOP or purchasing power parity (PPP) will hold.

can also be attributed to certain exporters practicing *Local Currency Pricing*(LCP) in the face of price stickiness or rigidity[8]. Devereux and Engel (2002), Campa and Goldberg (2005), Froot and Klemperer (1989), Knetter (1993), Devereux and Yetman (2003), Athukorala and Menon (1994) and a host of others have documented this in their studies.

Fisher (1989) also used a theoretical approach to examine the relationship between variability in the exchange rate and trade prices in a partial equilibrium model with identical firms each producing a homogeneous product. Contrary to Dornbusch's (1987) approach, Fisher (1989) developed a single model in which firms behave as Bertrand competitors in an oligopolistic competitive market. In the model firms are price makers and use a Bayesian Nash equilibrium approach when making optimal pricing decisions. In particular, Fisher (1989) built his model on the assumption that firms set their prices in anticipation of changes in exchange rates. In his findings, he argued that trade prices (import prices) respond positively to exchange rate variability and that the degree of exchange rate pass-through depends primarily on market structure and the exchange rate regime. Devereux *et al.* (2003) used a sticky price intertemporal model to analyse the welfare effects of the Euro. They argued that the adoption of a single European currency by European countries helps to increase the expected value of consumption in the US and European countries resulting in an overall improvement in welfare for consumers in the US and Europe.

One other study that drew from models of industrial organization was the seminal contribution of Baldwin (1988) in the ERPT literature. He developed a simple *beachhead* model in which foreign firms enter the market by incurring sunk costs. In the presence of these market entry sunk costs, Baldwin (1988) conjectured that transient large exchange rate changes have *hysteretic* effects on trade prices and quantities than small exchange rate shocks. This means that when there is a temporary big devaluation of the currency, trade prices and consumer

[8] In this case of LCP, exchange rate fluctuations are not passed on to trade prices suggesting that price stability in the system is not optimal. This argument was well documented in a similar study conducted by Devereux and Engel (2002).

prices assumed an upward trend but failed to return to their original level when the currency revalues in the long run[9]. In the Baldwin (1988) model, the market entry sunk costs induced the *hysteretic* effect on price and quantity adjustment. Based on the results of the structural breaks tests, he provided evidence that supports the hypothesis of structural break in ERPT. He attributed the structural break in ERPT to the temporary appreciation of the US dollar in the 80s.

In a partial equilibrium framework akin to Baldwin (1988), Baldwin and Krugman (1989) provided *prima facie* evidence on the effects of large exchange rate shocks on trade flows and the exchange rate itself. In their paper, the finite horizon perfect foresight model developed by Baldwin (1988) was replaced with an indefinite horizon stochastic exchange rate model. They argued that temporary exchange rate fluctuations result in entry and exit decisions that induce a hysteretic effect on trade flows. From their investigation of the feedback from entry and exit decisions to the exchange rate, Baldwin and Krugman (1989) documented that massive capital inflow that result in a temporary appreciation may lead to a persistent decrease in the exchange rate and a restoration of the trade balance. Some other studies have provided evidence for declining exchange rate pass-through in the literature[10]. One of the reasons advanced for declining exchange rate pass-through is the low inflation environment (Campa and Goldberg (2005), Taylor (2000), Nogueria *et al.* (2010)).

In the New Open Economy Macroeconomic (NOEM) models, some researchers like Devereux *et al.* (2003), Obstfeld and Rogoff (1995), Choudhri *et al.* (2005), McCarthy (2007), Ito and Sato (2008), have provided explanation for the incomplete pass-through of the 80s and 90s in industrialized countries, Asia, Europe and the US. My paper is related to works done by McCarthy (2007), Ito and Sato (2008) and Choudhri *et al.* (2005) in the sense that they all used a multivariate approach to estimate ERPT, an approach that appears to be consistent with the methodology of this paper. However, the distinguishing aspect of my paper is that it

[9]This is the *hysteresis* that is normally discussed in various fields in economics

[10]For more on declining pass-through studies see the studies conducted by Marazzi *et al.* (2005), Campa and Goldberg (2005), Choudri and Hakura (2006).

examines the pass-through process in two stages, an approach not found in the previous papers. Other studies that used macroeconomic models to examine the pass-through process include the works of Gagnon and Ihrig (2004), Devereux and Yetman (2014), to mention a few.

Devereux *et al.* (2003) also analyzed the implication for the formation of a single European currency by addressing the issue of how the Euro affects the responsiveness of consumer prices in the Euro area to variability in the exchange rates. Using a theoretical approach and the sticky price intertermporal model, they argued that the introduction of the Euro assist in augmenting the expected value of consumption in the US and and European countries leading to an improvement in welfare for consumers. Choudhri *et al.* (2005) also examine the ERPT phenomenon in the context of economic agents optimizing behavior in an open economy macroeconomic framework. In their study they used a variety of new open macroeconomic models to derive dynamic reponses to exchange rate shocks for different sets of prices. They compare these dynamic responses with those of the evidence based VAR model for a group of non-US G 7 countries to determine which models fit the data very well. In their results, they argue that the best model is the one that incorporates features of sticky prices, local currency pricing (LCP), producer currency pricing (PCP) and distribution costs. In a related study, the dynamic general equilibrium model of nominal rigidities and market imperfections developed by Rogoff (1995) to study exchange rate pass-through was extended by Betts and Devereux (2000) to incorporates *pricing to market* activities practised by firms. In their analysis they argued that the size of the exchange rate pass-through depends, to a large extent, on whether prices are set in the currency of the producer (Producer Currency Pricing) or the local currency of the importing country as in Local Currency Pricing.

Another strand in the ERPT literature emphasized declining pass-through. Marazzi *et al.* (2005), Gust *et al.* (2010), Taylor (2000), Campa and Goldberg (2005) and many others have documented declining ERPT in their studies on industrialized and emerging economies. For instance, Marazzi *et al.* (2005) attributed the decline in ERPT to import prices in the U S to the continuous increase in China's market share in world trade and the pricing behavior of many Chinese firms and other firms from Asian countries in the late 90s. The threat of competition with many Chinese firms prevents exporters of other countries from passing on changes in exchange rates to import prices.

This paper makes four contributions to the empirical exchange rate pass-through literature. First, the study extends the analysis of McCarthy (2007), Ito and Sato (2008) and Choudhri *et al.* (2005) by focusing on both industrialized and emerging economies with the help of a new dataset. Second, unlike previous studies, I decompose the ERPT into two stages *viz* **First Stage ERPT** and **Second Stage ERPT** via the use of a multivariate integrated framework[11]. This approach enables me to provide answers as to whether pass-through decreases along the distribution chain and whether the ERPT is higher for Latin American and Southeast Asian countries than for OECD countries. Third, I use short-run or contemporaneous restrictions to identify the structural shocks of the SVAR-AB model, an identification approach that has been overlooked by previous studies. Finally, since the primary objective of this paper is to investigate how trade prices and consumer prices adjust to exchange rate changes, I direct the analysis to both transactions in imported as well as exported goods. This approach departs from earlier VAR studies conducted by McCarthy (2007) and Ito and Sato (2008).

[11] Decomposing the exchange rate pass-through into these two stages makes sense because the transmission mechanism of changes in the exchange rate generally works in two stages —First Stage pass-through and Second Stage pass-through—rather than in one stage as suggested by many studies in the literature. For instance, studies conducted by Campa and Goldberg (2005), McCarthy (2007), Taylor (2000), Ito and Sato (2008), to mention a few, have all focused on only one of the two stages through which exchange rate fluctuations are transmitted into prices.

3.3 Theory

In this section, I develop a mark-up model of exchange rate pass-through in order to provide evidence on how trade prices and inflation respond to exchange rate shocks or fluctuations. In theory, prices respond to exchange rate fluctuations in two stages. In the first stage, variations in the nominal exchange rate are instantaneously reflected in the prices set by domestic exporters and, in the second stage, the response of producer and consumer prices to changes in exchange rates is not instantaneous, but proceed at a slow pace (Chew *et al.* (2011)). In the literature, with the exception of Chew *et al.* (2011) and Sekine (2006), all the past exchange rate pass-through studies only consider the first-stage pass-through when gauging the effect of exchange rate movements on both trade prices and price inflation (Import prices, export prices and producer prices). In this study, I decompose exchange rate pass-through into two stages—the first stage ERPT and the second stage ERPT—for a set of OECD, Latin American and Southeast Asian countries.

To show how trade prices and inflation adjust to variability in the exchange rate, I consider the Dixit and Stiglitz (1977), Yang (2007) and Markusen and Venables (2000) models of product differentiation. The model presented here is closely related to the models developed by Pollard and Coughlin (2004) and Nogueira *et al.* (2008). However, my approach differs from the one carried out by the previous researchers in two main respects. First, whereas Pollard and Coughlin (2004) considered only the supply side in their explanation of asymmetric price adjustment to exchange rate variability, the model developed in this paper includes both demand and supply side analyses. Second, the model developed here uses inflation persistence to derive the second stage ERPT relationship between inflation and import prices. One of the contributions of this paper to the growing literature on exchange rate pass-through is the integration of the mark-up and inflation persistence models to obtain reduced form equations of the first and second stage ERPT.

3.3.1 First Stage Exchange Rate Pass-Through

The first stage exchange rate pass-through, which is the effect of a change in trade prices to changes in exchange rates, is derived from a first-order profit maximization condition for the foreign exporting firm in a static partial equilibrium setting. From the first-order profit maximization equations, a reduced form equation that expresses import prices as a function of exchange rates, output gap and a set of other control variables was obtained. To carry out the process of obtaining the reduced form import price equation I divide the analysis into demand side and supply side.

Demand Side

On the demand side, I consider an economy that comprises a large number of identical consumers each consuming X_d amount of domestic goods and X_f amount of foreign goods imported by the home country. For simplicity, I assume that there are only two countries (the domestic and foreign country), consumers consume a group of differentiated products and there is no restriction on trade between the countries. As in Markusen and Venables (2000), the preferences of each consumer in the economy can be represented by a utility function that exhibits homogeneity and time separability. The utility function is a variant of the Dixit-Stiglitz (1977), Yang (1997) and Markusen and Venables (2000) models. The model assumes that there are N_d domestic firms and N_f foreign firms producing heterogeneous commodities suggesting that goods produced by domestic and foreign firms compete for the consumer's income on the market. The representative consumer in the domestic country maximizes utility according to

$$\underset{X_i}{\text{Max}} \quad U = (\sum_i N_i X_i^{\gamma})^{\frac{1}{\gamma}} \tag{3.1}$$

$\forall \quad i \in [d, f]$ and $\gamma \in [0, 1]$

subject to the consumer's budget constraint[12] as

$$\sum_i N_i P_i X_i = I_x \tag{3.2}$$

$\forall \quad i \in [d, f]$

where X_i denotes the quantities consumed of both the domestic goods and foreign goods produced by the domestic and foreign producers, P_i represent the prices of domestic and foreign goods and I_x is the total income of the consumer spent on the two goods. $\gamma = \frac{\sigma-1}{\sigma}$ and σ is the elasticity of substitution between varieties (domestic and foreign produced goods). The value of σ is greater than 1 and the lower this value the lower the tendency for consumers to substitute between domestic and foreign goods and the higher the degree of product differentiation (Yang 2007). Similarly, if the value of σ is higher, it would imply that there is a greater incentive for consumers to substitute between domestic produced goods and foreign goods. From the consumer maximization problem, the Lagrangean multiplier function is given by

$$\mathcal{L}(X_i, \lambda) = (\sum_i N_i X_i^{\gamma})^{\frac{1}{\gamma}} + \lambda[I_x - \sum_i N_i P_i X_i] \tag{3.3}$$

where λ is the Lagrange multiplier. Solving for the optimal values of X_d and X_f yields first order conditions as

$$\frac{\partial \mathcal{L}(X_i, \lambda)}{\partial X_i} = \frac{1}{\gamma} \times (\sum_i N_i X_i^{\gamma})^{\frac{1-\gamma}{\gamma}} \times \gamma N_i X_i^{\gamma-1} - N_i P_i \lambda = 0 \tag{3.4}$$

$$\frac{\partial \mathcal{L}(X_i, \lambda)}{\partial \lambda} = I_x - \sum_i N_i P_i X_i = 0 \tag{3.5}$$

[12] In this model I assume that consumers do not get transfers from government and do not own firms so they do not receive profits.

Replacing all the i's in equations (3.4) and (3.5) with subscripts d and f gives the first-order optimality conditions with respect to X_d , X_f and λ as

$$\frac{\partial \mathcal{L}(X_d, X_f, \lambda)}{\partial X_d} = \frac{1}{\gamma} \times (N_d X_d^{\gamma} + N_f X_f^{\gamma})^{\frac{1-\gamma}{\gamma}} \times \gamma N_d X_d^{\gamma - 1} - N_d P_d \lambda = 0 \tag{3.6}$$

$$\frac{\partial \mathcal{L}(X_d, X_f, \lambda)}{\partial X_f} = \frac{1}{\gamma} \times (N_d X_d^{\gamma} + N_f X_f^{\gamma})^{\frac{1-\gamma}{\gamma}} \times \gamma N_f X_f^{\gamma - 1} - N_f P_f \lambda = 0 \tag{3.7}$$

$$\frac{\partial \mathcal{L}(X_d, X_f, \lambda)}{\partial \lambda} = I_x - P_d N_d X_d - P_f N_f X_f = 0 \tag{3.8}$$

Solving for X_d and X_f from equations (3.6) and (3.7) gives

$$X_d = \frac{P_d^{\frac{1}{\gamma-1}}}{P_f^{\frac{1}{\gamma-1}}} X_f \tag{3.9}$$

$$X_f = \frac{P_f^{\frac{1}{\gamma-1}}}{P_d^{\frac{1}{\gamma-1}}} X_d \tag{3.10}$$

Subtituting for equations (3.9) and (3.10) into equation (3.8) and solving for optimal values of X_d and X_f gives the import demand in the domestic and foreign countries as

$$X_d = X_d(I_x, P_d, P_{Index}) = I_x \left(\frac{P_d^{\frac{1}{\gamma-1}}}{P_{Index}} \right) \tag{3.11}$$

$$X_f = X_f(I_x, P_f, P_{Index}) = I_x \left(\frac{P_f^{\frac{1}{\gamma-1}}}{P_{Index}} \right) \tag{3.12}$$

where the composite price index P_{Index} is expressed as $P_{Index} = [N_d P_d^{\frac{\gamma}{\gamma-1}} + N_f P_f^{\frac{\gamma}{\gamma-1}}]^{\frac{\gamma-1}{\gamma}}$. If I normalize P_{Index} at unity, then X_d and X_f are just functions of the consumer's income and their respective prices. Hence X_d and X_f in equations (3.11) and (3.12) can be expressed as $X_d = X_d(P_d, I_x^d)$ and $X_f = X_f(P_f, I_x^f)$. It is therefore easy to see that the overall quantity consumed in both the domestic and foreign countries can be represented as

$$X = X_d + X_f \tag{3.13}$$

Supply Side

Following Yang (1997), I assume that the exporting and importing firms engage in a Bertrand competition in their quest to maximize profits. In this case the choice variable is price and not quantity as in Cournot competition. Based on this assumption, the exporting (foreign) and domestic (importing) firms maximize profits according to

$$\underset{P_d}{\text{Max}} \quad \pi^d = P_d X_d - C_d(X, w) \tag{3.14}$$

$$\underset{P_f}{\text{Max}} \quad \pi^f = P_f X_f - SC_f(X, w) \tag{3.15}$$

where S denotes the nominal exchange rate expressed as the number of units of domestic currency per unit of the foreign currency, $C_d(X, w)$ is the cost incurred by the domestic firm in production and $C_f(X, w)$ is the cost incurred by the exporting or foreign firm in production respectively. The exporting firm in this setup is assumed to engage in a *Local Currency Pricing* strategy when setting the price of the good it wants to export. However, with regards to profit maximization it is assumed that the firm chooses its own currency in order to maximize profit. From equations (3.14) and (3.15), the first order conditions for profit maximization yields

$$\frac{\partial \pi^d}{\partial P_d} = X_d + P_d \frac{\partial X_d}{\partial P_d} - C_d' \frac{\partial X_d}{\partial P_d} = 0 \tag{3.16}$$

$$\frac{\partial \pi^f}{\partial P_f} = X_f + P_f \frac{\partial X_f}{\partial P_f} - SC_f' \frac{\partial X_f}{\partial P_f} = 0 \tag{3.17}$$

Rearranging equations (3.16) and (3.17) gives

$$\frac{\partial X_d}{\partial P_d} \left(\tfrac{\partial P_d}{\partial X_d} \times X_d \times \tfrac{P_d}{P_d} + P_d - C_d' \right) = 0 \tag{3.18}$$

$$\frac{\partial X_f}{\partial P_f}\left(\frac{\partial P_f}{\partial X_f} \times X_f \times \frac{P_f}{P_f} + P_f - SC'_f\right) = 0 \tag{3.19}$$

Notice that the first three terms in the parentheses of equations (3.18) and (3.19) represent the elasticities[13]. Solving for the Bertrand-Nash price-setting equilibrium gives

$$P_d\left(1 - \frac{1}{\eta_d}\right) = C'_d \tag{3.20}$$

$$P_f\left(1 - \frac{1}{\eta_f}\right) = SC'_f \tag{3.21}$$

Suppose the composite demand, X_c, is represented as $X_c = N_d X_d + N_f X_f$, the solution to the first order conditions can also be expressed in terms of the market shares as

$$P_d\left(1 - \frac{X_d}{\eta_d X_c}\right) = C'_d \tag{3.22}$$

$$P_f\left(1 - \frac{X_f}{\eta_f X_c}\right) = SC'_f \tag{3.23}$$

where X_c is the composite demand of the domestic and foreign goods and all the other variables carry the usual meaning. As in Menon (1996), suppose ψ_d=$\frac{X_d}{X_c}$ and ψ_f=$\frac{X_f}{X_c}$ represent the firm's market share in the domestic and foreign markets, then equations (3.22) and (3.23) can be expressed as

$$P_d\left(1 - \frac{\psi_d}{\eta_d}\right) = C'_d \tag{3.24}$$

$$P_f\left(1 - \frac{\psi_f}{\eta_f}\right) = sC'_f \tag{3.25}$$

Equations (3.24) and (3.25) are the usual *Lerner* pricing equations with the terms in parentheses representing the mark-ups of the importing and exporting firms respectively. The marginal costs are denoted by C'_d for the domestic firm and C'_f for the foreign firm. From the above expressions it can be established implicitly in the following proposition as:

[13]The elasticities η_d and η_f can be expressed as $\eta_d = \frac{\partial X_d}{\partial P_d} \times \frac{P_d}{X_d}$ and $\eta_f = \frac{\partial X_f}{\partial P_f} \times \frac{P_f}{X_f}$. This implies that $\frac{1}{\eta_d} = \frac{\partial P_d}{\partial X_d} \times \frac{X_d}{P_d}$ and $\frac{1}{\eta_f} = \frac{\partial P_f}{\partial X_f} \times \frac{X_f}{P_f}$

Proposition 1. *The exporting and importing firm's mark-up increases with an increase in market share.*

Proof: Let the firm's mark-up in the domestic and foreign markets be represented as μ_d and μ_f. From equations (3.24) and (3.25) it is easy to notice that $\mu_d = \frac{1}{1-\frac{\psi_d}{\eta_d}}$ and $\mu_f = \frac{1}{1-\frac{\psi_f}{\eta_f}}$. Now, taking derivatives of μ_d and μ_f with respect to ψ_d and ψ_f gives

$\frac{\partial \mu_d}{\partial \psi_d} = \frac{\eta_d}{\left(\eta_d - \psi_d\right)^2} > 0$ and $\frac{\partial \mu_f}{\partial \psi_f} = \frac{\eta_f}{\left(\eta_f - \psi_f\right)^2} > 0$ ■

Proposition 1 predicts that because exporters' profit margins are high when their market shares are high, they are able to absorb all the exchange rate changes in their mark-ups and producer prices meaning that exchange rate pass-through is low and incomplete. Now suppose marginal cost is not constant as was assumed by Dixit and Stiglitz (1977) and Pollard and Coughlin (2004), then equations (3.24) and (3.25) becomes

$$\frac{P_d}{\mu_d} = C'_d \tag{3.26}$$

$$\frac{P_f}{\mu_f} = SC'_f \tag{3.27}$$

where μ_d and μ_f, the reciprocal of the terms in parentheses, denote the mark-ups. It follows from equations (3.26) and (3.27) that the optimal prices in the domestic and foreign (export) markets yield

$$P_d = \mu_d C'_d \tag{3.28}$$

$$P_f = S\mu_f C'_f \tag{3.29}$$

In estimating exchange rate pass through, it is reasonable to assume that the *law of one* *price* (LOP) holds and firms can costlessly engage in *pricing to market* activities. This LOP can only be valid if the market for goods and services is free from transportation costs and other trade impediments like border costs and tariffs. Now, suppose these conditions are satisfied then the domestic price of imported goods in any country, say country i, must be the same as its foreign currency export price converted to the local currency of the importing country. This implies that the import price of the good in the importing country is the product of the exporting country's export prices and the exchange rate of the importing country[14]. Denoting country's i import prices as P_{it}^{M} and the export price of exporting country, i, as P_{it}^{E}, the pricing equation can be represented as

$$P_{it}^{M} = S_{it} P_{it}^{E} \tag{3.30}$$

where S_{it} is the exchange rate in local currency per unit of the foreign currency, P_{it}^{M} is the import price and P_{it}^{E} is the export price of the exporting country. From equation (3.28) it is easy to see that the price of goods in the domestic market is the firm's markup over its marginal cost. By symmetry, the export price of country's i is given by

$$P_{it}^{E} = \mu_{it}^{E} C_{it}^{\prime E} \tag{3.31}$$

where μ_{it}^{E} and $C_{it}^{\prime E}$ represent the mark-up and marginal cost of the exporting firm. Substituting for P_{it}^{E} into equation (3.30) gives the import price equation as

$$P_{it}^{M} = S_{it} \mu_{it}^{E} C_{it}^{\prime E} \tag{3.32}$$

Interestingly, P_{it}^{M} is similar to the optimal value of P_f in the static partial equilibrium optimization problem of the firm. Expressing equation (3.32) as its logarithmic transformation gives

[14]See Campa and Goldberg (2005) for more on the relationship between import and export prices.

$$p_{it}^{m} = s_{it} + \mu_{it}^{E} + c_{it}'^{E} \tag{3.33}$$

From equation (3.33), it is easy to see that import prices or the local currency price of a commodity (p_{it}^{m}) depends, to a large extent, on the changes or movement in the importing country's exchange rate, the changes in the firm's marginal cost and changes in its mark-up. To build on Campa and Goldberg (2005) and Aron *et al.* (2014), I model the mark-up of the exporting firm as a function of the real exchange rate, the demand conditions in the importing country and the real interest rates of the exporting country. Campa and Goldberg (2005), Mann (1986) and, most recently, Aron *et al.* (2014) omitted some of these macroeconomic variables in their mark-up equation. The demand conditions as proxied by the output gap of the importing country was incorporated into the mark-up function to account for changing demand conditions in the importing country. In theory, adverse demand conditions in the importing country lowers the mark-up of the exporting firm. The mark-up of the exporting firm in equation (3.33) can be expressed as

$$\mu_{it}^{E} = \varpi + \varphi(s_{it} - w^{E} + w^{M}) + \Phi(r_{it}^{E} - w^{E}) + \theta y_{it}^{M} \tag{3.34}$$

where the second term in parentheses is the real exchange rate defined—according to Aron *et al* (2014)—as the nominal exchange rate adjusted for prices of unit labor costs of the exporting and importing countries, the third term is the real interest rate defined as the nominal interest rate adjusted for prices of unit labor cost of the exporting country and y_{it}^{M} denotes output gap in the importing country to capture the effect of variation in demand conditions in the importing country. The nominal interest rate is r_{it}^{E}, $\varphi \in [0,1]$ and w^{E} and w^{M} are the prices of unit labor costs in the exporting and importing countries respectively. Since $\varphi \in [0,1]$, the following is true

$$\varphi = \begin{cases} 0 & \text{implies PCP occurs} \\ 1 & \text{implies LCP occurs} \end{cases}$$

From the above, it is easy to see that when the exporting firm set prices in its own currency—Producer Currency Pricing (PCP)—the value of φ is equal to 0 and so the second term of equation (3.34) collapses. Under this condition pass-through is complete implying that the exporting firms do not absorb exchange rate fluctuations in their own mark-up[15], but pass on the full amount of those fluctuations to the consuming country in the form of higher import prices—prices change one-for-one with exchange rate fluctuations and so the law of one price holds in this regard. In contrast, when prices are set in the importing country's own currency—Local Currency Pricing (LCP)—the value of φ is equal to 1 and so mark-up varies with the exchange rates one-for-one. In this case, pass-through is zero or incomplete because the exporting firms absorb all the exchange rate changes in their mark-up.

Following Campa and Goldberg (2005), the marginal cost of the exporting firm's function is modeled as increasing in the price of unit labor cost in the exporting country, w^E, increasing in commodity prices in the exporting country, $PCOM^E$ and increasing in the importing country's demand conditions. The exporting firm's marginal costs is therefore expressed as

$$c'^{E}_{it} = \alpha_1 w^E + \alpha_2 PCOM^E + \alpha_3 y^M_{it} \tag{3.35}$$

Substituting for equations (3.34) and (3.35) in equation (3.33) and solving gives the *First Stage ERPT* equation as

$$p^m_{it} = \varpi + (1+\varphi)s_{it} + \alpha_2 PCOM^E + (\theta+\alpha_3)y^M_{it} + (\alpha_1 - \varphi - \Phi)w^E + \varphi w^M + \Phi r^E_{it} \tag{3.36}$$

Equation (3.36) can be transformed into a long run regression equation as

$$p^m_{it} = \psi_0 + \psi_1 s_{it} + \psi_2 PCOM^E + \psi_3 y^M_{it} + \psi_4 w^E + \psi_5 w^M + \psi_6 r^E_{it} + \epsilon_{it} \tag{3.37}$$

where $\psi_0 = \varpi$, $\psi_1 = 1+\varphi$, $\psi_2 = \alpha_2$, $\psi_3 = \theta + \alpha_3$, $\psi_4 = \alpha_1 - \varphi - \Phi$, $\psi_5 = \varphi$, $\psi_6 = \Phi$ and $\epsilon_{it} \sim N[0, \sigma^2]$. The costs incurred by the exporting firms include, *inter alia*, input costs such as unit labor costs w^E and commodity prices, $PCOM^E$ and other costs like cost of borrowing r^E_{it}.

[15]In this case, the exporting firm's mark-up does not vary with the exchange rate.

In the importing country's market or destination market, demand conditions, y_{it}^{M}, and costs associated with moving the goods from the 'dock' to the domestic market like w^{M} were also included in the import price equation (3.37).

3.3.2 Second Stage Exchange Rate Pass-Through

In this subsection, I present a simple theoretical model that shows how import prices affect inflation. The rationale for doing this is to determine how the initial change in exchange rates feeds into import prices and eventually causes domestic prices to increase in a second round effect which I referred to as the 'Second Stage ERPT' in this paper. In theory, when the official currency of a country devalues the cost of all imported goods are expected to increase when they arrive in the country—this is the first stage of the exchange rate transmission process. If the imported goods are consumed in the importing country then it is expected that the rise in trade prices arising from the currency devaluation will be reflected in domestic consumer prices in the second stage. Unlike the 'First Stage ERPT' which is higher and faster, the 'Second Stage ERPT' is smaller and slower because of currency hedging and the fact that domestic consumer prices of imported goods include a considerable component of nontradables like transportation costs, profit margins of retail distributors, labor inputs and other nontradable items (Campa and Goldberg (2005), Gagnon and Ihrig (2004), Nakamura and Zerom (2010)) .

To model the relationship of the variables in the second stage of the exchange rate transmission process, I begin by assuming that the general consumer price index can be expressed as the geometric average of tradable and nontradable goods prices according to

$$P_{CPI} = P_N^{\theta} P_T^{1-\theta} \tag{3.38}$$

where P_{CPI} is the domestic consumer price index (CPI), N and T denote the nontradable and tradable components of the general CPI, $\theta \in [0,\, 1]$ is the share of tradable component in the consumer price basket, $1-\theta$ is the share of nontradable goods in the CPI, P_N and P_T are the nontradable and tradable price indices respectively. Loglinearizing equation (3.38) and solving gives

$$p = \theta p_N + (1-\theta)p_T \tag{3.39}$$

where p, p_N and p_T are the respective prices in logarithmic form and θ carries the usually meaning. Suppose the price of tradables is defined as

$$p_{(T)it} = \rho p_{(T)it-1} + \gamma \hat{p}^m_{it-1} + \psi y_{it} \tag{3.40}$$

where $\hat{p}^m_{it-1}$ is the predicted level of import prices, $p_{(T)it-1}$ is the lagged inflation and y_{it} is the output gap. According to McAdam and Willman (2004), inflation is known to exhibit no strutural inertia suggesting that price rigidity can be explained by aggregate demand conditions. Suppose there is a one period lag for both the tradable and nontradable components of prices to accomodate this inflation persistence, then our price equations can be define as

$$p_{(N)it} = \rho p_{(N)it-1} + \Phi y_{it} \tag{3.41}$$

$$p_{(T)it} = \rho p_{(T)it-1} + \gamma \hat{p}^m_{it-1} + \psi y_{it} \tag{3.42}$$

where y_{it} is the output gap (a measure of the aggregate demand conditions), $p_{(N)it-1}$ denotes one period lag inflation in the nontradable goods sectors of the economy, ρ is an adjustment parameter to accomodate price inertia and Φ is a parameter associated with aggregate demand conditions. Substituting for equations (3.41) and (3.42) into equation (3.39) gives the *Second Stage ERPT* equation as

$$p_{it} = \rho p_{it-1} + \gamma(1-\theta)\hat{p}^m_{it-1} + [\theta\Phi + \psi(1-\theta)]y_{it} + \varepsilon_{it} \tag{3.43}$$

Finally, from equation (3.43) it is easy to see that exchange rate fluctuations affect domestic prices through import prices ($\hat{p}^m_{it-1}$). This could be directly if consumers buy finished products imported from abroad or indirectly when the changes in cost of imported inputs affect prices of locally manufactured goods.

3.4 Econometric Framework and Methodology

In the previous section the transmission mechanism of exchange rate fluctuations was presented in two different stages of the distribution chain—First Stage and Second Stage ERPT. My main task in this section is to provide a vivid description of the econometric approach used to examine the pass-through process for nine countries in OECD, Latin America and Southeast Asia. This econometric method involves estimating an SVAR-AB model in the spirit of Amisano and Carlo (1997), Blanchard (1989), Bernanke (1986) and L$\ddot{u}$tkepohl (2005). This approach is superior to the ordinary VAR method in the sense that it uses economic theory to isolate the contemporaneous correlations among the variables by imposing the necessary restrictions on the underlying parameters of the reduced form equation for identification of the system. Therefore the SVAR-AB model—which is a system of nine equations with nine endogenous variables and nine structural disturbances—is regarded as appropriate for modeling the dynamic response of trade prices and inflation to exchange rate fluctuations. Another advantage of this multivariate approach is that it handles the issue of simultaneity often encountered when a single-equation estimation method is used.

Before estimating the model, an attempt was made to determine the univariate time series characteristics of the data to ensure that our results are not spurious. Spurious regression results occur when the time series data used in the regression are nonstationary. In the presence of spuriousness, OLS (Ordinary Least Squares) estimates appear to show a relationship among the variables when in actual fact none exist. The Durbin-Watson statistic converges in probability to zero and the calculated t-ratios, R^2 and F-statistic diverge in distribution as the sample size increases[16]. L$\ddot{u}$tkepohl (2005) underscored the importance of examining the trending properties of macroeconomic variables for the purpose of macroeconometric modelling and economic fore-

[16]A discussion of the time series properties of the macroeconomic variables is fully dealt with in the preliminary diagnosis of the data in section 3.5.1

casting. He argued that ignoring the stochastic trends of variables results in seriously misleading inference in the modelling of economic relationships among the variables in time series analysis. Following the trending properties of the variables, the impulse response functions were derived via contemporaneous restrictions on the parameters of the impact matrix.

3.4.1 Structural VAR-AB Model

In this subsection, I specify the empirical model used in the paper to investigate the pass-through process in the nine OECD, Latin American and Southeast Asian economies. This empirical specification, which is purely guided by the theoretical framework presented in Section 3.3, aims at formulating an SVAR-AB model in both its structural and reduced form. The model comprises nine variables *viz* commodity prices PCOM[17], a measure of aggregate demand conditions in the importing country (output gap), y_t, nominal exchange rate, s_t, a set of prices in the distribution chain—export prices (p_t^E), import prices (p_t^M), producer prices (p_t^{PPI}) and consumer prices (p_t^{CPI})—and a set of policy variables that capture the effect of monetary policy in the countries under investigation. The incorporation of the monetary policy variables—nominal interest rate (r_t) and money supply (m_t)—is plausible considering the fact that all the countries under investigation, especially the three Latin American countries and those in Southeast Asia, have adopted aggressive monetary policy to target inflation arising from wide swings in the exchange rate and other exogenous shocks. Following Choudhri *et al.* (2005), all nonstationary variables were first tranformed to stationary variables by first-differencing prior to the estimation of the model. In the model set-up, the non-policy variables are the set of prices, output gap and commodity prices. Therefore the model is specified as

$$\mathbf{A}Z_t = \alpha_0 + \mathbf{A}_1^* Z_{t-1} + \mathbf{A}_2^* Z_{t-2} + \mathbf{A}_3^* Z_{t-3} + ... + \mathbf{A}_p^* Z_{t-p} + \mathbf{B}\varepsilon_t \tag{3.44}$$

[17] In this paper, crude oil prices is used as a proxy for commodity prices (PCOM).

Alternatively, equation (3.44) can be represented in matrix form as

$$\mathbf{A}Z_t = \alpha_0 + \mathbf{A}^*(L)LZ_t + \mathbf{B}\varepsilon_t \tag{3.45}$$

where α_0 is an M×1 matrix of fixed coefficients $\mathbf{A}$ is an M × M matrix of contemporaneous correlations among the endogenous variables of the system, Z_t is a vector of endogenous variables, $\mathbf{A}^*(L) = \mathbf{A}_0^* + \mathbf{A}_1^*L + \mathbf{A}_2^*L^2 + ... + \mathbf{A}_p^*L^p$ is a polynomial matrix of order M in the lag operator L, $\mathbf{B}$ is an M × M matrix of contemporaneous correlations among the structural disturbances of the model, α_0 is a vector of constants, LZ_t is an M×1 matrix of lagged Z_t values and ε_t is a vector of innovations to the structural disturbances. As Blanchard (1989) pointed out, the matrix $\mathbf{B}$ associated with the vector of innovations allows for the direct effect of these shocks on a multitude of endogenous variables in the system. Expressing equation (3.45) in matrix form gives the structural form of the simple SVAR-AB model as

$$\mathbf{A}\begin{bmatrix}\Delta pcom_t\\ y_t\\ \Delta s_t\\ \Delta p_t^E\\ \Delta p_t^M\\ \Delta p_t^{PPI}\\ \Delta p_t^{CPI}\\ \Delta r_t\\ \Delta m_t\end{bmatrix} = \begin{bmatrix}\alpha_{11}\\ \alpha_{21}\\ \vdots\\ \alpha_{41}\\ \vdots\\ \vdots\\ \vdots\\ \vdots\\ \alpha_{91}\end{bmatrix} + \mathbf{A}^*(L)\begin{bmatrix}\Delta Lpcom_t\\ Ly_t\\ \Delta Ls_t\\ \Delta Lp_t^E\\ \Delta Lp_t^M\\ \Delta Lp_t^{PPI}\\ \Delta Lp_t^{CPI}\\ \Delta Lr_t\\ \Delta Lm_t\end{bmatrix} + \mathbf{B}\begin{bmatrix}\varepsilon_t^{pcom}\\ \varepsilon_t^{y_t}\\ \varepsilon_t^{s_t}\\ \varepsilon_t^{p^E}\\ \varepsilon_t^{p^M}\\ \varepsilon_t^{p^{PPI}}\\ \varepsilon_t^{p^{CPI}}\\ \varepsilon_t^{r_t}\\ \varepsilon_t^{m_t}\end{bmatrix} \tag{3.46}$$

where $\mathbf{A}$ is an invertible M× M matrix of contemporaneous correlations among the endogenous variables, Z_t is a vector of endogenous variables in the SVAR-AB system, $\mathbf{B}$ is an invertible M × M matrix and $\varepsilon_t \sim N[0, I_M]$ is an M × 1 matrix of innovations to the structural disturbances.

Since the matrices $\mathbf{A}$ and $\mathbf{B}$ are invertible, the Wold vector moving average (VMA) representation of equation (3.45) that expresses endogenous variables as a function of the structural disturbances in the system is given by

$$Z_t = \mathbf{C}(L)\varepsilon_t = \sum_{j=0}^{T} C_j \varepsilon_{t-j} \tag{3.47}$$

where $\mathbf{C}(L) = \mathbf{A}^{-1}\mathbf{B}$, $E[\varepsilon_t \varepsilon_t'] = I_M$ and $\mathbf{B}$ is a diagonal matrix of order M. It is important to note at this point that impulse response of trade prices and consumer price adjustment cannot be obtained by estimating equation (3.45) but the reduced form equation. Therefore, I obtain the reduced form SVAR by simply inverting $\mathbf{A}^{-1}$ and premultiplying equation (3.45) throughout by the result. Eliminating the constant or fixed coefficients, the reduced form representation of the structural VAR-AB model in equation (3.45) is expressed as

$$Z_t = \mathbf{A}^{-1}\mathbf{A}^{*}(L)LZ_t + u_t \tag{3.48}$$

where the reduced form disturbance is $u_t = \mathbf{A}^{-1}\mathbf{B}\varepsilon_t$ and the Wold VMA representation of equation (3.48) is given by

$$Z_t = \mathbf{P}(L)u_t = \sum_{j=0}^{T} \mathbf{P}_j u_{t-j} \tag{3.49}$$

We can also represent the reduced form innovations of the SVAR as a function of the innovations from the structural equation according to

$$\mathbf{A}u_t = \mathbf{B}\varepsilon_t \tag{3.50}$$

This is the so-called SVAR-AB model first formulated by Blanchard (1989) and later by Amisano and Giannini (1997) and Lütkepohl (2005). The estimation of the SVAR is based on the identification of the AB model in equation (3.50) and so to ensure that this is achieved I impose identifying restrictions on the invertible $\mathbf{A}$ and $\mathbf{B}$ matrices[18].

[18]Unlike the other SVAR models, more identifying restrictions are usually imposed on the parameters of the $\mathbf{A}$ and $\mathbf{B}$ matrices in the SVAR-AB model.

Since the order of the matrices **A** and **B** is M, the number of elements in each of them is M^2. Therefore to make the system identifiable, at least $\frac{M(3M-1)}{2}$ additional restrictions are needed to uniquely identify all the $2M^2$ elements of **A** and **B** and characterize the shocks in the model[19]. In all the standard SVAR analysis, the reduced form residuals can be obtained from the SVAR-AB model according to

$$u_t = \mathbf{A}^{-1}\mathbf{B}\varepsilon_t \tag{3.51}$$

It is also important to note that the reduced form innovations are mutually uncorrelated with a variance of

$$\text{Var}(u_t) = E(u_t u_t') = \mathbf{A}^{-1}\mathbf{B}E(\varepsilon_t\varepsilon_t')\mathbf{B}'\mathbf{A}^{-1\prime} = \mathbf{A}^{-1}\mathbf{B}I_M\mathbf{B}'\mathbf{A}^{-1\prime} = \Omega_u \tag{3.52}$$

where I_M is an $M \times M$ identity matrix of the variance covariance of the innovations to the structural disturbances, Ω_u is the variance-covariance matrix of the homoscedastic reduced form disturbances and $E(\varepsilon_t\varepsilon_s') = 0 \quad \forall t \neq s$. Equation(3.51) represents the contemporaneous correlations among the reduced form and structural parameters of the model[20].

3.4.2 SVAR Estimation and Identification Issues

In other to investigate how trade prices and inflation adjust to exchange rate movements for the set of OECD, Latin American and Southeast Asian economies, the SVAR model was used[21]. The SVAR is a multivariate regression approach and is regarded as the workhorse in empirical macroeconomic research. However, its application is fraught with some problems (Killian,

[19]See Lütkepohl (2005) for a comprehensive discussion on this and other types of SVAR models.

[20]In the SVAR-AB model the contemporaneous correlation among the endogenous policy and non-policy variables is modeled explicitly through the **A** matrix while the effects of the orthonomal shocks on the equations of the system is modeled through the **B** matrix (Lütkepohl (2005)).

[21]One major advantage of the structural vector autoregression analysis over single estimation methods is that SVAR estimation provides ERPT estimates of trade prices and consumer prices along the distribution chain and help to facilitate the identification of structural shocks via a Choleski decomposition of contemporaneous innovations (Ito and Sato, (2008)).

2011). One of the problems inherent in this estimation technique is identification, which arises because of drawing inferences from the reduced-form equations to the corresponding structural parameters of the model (Rubio-Ramirez *et al.* (2010)). The identification issue is resolved by contemporaneous restrictions on the parameters of the **A** and **B** matrices or orthogonalizing the errors of the reduced-form equations with the help of the Choleski decomposition of the variance-covariance matrix [22]. Estimation of the structural parameters of the SVAR-AB model is not possible because the parameters are not identified. In order to estimate the model or identify the structural shocks, certain restrictions are usually imposed on the parameters of the impact matrix on the basis of economic theory. Econometricians have usually employed three principal strategies for dealing with identification issues in SVAR models. The first strategy involves imposing zero contemporaneous restrictions on the parameters of the **A** and **B** matrices of equation (3.50) or modelling contemporaneous relationships among endogenous variables of the SVAR[23]. My paper adopted this approach to resolve the identification issues inherent in the SVAR-AB model. Contemporaneous restrictions, or rather short run restrictions, on the parameters results in either an exact or over identification of the structural shocks. Exact identification of the structural shocks is achieved if the number of zero contemporaneous restrictions on the off-diagonal elements of the **A** matrix is $\frac{M(M-1)}{2}$ because the estimated form of Ω_u has approximately $\frac{M(M+1)}{2}$ elements. On the other hand, an over identification of the structural shocks is achieved if the number of zero contemporaneous restrictions on the off-diagonal elements of the **A** matrix is greater than $\frac{M(M-1)}{2}$. With nine endogenous variables in the VAR, the variance-covariance matrix, Ω_u, has only 45 distinct elements and so identification of the structural SVAR-AB model requires at least 36 restrictions. It follows that the total number of restrictions on the **A** and **B** matrices for exact identification is $\frac{M(3M-1)}{2}$ or 117 for an SVAR

[22]In the words of Killian (2011), orthogonalizing the reduced-form errors simply means making the errors of the reduced-form equations in the SVAR model uncorrelated. Kim and Roubini (2000) noted that the standard assumption usually made in the Choleski approach of recovering the structural parameters from the estimated reduced form equation is the so called Wold causal chain or recursive ordering. This recursive ordering prevents contemporaneous interaction among the variables in the system and so renders the SVAR estimates by the Choleski approach biased or invalid.

[23]This approach has been used in most empirical macroeconomic studies conducted by Sims (1980), Blanchard (1989), Kim and Roubini (2000), Kozluk and Mehrotra (2009), among others in the literature.

with nine endogenous variables[24].

The second approach of resolving the identification issue is to impose long run restrictions on the parameters corresponding to the structural shocks in the system as in the case of Blanchard and Quah (1989). With regards to the long run restriction approach, the cumulative effect of the macroeconomic shock is usually restricted to have a certain value, say 0 or -1. The third and final strategy to resolving identification issues is to impose restrictions on the signs of the variables that respond to the structural shocks. Some of the recent contributions to the sign restrictions include Peersman (2005), Peersman and Straub (2009) and Rubio-Ramirez *et al.* (2010), to name but a few.

In this paper I proposed one identification scheme for each of the three regional economies in the sample based on economic theory, current monetary policy, exchange rate regimes and the prevailing characteristics of the respective economies. Hence, the identification schemes for the OECD countries (Canada, Sweden and the UK), Latin American countries (Argentina, Colombia and Mexico) and Southeast Asian economies (The Philippines, South Korea and Thailand) are shown in equations (3.53), (3.54) and (3.55) respectively. The restrictions imposed on the parameters of the impact matrix of these identification schemes follow the traditional SVAR-AB restrictions proposed by Kovluz and Mehrotra (2009) and Kim and Roubini (2000). However, some modifications were made to their own schemes by incorporating trade prices (export prices, import prices and producer prices) and nonfuel commodity prices in the final part of the paper.

[24] To explain further, suppose the number of contemporaneous restrictions imposed on the **A** matrix is represented as γ_A and the number of restrictions on the **B** matrix is given by γ_B, then the necessary condition to achieve identifiability of the structural shocks requires that the sum of γ_A and γ_B must be as great as M(3M-1)/2. Therefore for a just or exact identified system, the condition is that $\gamma_A + \gamma_B = \frac{M(3M-1)}{2}$ and for an over-identified system, the following condition $\gamma_A + \gamma_B > \frac{M(3M-1).}{2}$ holds.

Identification Scheme for OECD Countries

To identify the structural shocks, I used short run non-recursive restrictions. In order to allow the data to reveal the actual relationship among the variables in the VAR system, I impose the least set of restrictions on the underlying coefficients of the variables in the impact matrix. In this regard, the model in accordance with the identification scheme for the three OECD countries is shown in equation (3.53).

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 & a_{27} & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{34} & a_{35} & a_{36} & a_{37} & a_{38} & a_{39} \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 & 0 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 & 0 & 0 & 0 \\ a_{61} & a_{62} & a_{63} & 0 & a_{65} & 1 & 0 & 0 & 0 \\ a_{71} & a_{72} & 0 & 0 & a_{75} & a_{76} & 1 & 0 & 0 \\ a_{81} & a_{82} & a_{83} & 0 & a_{85} & a_{86} & a_{87} & 1 & 0 \\ a_{91} & a_{92} & 0 & 0 & 0 & 0 & a_{97} & a_{98} & 1 \end{pmatrix} \begin{pmatrix} u_t^{pcom} \\ u_t^{y_t} \\ u_t^{s_t} \\ u_t^{p^E} \\ u_t^{p^M} \\ u_t^{p^{PPI}} \\ u_t^{p^{CPI}} \\ u_t^{r_t} \\ u_t^{m_t} \end{pmatrix} = \begin{pmatrix} b_{11} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{55} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & b_{66} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & b_{77} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & b_{88} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & b_{99} \end{pmatrix} \begin{pmatrix} \varepsilon_t^{pcom} \\ \varepsilon_t^{y_t} \\ \varepsilon_t^{s_t} \\ \varepsilon_t^{p^E} \\ \varepsilon_t^{p^M} \\ \varepsilon_t^{p^{PPI}} \\ \varepsilon_t^{p^{CPI}} \\ \varepsilon_t^{r_t} \\ \varepsilon_t^{m_t} \end{pmatrix} \tag{3.53}$$

From equation (3.53), the vector of the reduced form innovations is represented as $u_t = \begin{pmatrix} u_t^{pcom} & u_t^{y_t} & u_t^{s_t} & u_t^{p^E} & u_t^{p^M} & u_t^{p^{PPI}} & u_t^{p^{CPI}} & u_t^{r_t} & u_t^{m_t} \end{pmatrix}'$ and the structural disturbances include commodity price (oil price) shocks (ε_t^{pcom}), aggregate demand shocks ($\varepsilon_t^{y_t}$), exchange rate shocks ($\varepsilon_t^{s_t}$), export price shocks ($\varepsilon_t^{p^E}$), import price shocks ($\varepsilon_t^{p^M}$), producer price shocks ($\varepsilon_t^{p^{PPI}}$), consumer price shocks ($\varepsilon_t^{p^{CPI}}$), monetary policy shocks ($\varepsilon_t^{r_t}$) and money supply or money demand shocks ($\varepsilon_t^{m_t}$). Clearly, the identification scheme shown in equation (3.53) is similar to the AB model presented earlier. It is worthy to note that the coefficients on the diagonal of the impact matrix $\mathbf{A}$ are normalised to 1 and the nonzero a_{ij} coefficients indicate that the jth variable contemporaneously affects the ith variable in the system.

According to the first row of equation (3.53) it is assumed that commodity price (crude oil price) variable is not contemporaneously affected by shocks to the other variables in the system, but contemporaneously affect all the other variables in the system. This assumption is plausible in the sense that crude oil is an important input in the production of goods in all the three OECD countries so an unexpected increase in oil commodity prices will affect the key macroeconomic variables like exchange rates, aggregate demand, domestic prices, interest rates, trade prices, producer prices and others. For instance, an increase in crude oil prices will lead to an instantaneous increase in domestic prices and a fall in aggregate demand in the domestic economy. The second and fifth rows of equation (3.53) describes the equilibrium of the products or goods market and row 8 represents the monetary policy reaction function of the central bank[25].

The interest rate is assumed to be contemporaneously affected by oil prices, output gap, import prices and inflation, implying that the coefficients associated with these variables remained unrestricted. However, because export prices do not contemporaneously affect interest rates the coefficient a_{84} was restricted to zero in the central bank's reaction function. The basic rationale for imposing this identifying restriction is that the monetary authorities in OECD countries anticipate the export price shock and respond to it with a lag since export prices do not affect domestic prices and so it does not warrant any reaction by the monetary authorities. This was well articulated in studies conducted by Kim and Roubini (2000), Ito and Sato (2008) and Kovluz and Mehrotra (2009). In contrast to Gordon and Leeper (1994) and Kim and Roubini (2000), the interest rate is assumed to contemporaneously respond to output gap and the price level since price level and output data are normally available after one quarter. They argued that there is considerable delay in publishing price and output data by the statistical agencies. Usually the data are not available within a month and so if a researcher is using monthly data it is reasonable to assume that the interest rates do not contemporaneously respond to the price and output levels since these data are unavailable during this period. However, because the data used in this study is quarterly the issue of delay in publishing price and output data

[25] In a study conducted by Kim and Roubini (2000), the money supply equation was assumed to be the monetary policy reaction function based on the argument that the central bank sets the interest rate after observing the current value of money.

becomes irrelevant. Hence due to availability of price and output data after 1 or 2 quarters, it is plausible to assume that the interest rates react to these variables and so the coefficients associated with the price and output gap in the monetary policy reaction function remained unrestricted.

In row 2 of equation (3.53), real economic activity is assumed to respond to oil price shocks in the three OECD since oil is regarded as a major input for most of the industries in Sweden, UK and Canada. Therefore, the coefficient in the aggregate demand function associated with oil commodity prices (a_{21}) remained unconstrained in equation (3.53). However, the coefficients associated with exchange rates, import prices, export prices, producer prices interest rates and money supply are all restricted to zero because I assumed that they do not affect aggregate demand contemporaneously. As in Kim and Roubini (2000), the justification for this assumption is that firms do not adjust their production level and prices unexpectedly in response to unanticipated changes in both financial and monetary policy signals instantaneously because of inertia, planning delays and adjustment costs.

In contrast to Kim and Roubini (2000), I assume that consumer prices in the domestic economy contemporaneously affects aggregate output and so the coefficient a_{27} remains unrestricted in row 2 of the **A** matrix in equation (3.53). This assumption is plausible on the grounds that firms are able to observe the prices of their individual products, but are unable to do so for the general price level of the economy as a whole. This means that firms in the economy only observe the prices of their individual products and are not certain whether the increase in price of their individual products reflects an increase in the general price level or an increase in aggregate demand. This lack of perfect information on the part of individual firms is what is referred to as the classical *Lucas-Phelps* imperfect information model. Because of this imperfect information, producers increase their output instantaneously in response to inflationary pressures in the economy.

The third row in equation (3.53) is the financial market equilibrium in each of the three OECD countries. Like Kim and Roubini (2000) and Ito and Sato (2008), the exchange rate is assumed to be contemporaneously affected by all the variables in the system and so all the coefficients in row 3 of the impact matrix remained unrestricted. With regards to the central bank's reaction function, I assume that interest rates respond instantaneously to real aggregate demand, the general price level, exchange rates and oil prices and so the coefficients associated with these variables are unrestricted. The plausibility of this assumption is based on the fact that the monetary authorities have complete information about the working of the real sector and follow a *Taylor-type* rule when conducting its monetary policy. In row six, producer prices respond contemporaneously to changes in oil prices, aggregate demand, import prices and the exchange rate.

Import prices of the respective OECD countries are assumed to contemporaneously affect the consumer prices of these countries so the coefficient, a_{75}, in the consumer price equation in row 7 remains unrestricted. This assumption is plausible considering the fact that imported goods prices affect domestic prices through their effects on tradables[26]. The producer price index—which is an index of three indices *viz* crude material index, index of intermediate goods and an index of final or finished goods—is assumed to affect the consumer prices contemporaneously, indicating that the coefficient, a_{76}, is unrestricted in row 7 of equation (3.53). I also assume that the interest rate responds contemporaneously to nominal exchange rate shocks and so the coefficient, a_{83}, is unrestricted in the central bank's reaction function. The plausibility of this assumption is that Canada, Sweden and UK, who are current inflation targeters, allow their respective monetary authorities to change interest rates in response to any exchange rate shock. The basic rationale for this type of monetary policy is to keep the inflation rate at a predetermined level in line with the inflation targeting objective of these countries. When there is an appreciation or depreciation of the nominal exchange rate, the change that occurs is re-

[26] I want to emphasize here that the tradable contents in all imported goods is high and so it is natural to believe that import prices are expected to contemporaneously affect consumer prices and not the other way round.

flected in the prices of both importables and exportables. This change in trade prices in turn leads to a decline in the general price level if the changes in exchange rate resulted in a fall in import prices or a rise in the general price level if the exchange rate depreciation raises import prices.

Following Kim and Roubini (2000), I assume that real economic activity responds to price and financial signals in the domestic economy and so all the coefficients associated with the real economic activity in the other variable equations of the system are unrestricted. The third, fourth, fifth and sixth rows indicate that the exchange rate has a contemporaneous impact on trade prices and so the coefficient associated with this variable remains unrestricted in the import prices, export prices and producer price equations. However, because of the slow response of domestic consumer prices to exchange rate and monetary shocks, the coefficients a_{73}, a_{78} and a_{79} are all constrained to zero. As Kovluz and Mehrotra (2009) argued, the slow adjustment of prices to exchange rate and monetary shocks is consistent with a *Calvo-type* staggered price-setting scheme where prices do not adjust instantaneously to monetary shocks. Because of this zero or incomplete price adjustment to monetary policy, real interest rates are expected to increase. As the real interest rate increases, a monetary contraction will be the ultimate result. The last equation represents the equilibrium of the money market in which money is expressed as a function of real income, interest rate, consumer prices and oil prices. I argue that the monetary authorities of the OECD countries react to changes in the world price of crude oil when conducting their monetary policy.

In a nutshell, it is necessary to conclude that the model presented in equation (3.53) is overidentified because the total number of contemporaneous restrictions on the **A** and **B** matrices, including the normalised diagonal elements, exceeds M(3M-1)/2. To determine whether our overidentifying restrictions are accurate, a likelihood ratio test for overidentifying restrictions was performed on the SVAR-AB model for each of the three OECD countries in the sample and the results are reported in Table 3.22. According to the results, the overidentifying restrictions cannot be rejected for all the models except for the UK and South Korea.

Identification Scheme for Latin American Countries

The model or rather identification scheme proposed for the three countries in Latin America is different from the one proposed for the OECD because of the restrictions imposed on the parameter associated with the exchange rate in the monetary policy reaction function. Since Argenitina, Mexico and Colombia are prone to hyperinflation, the central authorities of these Latin American economies often attempt to peg their currencies to the US$ in order to reduce the level of inflation in these economies.

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 & a_{27} & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{34} & a_{35} & a_{36} & a_{37} & a_{38} & a_{39} \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 & 0 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 & 0 & 0 & 0 \\ a_{61} & a_{62} & a_{63} & 0 & a_{65} & 1 & 0 & 0 & 0 \\ a_{71} & a_{72} & 0 & 0 & a_{75} & a_{76} & 1 & 0 & 0 \\ a_{81} & a_{82} & 0 & 0 & a_{85} & a_{86} & a_{87} & 1 & 0 \\ a_{91} & a_{92} & 0 & 0 & 0 & 0 & a_{97} & a_{98} & 1 \end{pmatrix} \begin{pmatrix} u_t^{pcom} \\ u_t^{y_t} \\ u_t^{s_t} \\ u_t^{p^E} \\ u_t^{p^M} \\ u_t^{p^{PPI}} \\ u_t^{p^{CPI}} \\ u_t^{r_t} \\ u_t^{m_t} \end{pmatrix} = \begin{pmatrix} b_{11} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{55} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & b_{66} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & b_{77} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & b_{88} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & b_{99} \end{pmatrix} \begin{pmatrix} \varepsilon_t^{pcom} \\ \varepsilon_t^{y_t} \\ \varepsilon_t^{s_t} \\ \varepsilon_t^{p^E} \\ \varepsilon_t^{p^M} \\ \varepsilon_t^{p^{PPI}} \\ \varepsilon_t^{p^{CPI}} \\ \varepsilon_t^{r_t} \\ \varepsilon_t^{m_t} \end{pmatrix} \tag{3.54}$$

Pegging a country's currency to the US$ often requires the central authorities to respond to exogenous shocks by implementing some adjustments on key variables of the economy like controlling fiscal spending. This policy stance often rules out the use of monetary policy to stimulate the economy implying that interest rates do not respond contemporaneously to the exchange rate. Using this basic assumption, the coefficient a_{83} in row 8 of the monetary policy reaction function in equation (3.54) is restricted to zero.

From the restrictions imposed on the **A** and **B** matrices, it is quite apparent that the underlying model is overidentified since the total number of restrictions (119) is over and above M(3M-1)/2=117 for exact identification of the SVAR system.

Identification Scheme for Southeast Asian Countries

The identification scheme for the three Southeast Asian economies is pretty much the same as the identification scheme for the OECD countries, except for the restriction imposed on the coefficients of the central bank's reaction function. Equation (3.55) shows the restrictions on the contemporaneous strutural parameters of both the **A** and **B** matrices.

$$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 & a_{27} & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{34} & a_{35} & a_{36} & a_{37} & a_{38} & a_{39} \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 & 0 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 & 0 & 0 & 0 \\ a_{61} & a_{62} & a_{63} & 0 & a_{65} & 1 & 0 & 0 & 0 \\ a_{71} & a_{72} & 0 & 0 & a_{75} & a_{76} & 1 & 0 & 0 \\ a_{81} & a_{82} & 0 & 0 & a_{85} & a_{86} & 0 & 1 & 0 \\ a_{91} & a_{92} & 0 & 0 & 0 & 0 & a_{97} & a_{98} & 1 \end{pmatrix} \begin{pmatrix} u_t^{pcom} \\ u_t^{y_t} \\ u_t^{s_t} \\ u_t^{p^E} \\ u_t^{p^M} \\ u_t^{p^{PPI}} \\ u_t^{p^{CPI}} \\ u_t^{r_t} \\ u_t^{m_t} \end{pmatrix} = \begin{pmatrix} b_{11} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & b_{55} & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & b_{66} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & b_{77} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & b_{88} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & b_{99} \end{pmatrix} \begin{pmatrix} \varepsilon_t^{pcom} \\ \varepsilon_t^{y_t} \\ \varepsilon_t^{s_t} \\ \varepsilon_t^{p^E} \\ \varepsilon_t^{p^M} \\ \varepsilon_t^{p^{PPI}} \\ \varepsilon_t^{p^{CPI}} \\ \varepsilon_t^{r_t} \\ \varepsilon_t^{m_t} \end{pmatrix} \tag{3.55}$$

Because many central banks in Southeast Asian countries actively used sterilised foreign exchange intervention as an effective policy tool to smooth exchange rates, domestic liquidity conditions and the interest rates remained unaffected (Devereux and Yetman (2014)). This means that the interest rate does not respond contemporaneously to the exchange rate and so the coefficient a_{83} is restricted to zero in row 8 of the impact matrix. In order for the model to be identified we need to make M(3M-1)/2 restrictions on both the **A** and **B** matrices. Following Kovluz and Mehrotra (2009), the coefficient of the consumer price variable in the monetary policy reaction function is also restricted to zero since most of the Southeast Asian economies have currency boards that effectively limit the independence of the central banks and the conduct of monetary policy. Since there are nine endogenous variables in the system, we need a total of 117 restrictions for an exact identification of the model. From the model in equation 3.55, it is easy to see that the total number of restrictions on both the **A** and **B** matrices amounted to

120 restrictions implying that the model is overidentified.

3.4.3 Data Sources and Description

As was mentioned in the introductory section, the analysis carried out in this paper focused mainly on economies from three regions with varying levels of economic development, that is, nine countries from OECD (Canada, Sweden and the UK), Latin America (Argentina, Colombia and Mexico) and Southeast Asia (The Philippines, South Korea and Thailand). To estimate the SVAR model and the ERPT for all the nine countries in the study, I use quarterly data of trade prices (Export prices and import prices) and other macroeconomic indicators for the period 1980q1 through 2012q4 for all the countries except for Argentina, Mexico, Colombia, Thailand and the Philippines. Quarterly time series data appears to be more appropriate than annual data for our multivariate SVAR approach. This is so because with quarterly data, there are enough degrees of freedom to estimate the SVAR-AB model and ERPT elasticities than in the case where annual data is used. The sample size used for each of these countries depends on the availability of data[27]. All data were obtained from the IMF International Financial Statistics CD ROM, FRED's and OECD websites and the national databases of some of the countries in the sample. The quarterly export and import prices are not normally calculated and reported for Argentina, Canada, South Korea and Thailand so unit value indices were used as proxies instead. All the data series were transformed into logarithmic values.

The statistical information on aggregate supply conditions, commodity prices, was also extracted from the IMF *International Financial Statistics* CD ROM. In this study, commodity price is divided into fuel and non-fuel commodity prices. Data on non-fuel commodity prices was obtained directly from the IMF CD-ROM. Unlike McCarthy (2007), and following Ito and Sato (2008), the fuel commodity price was constructed by taking the average of the world crude oil prices indices (2005=100) of Texas, Brent and Dubai.

[27]See Data Appendix for a detail description or elaboration on this.

Producer price index and consumer price index served as proxies for producer price inflation and consumer price inflation. This data was extracted from the IMF IFS CD-ROM. Like the import price and export price indices, the producer and consumer price indices were seasonally adjusted at the source. The consumer price index is a broad measure of inflation in all the countries studied in this paper. Information on nominal exchange rate was extracted from the IMF database, FRED's and the databases of the statistical agencies of the countries included in the study. Since quarterly data was used in the analysis, there was the need to seasonally adjust the data in order to eliminate the effect of any potential seasonal event from the time series data. Because of this requirement, I obtain seasonally adjusted data series at the source. Nominal GDP (gross domestic product) figures and the GDP deflator were obtained from the IMF IFS database. The nominal GDP was deflated to obtain real GDP which in turn was used to generate the output gap, the proxy for demand pressure in importing countries.

Output gap data was generated by using the standard Hodrick-Prescott (HP) filter method. This approach proceeds in two steps. First, the trend growth rate of GDP (potential output) was obtained by the HP filter method. In the second step, I obtain the deviation of actual ouput from the potential output generated in the first step. The potential output was derived according to the minimization of the following loss function in the HP filter method

$$L = \sum_{i=1}^{N}(y_i - y_i^*)^2 + \phi \sum_{i=2}^{N-1}(\Delta y_{i+1}^* - \Delta y_i^*)^2$$

where ϕ is the smoothing parameter, y^* is the potential ouput, y is the actual real GDP and N is the sample size. To set the smoothing parameter, I use the Ravn-Uhlig (2002) and the Hodrick-Prescott (1997) methods[28]. The standard practice by many econometricians has been to use a smoothing parameter of 1600 for quarterly data and a value less than 1600 for annual

[28] The smoothing parameter should be as large as possible to ensure smoothness of the series. The idea of having a larger value of the smoothing parameter has been enunciated by many econometricians including Hodrick and Prescott (1997). Potential output approaches actual output as ϕ tends to 0 because of little or no business cycle fluctuations. On the other hand, higher values of ϕ leads to a smoother trend.

data. In this paper I have used 1600 and the Ravn-Uhlig (2002) frequency rule of $1600/p_q^4$ to generate the data on potential output[29]. The resulting data series on potential output was subtracted from the actual output series to obtain the output gap. This approach departs from the quadratic trend approach used by McCarthy (2007). The advantage of generating output gap using the HP filter method is that it yields smoother estimates of the output gap than the quadratic trend approach. In particular, the quadratic trend method has the tendency of producing output gap series that exhibit unrealistic swings especially if the actual trend in output is not the same as the assumed quadratic trend of the series.

Finally, the monetary aggregates and interest rate data were obtainable from the same CD-ROM used to extract the other data for the study.

3.5 Empirical Evidence

In this section I provide an empirical analysis of the major findings of the paper, but before I proceed some initial diagnosis of the data is required. To meet this requirement, the preliminary diagnosis is presented in the ensuing section.

3.5.1 Preliminary Diagnosis

The first step in the empirical analysis of this paper is to conduct a preliminary enquiry on the data. This involves exploring the univariate time series behavior of the variables and their cointegrating relationships via the use of the ADF, the Phillips-Perron (PP), Zivot-Andrews (Zauroot) and Johansen cointegration tests[30]. Whereas the ADF, PP and Zauroot tests were used to test the variables for unit roots, the Johansen cointegration test determines whether the variables are cointegrated. This procedure is necessary because it enables me to weed out

[29] In Ravn and Uhlig (2002), p_q represents the number of periods per quarter in the series.

[30] Phillips and Perron (1988) and Zivot and Andrews (1992) argued that in the presence of structural break in the data, the ADF test is bias towards non-rejection of the null hypothesis for the presence of unit roots. In order to resolve the biasedness associated with the use of the ADF test, both Phillips *et al.* (1988) and Zivot *et al.*(1992) endogenously determine the structural break from the data.

nonstationarity from the data by transforming all I(1) series to I(0) or stationary series via first differencing[31]. Lütkepohl (2005) underscored the importance of subjecting macroeconomic time series to unit roots tests in multivariate models by arguing that the probability of obtaining consistent estimates of the impulse response functions at long forecast horizons is seriously undermined if nonstationary variables are used in the SVAR model estimation. However, if the variables used in the SVAR model estimation are stationary then the impulse response will decay to zero implying that the underlying estimates are consistent.

The results of the ADF, PP and Zauroot tests in Table 3.1 through Table 3.9 indicate that the null hypothesis that a given time series possessed a unit root is not rejected for all the variables in their levels save the output gap. These results hold true for all the nine countries in the OECD, Latin America and Southeast Asian regions. However, the first difference variables appear to be stationary suggesting that they are integrated of order 1 or they are I(1) series. Therefore all the time series variables in the baseline SVAR-AB model specification, with the exception of output gap, appear in their first difference. The time series plots reported in appendix B.2.1 also provided full support to the estimated ADF, PP and Zauroot test statistics in Tables 3.1 through 3.9. According to the results of the time series plots, the variables in their levels follow a random walk with a drift, except for the output gap variable. With regards to the quarterly changes—that is the variables in their first difference —in the variables, there is not a single pattern that is stable over time because the series gravitate to some steady state level. For the three OECD countries—Canada, Sweden and the UK—the quarterly changes in the exchange rates are apparently bigger between 2008 and 2010, except for Sweden where the changes seem to be bigger prior to the global financial crisis period (See Figures B.2, B.4 and B.6 in the appendix).

[31]With the exception of the output gap variable, all the variables are in first-differences because they are integrated of order 1 or I(1). This means that they are nonstationary in levels. Variables that are stationary in levels are referred to as I(0) series. Unlike I(1) series that wander away from the trend, I(0) series gravitate to some steady-state level.

The time series plots of the variables in their levels and first differences for the three Latin American countries (Argentina, Colombia and Mexico) also show clear evidence that the time series variables are I(1). This means that they have a stochastic trend or behave as a random walk with a drift in their levels (nonstationary), but are stationary after taking first differences (See Figures B.7-B.12 in appendix B.2). Similar results were obtained for the Southeast Asian countries—all the variables, save outgap, have unit roots according to the ADF, PP and Zau-root tests results in Tables 3.3, 3.6 and 3.9—in our sample . Therefore, in order to remove the stochastic trend from the variables and render the estimation of the SVAR-AB model for each of the nine countries valid I used the first difference variables to model the SVAR and obtain impulse response functions.

Given that the variables possess stochastic trends, the next step is to determine whether they are cointegrated or have a long-run equilibrium relationships via the use of the Johansen cointegration tests. In the Johansen cointegration tests two main statistics were computed *viz* the trace statistic (λ_{trace}) and the maximum eigenvalue statistic (λ_{max}). The results of the tests are reported in Tables 3.10, 3.11 and 3.12 for each of the nine countries in the sample. From the reported results, it is evident that the null hypothesis of no cointegration among the variables is rejected at the 5% level of significance according to the data. This implies that there is a long-run relationship among the variables. The λ_{trace} and λ_{max} statistics also reveal that in Canada and the UK, there are 4 cointegrating relationships or vectors among the variables in the cointegrating space since the null hypothesis of r=4 cannot be rejected (see the p-values of 0.085, 0.253, 0.069 and 0.333 in Table 3.10). Regarding Sweden, the λ_{trace} and λ_{max} statistics indicate that there are 3 cointegrating and 1 cointegrating vectors in the cointegrating space.

For the Latin American case, the number of cointegrating relationships among the variables differ from country to country. For instance, it can be seen that the trace test results suggest a cointegrating vector of r=5 for Argentina and r=4 for both Colombia and Mexico. With regards to the maximum eigenvalue test results the null hypothesis of 3 cointegrating vectors among the variables cannot be rejected for Colombia and Argentina. In the case of Mexico, the λ_{max} statistic indicate that the null hypothesis of 2 cointegrating vectors in the cointegrating space cannot be rejected (see the p-value of 0.078 in Table 3.11).

Finally, the Johansen cointegration tests results reported in Table 3.12 for the countries in Southeast Asia suggest that the null hypothesis of no cointegration among the variables is rejected resolutely for the Philippines, South Korea and Thailand. On the cointegrating relationship among the variables, the λ_{trace} statistic indicate that there are r=3, r=4 and r=3 cointegrating vectors or relationships among the variables for The Philippines, South Korea and Thailand respectively. Given the presence of cointegration or long-run equilibrium relationships among the variables for each of the nine countries in the sample, the VECM which combines the long-run and short-run dynamics into a compact model would have been appropriate for estimating the model of the paper. However, because the aim of this study is to examine the short-run effects of exchange rate fluctuations on trade prices and inflation it implies that the VECM approach is irrelevant in this regard. Hence I used the SVAR approach and identify the structural shocks of the multivariate system based on contemporaneous or short-run restrictions on the parameters of the impact matrix.

3.5.2 VAR Lag Order Selection

The selection of the appropriate lag order in SVAR analysis is one of the most significant step in the estimation of the impulse response functions. Many econometricians like Killian (2011), L$\ddot{u}$tkepohl (2005) and Hamilton (1994), believe that the validity of the impulse response functions depends, to a large extent, on the lag order of the VAR fitted to the data. Choosing the wrong lag order of the VAR would affect the estimates and interpretation of the impulse responses because the wrong lag order renders the estimates biased. To circumvent the issue of biased results of the IRFs, I used four different lag order criteria to select the appropriate lag order of the VAR prior to the estimation of the impulse response functions for each of the nine countries (Canada, Sweden, UK, Argentina, Colombia, Mexico, Philippines, South Korea and Thailand) in the study. The four lag order selection criteria are the Final Prediction Error (FPE), the Akaike Information Criterion (AIC), the Schwarz or Bayesian Information Criterion (SIC or BIC) and the Hannan-Quinn Criterion (HQC). The underlying equations for all four criteria are presented below

$$FPE(p) = |\bar{\Omega}(p)| + \left(\tfrac{T+Mp+1}{T-Mp-1}\right)^M \tag{3.56}$$

$$SIC(p) = ln|\bar{\Omega}(p)| + \frac{ln(T)}{T}pM^2 \tag{3.57}$$

$$AIC(p) = ln|\bar{\Omega}(p)| + \frac{2}{T}pM^2 \tag{3.58}$$

$$HQC(p) = ln|\bar{\Omega}(p)| + \frac{2ln(ln(T))}{T}pM^2 \tag{3.59}$$

where $\bar{\Omega}$ denotes the maximum likelihood estimate of the variance-covaraince matrix of the reduced form homoscedastic innovations, M is the number of endogenous variables in the VAR system, T denotes the sample size of the data and p is the lag order of the VAR. In the selection process, the lag order of the VAR that minimizes the criterion function, say $\tilde{p}$, is chosen as the order of the VAR. The accuracy of each of the four criteria depends on the type of data used in the study. According to Lütkepohl (2005), the Hannan-Quinn criterion is the most accurate criterion for quarterly data whilst the AIC performs better than the other criteria for monthly data. Since we are dealing with quarterly data in this study, the HQC was used to select the lag order for the VAR. The results are reported in Tables 3.13, 3.14 and 3.15. From the results in Table 3.13, I found an optimal VAR lag order of p=1 based on the SIC criterion whilst the results of the FPE and AIC criteria indicate a VAR lag order of p=6 for Canada. With regards to the Hannan-Quinn criteria, the results suggest an optimal VAR lag order of p=3 for Canada. Since the HQC was used to select the lag order of the VAR model in this study, I therefore select a lag order of p=3 for Canada. Regarding the VAR lag order for Sweden, the FPE, Akaike information, Schwarz information and Hannan-Quinn criteria suggest optimal lag lengths of p=4, p=4, p=0 and p=2 respectively. For our case we use the Hannan-Quinn suggestion of p=2 lags. In the case of UK, I estimate the SVAR-AB with two lags to avoid underestimation of the order of the VAR as suggested by the Hanna-Quinn criterion of a single lag. From the results presented in Figure 3.14, the Hannan-Quinn criterion suggests a single lag for both Argentina and Colombia and two lags for Mexico. For The Philippines, South Korea and Thailand, I estimated the SVAR with a lag length of p=3, p=1 and p=2 respectively (See Table 3.15).

3.5.3 Effect of Exchange Rate Shocks on Trade Prices

One of the objectives of this paper is to estimate the pass-through effects on trade prices and inflation following a nominal exchange rate shock. In order to achieve this, I derive the structural and accumulated impulse responses of these variables to a standardized 10% increase in the nominal exchange rate over time—that is, a nominal devaluation. The impulse response functions characterizing the dynamic effects of exchange rate shock on trade prices—export prices and import prices—are reported in Figures 3.6-3.23 for the OECD, Latin American and Southeast Asian countries. Figures 3.6, 3.12 and 3.18 characterize the structural impulse responses whilst Figures 3.9, 3.15 and 3.21 reports the accumulated response of trade prices to exchange rate shocks.

To analyze the effect of exchange rate fluctuations on trade prices, I will discuss first the results obtained for the three OECD countries in Figures 3.6 and 3.9 and later consider the results for the three Latin American countries in Figures 3.12 and 3.15 and finally the results for the three Southeast Asian countries in Figures 3.18 and 3.21. In Figure 3.6, each column gives the impulse response to a 1σ (one standard deviation) positive nominal exchange rate shock. The response variables—that is, export prices and import prices—to this shock are on top of each graph. Impulse responses of trade prices to nominal exchange rate shock are the thick and continuous red lines while the two dotted blue lines on either side of the impulse response denote a 2 standard error confidence bands. In all the pictorial representations, it is evident that IRFs are constructed over a period of 12 horizons (that is, about 12 quarters). The structural IRFs in Figure 3.6 indicate that an unanticipated increase in the nominal exchange rate leads to an initial increase in both export prices and import prices, with the effect reaching a peak and declining gradually after the peak towards the pre-shock level for all the three OECD countries (Canada, Sweden and The UK). However, the speed at which export prices revert back to the pre-shock level appears to be much slower than import prices reflecting a lower ERPT to export prices relative to import prices.

The effect of the exchange rate shock lasted much longer for the UK than the other two OECD countries. Whereas the initial impact of the nominal exchange rate shock on trade prices lasted for roughly 4 quarters in the case of Canada and Sweden, the duration of the exchange rate impact on trade prices in the case of the UK is approximately 5 and one-half quarters after the shock. The behavior of export prices following the exchange rate shock is purely driven by the rigidity of local currency prices. If local currency prices are sticky, a nominal devaluation will result in an increase in export prices and a deterioration in the terms of trade. Gopinath (2012), also provided similar reasoning in her analysis of international prices and exchange rates in the United States. She argued that in the presence of local currency price rigidity, an increase in nominal exchange rate will trigger an increase in export prices and a deterioration in the terms of trade.

Turning to the accumulated impulse responses, Figure 3.9 indicates that the response of trade prices (export and import prices) to a nominal exchange rate shock is statistically significant at all horizons for all the three OECD countries with the exception of Canada where the the response of export prices to nominal exchange rate shock appeared to be insignificant after the second quarter. Interestingly, the response of export prices to the nominal exchange rate shock is fairly weaker than the response of import prices to the exchange rate shock reflecting a lower ERPT to export prices (See the First Stage ERPT elasticities in Table 3.13). To further buttress these results, I consider the time when the effect of the exchange rate shock dies out for all the three countries. For instance, as shown in Figure 3.9 the effect of the shock on export prices is fully felt in the third quarter for all the three OECD countries. In contrast, the full impact of the shock on import prices occurred a little earlier in quarter 2 reflecting a greater speed of import price adjustment to nominal exchange rate shocks. In general, the exchange rate shock resulted in an increase in both export and import prices that eases after the full impact is felt and becomes persistent over the long run.These results are somewhat consistent with those obtained by Choudhri *et al.* (2005) for the non-US G 7 countries.

Regarding the three Latin American countries (Argentina, Colombia and Mexico), the structural impulse response functions in Figure 3.12 showed mixed results. Whereas a 10% nominal devaluation results in an immediate decrease in export prices for Argentina and Mexico, the export prices response to the exchange rate shock in Colombia is a positive increase that lasted for approximately 2 quarters before assuming an irregular trend that dies out after 12 quarters. In the case of Mexico, export prices initially decrease significantly following an unexpected nominal exchange rate increase. The decrease in export prices lasted for about 3 quarters before assuming an upward trend. With regards to import prices, the unexpected increase in nominal exchange rate leads to an initial increase in import prices in all the Latin American countries but Argentina. However, the persistence of the increase in import prices lasted for a short period of time before reverting back to the pre-shock level. The results for Argentina indicate that import prices initially decline following a devaluation, but increase towards the pre-shock level after about 2 quarters.

Having discussed the results of the structural impulse response of export and import prices to exchange rate shocks for the Latin American countries, I now delve into the accumulated impulse response of these prices to exchange rate shocks. The results are presented in Figure 3.15. According to the results, it is evident that the response of import prices to exchange rate shock is significantly higher than the response of export prices to nominal exchange rate shocks in all the Latin American countries but Argentina. The finding for Colombia and Mexico is not surprising since the share of imported inputs used in production relative to total variable costs is high for a large number of manufacturing firms in these countries. Acording to Choudhri *et al.* (2005), another implication for the higher response of import prices to exchange rate shocks than export prices in Colombia and Mexico is that the positive nominal exchange rate shock is usually associated with a deterioration in the terms of trade rather than an improvement in the terms of trade. Because of this it is expected that the response of import prices to nominal exchange rate shocks will be higher than the response of export prices to exchange rate shocks. Choudhri *et al.* (2005) also arrived at similar results for a group of seven non-US G7 countries. In the case of Argentina, the response of export prices to exchange rate shocks is insignificantly higher than the response of import prices to exchange rate shocks. This somewhat result surprising may be due to the fact that Argentina's exports constitute a larger share of quality goods. This greater share of quality products exported implies that export prices respond more to exchange rate changes.

Finally, I focus on the analysis of the response of export and import prices to exchange rate shocks in the three Southeast Asian countries (Philippines, Korea and Thailand). The structural IRFs and accumulated IRFs showing the effects of exchange rate shocks on trade prices are depicted in Figures 3.18 and 3.21 respectively. Both the structural IRFs and accumulated IRFs indicate that trade prices are affected by shocks to the nominal exchnage rate in The Philippines, Korea and Thailand. With the exception of South Korea, the response of import prices to a positive exchange rate shock is higher than the response of export prices to a nominal exchange rate shock. The accumulated impulse response functions in Figure 3.21 shows that import prices adjust faster to an exchange rate shock than export prices in The Philippines and Thailand. For instance, in the case of Philippines the effect of exchange rate persistence on import prices is approximately one-half quarter shorter than the persistent effect on export prices. In Thailand, the persistent effects of nominal exchange rate shock on import prices is about one quarter shorter than the effects on export prices. This expected results are consistent with the results reported by Choudhri *et al.* (2005). Interestingly, export prices adjusted faster to exchange rate shocks than import prices in South Korea. To summarize the results, it is worthy to note that a nominal exchange rate shock exert much more impact on import prices than export prices in OECD and emerging economies in Latin America and Southeast Asia.

3.5.4 Impact of Exchange Rate Shocks on Producer and Consumer Prices

Having analysed the effect of exchange rate movements on export and import prices in the sample of countries, I now turn my attention to the dynamic responses of producer and consumer prices to an exchange rate shock. The structural IRFs and accumulated IRFs for the OECD countries are depicted in Figures 3.7 and 3.10. As indicated earlier, the continuous thick red line represents the impulse response of producer and consumer prices to a one standard deviation exchange rate shock and the dotted blue lines on either side of the impulse response are the 2 standard error confidence bands. Each column in Figure 3.7 represents the structural impulse response of producer prices and consumer prices to one standard deviation positive exchange rate shock.

In response to a nominal exchange rate depreciation, both producer and consumer prices initially increase significantly and decline thereafter in each of the three OECD countries. The response of producer prices to exchange rate shocks is much higher than the response of consumer prices to nominal exchange rate shock. The weak response of consumer prices to exchange rate shock is not surprising since the share of tradable goods in the consumer price basket is lower than the share of tradable goods in producer prices. The higher the tradable content in a given price index the greater the response of that price index to an exchange rate shock. On the other hand, the higher the amount of nontradable goods in a price index the smaller will be the response of that price to an exchange rate shock. This argument explains why the response of consumer prices to exchange rate fluctuations is much lower than the response of producer prices. Previous studies conducted by Ito and Sato (2008), McCarthy (2007) and Choudhri *et al.* (2005) arrived at similar results. The results of the accumulated IRFs also indicate a declining response of producer and consumer prices along the distribution chain in all the three OECD countries.

The structural and accumulated IRFs in Figures 3.13 and 3.16 for the three Latin American countries (Argentina, Colombia and Mexico) also indicate that the response of producer prices and consumer prices to a nominal exchange rate shock is positive as expected. However, the response of producer prices to exchange rate shocks is much stronger than the response of consumer prices reflecting a declining response along the distribution chain. This result is similar to the results obtained by McCarthy (2007) and Ito and Sato (2008).

With regards to the results obtained for the three Southeast Asian countries, the structural IRFs in Figure 3.19 suggest that the response of consumer prices to a nominal exchange rate shock is much weaker than the response of producer prices for all the three Southeast Asian countries. However, the response of consumer prices to a positive exchange rate shock in the case of Thailand is not only insignificant but has the wrong sign. The weak response of consumer prices to exchange rate shock is not surprising since the presence of a larger share of nontradables goods in the CPI makes it difficult for consumer prices to respond to any exchange rate shock. If we consider the effect of the Asian Financial crisis in 1997, it is surprising to find out that consumer prices in South Korea do not respond significantly to exchange rate shocks. However, the results of the accumulated IRFs are encouraging since Figure 3.22 indicate that both consumer prices and producer prices respond positively to a nominal exchange rate shock.

Moreover, the response of producer prices to exchange rate shock is much bigger than the response of consumer prices to exchange rate shock. My results are very consistent with those of Ito and Sato (2008) although their estimates seem to be much smaller than the estimates obtained in this study. There is a considerable amount of evidence in the literature showing higher producer price response to exchange rate shocks than consumer price response to these shocks in both developed and developing countries. For instance, Campa and Goldberg (2005), Choudhri *et al.* (2005), McCarthy (2007), to mention a few, have reported higher responses of producer prices to exchange rate fluctuations and lower response of consumer prices to exchange rate shocks.

3.5.5 Import Price Shocks and Inflation

In this section, attention is directed towards the second round effects of changes in nominal exchange rate via import prices on both producer and consumer prices. I consider this second round effects as the import pass-through to producer and consumer prices or the **Second Stage** pass-through. To provide estimates for these effects, I derive the structural IRFs and accumulated IRFs for the response of producer and consumer prices to a one standard deviation of import price shock. The results of the structural IRFs are shown in Figures 3.8, 3.14 and 3.20 for the OECD, Latin American and Southeast Asian countries respectively. The accumulated IRFs are depicted in Figures 3.11, 3.17 and 3.23 for all the nine countries in the sample. From Figures 3.8 and 3.11, the response of producer prices to an import price shock is higher and more rapid than the response of consumer prices to import price shocks for Canada and the UK. The reaction of producer and consumer price inflation to a positive import price shock is ambiguous in the case of Sweden. Whereas Figure 3.8 indicates that producer prices decrease following an import price shock, Figure 3.11 indicates that consumer prices increase following a positive import price shock. The magnitude of the response of producer prices to import price shock is bigger than response of consumer prices to import price shocks for Canada, Sweden and The UK (See Figure 3.11).

In the case of Latin American countries (Argentina, Colombia and Mexico), Figure 3.14 shows that producer prices and consumer prices increases following an unanticipated increase in the price of imported inputs but decline at approximately the second quarter. This result is in line with the conventional view that an increase in the price of imported intermediate goods generally exerts upward pressure on both producer prices and consumer prices in the domestic economy. Interestingly, the result for the accumulated IRFs in Figure 3.17 suggest that producer and consumer prices hardly react to any sudden increase in import prices. This somewhat surprising results may be due to the paucity of data in Latin America.

Turning to the countries in Southeast Asia, the structural IRFs in Figure 3.20 shows that producer prices and consumer prices react negatively to an increase in import prices at the initial period in Korea and Thailand. In Korea, whereas the decline in producer prices lasted for about 5 quarters following the import price shock, the fall in consumer prices lasted for approximately 6 quarters. In the Philippines, both producer prices and consumer prices increase initially following an import price shock but decline in quarter 3 after the shock. In contrast, the accumulated IRFs in Figure 3.23 indicate that a positive import price shock generally induces an increase in producer prices and consumer prices in Philippines, Korea and Thailand. This finding is consistent with the general view that an increase in the cost of imported inputs puts an upward pressure on producer and consumer prices in the economy.

3.5.6 Exchange Rate Pass-Through Elasticities

In order to address the issue of whether the ERPT to trade prices and inflation for OECD and emerging economies have declined, I estimate the accumulated ERPT elasticities from the impulse response functions . The analysis in this section considers the fact that the transmission mechanism in the ERPT process occur in two stages, that is, the First Stage and Second Stage. In the First Stage, I analyze the direct effect of exchange rate changes on trade prices and in the Second Stage I assess the impact via the producer and consumer prices. The equation for deriving the 'First Stage' ERPT elasticities is given by

$$ERPT_{t,t+l} = \frac{\sum_{l=1}^{T} \frac{\partial Z_{j,t+l}}{\partial \varepsilon^{j}_{t,t+l}}}{\sum_{l=1}^{T} \frac{\partial S_{t,t+l}}{\partial \varepsilon^{s_t}_{t,t+l}}} \quad \forall j \in [p^E, p^M, p^{PPI}, p^{CPI}] \tag{3.60}$$

where l denotes the number of horizons or quarters, Z_j represents a vector of the jth price, that is, export prices, import prices, producer prices and consumer prices, S_t is the nominal exchange rates, $\varepsilon^{j}_{t,t+l}$ is the innovation of the jth price (export prices, import prices, producer prices and CPI) and $\varepsilon^{s_t}_{t,t+l}$ denotes the innovation to the nominal exchange rate. The numerator,

$\sum_{l=1}^{T} \frac{\partial Z_{j,t+l}}{\partial \varepsilon^{j}_{t,t+l}}$, is the accumulated response of trade prices, producer and consumer prices evaluated l periods after the nominal exchange rate shock while the denominator, $\sum_{l=1}^{T} \frac{\partial S_{t,t+l}}{\partial \varepsilon^{st}_{t,t+l}}$, represents the accumulated response of nominal exchange rate evaluated l periods after the innovations to the nominal exchange rate.

On the other hand, the accumulated response of producer and consumer prices to import price shocks ('Second Stage' ERPT) is derived according to the following equation

$$ERPT_{t,t+l} = \frac{\sum_{l=1}^{T} \frac{\partial Z_{j,t+l}}{\partial \varepsilon^{j}_{t,t+l}}}{\sum_{l=1}^{T} \frac{\partial p^{M}_{t,t+l}}{\partial \varepsilon^{p^{M}_{t}}_{t,t+l}}} \quad \forall j \in [p^{M}, p^{CPI}] \tag{3.61}$$

where $\sum_{l=1}^{T} \frac{\partial Z_{j,t+l}}{\partial \varepsilon^{j}_{t,t+l}}$ is the accumulated response of producer and consumer prices evaluated l periods after the innovations to import prices and $\sum_{l=1}^{T} \frac{\partial p^{M}_{t,t+l}}{\partial \varepsilon^{p^{M}_{t}}_{t,t+l}}$ is the accumulated response of import prices to its own innovation l periods ahead.

Using the above equations, the ERPT elasticities for the two stages of the exchange rate pass-through transmission process were estimated and reported in Tables 3.16-3.21. Table 3.16 shows the pass-through elasticities of trade prices (export prices and import prices) and inflation (producer prices and consumer prices) for Canada, Sweden and UK over 12 quarters. According to the results in Table 3.16, pass-through to trade prices increases following an exchange rate shock, overshooting its long run level and gradually reverting towards its original level. Pass-through elasticities to export prices in Column (2) are somewhat lower than ERPT to import prices in column (3) for all the three OECD countries. On average, the pass-through elasticities to export prices in Canada, Sweden and The UK are 0.255, 0.200 and 0.319 respectively. With regards to ERPT elasticities to import prices, the average values ranges between 0.239 and 0.610 for the three OECD countries. My results corroborate those of Campa and Goldberg (2005) who used single-equation estimation methods to obtain the ERPT elasticities for a group of 23 OECD countries.In general, ERPT elasticities decline along the pricing distribution chain from import prices to producer prices and finally consumer prices for each of the three OECD countries. This is consistent with the general notion that as the share of tradable goods in the price basket decreases the ERPT also declines. Since the share of tradable goods in the price baskets declines from import prices all the way to consumer prices, it is expected that the ERPT will decline from import prices right down to consumer prices. Looking at the estimated ERPT elasticities we can safely conclude that ERPT is incomplete in Canada, Sweden and UK implying that trade prices and inflation do not adjust to exchange rate changes one-for-one. The increase in import prices following the exchange rate depreciation is much higher for Canada than for the other two OECD countries. The ERPT elasticity of import prices increases in the first two quarters after the depreciation in each of the three OECD countries, but remained at approximately 62% in Canada, 25% in Sweden and 37% in the UK reflecting an incomplete pass-through. The implication of this result is that foreign firms are probably engaging in pricing to market activities or absorbing the changes in exchange rates in their profit margins.

Table 3.17 shows the results for the pass-through elasticities for trade prices and inflation in the three Latin American countries. With the exception of Argentina, the average ERPT to export prices per quarter is lower than the ERPT to import prices in the case of Colombia and Mexico. The implication of this finding is that the share of imported inputs used in production relative to total variable costs is high for a large number of manufacturing firms in Mexico and Colombia suggesting that ERPT to export prices will be lower than pass-through to import prices. If we assume Canada and Argentina to be the outliers, columns (2) and (3) of Tables 3.16 and 3.17 indicate that emerging economies in Latin America experience higher ERPT to trade prices and inflation than those in the OECD. The lower pass-through elasticities result for OECD countries is not surprising since these economies are characterized by a more stable monetary policy environment, low rates of inflation and lower import share relative to the Latin American countries with a history of unstable monetary policy environment and high inflation.

In addition, because the import shares of Mexico, Colombia and Argentina are higher in relation to Sweden, Canada and the UK it is likely that the ERPT elasticities in the Latin American countries will be higher than those in the OECD.

In Table 3.18 I report the pass-through elasticities for the Philippines, Korea and Thailand. From the results it is evident that the ERPT to trade prices and inflation are higher than the ratios for the three OECD countries but lower than the ERPT for Colombia and Mexico. The estimates of the pass-through elasticities also indicate that ERPT is declining along the pricing distribution chain and is incomplete. The First Stage pass-through elasticities in Tables 3.19, 3.20 and 3.21 are higher than the Second Stage pass-through elasticities. In particular, whereas trade prices adjust faster to exchange rate fluctuations, producer prices and consumer prices adjust sluggishly to fluctuations in import prices.

3.6 Stability of SVAR Model

In order to determine the stability of the SVAR-AB model, I derive the reciprocal VAR roots of the characteristic polynomial. The results are presented in Figures 3.24-3.26. From the graphs, it is easy to see that the structural and accumulated IRFs behave very well according to the results of the eigenvalue condition for SVAR stability . For instance in Figures 3.24, 3.25 and 3.26, it is quite apparent that the modulus of each and every eigenvalue of the SVAR falls either on the unit circle or inside it[32]. This implies that the SVAR is stable and the impulse responses decay gradually to zero as the number of horizons increases implying that the underlying variables of the SVAR system are stationary and ergodic.

[32]The zigzag movements of the impulse response functions indicate that some of the eigenvalues have complex roots.

3.7 Conclusion

This paper used quarterly time series data to provide a macro-level empirical investigation on the dynamic effects of exchange rate fluctuations on trade prices and inflation for nine countries in the OECD, Latin America and Southeast Asia. To carry out this investigation, I employ an identification procedure based on short run or contemporaneous restrictions to identify the structural shocks of the multivariate SVAR-AB model. This approach departs from the standard recursive identification procedure or Choleski decomposition used by McCarthy (2007), Ito and Sato (2008), Choudhri *et al.* (2005), Devereux and Yetman (2014), among others. The identification schemes for each of the three regional economies was contructed by paying close attention to the prevailing macroeconomic conditions in these economies. Another notable departure of this study from the previous studies in the extant literature is that this paper examines both the exchange rate pass-through to trade prices and the import pass-through to domestic prices in each of the nine countries included in the sample. This approach helps to provide a clear interpretation of the pass-through process.

As a preamble to the analysis in this paper, I used standard optimizing models to decompose the exchange rate pass-through into 'First Stage' ERPT and 'Second Stage ERPT'. From this approach, ERPT elasticities were estimated for both trade prices and inflation for each of the nine countries from the cumulative impulse responses of export prices, import prices, producer and consumer prices to exchange rate shocks. From the SVAR analysis, the paper reveals some interesting results. First, the pass-through elasticities for the 'First Stage' and 'Second Stage' differ accross economic regions and countries. For instance, with the exception of Canada and Argentina, the ERPT to trade prices for the three OECD countries appears to be much lower than the estimates for the five emerging economies in Latin America and Southeast Asia. In addition, the results indicate that ERPT to import and export prices are both incomplete for all the nine countries. Second, trade prices adjust to exchange rate fluctuations much quicker than both producer prices and consumer prices. The implication of this result is that *First Stage*

ERPT is more rapid than the *Second Stage ERPT*. Third, pass-through to import prices in each of the nine countries is less than one reflecting incomplete adjustment of prices to exchange rate and import price fluctuations.

One important caveat of this research paper relates to the frequency of the data used in carrying out the analysis. The quarterly data used in this paper may not be appropriate for providing better estimates of ERPT, especially if the frequency at which the exchange rate changes is high. A simple way of resolving this issue will be to embark on research in which higher frequency data is used. Thus, it is recommended that future research be directed towards the use of monthly time series data. A second limitation of this study is that the ERPT was estimated at the aggregated level which means that heterogeneity of price adjustment for individual goods across sectors was ignored. This has the potential to either overestimate or underestimate the true ERPT and therefore cloud inference. In order to resolve this issue it would be desirable to consider micro-level price data of individual goods. This will provide considerable insight into the different price adjustments of goods to exchange rate shocks.

3.8 Tables and Figures

Table 3.1: Augmented Dickey Fuller Unit Roots Test Results for OECD

Variables	ADF Test Statistics			
	Level	First Difference	Critical Value[a]	Order of Integration
		CANADA		
Import Prices	-1.808	−9.226*	-3.445	I(1)
Export Prices	-2.222	−8.227*	-3.445	I(1)
Producer Prices	-2.546	−8.233*	-3.445	I(1)
Consumer Prices	-3.274	−6.148*	-3.445	I(1)
Exchange Rate	-1.366	−10.015*	-3.445	I(1)
Commodity Prices (Non-Fuel)	-1.839	−8.319*	-3.445	I(1)
Output Gap	−4.966*	(—)	-3.445	I(0)
Oil Prices	-1.766	−10.087*	-3.445	I(1)
Money Supply	-1.859	−4.128*	-3.445	I(1)
Interest Rates	-3.392	−6.325*	-3.445	I(1)
		SWEDEN		
Import Prices	-3.440	−8.436*	-3.445	I(1)
Export Prices	-2.366	−6.927*	-3.445	I(1)
Producer Prices	-2.609	−7.702*	-3.445	I(1)
Consumer Prices	-1.969	−7.926*	-3.445	I(1)
Exchange Rate	-2.456	−9.637*	-3.445	I(1)
Commodity Prices (Non-Fuel)	-1.839	−8.319*	-3.445	I(1)
Output Gap	−4.402*	(—)	-3.445	I(0)
Oil Prices	-1.766	−10.087*	-3.445	I(1)
Money Supply	-1.811	−4.643*	-3.445	I(1)
Interest Rates	-2.614	−6.033*	-3.445	I(1)
		U K		
Import Prices	-2.556	−7.329*	-3.445	I(1)
Export Prices	-2.417	−8.013*	-3.445	I(1)
Producer Prices	-2.795	−3.860*	-3.445	I(1)
Consumer Prices	-1.921	−3.845*	-3.446	I(1)
Exchange Rate	-3.066	−9.288*	-3.445	I(1)
Commodity Prices (Non-Fuel)	-1.839	−8.319*	-3.445	I(1)
Output Gap	−4.648*	(−−)	-3.445	I(0)
Oil Prices	-1.775	−10.061*	-3.445	I(1)
Money Supply	-1.756	−11.611*	-3.444	I(1)
Interest Rates	-1.641	−6.835*	-3.445	I(1)

Notes: The ADF statistic is derived according to the equation $y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=2}^{k} \beta_i \Delta y_{t-i+1} + \varepsilon_t$, where y_t denotes the time series, α_0, γ and β_i are parameters to be estimated, Δy_{t-i+1} was included in the regression to resolve any potential issue of serial correlation and ε_t is the white-noise error term. The main parameter of interest is γ. In the ADF test, the null hypothesis is that the time series has unit roots (nonstationary), that is, $\gamma = 1$ and the alternative hypothesis is that the series is stationary or $\gamma < 1$. The Akaike information criteria (AIC) was used to select the lag length in the unit roots test regression. * Denotes rejection of the null hypothesis that the time series have a unit root at 5% level, [a] Denotes critical value at the 5% level of significance.

Table 3.2: Augmented Dickey Fuller Unit Roots Test Results for Latin America

Variables	ADF Test Statistics			
	Level	First Difference	Critical Value[a]	Order of Integration
		ARGENTINA		
Import Prices	-2.150	−11.159*	-3.475	I(1)
Export Prices	-2.077	−15.451*	-3.475	I(1)
Producer Prices	-0.898	− − 5.545*	-3.475	I(1)
Consumer Prices	-2.263	−5.322*	-3.475	I(1)
Exchange Rate	-1.517	−7.229*	-3.475	I(1)
Commodity Prices (Non-Fuel)	-2.488	−6.324*	-3.475	I(1)
Output Gap	−4.917*	(—)	-3.475	I(0)
Oil Prices	-2.726	−6.239*	-3.475	I(1)
Money Supply	-1.221	−4.448*	-3.475	I(1)
Interest Rates	-2.873	−7.382*	-3.475	I(1)
		COLOMBIA		
Import Prices	-1.857	−6.128*	-3.472	I(1)
Export Prices	-1.818	−9.053*	-3.472	I(1)
Producer Prices	-2.177	−7.433*	-3.472	I(1)
Consumer Prices	-2.948	−6.387*	-3.472	I(1)
Exchange Rate	-1.037	−9.197*	-3.472	I(1)
Commodity Prices (Non-Fuel)	-2.186	−6.452*	-3.472	I(1)
Output Gap	−4.129*	(—)	-3.472	I(0)
Oil Prices	-3.342	−7.019*	-3.472	I(1)
Money Supply	-2.951	−6.244*	-3.472	I(1)
Interest Rates	-2.521	−4.162*	-3.472	I(1)
		MEXICO		
Import Prices	-2.072	−6.487*	-3.446	I(1)
Export Prices	-2.348	−7.515*	-3.446	I(1)
Producer Prices	-2.592	−4.468*	-3.446	I(1)
Consumer Prices	-2.549	−4.433*	-3.446	I(1)
Exchange Rate	-3.226	−11.121*	-3.446	I(1)
Commodity Prices (Non-Fuel)	-1.611	−8.001*	-3.446	I(1)
Output Gap	−5.059*	(—)	-3.446	I(0)
Oil Prices	-1.996	−9.921*	-3.446	I(1)
Money Supply	-3.072	−5.615*	-3.446	I(1)
Interest Rates	-3.194	−5.495*	-3.446	I(1)

Notes: The ADF statistic is derived according to the equation $y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=2}^{k} \beta_i \Delta y_{t-i+1} + \varepsilon_t$, where y_t denotes the time series, α_0, γ and β_i are parameters to be estimated, Δy_{t-i+1} was included in the regression to resolve any potential issue of serial correlation and ε_t is the white-noise error term. The main parameter of interest is γ. In the ADF test, the null hypothesis is that the time series has unit roots (nonstationary), that is, $\gamma = 1$ and the alternative hypothesis is that the series is stationary or $\gamma < 1$. The Akaike information criteria (AIC) was used to select the lag length in the unit roots test regression. * Denotes rejection of the null hypothesis that the time series have a unit root at 5% level, [a] Denotes critical value at the 5% level of significance.

Table 3.3: Augmented Dickey Fuller Unit Roots Test Results for Southeast Asia

Variables	ADF Test Statistics			
	Level	First Difference	Critical Value[a]	Order of Integration
PHILIPPINES				
Import Prices	-2.350	-10.734^{*}	-3.460	I(1)
Export Prices	-2.805	-9.070^{*}	-3.460	I(1)
Producer Prices	-1.151	-7.223^{*}	-3.460	I(1)
Consumer Prices	-1.835	-6.580^{*}	-3.460	I(1)
Exchange Rate	-0.776	-8.137^{*}	-3.460	I(1)
Commodity Prices (Non-Fuel)	-1.179	-7.062^{*}	-3.460	I(1)
Output Gap	-4.743^{*}	(—)	-3.460	I(0)
Oil Prices	-2.870	-9.008^{*}	-3.460	I(1)
Money Supply	-1.846	-8.056^{*}	-3.460	I(1)
Interest Rates	-0.965	-6.939^{*}	-3.460	I(1)
SOUTH KOREA				
Import Prices	-3.360	-8.647^{*}	-3.445	I(1)
Export Prices	-2.893	-10.288^{*}	-3.445	I(1)
Producer Prices	-3.049	-6.459^{*}	-3.445	I(1)
Consumer Prices	-0.927	-5.281^{*}	-3.445	I(1)
Exchange Rate	-2.698	-13.024^{*}	-3.445	I(1)
Commodity Prices (Non-Fuel)	-1.839	-8.319^{*}	-3.445	I(1)
Output Gap	-7.860^{*}	(—)	-3.445	I(0)
Oil Prices	-1.766	-10.087^{*}	-3.445	I(1)
Money Supply	-1.730	-8.637^{*}	-3.445	I(1)
Interest Rates	-3.140	-7.283^{*}	-3.445	I(1)
THAILAND				
Import Prices	-2.395	-6.475^{*}	-3.468	I(1)
Export Prices	-2.802	-7.390^{*}	-3.468	I(1)
Producer Prices	-3.366	-7.333^{*}	-3.468	I(1)
Consumer Prices	-2.625	-6.696^{*}	-3.468	I(1)
Exchange Rate	-1.469	-8.597^{*}	-3.468	I(1)
Commodity Prices (Non-Fuel)	-1.529	-6.548^{*}	-3.468	I(1)
Output Gap	-3.548^{*}	(—)	-3.468	I(0)
Oil Prices	-2.898	-7.214^{*}	-3.468	I(1)
Money Supply	-1.759	-8.695^{*}	-3.468	I(1)
Interest Rates	-2.262	-6.864^{*}	-3.468	I(1)

Notes: The ADF statistic is derived according to the equation $y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=2}^{k} \beta_i \Delta y_{t-i+1} + \varepsilon_t$, where y_t denotes the time series, α_0, γ and β_i are parameters to be estimated, Δy_{t-i+1} was included in the regression to resolve any potential issue of serial correlation and ε_t is the white-noise error term. The main parameter of interest is γ. In the ADF test, the null hypothesis is that the time series has unit roots (nonstationary), that is, $\gamma = 1$ and the alternative hypothesis is that the series is stationary or $\gamma < 1$. The Akaike information criteria (AIC) was used to select the lag length in the unit roots test regression. * Denotes rejection of the null hypothesis that the time series have a unit root at 5% level, [a] Denotes critical value at the 5% level of significance.

Table 3.4: Phillips-Perron Unit Roots Test Results for OECD

Variables	PP Test Statistics			
	Level	First Difference	Critical Value[a]	Order of Integration
		CANADA		
Import Prices	-1.036	-9.103^{*}	-3.444	I(1)
Export Prices	-2.206	-9.531^{*}	-3.445	I(1)
Producer Prices	-2.756	-7.638^{*}	-3.444	I(1)
Consumer Prices	-2.784	-6.978^{*}	-3.444	I(1)
Exchange Rate	-1.476	-9.967^{*}	-3.445	I(1)
Commodity Prices (Non-Fuel)	-1.616	-7.113^{*}	-3.444	I(1)
Output Gap	-3.934^{*}	(—)	-3.444	I(0)
Oil Prices	-1.761	-9.846^{*}	-3.444	I(1)
Money Supply	-2.185	-6.044^{*}	-3.444	I(1)
Interest Rates	-3.221	-6.983^{*}	-3.444	I(1)
		SWEDEN		
Import Prices	-3.402	-8.351^{*}	-3.444	I(1)
Export Prices	-2.492	-7.008^{*}	-3.445	I(1)
Producer Prices	-3.173	-7.960^{*}	-3.445	I(1)
Consumer Prices	-3.179	-9.310^{*}	-3.445	I(1)
Exchange Rate	-2.605	-9.649^{*}	-3.445	I(1)
Commodity Prices (Non-Fuel)	-1.616	-7.113^{*}	-3.445	I(1)
Output Gap	-8.503^{*}	(—)	-3.445	I(0)
Oil Prices	-1.761	-9.846^{*}	-3.445	I(1)
Money Supply	-2.354	-5.079^{*}	-3.445	I(1)
Interest Rates	-2.624	-5.570^{*}	-3.445	I(1)
		U K		
Import Prices	-2.469	-7.330^{*}	-3.444	I(1)
Export Prices	-2.621	-8.013^{*}	-3.445	I(1)
Producer Prices	-3.257	-7.075^{*}	-3.445	I(1)
Consumer Prices	-3.414	-11.140^{*}	-3.445	I(1)
Exchange Rate	-3.066	-10.064^{*}	-3.445	I(1)
Commodity Prices (Non-Fuel)	-1.616	-7.113^{*}	-3.444	I(1)
Output Gap	-4.648^{*}	(—)	-3.445	I(0)
Oil Prices	-1.766	-9.829^{*}	-3.445	I(1)
Money Supply	-1.987	-11.701^{*}	-3.445	I(1)
Interest Rates	-1.004	-6.790^{*}	-3.444	I(1)

*Notes:** Denotes rejection of the null hypothesis of time series have a unit root at 5% level, [a] Denotes critical Value at the 5% level of significance.

Table 3.5: Phillips-Perron Unit Roots Test Results for Latin America

Variables	PP Test Statistics			
	Level	First Difference	Critical Value[a]	Order of Integration
		ARGENTINA		
Import Prices	-2.150	−11.425*	-3.474	I(1)
Export Prices	-3.176	−15.451*	-3.474	I(1)
Producer Prices	-1.022	−4.339*	-3.474	I(1)
Consumer Prices	-3.181	−4.675*	-3.474	I(1)
Exchange Rate	-1.488	−7.150*	-3.474	I(1)
Commodity Prices (Non-Fuel)	-2.002	−5.243*	-3.474	I(1)
Output Gap	−6.316*	(—)	-3.474	I(0)
Oil Prices	-3.033	−5.970*	-3.474	I(1)
Money Supply	-1.547	−8.001*	-3.474	I(1)
Interest Rates	-3.028	−7.382*	-3.474	I(1)
		COLOMBIA		
Import Prices	-1.678	−6.976*	-3.471	I(1)
Export Prices	-2.553	−9.159*	-3.471	I(1)
Producer Prices	-2.524	−6.730*	-3.471	I(1)
Consumer Prices	-1.179	−7.229*	-3.471	I(1)
Exchange Rate	-0.942	−9.266*	-3.471	I(1)
Commodity Prices (Non-Fuel)	-1.600	−5.407*	-3.471	I(1)
Output Gap	−3.563*	(—)	-3.471	I(0)
Oil Prices	-2.933	−6.241*	-3.471	I(1)
Money Supply	-2.815	−11.837*	-3.471	I(1)
Interest Rates	-2.517	−5.998*	-3.471	I(1)
		MEXICO		
Import Prices	-1.455	−6.120*	-3.446	I(1)
Export Prices	-2.581	−10.019*	-3.446	I(1)
Producer Prices	-2.190	−4.481*	-3.446	I(1)
Consumer Prices	-2.219	−4.475*	-3.446	I(1)
Exchange Rate	-3.440	−11.399*	-3.446	I(1)
Commodity Prices (Non-Fuel)	-1.743	−7.007*	-3.446	I(1)
Output Gap	−9.471*	(—)	-3.446	I(0)
Oil Prices	-2.014	−9.650*	-3.446	I(1)
Money Supply	-2.773	−8.492*	-3.446	I(1)
Interest Rates	-3.338	−10.048*	-3.446	I(1)

Notes:* Denotes rejection of the null hypothesis of time series have a unit root at 5% level, [a] Denotes critical Value at the 5% level of significance.

Table 3.6: Phillips-Perron Unit Roots Test Results for Southeast Asia

Variables	PP Test Statistics			
	Level	First Difference	Critical Value[a]	Order of Integration
		PHILIPPINES		
Import Prices	-2.172	−11.067*	-3.460	I(1)
Export Prices	-2.801	−9.726*	-3.460	I(1)
Producer Prices	-0.708	−7.235*	-3.460	I(1)
Consumer Prices	-3.159	−6.358*	-3.460	I(1)
Exchange Rate	-1.048	−8.154*	-3.460	I(1)
Commodity Prices (Non-Fuel)	-1.636	−5.967*	-3.460	I(1)
Output Gap	−14.956*	(—)	-3.460	I(0)
Oil Prices	-2.627	−8.169*	-3.460	I(1)
Money Supply	-1.909	−13.104*	-3.460	I(1)
Interest Rates	-1.031	−3.951*	-3.460	I(1)
		SOUTH KOREA		
Import Prices	-2.958	−9.459*	-3.444	I(1)
Export Prices	-2.925	−10.526*	-3.444	I(1)
Producer Prices	-1.674	−8.196*	-3.444	I(1)
Consumer Prices	-3.146	−7.954*	-3.444	I(1)
Exchange Rate	-2.589	−12.963*	-3.444	I(1)
Commodity Prices (Non-Fuel)	-1.616	−7.113*	-3.444	I(1)
Output Gap	−15.734*	(—)	-3.444	I(0)
Oil Prices	-1.761	−9.846*	-3.444	I(1)
Money Supply	-1.297	−9.235*	-3.444	I(1)
Interest Rates	-2.454	−7.369*	-3.444	I(1)
		THAILAND		
Import Prices	-1.815	−6.467*	-3.468	I(1)
Export Prices	-2.197	−7.488*	-3.468	I(1)
Producer Prices	-2.893	−7.682*	-3.468	I(1)
Consumer Prices	-2.403	−5.917*	-3.468	I(1)
Exchange Rate	-1.495	−8.597*	-3.468	I(1)
Commodity Prices (Non-Fuel)	-1.569	−5.438*	-3.468	I(1)
Output Gap	−5.333*	(—)	-3.468	I(0)
Oil Prices	-3.130	−6.353*	-3.468	I(1)
Money Supply	-0.267	−12.128*	-3.468	I(1)
Interest Rates	-2.236	−6.876*	-3.468	I(1)

Notes:* Denotes rejection of the null hypothesis of time series have a unit root at 5% level, [a] Denotes critical Value at the 5% level of significance.

Table 3.7: Zivot-Andrews Unit Roots Test Results for OECD

Variables	ZAURoot Test Statistics			
	Level	First Difference	Critical Value[a]	Order of Integration
		CANADA		
Import Prices	-4.927	-6.453^{*}	-5.080	I(1)
Export Prices	-5.031	-6.045^{*}	-5.080	I(1)
Producer Prices	-5.003	-8.984^{*}	-5.080	I(1)
Consumer Prices	-4.998	-5.364^{*}	-5.080	I(1)
Exchange Rate	-3.219	-9.617^{*}	-5.080	I(1)
Commodity Prices (Non-Fuel)	-4.611	-8.698^{*}	-5.080	I(1)
Output Gap	-5.260^{*}	(—-)	-5.080	I(0)
Oil Prices	-3.720	-7.427^{*}	-5.080	I(1)
Money Supply	-2.382	-5.237^{*}	-5.080	I(1)
Interest Rates	-4.326	-7.116^{*}	-5.080	I(1)
		SWEDEN		
Import Prices	-4.891	-7.116^{*}	-5.080	I(1)
Export Prices	-3.743	-7.400^{*}	-5.080	I(1)
Producer Prices	-4.860	-5.125^{*}	-5.080	I(1)
Consumer Prices	-4.657	-5.150^{*}	-5.080	I(1)
Exchange Rate	-4.548	-10.245^{*}	-5.080	I(1)
Commodity Prices (Non-Fuel)	-4.611	-8.698^{*}	-5.080	I(1)
Output Gap	-6.420^{*}	(—)	-5.080	I(0)
Oil Prices	-3.720	-7.427^{*}	-5.080	I(1)
Money Supply	-4.134	-5.400^{*}	-5.080	I(1)
Interest Rates	-4.118	-6.574^{*}	-5.080	I(1)
		U K		
Import Prices	-3.333	-8.288^{*}	-5.080	I(1)
Export Prices	-3.279	-8.274^{*}	-5.080	I(1)
Producer Prices	-2.888	-5.619^{*}	-5.080	I(1)
Consumer Prices	-4.919	-6.079^{*}	-5.080	I(1)
Exchange Rate	-4.544	-5.887^{*}	-5.080	I(1)
Commodity Prices (Non-Fuel)	-3.717	-8.557^{*}	-5.080	I(1)
Output Gap	-5.607^{*}	(—)	-5.080	I(0)
Oil Prices	-3.574	-7.431^{*}	-5.080	I(1)
Money Supply	-3.476	-11.950^{*}	-5.080	I(1)
Interest Rates	-4.077	-7.277^{*}	-5.080	I(1)

Notes: The table shows the reported Zauroot test results on the time series. Zivot-Andrews (Zauroot) tests performed on the series allows for a single structural break for both the intercept and trend of the time series. In order to determine this single structural break, a grid search procedure was conducted over some potential breakpoints. * Denotes rejection of the null hypothesis that the time series have a unit root at 5% level, [a] Denotes critical value at the 5% level of significance.

Table 3.8: Zivot-Andrews Unit Roots Test Results for Latin America

Variables	ZAURoot Test Statistics			
	Level	First Difference	Critical Value[a]	Order of Integration
		ARGENTINA		
Import Prices	-3.732	−11.748*	-5.080	I(1)
Export Prices	-3.844	−15.884*	-5.080	I(1)
Producer Prices	-4.822	−6.697*	-5.080	I(1)
Consumer Prices	-4.391	−6.543*	-5.080	I(1)
Exchange Rate	-3.726	−8.393*	-5.080	I(1)
Commodity Prices (Non-Fuel)	-3.104	−6.830*	-5.080	I(1)
Output Gap	−5.229*	(−)	-5.080	I(0)
Oil Prices	-4.109	−6.830*	-5.080	I(1)
Money Supply	-5.003	−5.212*	-5.080	I(1)
Interest Rates	-4.327	−6.083*	-5.080	I(1)
		COLOMBIA		
Import Prices	-3.389	−7.224*	-5.080	I(1)
Export Prices	-4.283	−6.117*	-5.080	I(1)
Producer Prices	-3.210	−5.833*	-5.080	I(1)
Consumer Prices	-3.752	−5.416*	-5.080	I(1)
Exchange Rate	-4.750	−9.700*	-5.080	I(1)
Commodity Prices (Non-Fuel)	-3.600	−6.790*	-5.080	I(1)
Output Gap	−5.284*	(−)	-5.080	I(0)
Oil Prices	-4.229	−7.584*	-5.080	I(1)
Money Supply	-3.487	−6.996*	-5.080	I(1)
Interest Rates	-3.780	−5.427*	-5.080	I(1)
		MEXICO		
Import Prices	-4.266	−7.028*	-5.080	I(1)
Export Prices	-2.913	−10.291*	-5.080	I(1)
Producer Prices	-4.077	−9.717*	-5.080	I(1)
Consumer Prices	-4.242	−8.596*	-5.080	I(1)
Exchange Rate	-3.752	−5128*	-5.080	I(1)
Commodity Prices (Non-Fuel)	-4.371	−8.342*	-5.080	I(1)
Output Gap	−5.916*	(−)	-5.080	I(0)
Oil Prices	-3.762	−7.279*	-5.080	I(1)
Money Supply	-4.517	−6.502*	-5.080	I(1)
Interest Rates	-4.695	−6.306*	-5.080	I(1)

Notes: The table shows the reported Zauroot test results on the time series. Zivot-Andrews (Zauroot) tests performed on the series allows for a single structural break for both the intercept and trend of the time series. In order to determine this single structural break, a grid search procedure was conducted over some potential breakpoints.* Denotes rejection of the null hypothesis that the time series have a unit root at 5% level, [a] Denotes critical value at the 5% level of significance.

Table 3.9: Zivot-Andrews Unit Roots Test Results for Southeast Asia

Variables	ZAURoot Test Statistics			
	Level	First Difference	Critical Value[a]	Order of Integration
		PHILIPPINES		
Import Prices	-3.297	-10.543^{*}	-5.080	I(1)
Export Prices	-4.539	-9.395^{*}	-5.080	I(1)
Producer Prices	-2.714	-8.667^{*}	-5.080	I(1)
Consumer Prices	-4.122	-6.186^{*}	-5.080	I(1)
Exchange Rate	-5.003	-8.678^{*}	-5.080	I(1)
Commodity Prices (Non-Fuel)	-3.856	-7.368^{*}	-5.080	I(1)
Output Gap	-4.500	-5.104^{*}	-5.080	I(1)
Oil Prices	-4.788	-6.582^{*}	-5.080	I(1)
Money Supply	-3.991	$--5.203^{*}$	-5.080	I(1)
Interest Rates	-3.617	-7.413^{*}	-5.080	I(1)
		SOUTH KOREA		
Import Prices	-4.077	-7.581^{*}	-5.080	I(1)
Export Prices	-3.622	-7.067^{*}	-5.080	I(1)
Producer Prices	-4.454	-6.870^{*}	-5.080	I(1)
Consumer Prices	-4.116	-6.912^{*}	-5.080	I(1)
Exchange Rate	-4.460	-13.273^{*}	-5.080	I(1)
Commodity Prices (Non-Fuel)	-3.717	-8.557^{*}	-5.080	I(1)
Output Gap	-8.519^{*}	(—)	-5.080	I(0)
Oil Prices	-3.205	-7.333^{*}	-5.080	I(1)
Money Supply	-2.591	-5.978^{*}	-5.080	I(1)
Interest Rates	-4.869	-8.476^{*}	-5.080	I(1)
		THAILAND		
Import Prices	-4.822	-7.472^{*}	-5.080	I(1)
Export Prices	-4.258	-8.612^{*}	-5.080	I(1)
Producer Prices	-4.677	-7.315^{*}	-5.080	I(1)
Consumer Prices	-3.238	-6.105^{*}	-5.080	I(1)
Exchange Rate	-3.514	-10.582^{*}	-5.080	I(1)
Commodity Prices (Non-Fuel)	-3.558	-6.968^{*}	-5.080	I(1)
Output Gap	-4.384	-5.023^{*}	-5.080	I(1)
Oil Prices	-4.334	-5.838^{*}	-5.080	I(1)
Money Supply	-4.416	-9.892^{*}	-5.080	I(1)
Interest Rates	-4.876	-5.351^{*}	-5.080	I(1)

Notes: The table shows the reported Zauroot test results on the time series. Zivot-Andrews (Zauroot) tests performed on the series allows for a single structural break for both the intercept and trend of the time series. In order to determine this single structural break, a grid search procedure was conducted over some potential breakpoints.* Denotes rejection of the null hypothesis of time series have a unit root at 5% level, [a] Denotes critical value at the 5% level of significance.

Table 3.10: Maximum Eigenvalue ($\lambda_{\max}$) and Trace (λ_{trace}) Test Results for OECD

Null Hypothesis	Alternative Hypothesis	Test Statistic	Critical Value	p-Values**
	CANADA			
Trace Statistic				
$r = 0$	$r \geq 1$	420.897*	197.371	0.000
$r \leq 1$	$r \geq 2$	252.353	159.530	0.000
$r \leq 2$	$r \geq 3$	189.423	125.615	0.000
$r \leq 3$	$r \geq 4$	119.246	95.754	0.001
$r \leq 4$	$r \geq 5$	66.787	69.819	0.085
Maximum Eigenvalue Statistic				
$r = 0$	$r = 1$	138.544*	58.434	0.000
$r \leq 1$	$r = 2$	92.930	52.363	0.000
$r \leq 2$	$r = 3$	70.177	46.231	0.000
$r \leq 3$	$r = 4$	52.459	40.078	0.001
$r \leq 4$	$r = 5$	27.195	40.078	0.253
	SWEDEN			
Trace Statistic				
$r = 0$	$r \geq 1$	248.285*	197.371	0.000
$r \leq 1$	$r \geq 2$	181.653	159.530	0.002
$r \leq 2$	$r \geq 3$	131.559	125.615	0.021
$r \leq 3$	$r \geq 4$	93.987	95.754	0.066
Maximum Eigenvalue Statistic				
$r = 0$	$r = 1$	66.632*	58.434	0.007
$r \leq 1$	$r = 2$	50.094	52.363	0.084
	U K			
Trace Statistic				
$r = 0$	$r \geq 1$	330.522*	197.371	0.000
$r \leq 1$	$r \geq 2$	245.957	159.530	0.000
$r \leq 2$	$r \geq 3$	177.203	125.615	0.000
$r \leq 3$	$r \geq 4$	116.692	95.754	0.001
$r \leq 4$	$r \geq 5$	68.865	69.819	0.059
Maximum Eigenvalue Statistic				
$r = 0$	$r = 1$	84.564*	58.434	0.000
$r \leq 1$	$r = 2$	68.754	52.363	0.001
$r \leq 2$	$r = 3$	60.511	46.231	0.001
$r \leq 3$	$r = 2$	47.828	40.078	0.006
$r \leq 4$	$r = 5$	25.806	33.877	0.333

Notes: * Denotes rejection of null hypothesis of no cointegration among the variables at 5% level. ** p-values are based on Mackinnon-Haug-Michelis (1999) p-values.

Table 3.11: Maximum Eigenvalue ($\lambda_{\max}$) and Trace (λ_{trace}) Test Results for Latin America

Null Hypothesis	Alternative Hypothesis	Test Statistic	Critical Value	p-Values**
	ARGENTINA			
Trace Statistic				
$r = 0$	$r \geq 1$	391.371*	197.371	0.000
$r \leq 1$	$r \geq 2$	242.753	159.530	0.000
$r \leq 2$	$r \geq 3$	168.847	125.615	0.000
$r \leq 3$	$r \geq 4$	114.242	95.754	0.002
$r \leq 4$	$r \geq 5$	76.804	69.819	0.012
$r \leq 5$	$r \geq 6$	44.806	47.856	0.094
Maximum Eigenvalue Statistic				
$r = 0$	$r = 1$	148.382*	58.434	0.000
$r \leq 1$	$r = 2$	73.905	52.363	0.000
$r \leq 2$	$r = 3$	54.607	46.231	0.005
$r \leq 3$	$r = 4$	37.436	40.078	0.096
	COLOMBIA			
Trace Statistic				
$r = 0$	$r \geq 1$	313.947*	197.371	0.000
$r \leq 1$	$r \geq 2$	219.573	159.530	0.000
$r \leq 2$	$r \geq 3$	148.502	125.615	0.001
$r \leq 3$	$r \geq 4$	100.984	95.754	0.021
$r \leq 4$	$r \geq 5$	68.729	69.819	0.061
Maximum Eigenvalue Statistic				
$r = 0$	$r = 1$	38.121	58.434	0.000
$r \leq 1$	$r = 2$	35.195	52.363	0.000
$r \leq 2$	$r = 3$	36.143	46.231	0.036
$r \leq 3$	$r = 4$	32.254	40.078	0.289
	MEXICO			
Trace Statistic				
$r = 0$	$r \geq 1$	291.042*	197.371	0.000
$r \leq 1$	$r \geq 2$	216.286	159.530	0.000
$r \leq 2$	$r \geq 3$	153.263	125.615	0.000
$r \leq 3$	$r \geq 4$	108.875	95.754	0.005
$r \leq 4$	$r \geq 5$	66.392	69.819	0.091
Maximum Eigenvalue Statistic				
$r = 0$	$r = 1$	74.756*	58.434	0.001
$r \leq 1$	$r = 2$	63.023	52.363	0.003
$r \leq 2$	$r = 3$	44.388	46.231	0.078

Notes: * Denotes rejection of null hypothesis of no cointegration among the variables at 5% level. ** p-values are based on Mackinnon-Haug-Michelis (1999) p-values.

Table 3.12: Maximum Eigenvalue (λ_{max}) and Trace (λ_{trace}) Test Results for Southeast Asia

Null Hypothesis	Alternative Hypothesis	Test Statistic	Critical Value	p-Values**
	PHILIPPINES			
Trace Statistic				
$r = 0$	$r \geq 1$	300.050*	197.371	0.000
$r \leq 1$	$r \geq 2$	187.439	159.530	0.001
$r \leq 2$	$r \geq 3$	126.345	125.615	0.045
$r \leq 3$	$r \geq 4$	74.213	95.754	0.573
Maximum Eigenvalue Statistic				
$r = 0$	$r = 1$	112.611*	58.434	0.000
$r \leq 1$	$r = 2$	61.094	52.363	0.005
$r \leq 2$	$r = 3$	52.132	46.231	0.011
$r \leq 3$	$r = 4$	29.061	40.078	0.487
	SOUTH KOREA			
Trace Statistic				
$r = 0$	$r \geq 1$	279.684*	197.371	0.000
$r \leq 1$	$r \geq 2$	206.419	159.530	0.000
$r \leq 2$	$r \geq 3$	143.213	125.615	0.003
$r \leq 3$	$r \geq 4$	104.894	95.754	0.010
$r \leq 4$	$r \geq 5$	67.050	69.819	0.082
Maximum Eigenvalue Statistic				
$r = 0$	$r = 1$	73.265*	58.434	0.001
$r \leq 1$	$r = 2$	63.206	52.363	0.003
$r \leq 2$	$r = 3$	38.319	46.231	0.272
	THAILAND			
Trace Statistic				
$r = 0$	$r \geq 1$	242.912*	197.371	0.000
$r \leq 1$	$r \geq 2$	168.520	159.530	0.015
$r \leq 2$	$r \geq 3$	125.709	125.615	0.049
$r \leq 3$	$r \geq 4$	92.157	95.754	0.086
Maximum Eigenvalue Statistic				
$r = 0$	$r = 1$	74.392*	58.434	0.001
$r \leq 1$	$r = 2$	42.810	52.363	0.334

Notes: * Denotes rejection of null hypothesis of no cointegration among the variables at 5% level. ** p-values are based on Mackinnon-Haug-Michelis (1999) p-values.

Table 3.13: VAR Lag Order Selection Criteria for OECD

Lag Order	FPE	AIC	SIC	Hannan-Quinn
		CANADA		
0	2.85×10^{-15}	-7.950	-7.659	-7.834
1	1.08×10^{-16}	-11.242	-8.328*	-10.086
2	8.27×10^{-17}	-11.622	-6.085	-9.425
3	4.34×10^{-17}	-12.580	-4.421	-9.343*
4	1.61×10^{-17}	-14.257	-3.475	-9.980
5	5.23×10^{-18}	-16.736	-3.331	-11.418
6	$3.65 \times 10^{-18}*$	-19.894*	-3.866	-13.535
		SWEDEN		
0	1.49×10^{-26}	-33.929	-33.752*	-33.846
1	2.42×10^{-27}	-35.748	-33.711	-34.920
2	1.89×10^{-27}	-36.012	-32.143	-34.440*
3	1.90×10^{-27}	-36.055	-30.354	-33.739
4	$3.66 \times 10^{-28}*$	-37.797*	-30.263	-34.736
5	5.43×10^{-28}	-37.566	-28.199	-33.761
6	9.08×10^{-18}	-37.306	-26.105	-32.756
		UK		
0	2.68×10^{-28}	-37.947	-37.742	-37.864
1	1.71×10^{-29}	-40.699	-38.641*	-39.863*
2	1.58×10^{-29}	-40.798	-36.888	-39.210
3	1.39×10^{-29}	-40.977	-35.215	-38.637
4	$1.38 \times 10^{-29}*$	-41.086	-33.472	-37.993
5	1.96×10^{-29}	-40.905	-31.440	-37.060
6	2.86×10^{-29}	-40.796	-29.479	-36.199
7	2.19×10^{-29}	-41.466	-28.297	-36.117
8	2.36×10^{-29}	-41.986 *	-26.965	-35.885

Notes: FPE denotes Final Prediction Error, AIC denotes Akaike Information Criterion, SIC denotes Schwarz Information Criterion and * indicates the lag order selected by a given criterion. From the results it is easy to notice that $\tilde{p}^{AIC} \geq \tilde{p}^{HQC} \geq \tilde{p}^{SIC} \quad \forall T \geq 12$ and $\tilde{p}^{HQC} \geq \tilde{p}^{SIC} \quad \forall T$.

Table 3.14: VAR Lag Order Selection Criteria for Latin America

Lag Order	FPE	AIC	SIC	Hannan-Quinn
		ARGENTINA		
0	2.62×10^{-15}	-8.036	-7.749	-7.922
1	1.14×10^{-16}	-11.184	-8.316*	-10.044*
2	1.14×10^{-16}	-11.291	-5.841	-9.124
3	6.84×10^{-17}	-12.087	-4.056	-8.893
4	3.38×10^{-17}*	-13.406*	-2.794	-9.186
		COLOMBIA		
0	1.17×10^{-20}	-20.357	-20.068*	-20.242
1	1.35×10^{-21}	-22.528	-19.637	-21.380*
2	1.08×10^{-21}	-22.862	-17.369	-20.680
3	8.82×10^{-22}	-23.364	-15.270	-20.149
4	5.75×10^{-22}*	-24.440	-13.743	-20.191
5	7.48×10^{-22}	-25.455*	-12.157	-20.173
		MEXICO		
0	8.19×10^{-22}	-23.014	-22.803	-22.928
1	5.59×10^{-23}	-25.700	-23.599*	-24.847
2	6.42×10^{-23}	-25.583	-21.590	-23.962*
3	7.79×10^{-23}	-25.447	-19.562	-23.057
4	5.84×10^{-23}	-25.845	-18.068	-22.687
5	3.57×10^{-23}*	-26.527	-16.858	-22.601
6	4.02×10^{-23}	-26.710	-15.150	-22.016
7	5.11×10^{-23}	-26.926	-13.474	-21.464
8	7.16×10^{-23}	-27.268 *	-11.924	-21.038

Notes: FPE denotes Final Prediction Error, AIC denotes Akaike Information Criterion, SIC denotes Schwarz Information Criterion and * indicates the lag order selected by a given criterion. From the results it is easy to notice that $\tilde{p}^{AIC} \geq \tilde{p}^{HQC} \geq \tilde{p}^{SIC} \quad \forall T \geq 12$ and $\tilde{p}^{HQC} \geq \tilde{p}^{SIC} \quad \forall T$.

Table 3.15: VAR Lag Order Selection Criteria for Southeast Asia

Lag Order	FPE	AIC	SIC	Hannan-Quinn
		PHILIPPINES		
0	2.15×10^{-22}	-24.349	-24.089*	-24.245
1	1.96×10^{-22}	-24.453	-21.848	-23.406
2	2.54×10^{-22}	-24.257	-19.309	-22.268
3	3.49×10^{-22}	-24.104	-16.811	-21.172*
4	1.52×10^{-22}	-26.277	-15.641	-21.403
5	8.91×10^{-23}*	-26.444	-14.464	-21.628
6	2.07×10^{-22}	-26.706	-12.381	-20.947
7	2.53×10^{-22}	-28.489*	-11.820	-21.788
		SOUTH KOREA		
0	6.55×10^{-21}	-20.933	-20.731	-20.851
1	4.95×10^{-22}	-23.520	-21.494*	-22.697*
2	3.75×10^{-22}	-23.815	-19.966	-22.251
3	2.92×10^{-22}	-24.114	-18.441	-21.809
4	8.62×10^{-23}	-25.425	-17.929	-22.379
5	7.21×10^{-23}*	-25.760*	-16.441	-21.974
		THAILAND		
0	1.06×10^{-23}	-27.361	-27.081	-20.851
1	2.38×10^{-24}*	-28.871	-26.068*	-22.697
2	2.43×10^{-24}	-28.939	-23.614	-26.815*
3	3.97×10^{-24}	-28.699	-20.852	-25.569
4	6.95×10^{-24}	-28.670	-18.302	-24.534
5	4.05×10^{-24}	-30.231*	-17.340	-25.089

Notes: FPE denotes Final Prediction Error, AIC denotes Akaike Information Criterion, SIC denotes Schwarz Information Criterion and * indicates the lag order selected by a given criterion. From the results it is easy to notice that $\tilde{p}^{AIC} \geq \tilde{p}^{HQC} \geq \tilde{p}^{SIC} \quad \forall T \geq 12$ and $\tilde{p}^{HQC} \geq \tilde{p}^{SIC} \quad \forall T$.

Table 3.16: First Stage ERPT Elasticities (OECD)

Quarterly Horizon	**Trade Prices**		**Price Inflation**	
	Export Prices	*Import Prices*	*Producer Prices*	*Consumer Prices*
		CANADA		
1	0.208	0.406	0.089	-0.016
2	0.317	0.651	0.153	0.011
3	0.240	0.623	0.165	0.030
4	0.227	0.629	0.169	0.040
5	0.227	0.628	0.171	0.045
6	0.236	0.628	0.173	0.047
7	0.247	0.628	0.175	0.046
8	0.258	0.627	0.177	0.044
9	0.267	0.627	0.179	0.041
10	0.274	0.626	0.181	0.039
11	0.279	0.624	0.182	0.035
12	0.283	0.623	0.183	0.032
Mean Per Quarter	**0.255**	**0.610**	**0.166**	**0.033**
		SWEDEN		
1	0.063	0.130	0.069	0.016
2	0.162	0.244	0.127	0.026
3	0.196	0.248	0.135	0.041
4	0.212	0.249	0.139	0.047
5	0.217	0.250	0.141	0.051
6	0.219	0.251	0.142	0.053
7	0.219	0.250	0.143	0.055
8	0.219	0.250	0.143	0.056
9	0.219	0.250	0.143	0.056
10	0.219	0.250	0.143	0.057
11	0.219	0.250	0.143	0.057
12	0.219	0.250	0.143	0.057
Mean Per Quarter	**0.200**	**0.239**	**0.134**	**0.048**
		U K		
1	0.115	0.123	0.014	-0.012
2	0.249	0.295	0.038	-0.016
3	0.343	0.369	0.066	-0.012
4	0.354	0.379	0.082	0.003
5	0.349	0.375	0.087	0.010
6	0.348	0.375	0.088	0.019
7	0.348	0.375	0.089	0.012
8	0.347	0.374	0.088	0.012
9	0.345	0.372	0.088	0.011
10	0.344	0.371	0.087	0.010
11	0.342	0.370	0.086	0.009
12	0.341	0.369	0.085	0.009
Mean Per Quarter	**0.319**	**0.346**	**0.075**	**0.004**

Notes: The reported ERPT elasticities are derived from the accumulated impulse response functions according to the following equation: $ERPT_{t,t+l} = \frac{\sum_{l=1}^{T} \frac{\partial Z_{j,t+l}}{\partial \varepsilon^{j}_{t,t+l}}}{\sum_{l=1}^{T} \frac{\partial S_{t,t+l}}{\partial \varepsilon^{s_t}_{t,t+l}}} \quad \forall j \in [p^E, p^M, p^{PPI}, p^{CPI}]$. The numerator represents the accumulated response of trade prices, producer prices and consumer prices to a nominal exchange rate innovation evaluated l quarters after the shock and the denominator represents the accumulated response of nominal exchange rate to its own shock evaluated l quarters after the shock.

Table 3.17: First Stage ERPT Elasticities (Latin America)

Quarterly Horizon	Trade Prices		Price Inflation	
	Export Prices	*Import Prices*	*Producer Prices*	*Consumer Prices*
		ARGENTINA		
1	0.063	0.046	0.179	0.058
2	0.056	0.015	0.480	0.202
3	0.124	0.023	0.641	0.277
4	0.175	0.012	0.678	0.319
5	0.269	0.052	0.736	0.364
6	0.264	0.060	0.789	0.410
7	0.194	0.031	0.717	0.386
8	0.126	0.021	0.610	0.325
9	0.141	0.041	0.609	0.315
10	0.160	0.049	0.604	0.305
11	0.177	0.046	0.614	0.308
12	0.180	0.045	0.620	0.312
Mean Per Quarter	**0.161**	**0.037**	**0.399**	**0.298**
		COLOMBIA		
1	0.332	0.251	0.056	0.006
2	0.629	0.567	0.201	0.041
3	0.492	0.626	0.256	0.104
4	0.325	0.494	0.208	0.108
5	0.419	0.490	0.191	0.087
6	0.433	0.559	0.212	0.086
7	0.388	0.546	0.210	0.093
8	0.418	0.531	0.212	0.098
9	0.427	0.531	0.212	0.093
10	0.421	0.542	0.213	0.089
11	0.415	0.543	0.216	0.092
12	0.416	0.541	0.219	0.096
Mean Per Quarter	**0.426**	**0.518**	**0.200**	**0.082**
		MEXICO		
1	0.050	0.171	0.087	0.032
2	0.204	0.203	0.332	0.250
3	0.298	1.013	0.464	0.398
4	0.227	0.829	0.514	0.461
5	0.211	0.758	0.559	0.511
6	0.205	0.712	0.596	0.553
7	0.360	0.611	0.624	0.585
8	0.087	0.633	0.645	0.609
9	0.199	0.606	0.663	0.628
10	0.095	0.581	0.677	0.644
11	0.097	0.560	0.688	0.657
12	0.321	0.543	0.698	0.668
Mean Per Quarter	**0.196**	**0.602**	**0.546**	**0.500**

Notes: The reported ERPT elasticities are derived from the accumulated impulse response functions according to the following equation: $ERPT_{t,t+l} = \frac{\sum_{l=1}^{T} \frac{\partial Z_{j,t+l}}{\partial \varepsilon^{j}_{t,t+l}}}{\sum_{l=1}^{T} \frac{\partial S_{t,t+l}}{\partial \varepsilon^{s_t}_{t,t+l}}} \quad \forall j \in [p^E, p^M, p^{PPI}, p^{CPI}]$. The numerator represents the accumulated response of trade prices, producer prices and consumer prices to a nominal exchange rate innovation evaluated l quarters after the shock and the denominator represents the accumulated response of nominal exchange rate to its own shock evaluated l quarters after the shock.

Table 3.18: First Stage ERPT Elasticities (Southeast Asia)

Quarterly Horizon	**Trade Prices**		**Price Inflation**	
	Export Prices	*Import Prices*	*Producer Prices*	*Consumer Prices*
		PHILIPPINES		
1	-0.006	0.114	0.073	0.024
2	0.068	0.331	0.148	0.044
3	-0.028	0.208	0.230	0.086
4	0.012	0.106	0.179	0.096
5	0.011	0.090	0.175	0.118
6	0.071	0.111	0.208	0.142
7	0.077	0.073	0.217	0.151
8	0.048	0.075	0.197	0.139
9	0.041	0.126	0.186	0.133
10	0.060	0.137	0.197	0.132
11	0.062	0.108	0.204	0.131
12	0.048	0.096	0.198	0.130
Mean Per Quarter	**0.039**	**0.131**	**0.184**	**0.110**
		SOUTH KOREA		
1	0.140	0.147	0.013	0.007
2	0.804	0.673	0.148	0.068
3	0.628	0.505	0.154	0.076
4	0.641	0.473	0.151	0.088
5	0.622	0.448	0.148	0.094
6	0.631	0.454	0.150	0.099
7	0.630	0.454	0.153	0.102
8	0.635	0.455	0.155	0.106
9	0.635	0.453	0.156	0.108
10	0.635	0.452	0.157	0.109
11	0.636	0.451	0.158	0.111
12	0.636	0.451	0.158	0.112
Mean Per Quarter	**0.606**	**0.451**	**0.142**	**0.090**
		THAILAND		
1	0.359	0.366	0.005	0.031
2	0.661	0.746	0.101	0.038
3	0.678	0.874	0.161	0.062
4	0.458	0.565	0.118	0.068
5	0.486	0.597	0.184	0.085
6	0.282	0.402	0.072	0.064
7	0.208	0.227	-0.015	0.026
8	0.195	0.193	0.022	0.012
9	0.228	0.250	0.037	0.013
10	0.273	0.335	0.071	0.010
11	0.318	0.417	0.114	0.009
12	0.289	0.386	0.115	0.014
Mean Per Quarter	**0.370**	**0.447**	**0.082**	**0.036**

Notes: The reported ERPT elasticities are derived from the accumulated impulse response functions according to the following equation: $ERPT_{t,t+l} = \frac{\sum_{l=1}^{T} \frac{\partial z_{j,t+l}}{\partial \varepsilon^{j}_{t,t+l}}}{\sum_{l=1}^{T} \frac{\partial S_{t,t+l}}{\partial \varepsilon^{s_t}_{t,t+l}}} \quad \forall j \in [p^E, p^M, p^{PPI}, p^{CPI}]$. The numerator represents the accumulated response of trade prices, producer prices and consumer prices to a nominal exchange rate innovation evaluated l quarters after the shock and the denominator represents the accumulated response of nominal exchange rate to its own shock evaluated l quarters after the shock.

Table 3.19: Second Stage ERPT Elasticities (OECD)

Quarterly Horizon	Price Inflation	
	Producer Prices	*Consumer Prices*
	CANADA	
1	0.073	0.068
2	0.106	0.063
3	0.226	0.096
4	0.215	0.114
5	0.235	0.121
6	0.232	0.121
7	0.228	0.114
8	0.216	0.104
9	0.209	0.092
10	0.202	0.080
11	0.198	0.069
12	0.196	0.060
Mean Per Quarter	**0.195**	**0.087**
	SWEDEN	
1	0.549	0.040
2	0.584	0.235
3	0.600	0.272
4	0.595	0.313
5	0.600	0.334
6	0.600	0.348
7	0.600	0.355
8	0.600	0.359
9	0.600	0.361
10	0.600	0.363
11	0.600	0.363
12	0.600	0.363
Mean Per Quarter	**0.594**	**0.308**
	UK	
1	0.103	-0.044
2	0.200	0.000
3	0.247	0.062
4	0.271	0.085
5	0.281	0.098
6	0.286	0.103
7	0.289	0.106
8	0.291	0.108
9	0.291	0.108
10	0.291	0.108
11	0.291	0.107
12	0.291	0.107
Mean Per Quarter	**0.261**	**0.079**

Notes: The reported pass-through elasticities are derived from the accumulated impulse response functions of producer prices, consumer prices and import prices.

Table 3.20: Second Stage ERPT Elasticities (Latin America)

Quarterly Horizon	Price Inflation	
	Producer Prices	*Consumer Prices*
	ARGENTINA	
1	0.144	0.052
2	0.380	0.112
3	1.774	0.609
4	0.206	0.121
5	0.119	0.041
6	0.323	0.099
7	0.318	0.119
8	0.169	0.065
9	0.274	0.090
10	0.396	0.133
11	0.357	0.123
12	0.326	0.111
Mean Per Quarter	**0.399**	**0.140**
	COLOMBIA	
1	0.046	0.007
2	0.073	0.071
3	0.011	0.120
4	-0.011	0.102
5	-0.069	0.032
6	-0.050	0.047
7	-0.001	0.092
8	0.013	0.099
9	0.015	0.081
10	0.025	0.092
11	0.024	0.112
12	0.017	0.117
Mean Per Quarter	**0.008**	**0.081**
	MEXICO	
1	0.137	0.026
2	0.185	0.022
3	0.194	0.026
4	0.135	0.075
5	0.126	0.028
6	0.123	0.036
7	0.126	0.040
8	0.129	0.047
9	0.131	0.052
10	0.132	0.057
11	0.132	0.060
12	0.134	0.063
Mean Per Quarter	**0.140**	**0.044**

Notes: The reported pass-through elasticities are derived from the accumulated impulse response functions of producer prices, consumer prices and import prices.

Table 3.21: Second Stage ERPT Elasticities (Southeast Asia)

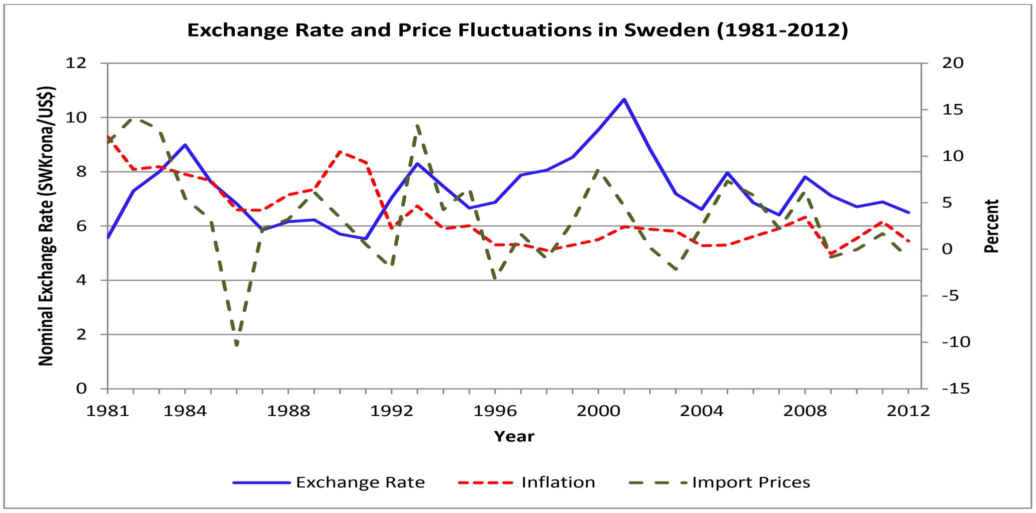
Quarterly Horizon	Price Inflation	
	Producer Prices	*Consumer Prices*
	PHILIPPINES	
1	0.003	0.013
2	0.223	0.023
3	0.041	0.043
4	0.043	0.119
5	0.099	0.146
6	0.107	0.157
7	0.114	0.156
8	0.095	0.141
9	0.134	0.146
10	0.138	0.150
11	0.124	0.156
12	0.117	0.155
Mean Per Quarter	**0.103**	**0.117**
	SOUTH KOREA	
1	0.147	0.04
2	0.201	0.079
3	0.232	0.116
4	0.245	0.136
5	0.247	0.144
6	0.249	0.148
7	0.252	0.152
8	0.255	0.155
9	0.256	0.157
10	0.258	0.159
11	0.258	0.160
12	0.259	0.161
Mean Per Quarter	**0.238**	**0.134**
	THAILAND	
1	0.160	0.067
2	0.035	0.087
3	0.021	0.012
4	0.310	0.094
5	0.012	0.067
6	0.093	0.042
7	-0.110	0.062
8	0.004	0.096
9	0.032	0.096
10	-0.111	0.085
11	0.090	0.075
12	-0.112	0.084
Mean Per Quarter	**0.035**	**0.072**

Notes: The reported pass-through elasticities are derived from the accumulated impulse response functions of producer prices, consumer prices and import prices.

Table 3.22: Test for Overidentifying Restrictions

Countries	Likelihood Ratio Test	p-values
	OECD	
Canada	$\chi^2(2) = 1.284$	0.348
Sweden	$\chi^2(3) = 5.008$	0.085
UK	$\chi^2(4) = 10.364$	0.125
	Latin America	
Argentina	$\chi^2(3) = 4.034$	0.025
Colombia	$\chi^2(3) = 8.018$	0.105
Mexico	$\chi^2(2) = 3.457$	0.078
	Southeast Asia	
Phillipines	$\chi^2(2) = 6.087$	0.033
South Korea	$\chi^2(3) = 9.170$	0.510
Thailand	$\chi^2(3) = 0.879$	0.099

Notes:



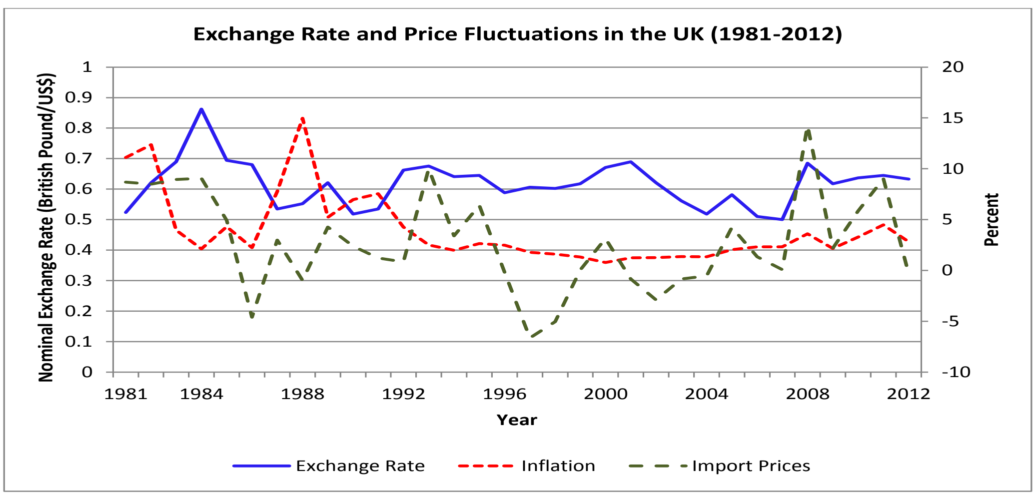
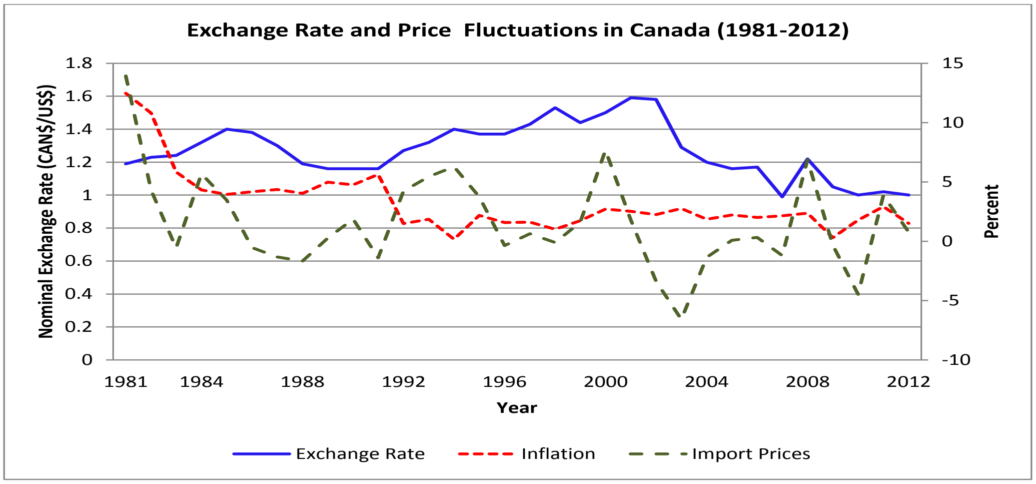


Figure 3.1: Exchange Rates and Price Fluctuations in Sweden and UK (1981-2012)

Notes: The figure shows the trend in exchange rate fluctuations, trade prices and inflation for the Swedish and British economies. Nominal exchange rate is defined as the amount of domestic currency per unit of the foreign currency (in our case the US$). Based on this definition, an appreciation of the domestic currency appear as a decrease in the nominal exchange rate and a depreciation as an increase in the nominal exchange rate.



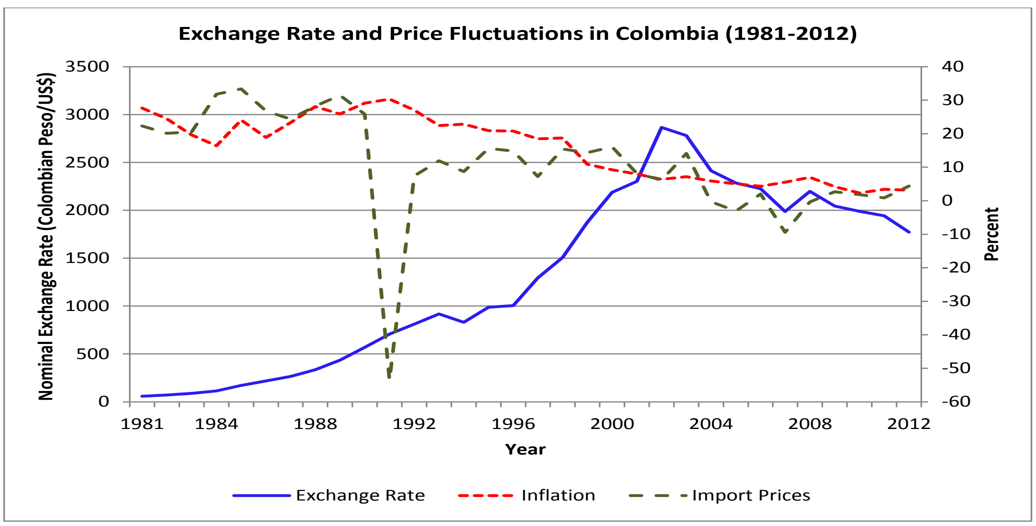


Figure 3.2: Exchange Rates and Price Movement in Canada and Colombia (1981-2012)

Notes: The figure shows the trend in exchange rate fluctuations, trade prices and inflation for the Canadian and Colombian economies. Nominal exchange rate is defined as the amount of domestic currency per unit of the foreign currency (in our case the US$). Based on this definition, an appreciation of the domestic currency appear as a decrease in the nominal exchange rate and a depreciation as an increase in the nominal exchange rate.

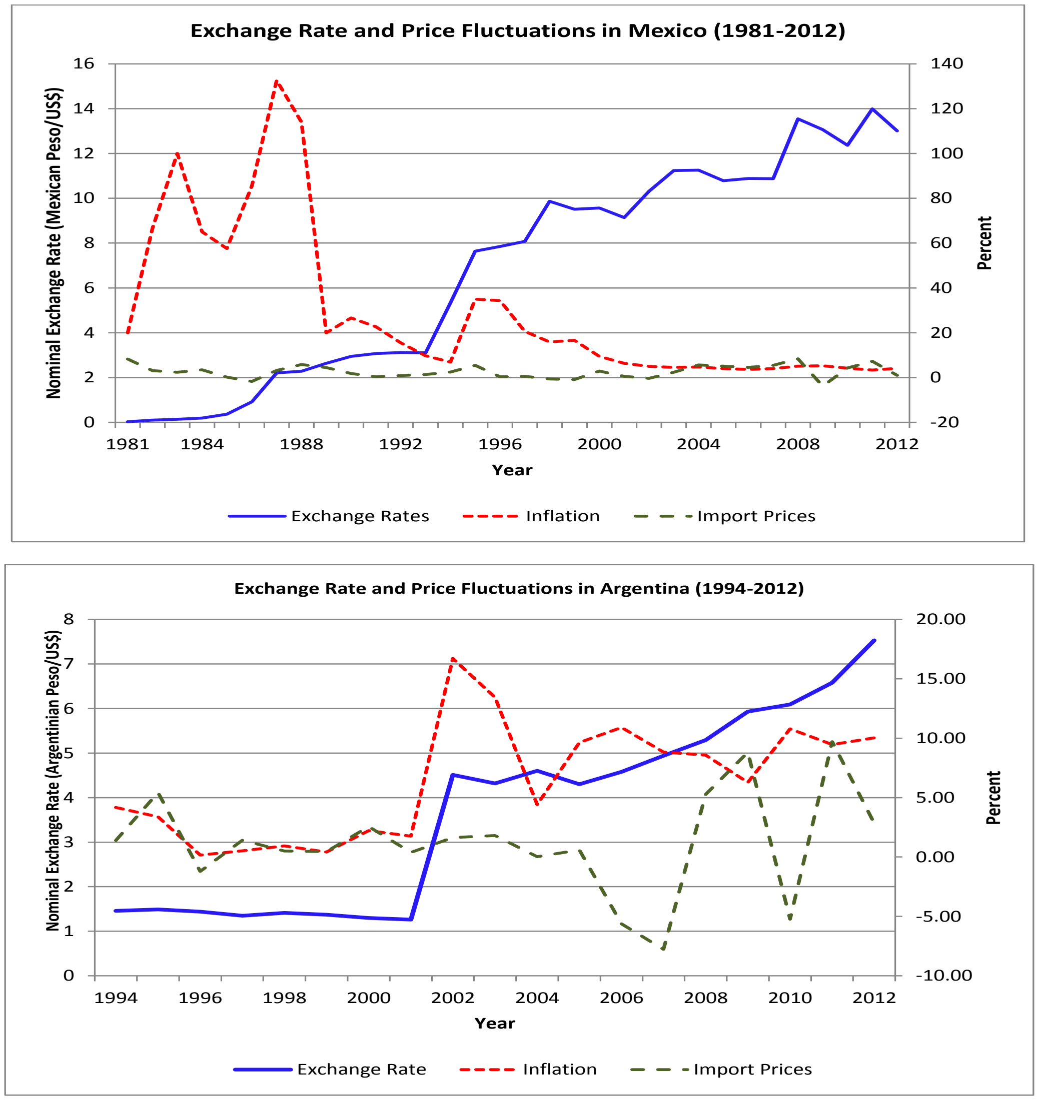
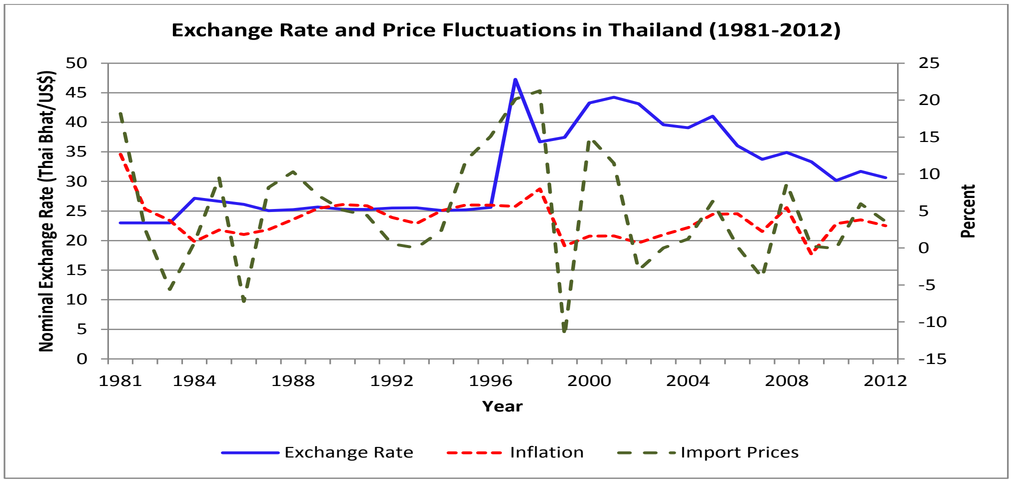


Figure 3.3: Exchange Rates and Price Fluctuations in Mexico and Argentina

Notes: The figure shows the trend in exchange rate fluctuations, trade prices and inflation for the Mexican and Argentine economies. Nominal exchange rate is defined as the amount of domestic currency per unit of the foreign currency (in our case the US$). Based on this definition, an appreciation of the domestic currency appear as a decrease in the nominal exchange rate and a depreciation as an increase in the nominal exchange rate.



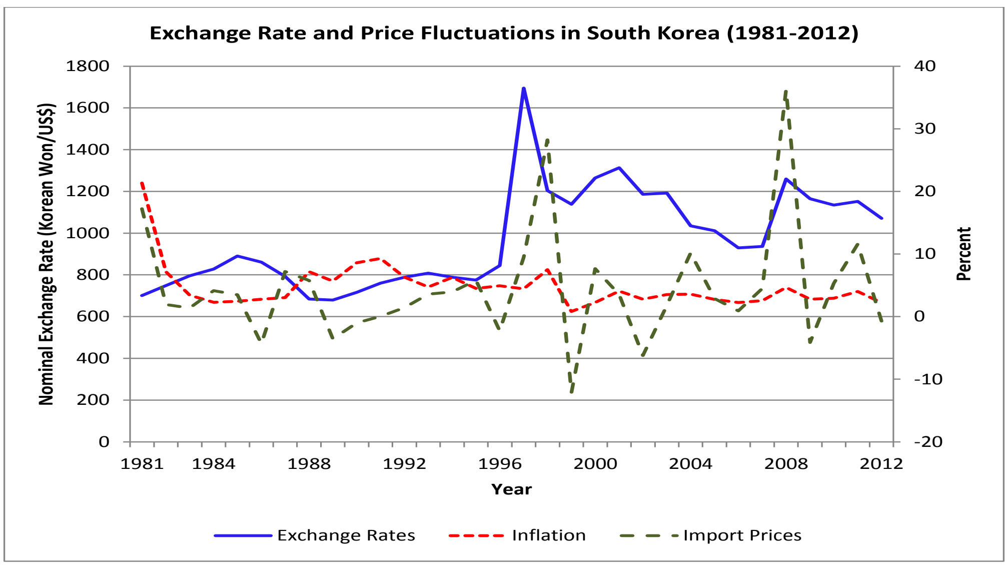


Figure 3.4: Exchange Rates and Price Fluctuations in South Korea and Thailand (1981-2012)

Notes: The figure shows the trend in exchange rate fluctuations, trade prices and inflation for the Korean and Thai economies. Nominal exchange rate is defined as the amount of domestic currency per unit of the foreign currency (in our case the US$). Based on this definition, an appreciation of the domestic currency appear as a decrease in the nominal exchange rate and a depreciation as an increase in the nominal exchange rate.

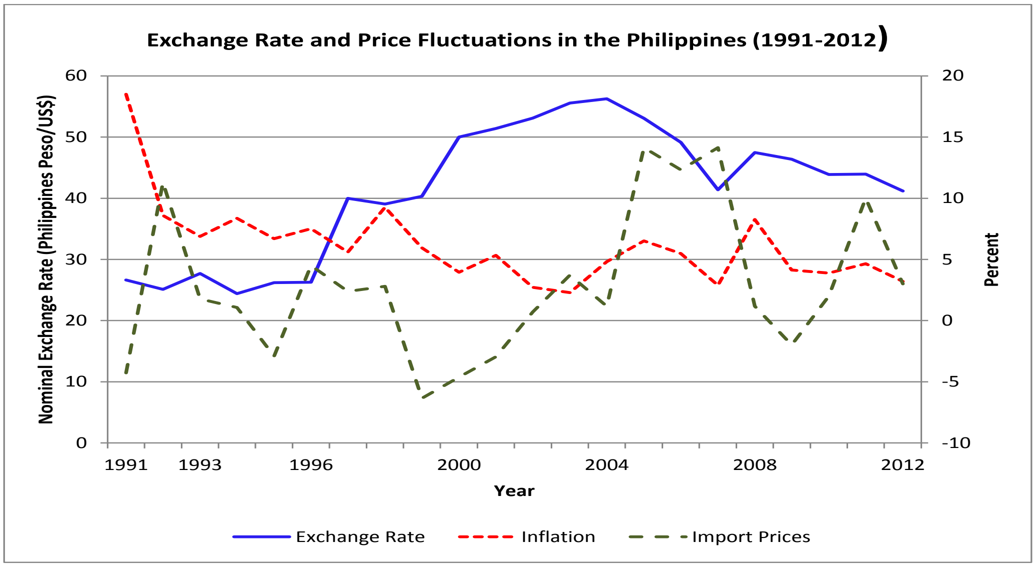


Figure 3.5: Exchange Rates and Price Movement in the Philippines (1991-2012)

Notes: The figure shows the trend in exchange rate fluctuations, trade prices and inflation for The Philippines. Nominal exchange rate is defined as the amount of domestic currency per unit of the foreign currency (in our case the US$). Based on this definition, an appreciation of the domestic currency appear as a decrease in the nominal exchange rate and a depreciation as an increase in the nominal exchange rate.

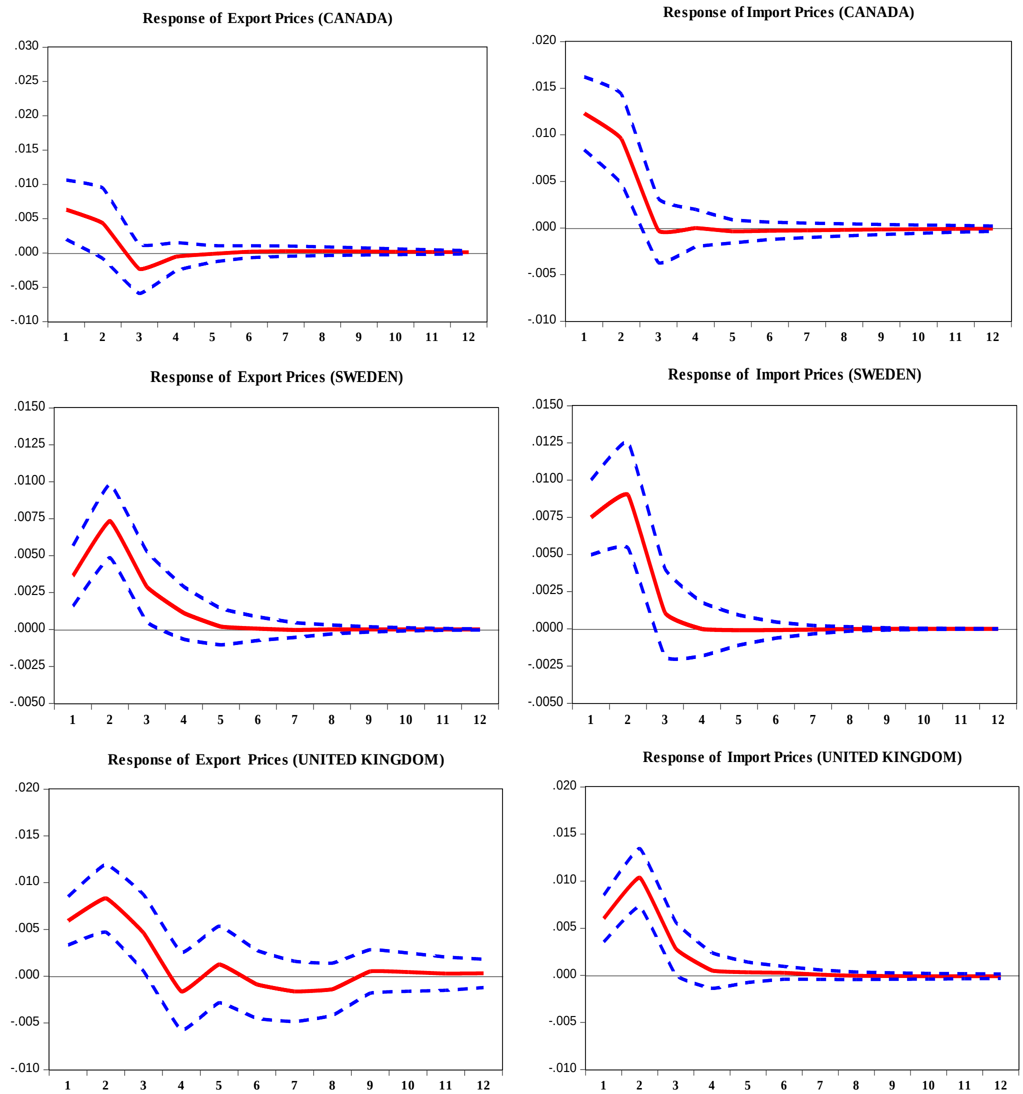


Figure 3.6: Structural Impulse Response of Trade Prices to Exchange Rate Shock (OECD Countries)

Notes:The figure shows the estimated structural impulse responses of trade prices to a one standard deviation exchange rate shock for the three OECD countries. The impulse response to a positive exchange rate shock is represented as the thick and continuous red line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

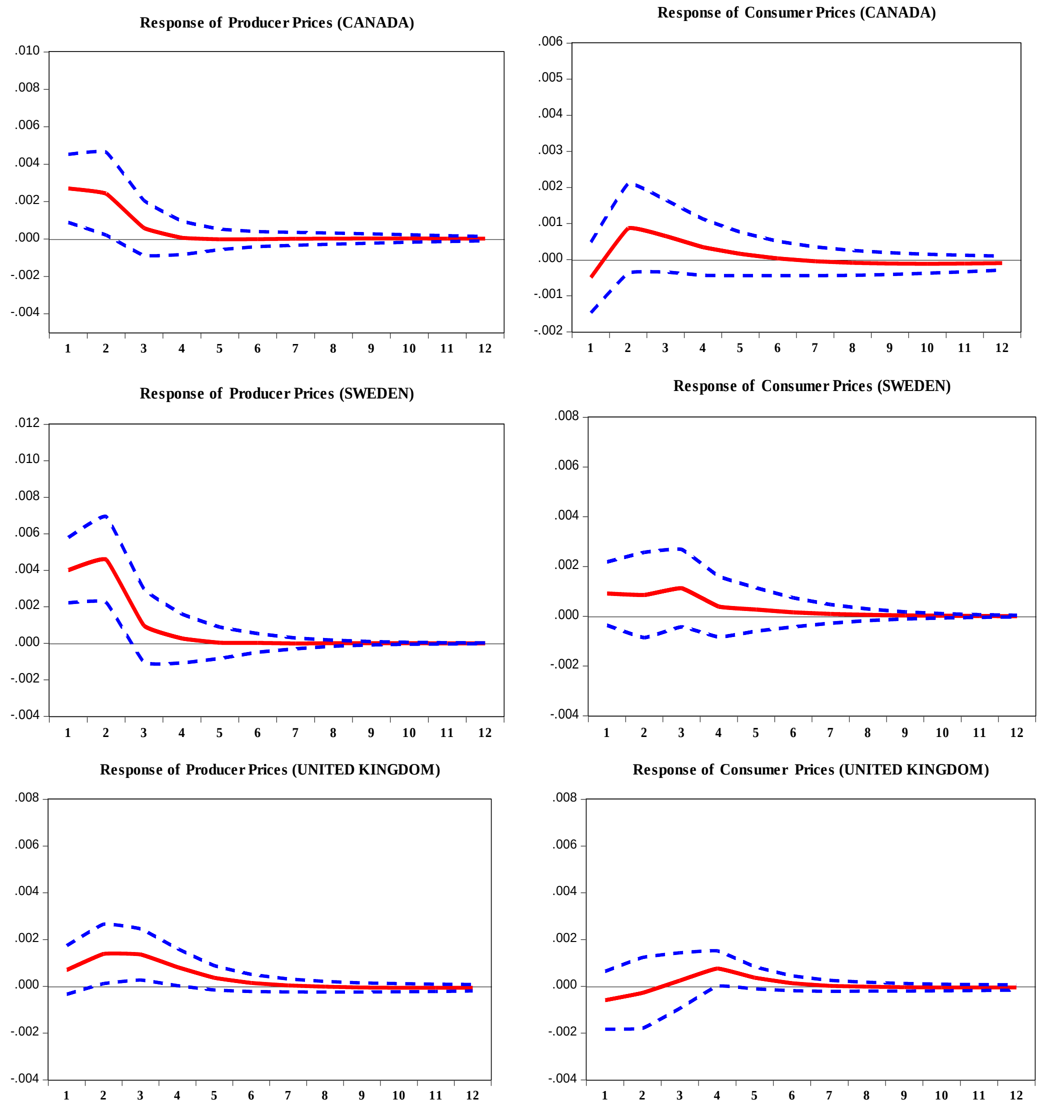


Figure 3.7: Structural Impulse Response of PPI and CPI to Exchange Rate Shock (OECD Countries)

Notes:The figure shows the estimated structural impulse responses of PPI and CPI to a one standard deviation exchange rate shock for the three OECD countries. The impulse response to a positive exchange rate shock is represented as the thick and continuous red line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

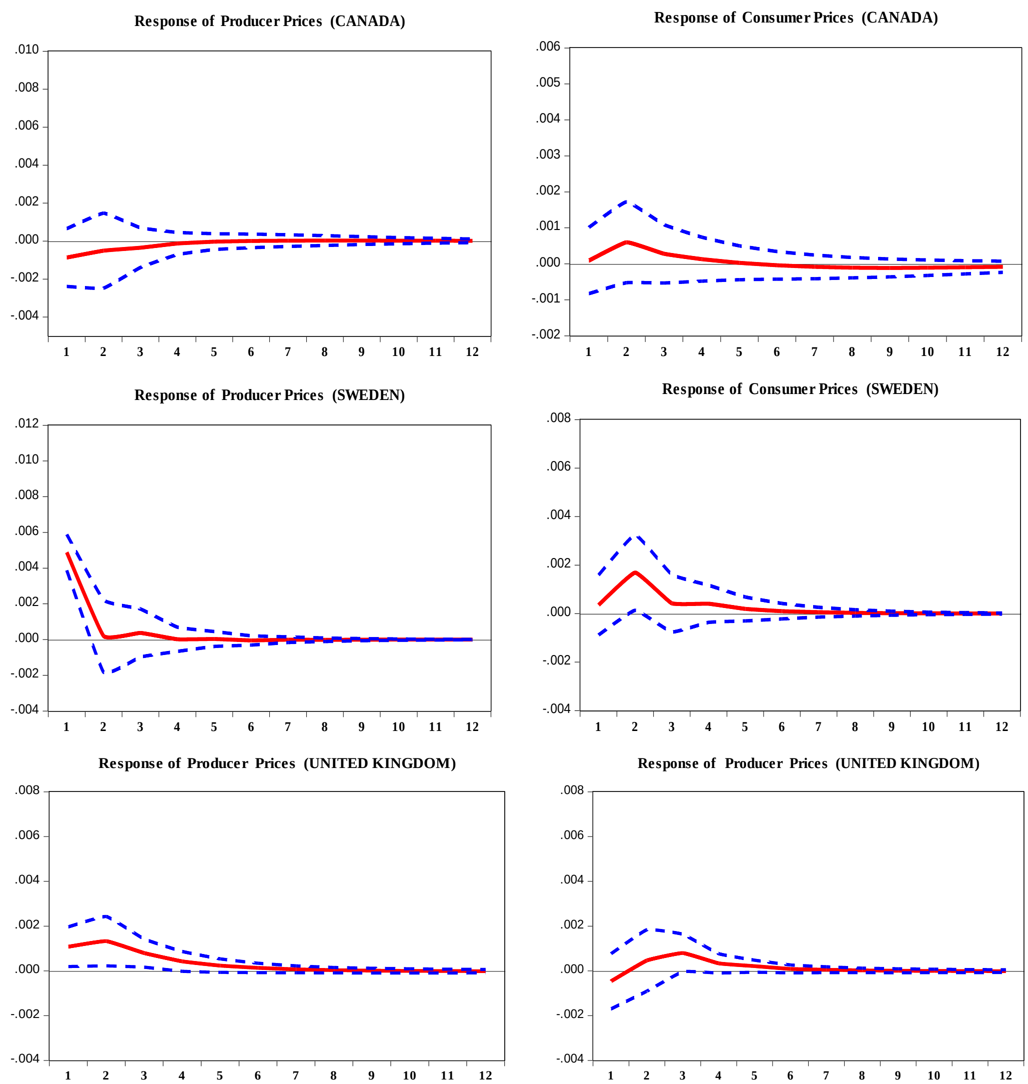


Figure 3.8: Structural Impulse Response of PPI and CPI to Import Price Shock (OECD Countries)

Notes: The figure shows the estimated structural impulse responses of PPI and CPI to a one standard deviation import price shock for the three OECD countries. The impulse response to a positive import price shock is represented as the thick and continuous red line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

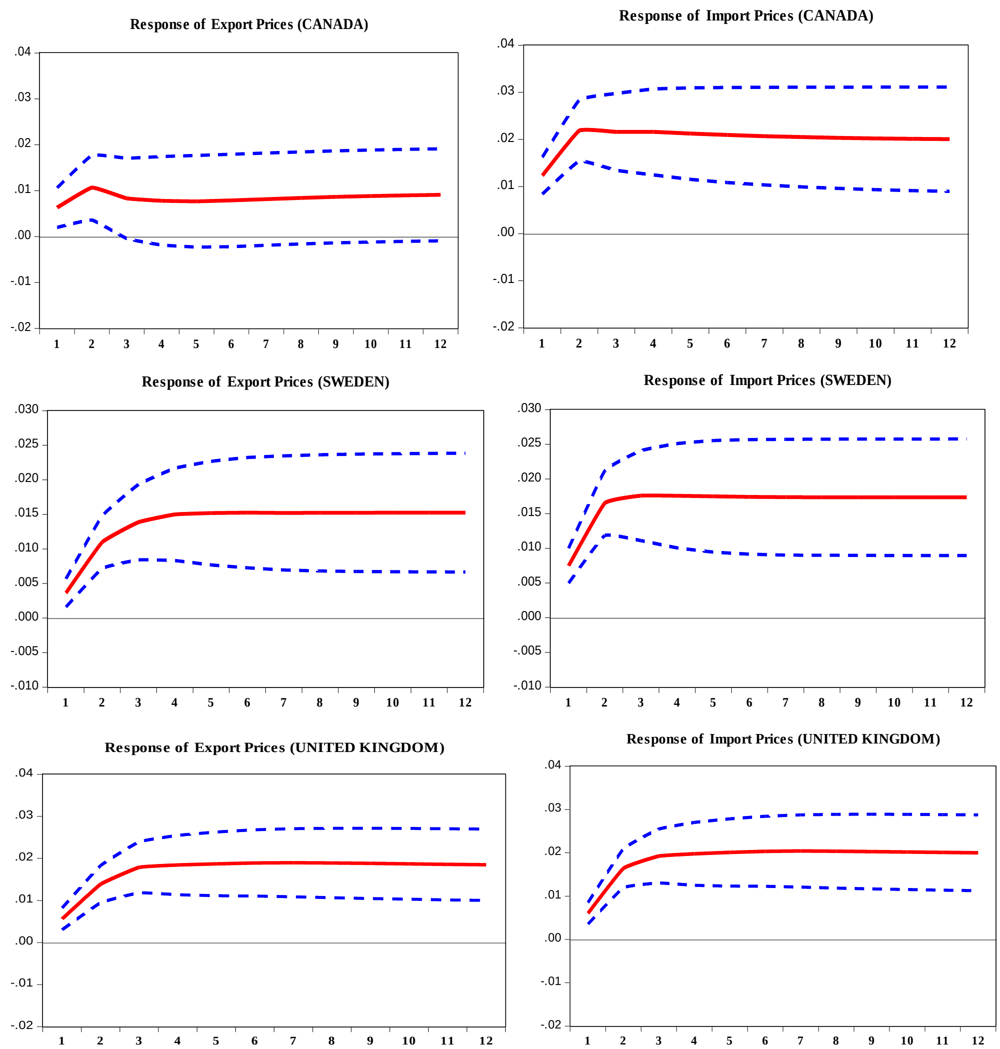


Figure 3.9: Accumulated Impulse Response of Trade Prices to Exchange Rate Shock (OECD Countries)

Notes:The figure shows the estimated accumulated impulse responses of trade prices to a one standard deviation exchange rate shock for the three OECD countries. The impulse response to a positive exchange rate shock is represented as the thick and continuous red line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

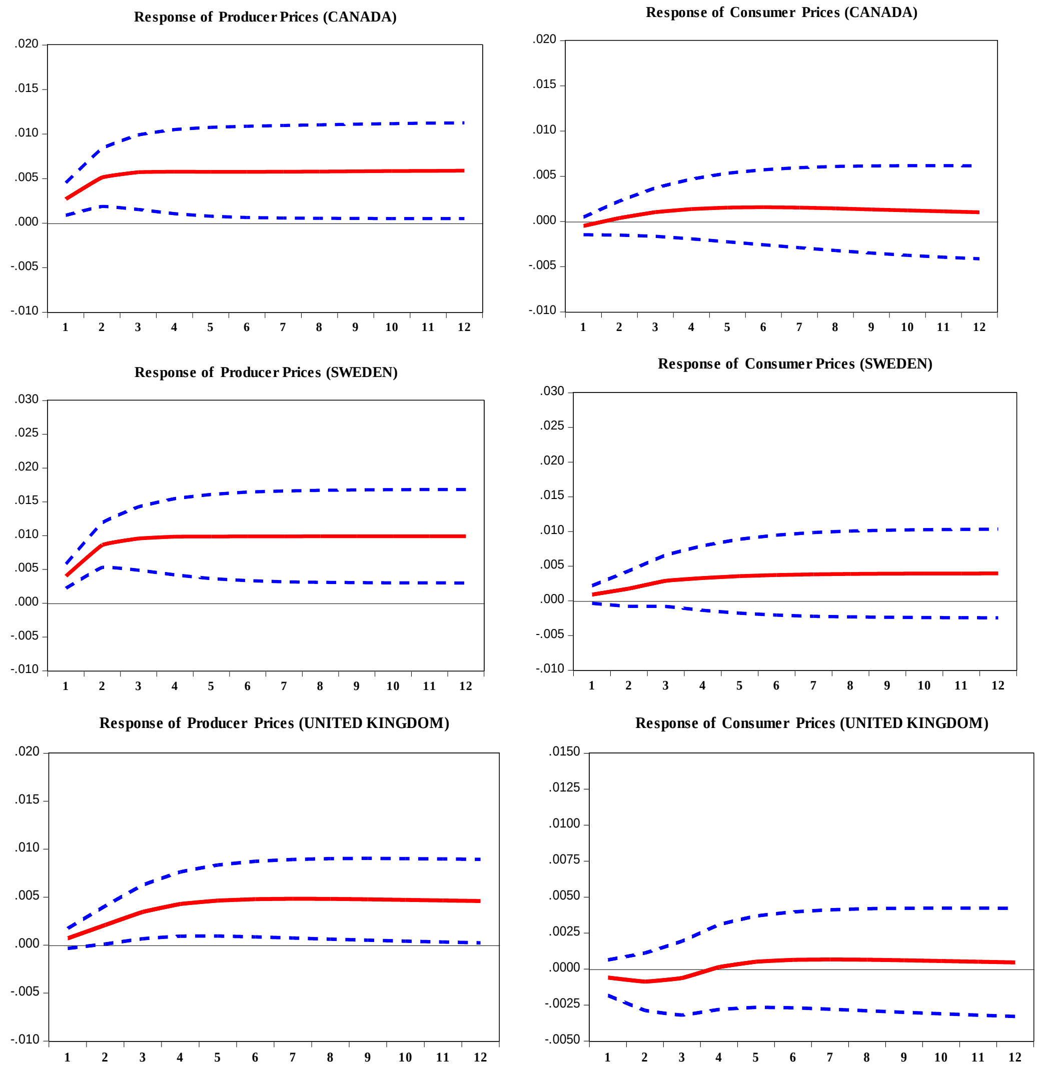


Figure 3.10: Accumulated Impulse Response of PPI and CPI to Exchange Rate Shock (OECD Countries)

Notes:The figure shows the estimated accumulated impulse responses of PPI and CPI to a one standard deviation exchange rate shock for the three OECD countries. The impulse response to a positive exchange rate shock is represented as the thick and continuous red line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

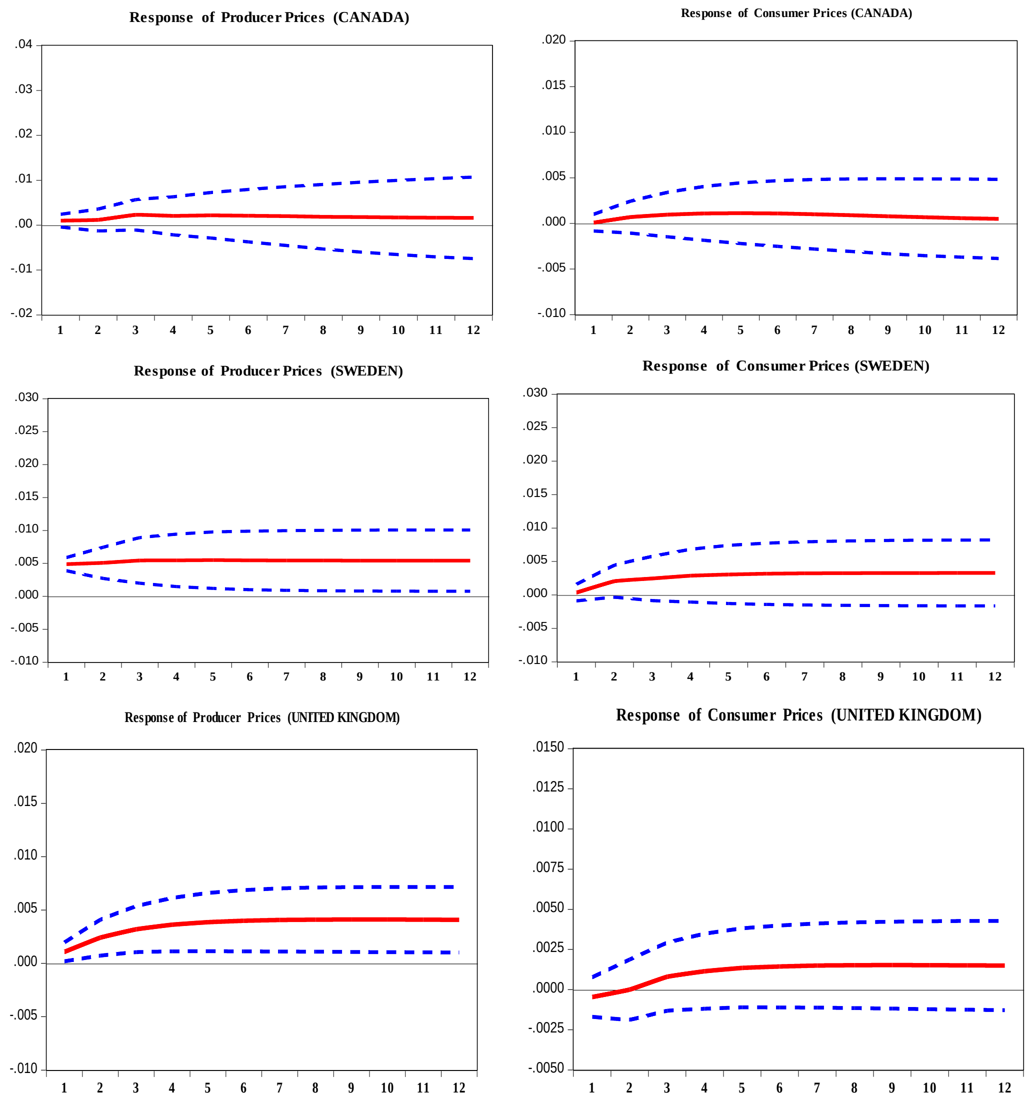


Figure 3.11: Accumulated Impulse Response of PPI and CPI to Import Price Shock (OECD Countries)

Notes: The figure shows the estimated accumulated impulse responses of PPI and CPI to a one standard deviation import price shock for the three OECD countries. The impulse response to a positive import price shock is represented as the thick and continuous red line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

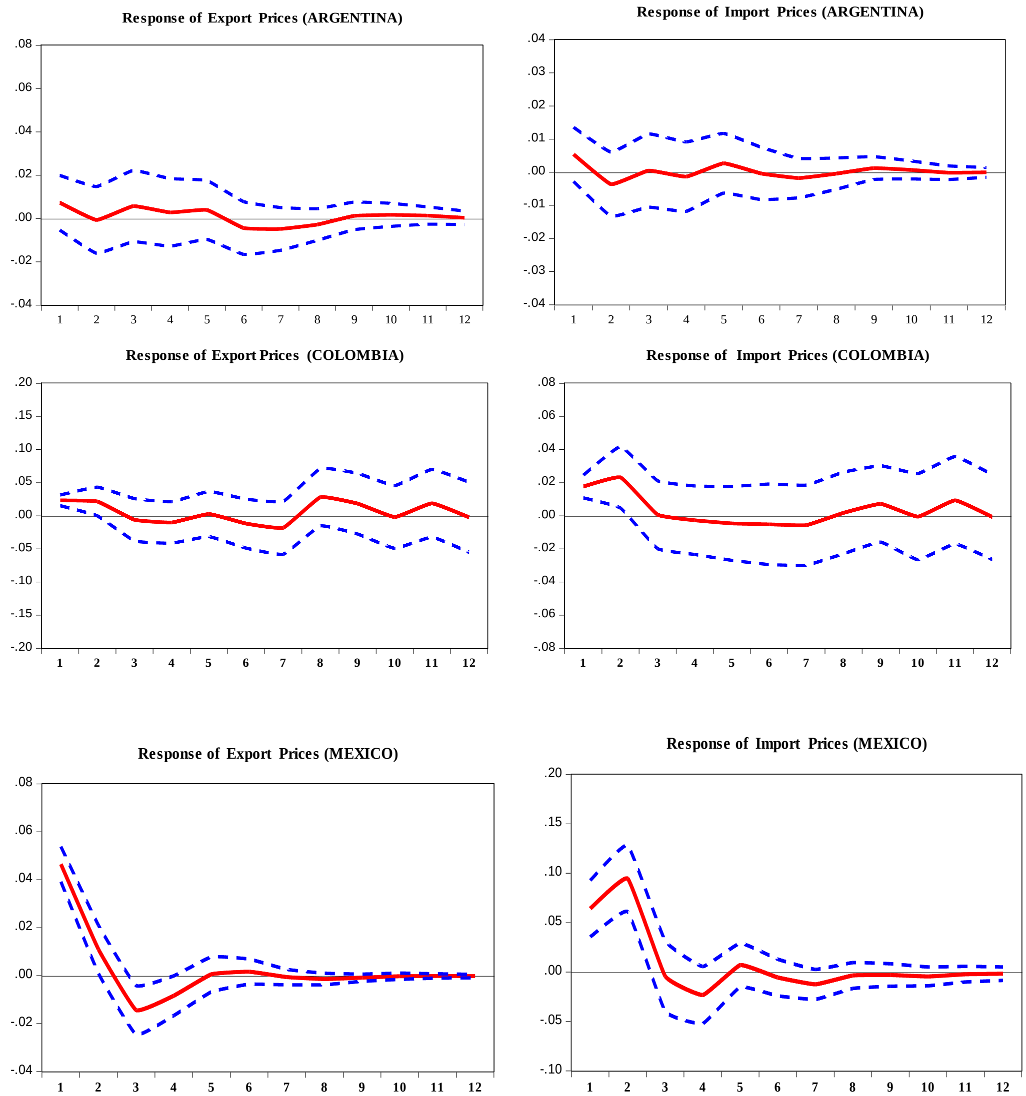


Figure 3.12: Structural Impulse Response of Trade Prices to Exchange Rate Shock (Latin American Countries)

Notes:The figure shows the estimated structural impulse responses of trade prices to a one standard deviation exchange rate shock for the threeLatin American countries. The impulse response to a positive exchange rate shock is represented as the thick and continuous red line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

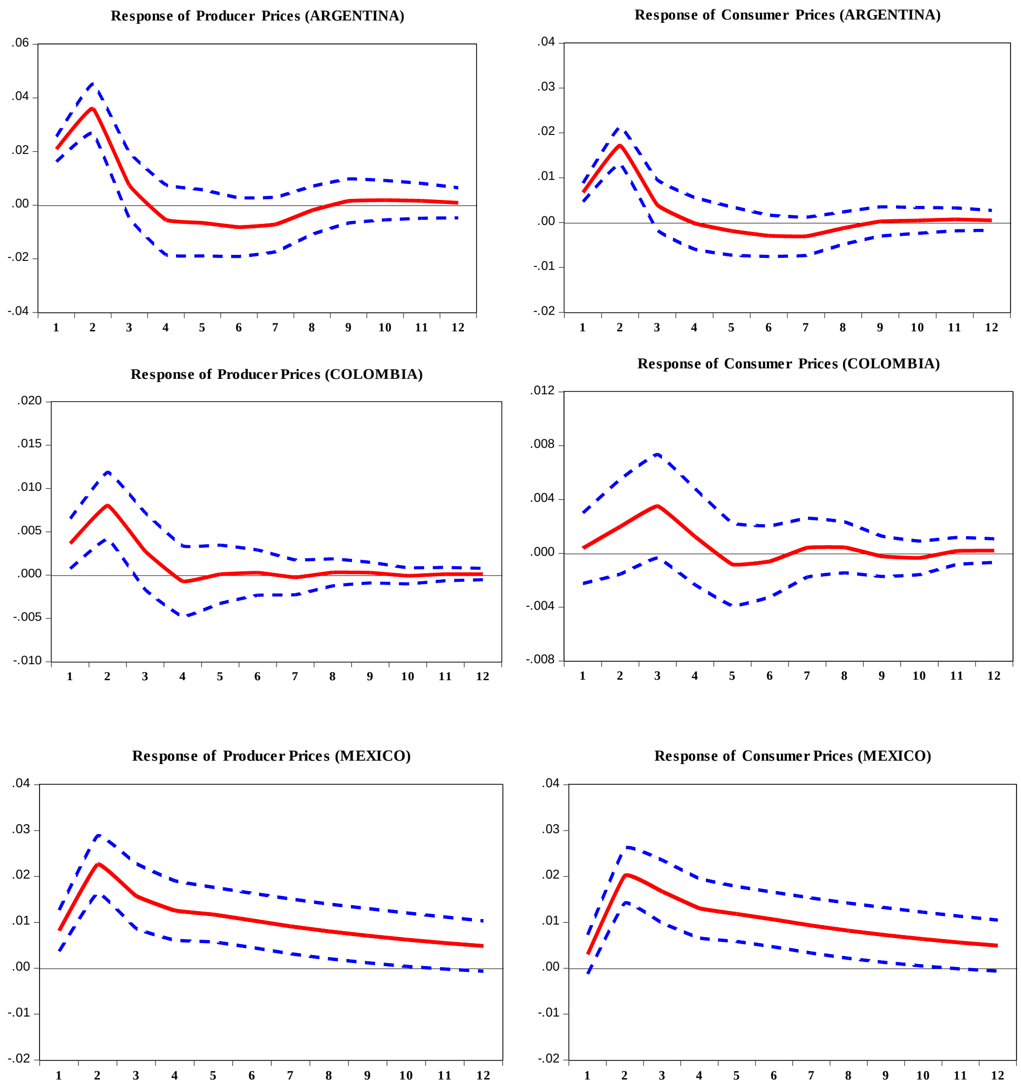


Figure 3.13: Structural Impulse Response of PPI and CPI to Exchange Rate Shock (Latin American Countries)

Notes:The figure shows the estimated structural impulse responses of PPI and CPI to a one standard deviation exchange rate shock for the three Latin American countries. The impulse response to a positive exchange rate shock is represented as the thick and continuous red line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

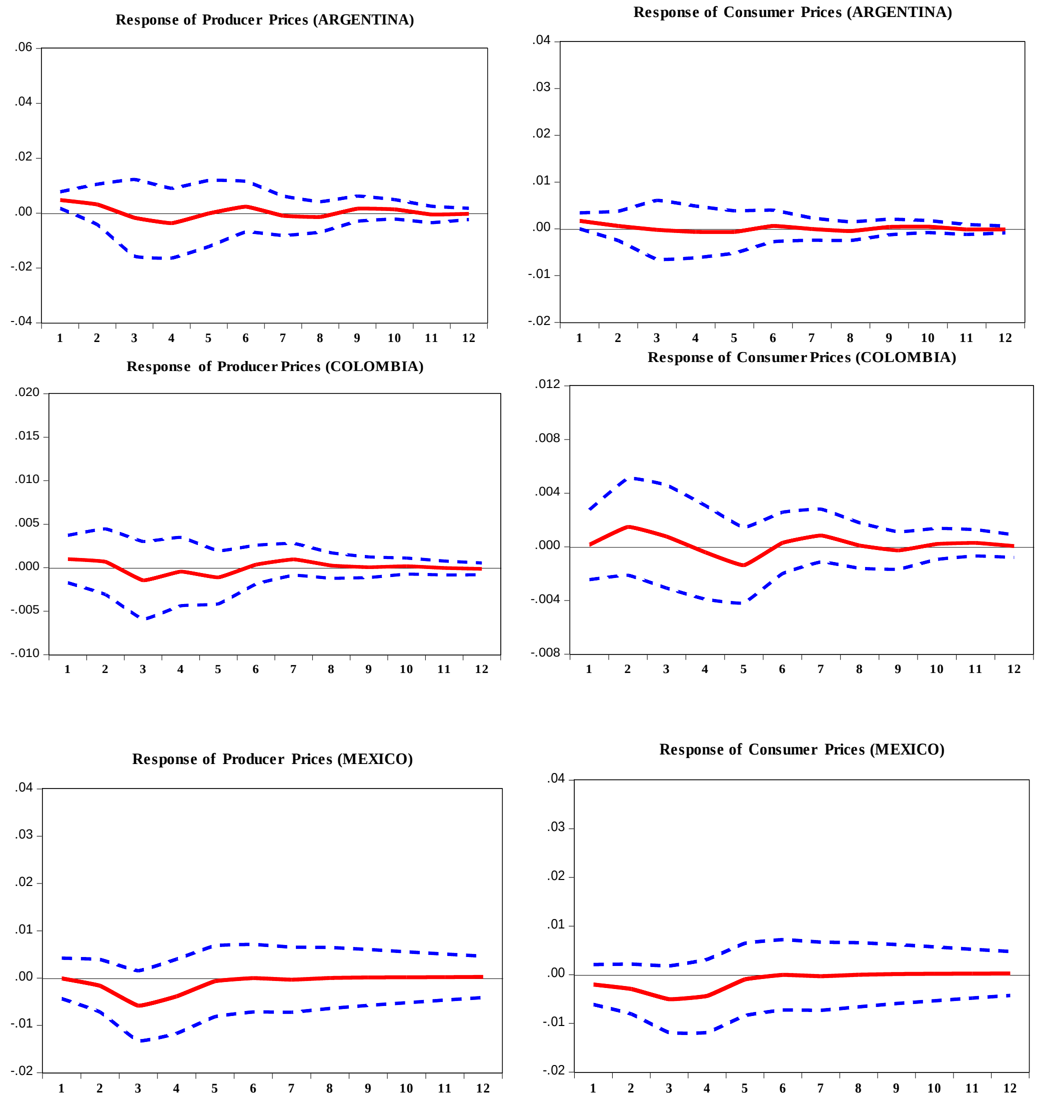


Figure 3.14: Structural Impulse Response of PPI and CPI to Import Price Shock (Latin American Countries)

Notes: The figure shows the estimated structural impulse responses of PPI and CPI to a one standard deviation import price shock for the three Latin American countries. The impulse response to a positive import price shock is represented as the thick and continuous red line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

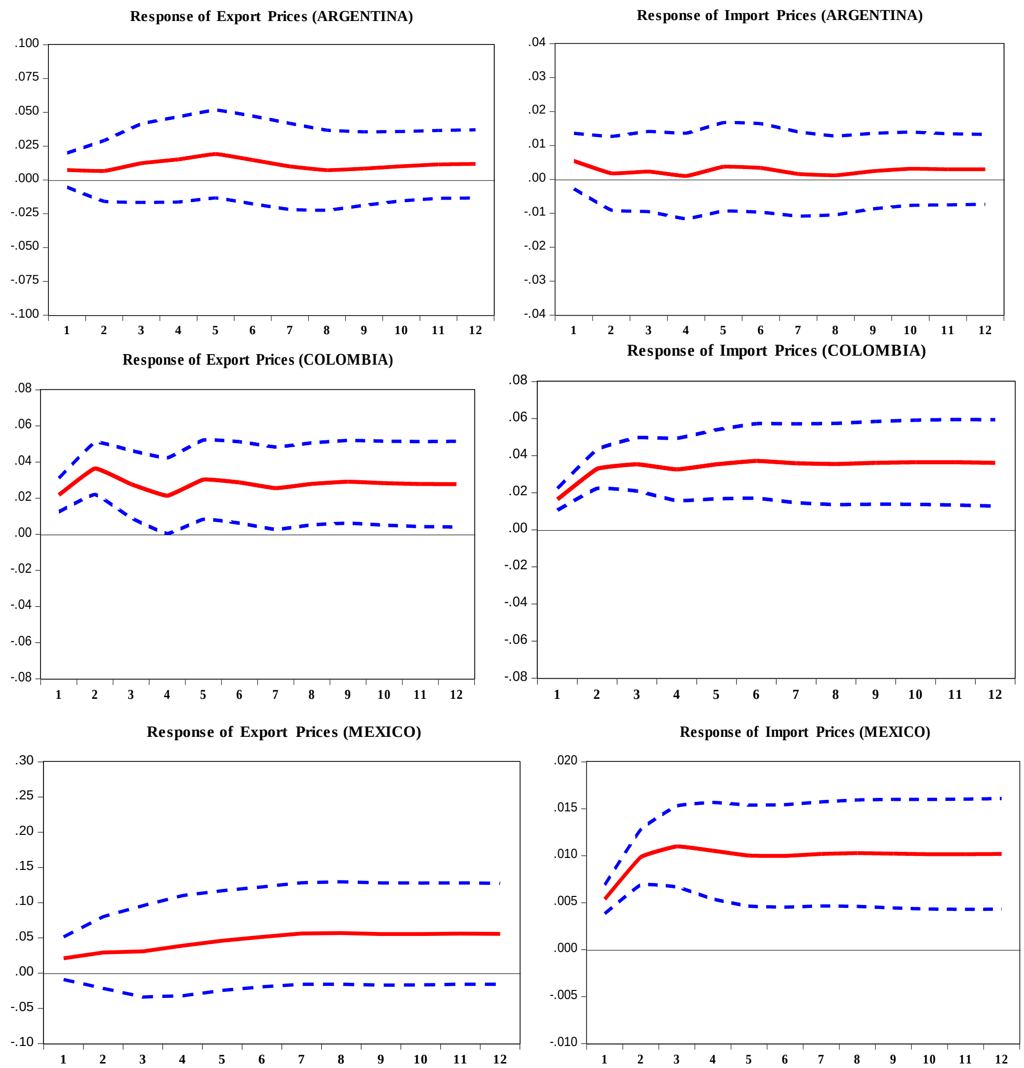


Figure 3.15: Accumulated Impulse Response of Trade Prices to Exchange Rate Shock (Latin American Countries)

Notes:The figure shows the estimated accumulated impulse responses of trade prices to a one standard deviation exchange rate shock for the three Latin American countries. The impulse response to a positive exchange rate shock is represented as the thick and continuous red line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

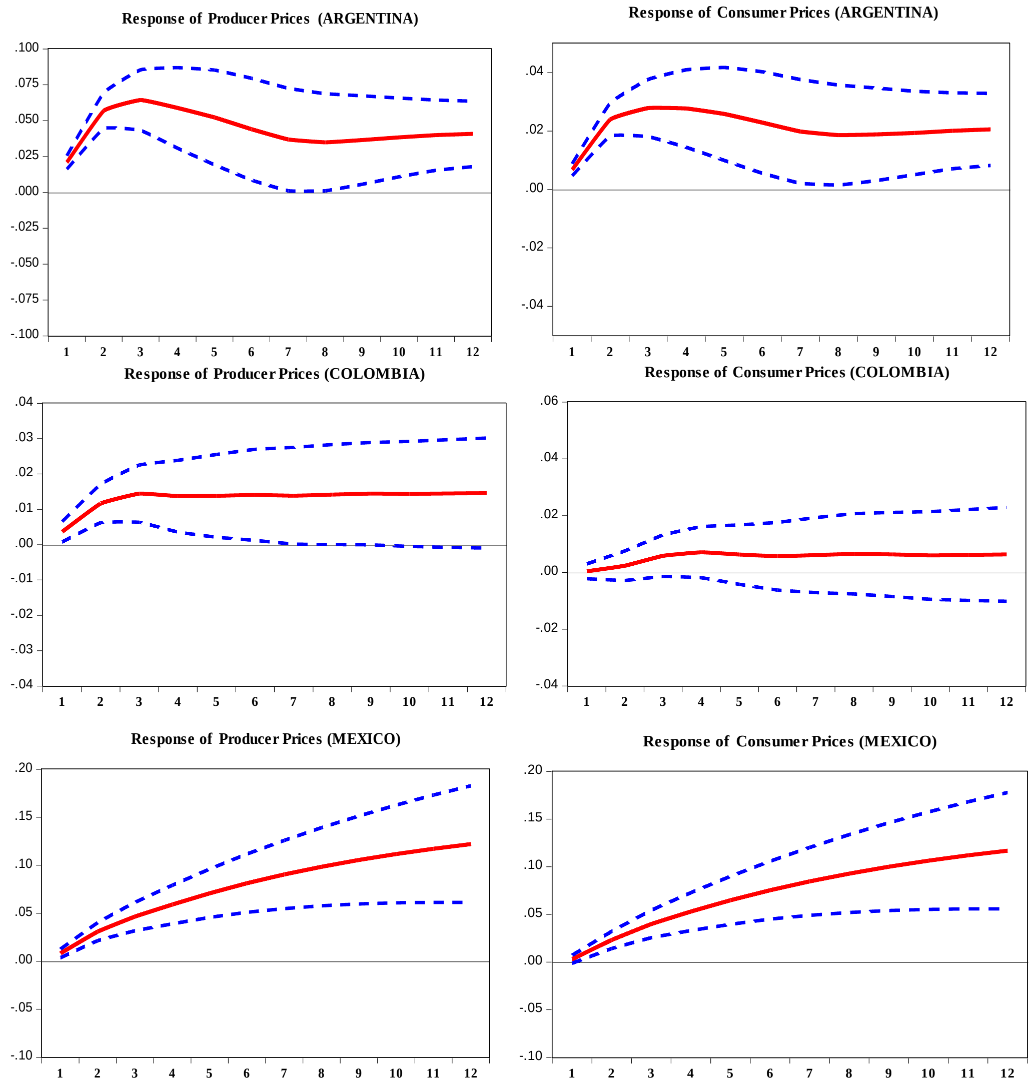


Figure 3.16: Accumulated Impulse Response of PPI and CPI to Exchange Rate Shock (Latin American Countries)

Notes:The figure shows the estimated accumulated impulse responses of PPI and CPI to a one standard deviation exchange rate shock for the three Latin American countries. The impulse response to a positive exchange rate shock is represented as the thick and continuous red line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

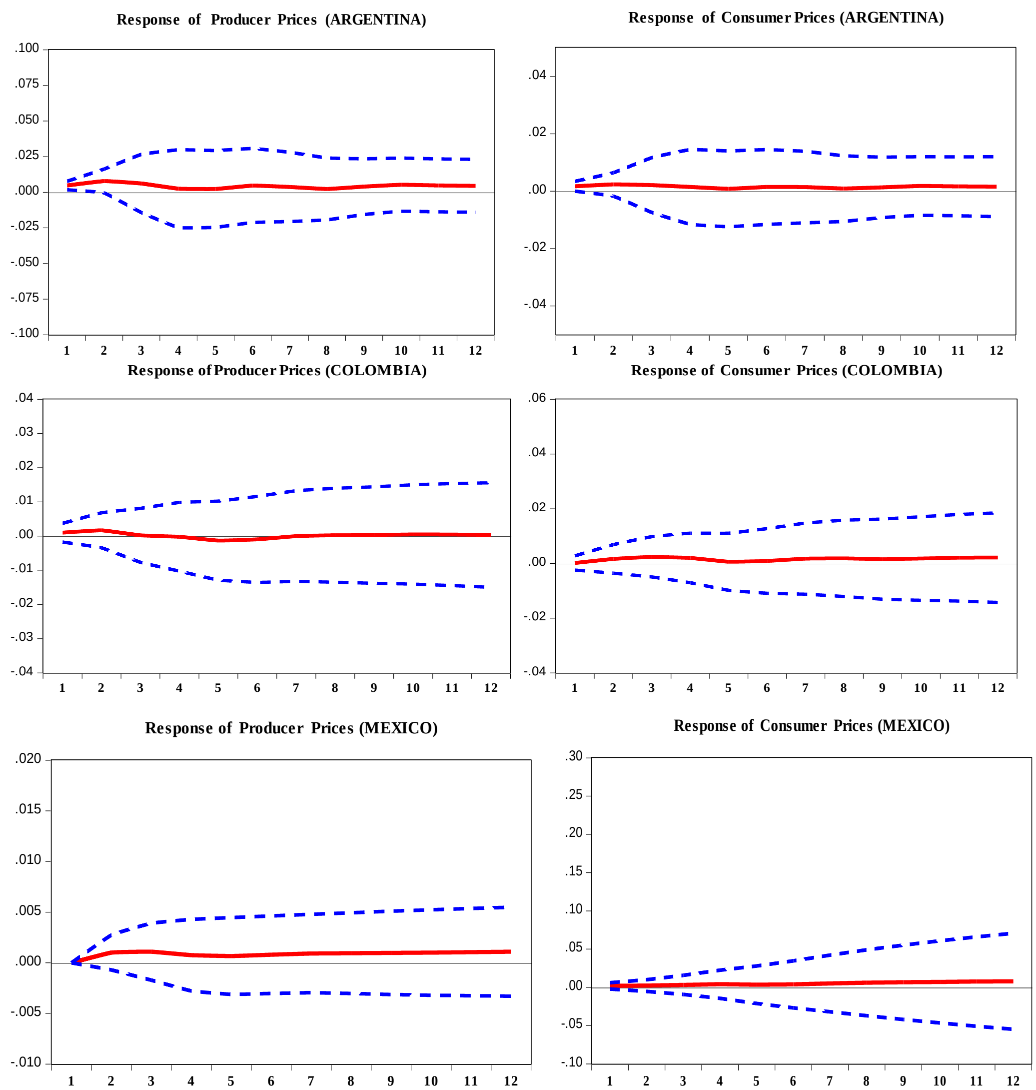


Figure 3.17: Accumulated Impulse Response of PPI and CPI to Import Price Shock (Latin American Countries)

Notes: The figure shows the estimated accumulated impulse responses of PPI and CPI to a one standard deviation import price shock for the three Latin American countries. The impulse response to a positive import price shock is represented as the thick and continuous red line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

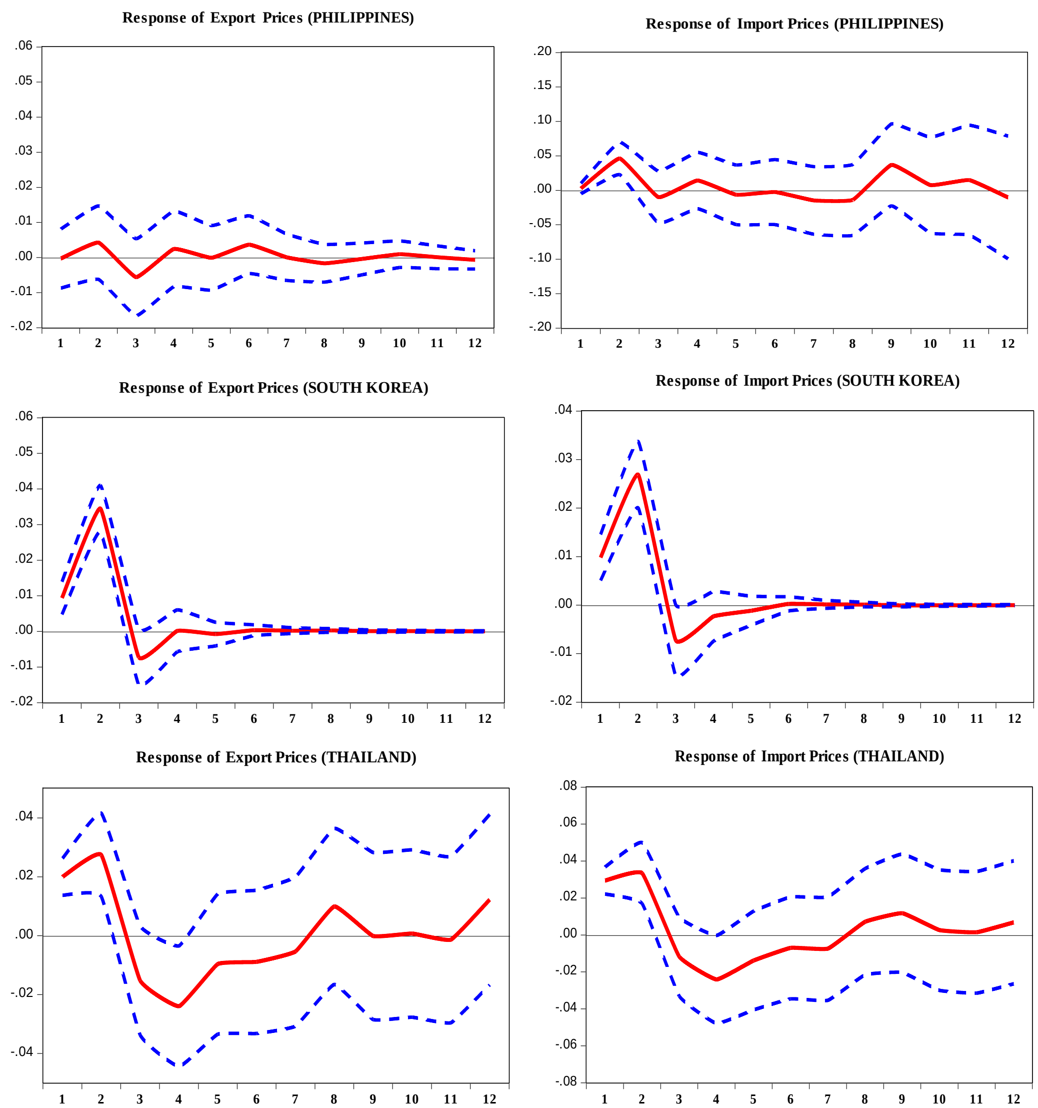


Figure 3.18: Structural Impulse Response of Trade Prices to Exchange Rate Shock (Southeast Asian Countries)

Notes:The figure shows the estimated structural impulse responses of trade prices to a one standard deviation exchange rate shock for the three Southeast Asian countries. The impulse response to a positive exchange rate shock is represented as the thick and continuous red line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

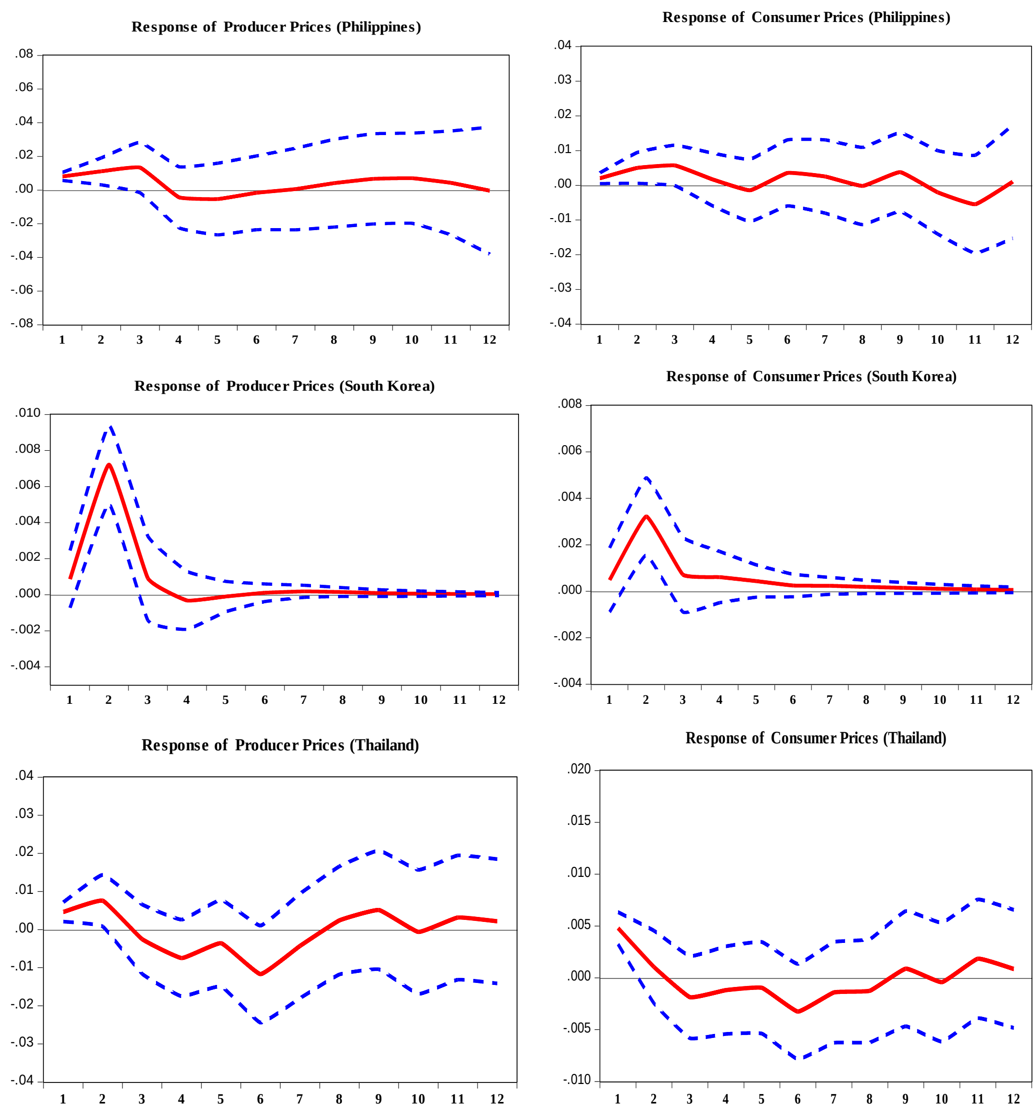


Figure 3.19: Structural Impulse Response of PPI and CPI to Exchange Rate Shock (Southeast Asian Countries)

Notes:The figure shows the estimated structural impulse responses of PPI and CPI to a one standard deviation exchange rate shock for the three Southeast Asian countries. The impulse response to a positive exchange rate shock is represented as the thick and continuous red line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

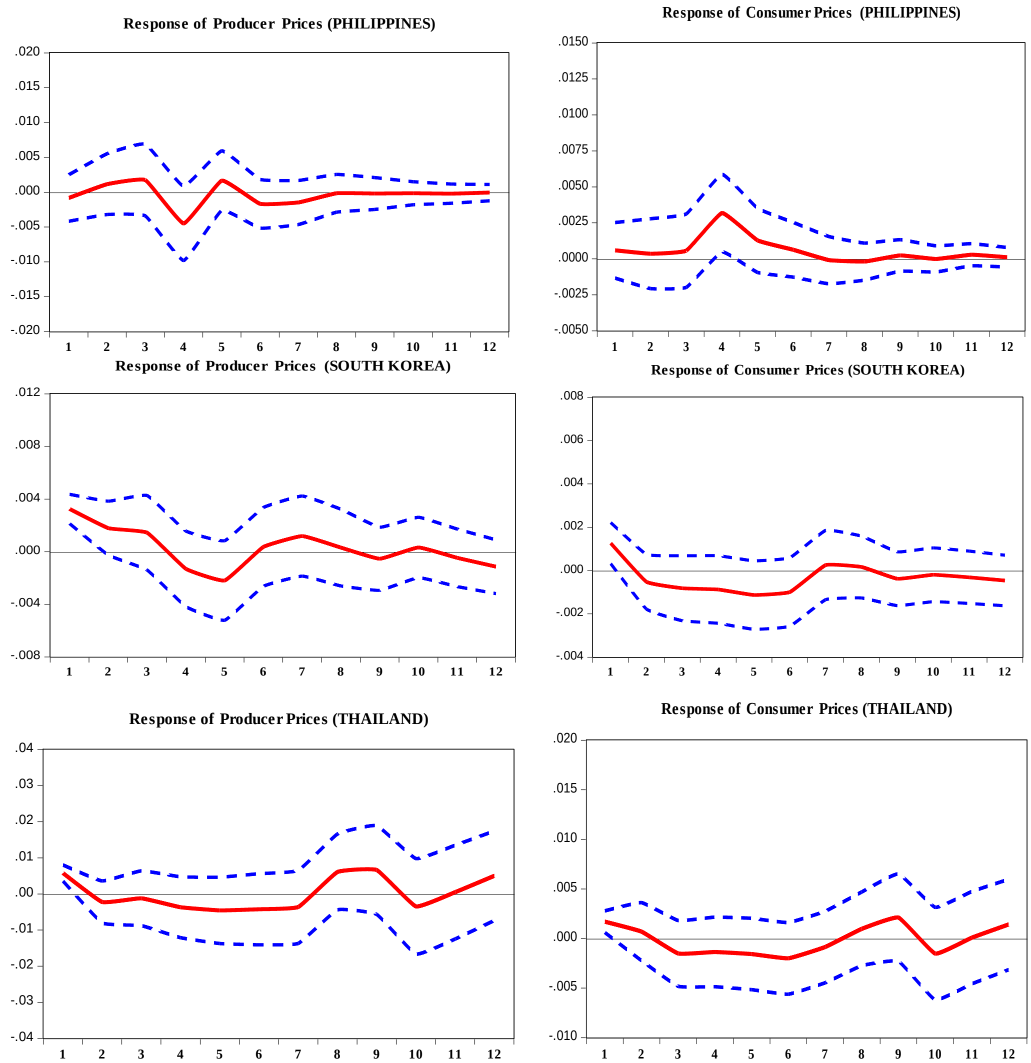


Figure 3.20: Structural Impulse Response of PPI and CPI to Import Price Shock (Southeast Asian Countries)

Notes: The figure shows the estimated structural impulse responses of PPI and CPI to a one standard deviation import price shock for the three Southeast Asian countries. The impulse response to a positive import price shock is represented as the thick and continuous red line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

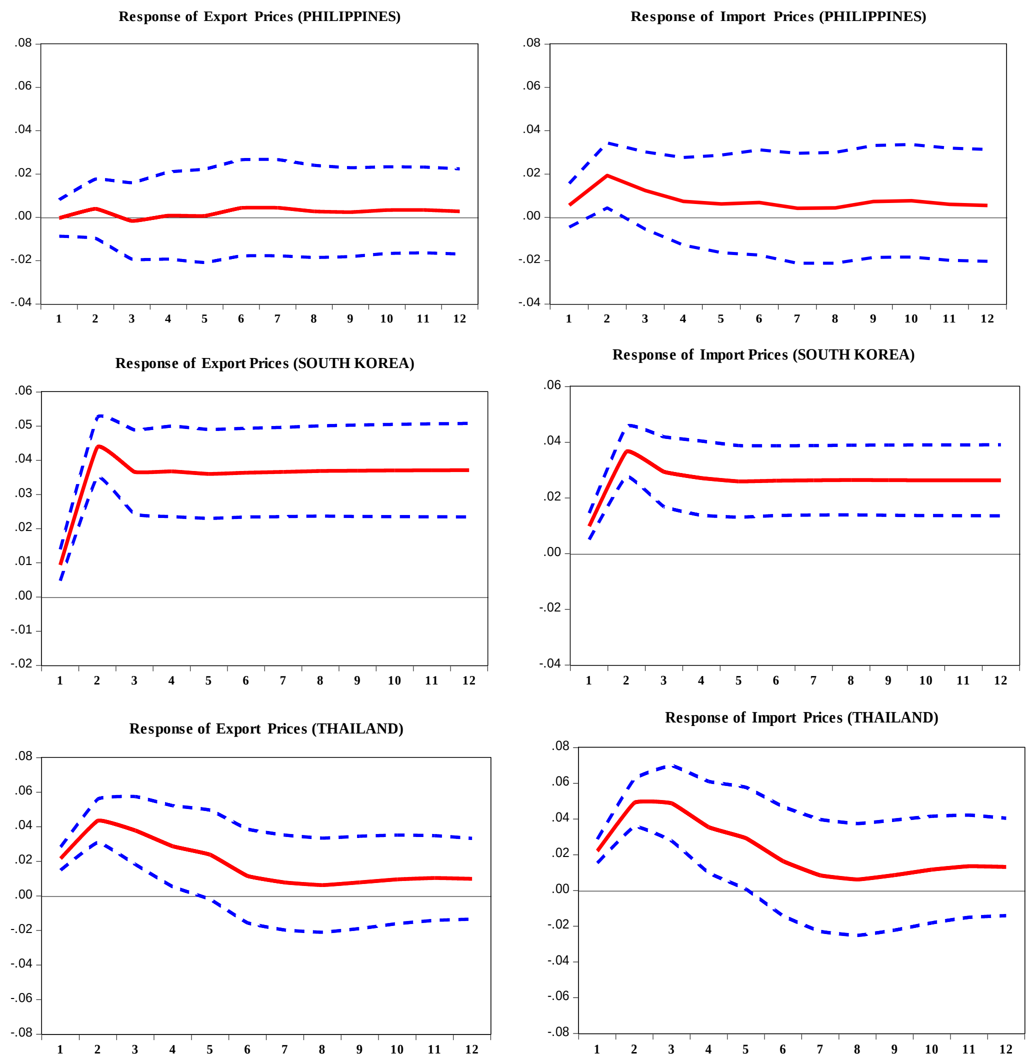


Figure 3.21: Accumulated Impulse Response of Trade Prices to Exchange Rate Shock (Southeast Asian Countries)

Notes:The figure shows the estimated accumulated impulse responses of trade prices to a one standard deviation exchange rate shock for the three Southeast Asian countries. The impulse response to a positive exchange rate shock is represented as the thick and continuous red line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

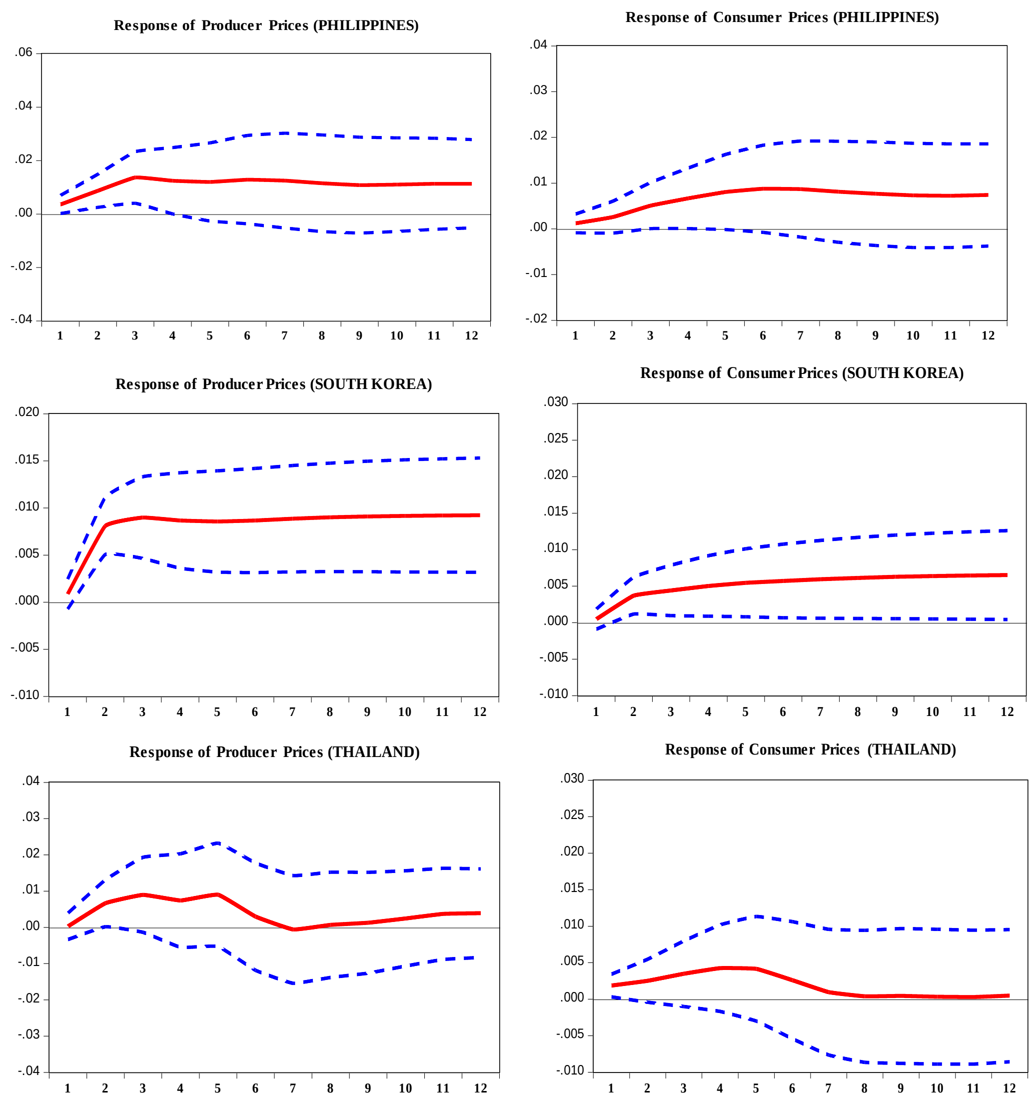


Figure 3.22: Accumulated Impulse Response of PPI and CPI to Exchange Rate Shock (Southeast Asian Countries)

Notes:The figure shows the estimated accumulated impulse responses of PPI and CPI to a one standard deviation exchange rate shock for the three Southeast Asian countries. The impulse response to a positive exchange rate shock is represented as the thick and continuous red line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

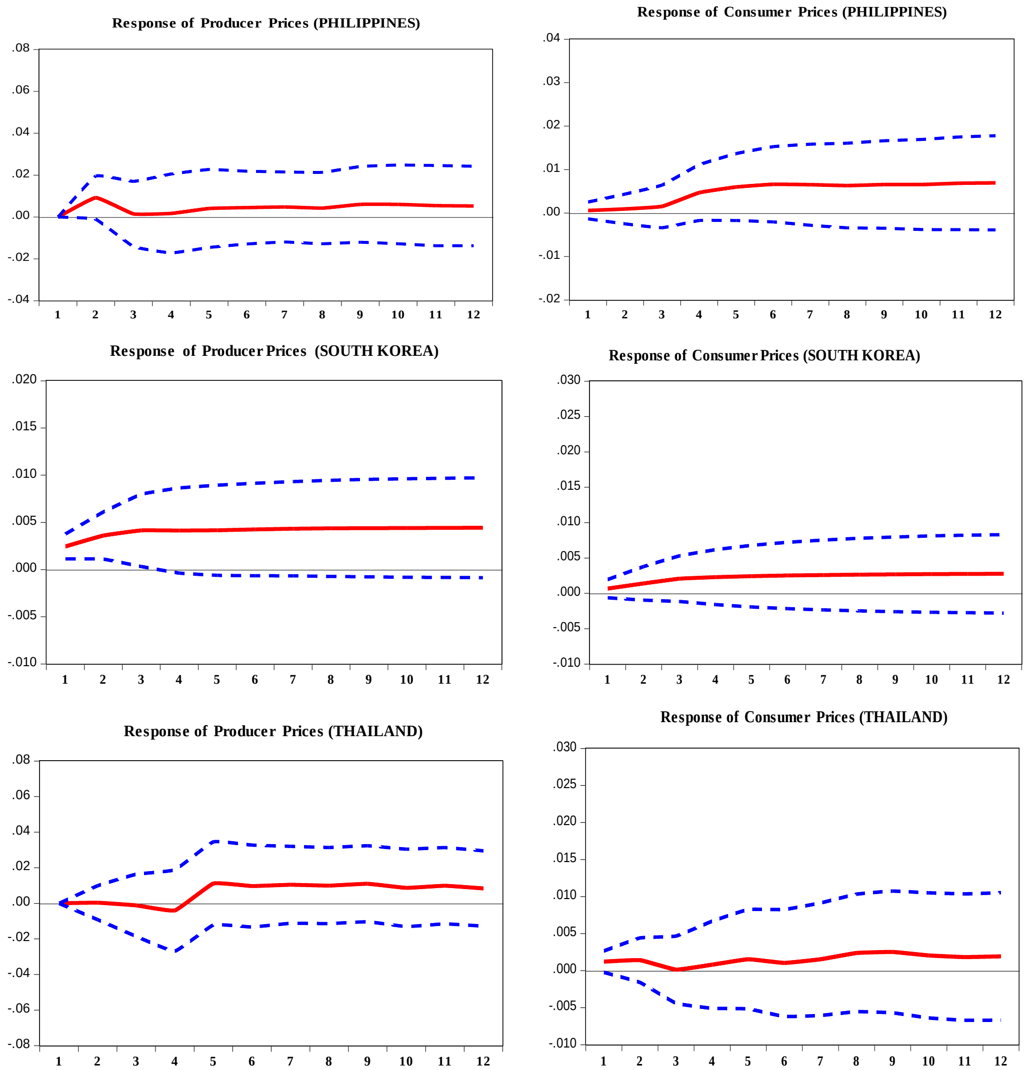


Figure 3.23: Accumulated Impulse Response of PPI and CPI to Import Price Shock (Southeast Asian Countries)

Notes: The figure shows the estimated accumulated impulse responses of PPI and CPI to a one standard deviation import price shock for the three Southeast Asian countries. The impulse response to a positive import price shock is represented as the thick and continuous red line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

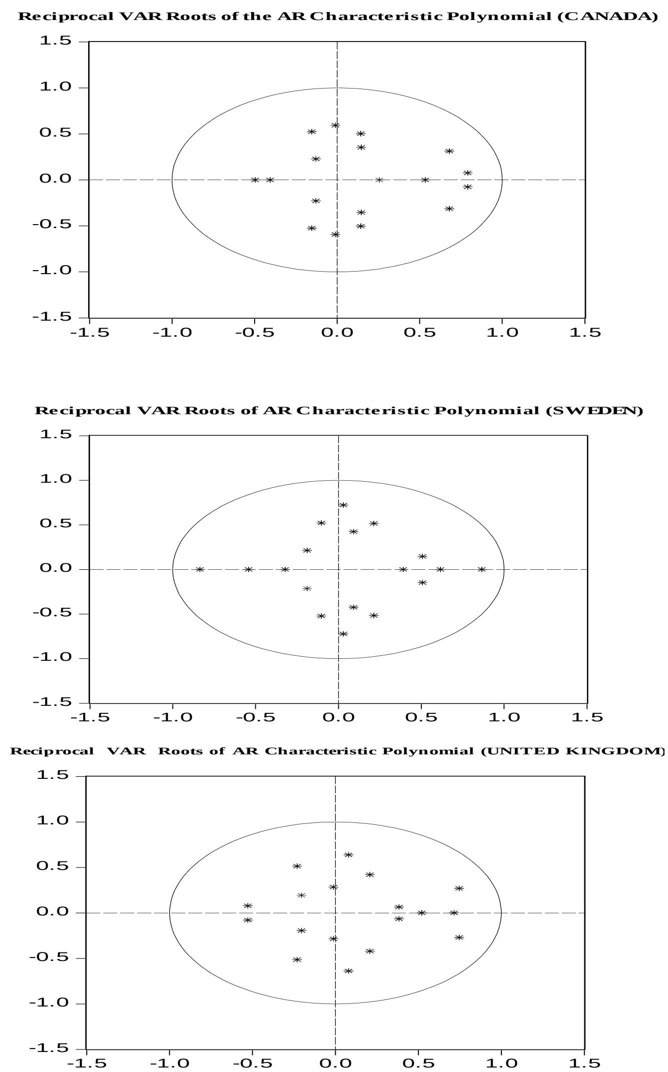


Figure 3.24: Eigenvalue (λ) Condition for Stability of SVAR Model (OECD Countries)

Notes:The figure shows the eigenvalue condition for the stability of the SVAR. The criteria for stability is that if the modulus of all the eigenvalues fall inside the unit circle then the SVAR is stable. On the other hand if at least one modulus of an eigenvalue falls outside the unit circle, then the stability condition for the SVAR does not hold.

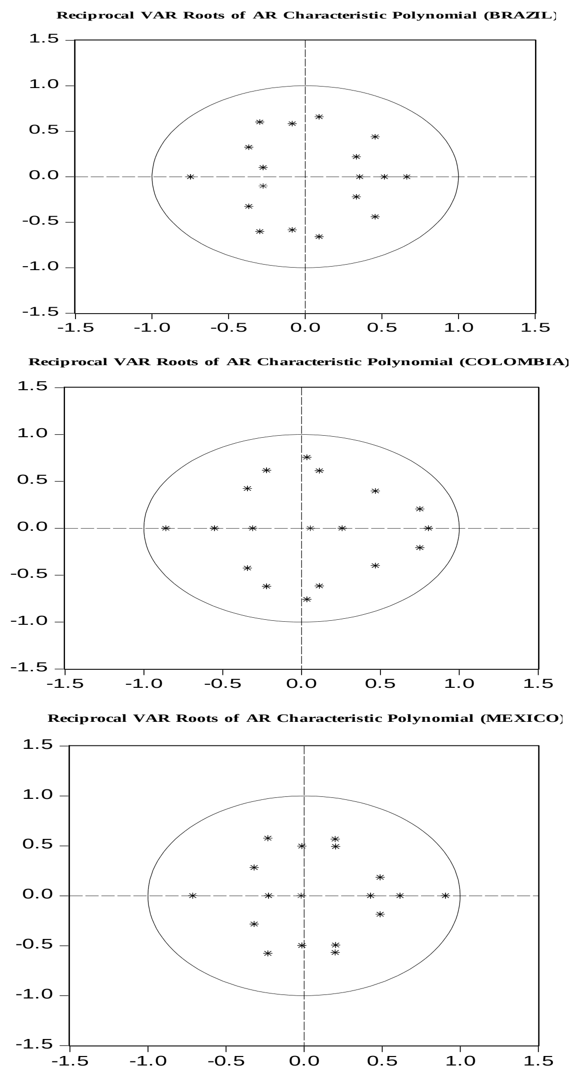


Figure 3.25: Eigenvalue (λ) Condition for Stability of SVAR Model (Latin American Countries)

Notes:The figure shows the eigenvalue condition for the stability of the SVAR. The criteria for stability is that if the modulus of all the eigenvalues fall inside the unit circle then the SVAR is stable. On the other hand if at least one modulus of an eigenvalue falls outside the unit circle, then the stability condition for the SVAR does not hold.

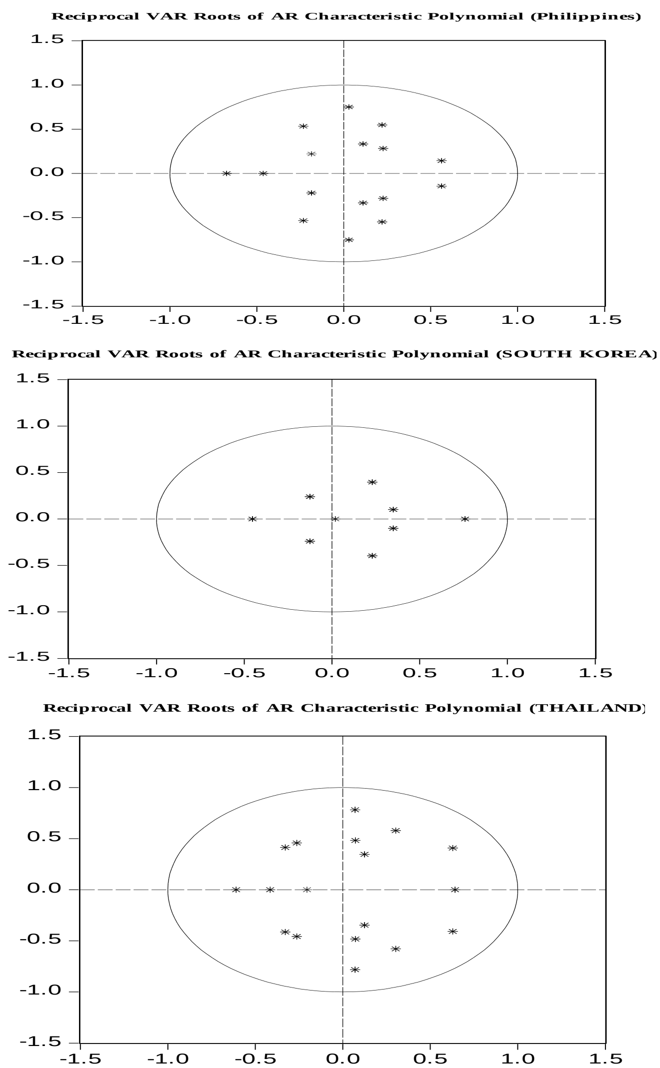


Figure 3.26: Eigenvalue (λ) Condition for Stability of SVAR Model (Southeast Asian Countries)

Notes:The figure shows the eigenvalue condition for the stability of the SVAR. The criteria for stability is that if the modulus of all the eigenvalues fall inside the unit circle then the SVAR is stable. On the other hand if at least one modulus of an eigenvalue falls outside the unit circle, then the stability condition for the SVAR does not hold.

Chapter 4

Productivity Differential Hypothesis and the Real Exchange Rate

4.1 Introduction

In the period following the seminal contributions of Balassa (1964) and Samuelson (1964), understanding the theoretical and empirical link between the real exchange rate and productivity differential has been at the center of many debates in international macroeconomics and economic policy. This difficulty in establishing a link between the real exchange rates movements and differences in productivity between the tradable and nontradable sectors, especially in fast growng economies have resulted in wide-ranging studies to resolve the issue. However, most of these studies, if not all, have arrived at conflicting results. For instance, Asea and Mendoza (1994) found a strong correlation between productivity differential and relative price of non-tradables, but argued that their results do not provide any support to the productity differential hypothesis that the real exchange rates appreciate because of variations in productivity between the tradable and nontradable sectors[1].

[1]The apparent weakness of the productivity differential theory is more noticeable in studies conducted in developed or advanced countries with flexible exchange rates, strong institutions and developed financial markets.

In contrast, Berka *et al.* (2013) have argued that productivity differentials between the tradable and nontradable industries in fast growing economies have contributed to the appreciation of the real exchange rates in the Eurozone as dictated by the Balassa-Samuelson (B-S) hypothesis. This paper aims to resolve the earlier controversies by shedding new light on the subject for the fast growing South African economy. One stylized fact is that countries experiencing faster labor productivity in their tradable relative to the nontradable sectors tend to experience an appreciation in their real exchange rates. Since this asymmetry in labor productivity has an effect on economic growth, identifying how the real exchange rate respond to differences in productivity across countries is crucial for exchange rate policy formulation and the trade-off between the inflation target and exchange rate stability.

Therefore the paper examines how productivity differentials between the tradables and nontradables sectors in South Africa and the United States affect the South African real exchange rate. Specifically, this paper analyzes the long run behavior of real exchange rates by investigating the relationship between productivity differentials and the real exchange rates in South Africa. In particular, the paper attempts to provide answers to the following questions. First, does sectoral differences in productivity appreciate the South African real exchange rate? Second, how does openness in the economy affect the real exchange rate? Finally, does real interest rate differentials between South Africa and the United States drive the Rand-US$ real exchange rate?

To carry out the empirical analysis in this study, I use a multivariate structural cointegrated vector autoregressive model with weakly exogeneous foreign variables (VECX*) in the spirit of Garratt *et al.* (2003). One of the advantages of using the VECX* technique is that it encompasses both long run relationships among the variables and short run dynamics in the multivariate regressions, an essential ingredient in obtaining multiple cointegrating relationships between real exchange rate and productivity differential of nontradables. Before estimating the VECX* model, I obtain the estimates of the domestic and international B-S models via an autoregressive distributed lag (ARDL) estimation technique. This single-equation estimation method helps to provide some preliminary analysis of the long-run equilibrium relationships for the sets of macroeconomic variables of the original model. To find out whether a productivity shock has an impact on the real exchange rates I employ the VECX* technique which embodies the impulse response functions for characterizing real exchange rate and productivity dynamics. In order to generate the data for total factor productivity in the tradable and nontradable sectors or deal with any potential endogeneity problem, I used Dynamic Least Squares (DLS) estimation methods.

As was documented in the literature, the increased research interest on the B-S hypothesis led economists and policy makers to develop various models of real exchange rate determination. Among the various models developed by previous researchers, two main models have dominated the debate on real exchange rate determination in both developed and developing countries. One of these notable models is the Purchasing Power Parity (PPP) which conjectures that the equilibrium exchange rates of the currencies of two different countries should equalize their national price levels assuming zero arbitrage opportunities in global markets for goods and services[2]. According to the PPP theory, real exchange rates must follow a stationary process suggesting that at any point in time it is possible to have transitory deviations from the equilibrium real exchange rates and not persistent deviations[3].

Empirical evidence in favor of this proposition shows mixed results. Balassa (1964) and Samuelson (1964), for instance, provided an explanation for the failings of the absolute PPP as a theory of exchange rate determination. According to them, countries with high productivity growth in tradables relative to nontradables experience an appreciation in their real exchange

[2]The implication of the PPP theory is that a unit of currency should be able to buy the same amount of goods in the domestic country as the equivalent amount of the foreign currency can buy in the foreign economy in order to achieve parity in the purchasing power of the unit of currency across both countries

[3]In the short run deviations from the equilibrium real exchange rates appears to be transient, but revert to their long-term trend in the long-run.

rates suggesting that the PPP will not hold between countries with different levels of growth[4]. This basic explanation for the deviation of the real exchange rates from its long run PPP value led to the second theory on real exchange rate determination-the productivity differential hypothesis. This theory, which provides a vivid explanation on the effect of changes in international prices of goods and services in a static environment under conditions of perfect competition and zero market frictions, has been explored by Rogoff (1992), De Gregorio and Wolf (1994), Berka *et al.* (2012, 2013), Kakkar and Yan (2012), Choudri and Khan (2005), Strauss (1999), Chinn and Johnston (1997) and others in the literature.

The theory posits that a higher productivity in tradables relative to nontradable commodities is associated with a real appreciation of the exchange rate. The argument here is that a positive innovation to tradables productivity in the home country will lead to an expansion in tradable sector economic activity and a fall in both marginal cost and prices of tradable goods in the economy. The expansion in economic activity in the tradable sector implies that aggregate demand will increase. This increase in aggregate demand leads to an increase in the cost of labor and so wages are bound to increase in the tradable sector. Since labor is mobile between sectors, workers move from the nontraded sector to the traded goods sector in response to the increase in wages. Consequently, the movement of labor away from nontradables puts a downward pressure on the supply of nontradables because a smaller workforce would imply less production, *ceteris paribus*. The fall in supply of nontradables results in an increase in price and an upward pressure on wages in the nontradables goods sector. The increase in nontradable goods prices occur because the increase in wages in the nontradable goods sector is not accompanied by productivity gains. As prices in the nontradable sector increases relative to declining

[4]According to the productivity differential theory, technical progress in the tradable goods sector is much higher for highly industrialized or developed countries like USA and Germany than for less developed countries like Sierra Leone and Bangladesh. This productivity bias triggers an increase in wages in the tradable sector. With unchanged wages in the nontradable sector, labor will be tilted towards tradable goods production and the competition that occured forces firms in the nontradable sector to increase wages. Since productivity in the nontradable sector has not changed, the higher wages would imply increased marginal costs and an increase in nontradable goods price.This explains why prices of nontradable goods and services like haircut are higher in USA and the UK than in developing countries in Africa and Asia.

prices in the tradable sector, the domestic real exchange rate falls resulting in an appreciation of the Rand-US$ real exchange rate. This mechanism explains why the wage rate of a barber in the U S is higher than the wage rate of a barber in Malawi even though the services provided by both barbers could be the same.

On the other hand, if productivity growth in the tradable goods sector declines relative to the nontradable goods sector, economic activity in the tradable sector will contract implying less competition for resources in the nontradable sector. This results in a downward pressure on both nominal and real wages and a depreciation in the internal real exchange rate of the country. From this and the preceding arguments it is easy to see that productivity differential of tradable relative to nontradables is the main exogenous determinant of equilibrium real exchange rates.

The productivity bias hypothesis *à* la Balassa-Samuelson (B-S) hypothesis on long run real exchange rates is based on three basic assumptions. First, there is perfect competition in the labor markets within each country and perfect mobility of factors between sectors to ensure wage equalization between the traded and nontraded goods sector in the economy.[5] Second, traded goods are homogenous so that the Purchasing Power Parity only holds true for the tradable goods sector in the long run. Third, the Balassa-Samuelson model also assumes that labor markets are frictionless so that there is always full employment in the economy. Many of the empirical works on the relevance of the Balassa-Samuelson hypothesis tend to focus on the relevance or validity of these assumptions. Canzoneri *et al.* (1999), for instance, tested these assumptions by using annual data for a panel of OECD countries. They documented that productivity differentials are cointegrated one-for-one with the relative price of nontradables. Marston (1987) and De Gregorio and Wolf (1994) also examine the effect of productivity in the tradables and nontradables sectors on the real exchange rate and arrived at results that support the Balassa-Samuelson proposition.

[5]See Faria and Leon-Ledesma (2003) for a detail analysis of this assumption.

This paper contributes to the existing literature in three ways. First, I use a more rigorous approach to classify the sectors of the economy into traded and nontraded goods sector based on the revised United Nations dissagregated methodology. Classifying the sectors in this manner does make sense since it helps me to obtain a more accurate measure of the prices of tradables and nontradables and the productivity differentials than the proxy measure of GDP per capita used in previous studies conducted by Balassa (1964), Alexius and Nilsson (2000), Drine and Rault (2005), Lane and Milesi-Ferreti (2004), Lewis (2007) and many others. Second, the existing time series studies in the literature have largely focused on OECD, Latin American and Asian countries, ignoring fast growing economies in Sub-Saharan Africa like South Africa. In contrast, this paper provide an extension of the literature to other areas that have not been explored before. Finally, I employed a modelling technique that combines the long run equilibrium relationships of the macroeconomic economic variables and short run dynamics in the framework of the VECX* with a set of weakly exogenous external variables for a small open economy.

In this paper, I use the standard B-S model in which the technology of the firm exhibit constant returns to scale. In formulating the model used in this paper I rely on the assumptions of small country, perfect competition and complete labor mobility between sectors. According to the results of the ARDL and VECX* regressions, I argue that an increase in productivity growth in the tradable goods sector leads to an appreciation of both the internal and external real exchange rate in South Africa. This finding provides support for the productivity differential hypothesis. The results also suggest that the recent trade liberalization in South Africa contributes towards the movement in the real exchange rate. My findings also revealed that the weakly exogenous variables have little effect on the real exchange rate in the VECX* model.

The plan of the paper is as follows. In section 4.2 I provide some landmark contributions by previous researchers on the relationship between the real exchange rates movement and productivity. Section 4.3 provides some theoretical discussion on the evolution of the real exchange rate and the productivity differential hypothesis. Section 4.4 provides a thorough description of the data and the VECX* method use to examine the relevance of the productivity differential hypothesis to the South African case. To ensure that productivity in the tradable and nontradable sectors is measured correctly, I embark on a careful classification of the sectors into tradable and nontradables in this section. Section 4.5 embodies detailed econometric analysis of the results. Section 4.6 summarizes the paper and recommends areas for further research.

4.2 Survey of Landmark Contributions

The debate concerning the role of productivity differential between tradables and nontradables in determining real exchange rate movement is not new. Empirical evidence on the relevance of the Balassa-Samuelson hypothesis for industrialized and developing countries is enormous and shows a lot of conflicting arguments among various scholars. Earlier works on the Balassa-Samuelson theory include the original work of Balassa (1964), the paper by Officer (1976) and Hsieh (1982). Balassa (1964) used OLS technique to regress real exchange rates on per capita income for a cross-section of 12 industrialized countries. Based on his findings, Balassa documented that growth in productivity as measured by the growth in GDP per capita is related to changes in the real exchange rates.

In his seminal paper, Hsieh (1982) used a sectoral productivity approach to study the behavior of real exchange rates in Germany and Japan for the period 1954 through 1976. Using IV (Instrumental Variables) and OLS (Ordinary Least Squares) estimation techniques, he was able to provide support for the Balassa-Samuelson proposition that differences in productivity of tradables relative to nontradables across countries result in differences in wages, prices and an appreciation of the real exchange rates. A striking weakness of Hsieh's (1982) study is that he failed to determine the time series characteristics of the variables in his regressions. Ignoring the time series properties of the variables does not only lead to spurious regression results, but also has the tendency to cloud inference. In order to circumvent this problem, this study uses a multivariate Johansen cointegration framework to determine the relationship between the real exchange rate and productivity differentials of tradables and nontradables for South Africa.

Probably motivated by the findings of Hsieh (1982), Asea and Mendoza (1994) used an intertemporal equilibrium model of exchange rate to examine the cross-sectional implication of the Balassa-Samuelson effect for a group of 14 OECD countries between 1975 and 1985. In their analysis, they concluded that productivity differential has a strong correlation with the relative price of nontradables. However, their results failed to support the Balassa-Samuelson's proposition that the productivity differential of tradables relative to nontradables has a relationship with the real exchange rate. Choudhri and Khan (2005) used panel data on 16 developing countries to explain the long run behavior of real exchange rates and concluded that productivity differential between traded and nontraded goods significantly influence variations in the real exchange rates. Their findings seem to corroborate the Balassa-Samuelson's proposition for developing countries. Kakkar and Yan (2012) also provided support for the productivity differential hypothesis for six countries in Southeast Asia. Using the cointegration approach and disaggregated or micro-level data for various industries, they documented that productivity differentials of the tradable relative to the nontradable sectors play a key role in explaining the long run behavior of the real exchange rate in Southeast Asia. They also attributed the asian financial crisis of 1997 to the overvaluation of the real exchange rates in many Asian economies.

Some other methods used to examine the effect of productivity differentials on real exchange rate movements include the two-country two-sector NOEM (New Open Economy Macro) modelling and vector autoregressions (VAR). One significant contribution to this literature was the study conducted by Lewis (2007) for the United States *vis-a-vis* the Euro Area. Using sign restrictions to identify the structural shocks, she argued that differences in productivity between the tradable and nontradable sectors have little or no effect on real exchange rate movements in the US. However, her results supported the theory that aggregate demand and nominal shocks contributed immensely towards the appreciation of the Euro-dollar exchange rate.

Other recent studies on the relationship between productivity shocks and real exchange rates used a cointegrated vector autoregression methodology to determine the long run equilibrium relationship between labor productivity and real exchange rate movements. Beckmann *et al.* (2015) used this approach for 18 countries in Central and Eastern Europe and arrived at results that support the productivity differential hypothesis for most of the countries in their sample. They argued that the increasing productivity that occurred in Central and Eastern European countries after the European integration was attributed to the deepening form of economic integration in Europe. They also found that this rise in productivity resulted in a real exchange rate appreciation in that region, a result that is in firm agreement with the Balassa-Samuelson hypothesis. In a study conducted on economies in transition, $\grave{E}$gert (2002) decomposed the Balassa-Samuelson's effect into domestic and foreign to investigate the effect of productivity differential on relative prices and the real exchange rates for a group of six East European countries. In his analysis, he was able to provide strong evidence in support of the Balassa-Samuelson theory. My paper is similar to these papers in some aspects but differ in methodological approach. Whereas Beckmann *et al.* (2015) and $\grave{E}$gert (2002) used the VECM approach in carrying out their analysis, this paper employs a structural cointegrated VAR with weakly exogenous foreign variables to examine the long-run relationship between the real exchange rate and sectoral productivity differential in South Africa. In addition, my paper uses the ARDL model to determine the evolution of the internal and foreign real exchange rate in South Africa.

4.3 Theoretical Consideration

To motivate the empirical analysis in this paper, I begin by providing a brief theoretical framework on the relationship between the real exchange rate and the prices of both tradables and nontradables. This involves using the standard approach of decomposing the real exchange rate into prices of tradables and nontradables and subsequently linking the ultimate relationship to the productivity differential of those goods.

4.3.1 PPP and Real Exchange Rate

In theory, purchasing power parity can be regarded as an equilibrium relationship between the domestic price and the foreign price evaluated in the nominal exchange rate according to

$$P_t = E_t P_t^* \tag{4.1}$$

where P_t is the general price in the home country, P_t^* is the price level in the foreign country and E_t is the nominal exchange rate. A simple interpretation of equation (4.1) is that the price of a common basket of goods and services should be equal across countries when measured in a common currency if there are no opportunities for arbitrage. However, the presence of taxes, transport costs, trade restrictions such as tariffs and non-tariff barriers and information asymmetry across countries, implies that equation (4.1) may not hold (Garrett *et al.* (2003)). In the literature, the productivity differential theory provides an explanation for this deviation from purchasing power parity.

Incorporating the effect of arbitrage into equation (4.1) as in Garrett *et al.* (2003) gives

$$P_t = E_t P_t^* \exp(\xi_{ppp,t}) \tag{4.2}$$

where E_t is the nominal exchange rate, P_t is the domestic price level, P_t^* is the foreign price level and $\xi_{ppp,t}$ is a stationary process and captures the deviation from the PPP or the effect of information asymmetry, transport costs and other impediments as in Garrett *et al.* (2003). Suppose the PPP does not hold so that the general price index in the home country is a weighted average of traded and nontraded goods prices, then our price equation becomes

$$P = (P^T)^{\phi}(P^{NT})^{1-\phi} \tag{4.3}$$

By symmetry, the general price index in the foreign country is of the form

$$P^* = (P^{*T})^{\phi^*}(P^{*NT})^{1-\phi^*} \tag{4.4}$$

where P and P^* are weighted averages of the prices of tradables and nontradables in the home and foreign country respectively. The parameters ϕ and ϕ^* are the shares of tradables in aggregate consumption at home and abroad.

The real exchange rate of any country is the relative price of foreign goods in terms of domestic goods measured in a single currency. Algebraically, the real exchange rate is expressed as

$$Q = E\frac{P^*}{P} \tag{4.5}$$

where Q is the real exchange rate, E is the nominal exchange rate, P is the domestic price level and P^* is the foreign price level. According to equation (4.5), a real appreciation of the domestic currency is seen as a fall in Q and a real depreciation as an increase in Q. Log linearizing equations (4.3), (4.4) and (4.5) gives

$$p = \phi p^T + (1-\phi)p^{NT} \tag{4.6}$$

$$p^* = \phi^* p^{*T} + (1-\phi^*)p^{*NT} \tag{4.7}$$

$$q = e + p^* - p \tag{4.8}$$

where the lowercase letters denote variables in logarithmic form. Substituting equations (4.6) and (4.7) into equation (4.8) gives

$$q = e + \phi^* p^{*T} + (1 - \phi^*) p^{*NT} - \phi p^T - (1 - \phi) p^{NT} \tag{4.9}$$

Taking first differences of equation (4.8) gives

$$\Delta q = \Delta(e + p^{*T} - p^T) + (1 - \phi^*)\Delta(p^{*NT} - p^{*T}) + (\phi - 1)\Delta(p^{NT} - p^T) \tag{4.10}$$

From equation (4.10) it is clear that the real exchange rate is the sum of three components. These include, the relative price of tradables, the relative price of nontradables in terms of tradables in the home or domestic country and the relative price of nontradables in terms of tradables in the foreign country. If the weights of nontradables in the aggregate price index are the same for both the home and foreign country, then the second and third terms of equation (4.10) collapse so that

$$\Delta q = \Delta(e + p^{*T} - p^T) \tag{4.11}$$

Now suppose the Purchasing Power Parity theory holds for the tradable goods sector so that

$$\Delta e = \Delta(p^T - p^{*T}) \tag{4.12}$$

Plugging for Δe into equation (4.10) gives

$$\Delta q = (1 - \phi^*)\Delta(p^{*NT} - p^{*T}) + (\phi - 1)\Delta(p^{NT} - p^T) \tag{4.13}$$

Equation (4.13) says that the real exchange rate will appreciate if the relative price of nontradables relative to tradables falls in the domestic economy or increases in the foreign economy. The PPP assumption implies that the first term in equation (4.10) goes to zero and collapses from the equation.

4.3.2 Tradable and Nontradable Goods Production

On the production side of the economy, firms employ labor, rent capital from households and combine these inputs by using a constant returns to scale technology to produce output. There are only two types of goods produced in this economy (tradables and nontradables). In this setup, I assume as in the BS model that capital is perfectly mobile internationally and labor immobile internationally but both inputs are mobile between the tradable and nontradable goods sector in the domestic economy. Hence firms in this economy produced the two commodities according to the Cobb-Douglas production functions as

$$Y_{jt}^{T} = A_{jt}^{T}(L_{jt}^{T})^{\alpha_j^T}(K_{jt}^{T})^{(1-\alpha_j^T)} \tag{4.14}$$

$$Y_{jt}^{NT} = A_{jt}^{NT}(L_{jt}^{NT})^{\beta_j^{NT}}(K_{jt}^{NT})^{(1-\beta_j^{NT})} \tag{4.15}$$

where $Y_{jt}^{T}(Y_{jt}^{NT})$ denote output of goods produce in the tradable (nontradable) sector of country j in period t, $A_{jt}^{T}(A_{jt}^{NT})$ denote a measure of country's j tradable (nontradable) productivity in period t, $L_{jt}^{T}(L_{jt}^{NT})$ represent units of labor employed in country's j tradable (nontradable) sectors, $K_{jt}^{T}(K_{jt}^{T})$ is capital used in country's j tradable (nontradable) sectors, $\alpha \in [0,1]$ and β $\in [0,1]$. The subscripts $j \in [D,F]$ denotes domestic and foreign countries—in our case South Africa and USA—respectively and t is time period. Since it is assumed that firms operate in a perfectly competitive environment, each of them take factor and output prices as given and choose capital and labor so as to maximize profits. In this setup their is equalization of factor prices between sectors since capital and labor are assumed to be mobile. The profit maximization problem of the firm producing the tradable goods is of the form

$$\underset{K_{jt}^{T},L_{jt}^{T}}{\text{Max}} A_{jt}^{T}(L_{jt}^{T})^{\alpha_j^T}(K_{jt}^{T})^{(1-\alpha_j^T)} - WL_{jt}^{T} - RK_{jt}^{T} \tag{4.16}$$

where W is the wage rate and R is the rate of return on the use of capital. Notice that the price of the tradable good, P_{jt}^{T}, does not appear in equation (4.16) because of the small open economy assumption. In particular, the price of tradables, P_{jt}^{T}, is regarded as the *numeraire*, that is, the price of tradables in the home country (South Africa) and the foreign country (USA) is normalised as unity. The optimization problem for the firm producing the nontradable goods is expressed as

$$\underset{K_{jt}^{NT},L_{jt}^{NT}}{\text{Max}} P_{jt}^{NT}A_{jt}^{NT}(L_{jt}^{NT})^{\beta_j^{NT}}(K_{jt}^{NT})^{(1-\beta_j^{NT})} - WL_{jt}^{NT} - RK_{jt}^{NT} \tag{4.17}$$

Solving for the optimal values of labor and capital yields the first order conditions as

$$W = \alpha_j^T A_{jt}^T (L_{jt}^T)^{\alpha_j^T - 1}(K_{jt}^T)^{(1-\alpha_j^T)} = \alpha_j^T \frac{Y_{jt}^T}{L_{jt}^T} = A_{jt}^T \alpha_j^T \left(\frac{K_{jt}^T}{L_{jt}^T}\right)^{(1-\alpha_j^T)} \tag{4.18}$$

$$W = \beta_j^{NT} P_{jt}^{NT} A_{jt}^{NT}(L_{jt}^{NT})^{(\beta_j^{NT}-1)}(K_{jt}^{NT})^{(1-\beta_j^{NT})} = \left(\frac{P_{jt}^{NT}}{P_{jt}^T}\right) A_{jt}^{NT}\beta_j^{NT}\left(\frac{K_{jt}^{NT}}{L_{jt}^{NT}}\right)^{(1-\beta_j^{NT})} \tag{4.19}$$

$$R = 1 - \alpha_j^T A_{jt}^T (L_{jt}^T)^{\alpha_j^T}(K_{jt}^T)^{-\alpha_j^T} = (1-\alpha_j^T)\frac{Y_{jt}^T}{K_{jt}^T} = A_{jt}^T(1-\alpha_j^T)\left(\frac{K_{jt}^T}{L_{jt}^T}\right)^{-\alpha_j^T} \tag{4.20}$$

$$R = 1 - \beta_j^{NT} P_{jt}^{NT} A_{jt}^{NT}(L_{jt}^{NT})^{\beta_j^{NT}}(K_{jt}^{NT})^{-\beta_j^{NT}} = \left(\frac{P_{jt}^{NT}}{P_{jt}^T}\right) A_{jt}^{NT}(1-\beta_j^{NT})\left(\frac{K_{jt}^{NT}}{L_{jt}^{NT}}\right)^{-\beta_{jt}^{NT}} \tag{4.21}$$

Taking logarithms of the above first order conditions gives

$$w = a_{jt}^T + log\alpha_j^T + (1-\alpha_j^T)(k_{jt}^T - l_{jt}^T) \tag{4.22}$$

$$w = (p_{jt}^{NT} - p_{jt}^T) + a_{jt}^{NT} + log\beta_j^{NT} + (1-\beta_j^{NT})(k_{jt}^{NT} - l_{jt}^{NT}) \tag{4.23}$$

$$r = a_{jt}^T + log(1-\alpha_{jt}^T) - \alpha_{jt}^T(k_{jt}^T - l_{jt}^T) \tag{4.24}$$

$$r = (p_{jt}^{NT} - p_{jt}^T) + a_{jt}^{NT} + log(1-\beta_j^{NT}) - \beta_j^{NT}(k_{jt}^{NT} - l_{jt}^{NT}) \tag{4.25}$$

where lowercase letters denote variables in their logarithms. In order to establish a relation between changes in the relative price of nontradables to tradables and the productivity differential between the tradable and nontradable sector, I took first differences of equations (4.22)-(4.25) and apply some mathematical manipulation to obtain the so-called domestic version of the

Balassa-Samuelson Effect as:

$$\Delta(p_t^{NT} - p_t^T) = \frac{\beta}{\alpha}\Delta(a_t^T - a_t^{NT}) + \zeta_{1t} \tag{4.26}$$

By symmetry, the relationship between the relative price of nontradables to tradables and the productivity differential between tradables and nontradables in the foreign country can be expressed as

$$\Delta(p_t^{*NT} - p_t^{*T}) = \frac{\beta^*}{\alpha^*}\Delta(a_t^{*T} - a_t^{*NT}) + \zeta_{1t}^* \tag{4.27}$$

Egert (2002), Strauss (1999) and Choudhri and Khan (2005) arrived at this relationship in their studies. Assuming equal factor intensity of tradables and nontradables, β=α, then the prices of nontradables are expected to increase faster than the prices of tradables if productivity growth in the tradable goods sector exceeds growth in the nontradable goods sector. If $\beta > \alpha$, then a small difference between productivity growth in the tradables and the nontradable good sector will result in an increase in the relative price of nontradables. The opposite effect will occur if $\beta < \alpha$. Substituting equations (4.26) and (4.27) into equation (4.13) and using the real exchange rate relation in equation (4.5) gives the specification for the *International Balassa-Samuelson Effect* as

$$\Delta q_t = (1 - \phi^*)\left[\frac{\beta^*}{\alpha^*}\Delta(a_t^{*T} - a_t^{*NT})\right] + (\phi - 1)\left[\frac{\beta}{\alpha}\Delta(a_t^T - a_t^{NT})\right] + \zeta_{2t} \tag{4.28}$$

Now if we define $c_1 = (1 - \phi^*)\frac{\beta^*}{\alpha^*}$ and $c_2 = (\phi - 1)\frac{\beta}{\alpha}$ then equation (4.28) becomes

$$\Delta q_t = c_1\Delta(a_t^{*T} - a_t^{*NT}) + c_2\Delta(a_t^T - a_t^{NT}) + \zeta_{2t} \tag{4.29}$$

From equation (4.29), the signs of the parameters c_1 and c_2 can either be positive or negative. If c_2 is negative, then an increase in productivity in the tradable sector will lead to an appreciation of the real exchange rate implying that the productivity differential hypothesis holds true. On the other hand, if c_2 is positive then an increase in productivity in the tradable sector results in a depreciation of the real exchange rate—a relationship that is consistent with the prediction of the new open macroeconomic models (NOEM).

4.4 Empirical Model and VECX* Methodology

In this paper, a VECX* model was used to explore the relationship between the real exchange rate and productivity differential of the South African tradable sector relative to the nontradable sector. This approach, which was first used by Garrett *et al.* (2003), combines a vector of the main macroeconomic variables, $\mathbf{X}_t$, and a vector of current and lagged values of a set of weakly exogenous variables, $\mathbf{X}_t^*$, in the framework of an augmented vector error correction model (VECM). The model encompasses both long run properties and short run dynamics. Algebraically, our VECX* model is represented as

$$\Delta\mathbf{Y}_t = -\Pi_y\left(\mathbf{Z}_{t-1} - \gamma(t-1)\right) + \Psi\Delta\mathbf{X}_t^* + \sum_{i=1}^{P-1}\Omega_i\Delta\mathbf{Z}_{t-i} + \mathbf{c}_0 + \mathbf{v}_t \tag{4.30}$$

and an augmented or rather marginal model of a set of weakly exogenous variables as

$$\Delta\mathbf{X}_t^* = \alpha_{x^*0} + \sum_{i=1}^{P-1}\Gamma_{x^*i}\Delta\mathbf{Z}_{t-i} + \mathbf{u}_{x^*t} \tag{4.31}$$

where $\mathbf{Z}_{t-1} - \gamma(t-1)$ denotes the error correction term, $\mathbf{c}_0$ is a vector of fixed coefficients, Ω_i is a matrix of dynamic or short-run coefficients, Ψ is a vector that denotes the effects of a change in the weakly exogenous variables on $\Delta\mathbf{Y}_t$, Π_y is the long-run multiplier matrix of the augmented VECM, $\mathbf{u}_{x^*t}$ and $\mathbf{v}_t$ are the homoscedastic disturbances of the system. In particular, the disturbances are assumed to be $\mathbf{v}_t \sim i.i.d\ [0, \Sigma_y]$ and $\mathbf{u}_{x^*t} \sim i.i.d\ [0, \Sigma_{x^*}]$.

The VECX* model developed here comprises a total of six endogenous variables and four weakly exogenous variables. To show how these variables fit into the model, it is important to partition the $\mathbf{Z}_t$ matrix so that

$$\mathbf{Z}_t = \left(\mathbf{X}_t', \mathbf{X}_t^{*\prime}\right)' \tag{4.32}$$

where the sub-matrix of the six endogenous variables is given by

$$\mathbf{X}_t = \begin{pmatrix} q_t \\ a_t^T - a_t^{NT} \\ p_t^{NT} - p_t^T \\ tot^{SA} \\ opn_t^{SA} \\ r_t^{SA} - r_t^{*USA} \end{pmatrix} \tag{4.33}$$

and the sub-matrix of weakly exogenous variables denoted by

$$\mathbf{X}_t^* = \begin{pmatrix} a_t^{*T} - a_t^{*NT} \\ p_t^{*NT} - p_t^{*T} \\ tot_t^{*USA} \\ opn_t^{*USA} \end{pmatrix} \tag{4.34}$$

From equation (4.33) the endogenous variables include the real exchange rate (q_T), the productivity differential of tradables relative to nontradables in South Africa ($a_t^T - a_t^{NT}$), South African internal real exchange rate or relative price of nontradables ($p_t^{NT} - p_t^T$), the South African terms of trade (tot_t^{SA}), openness to trade in South Africa (opn_t^{SA}) and the interest rate differential between South Africa and the US ($r_t^{SA} - r_t^{*USA}$). The variables of the matrix in equation (4.34) are the foreign counterparts, and in our case the weakly exogenous. If we combine the two sub-matrices, it is easy to see that the dimension of the $\mathbf{Z}_t$ matrix in the VECX* model is 10×1. The inclusion of the openness to trade in the analysis of the real exchange rate in South Africa is relevant in the sense that South Africa is moving more towards a policy of trade liberalization in SADC (South African Development Community) in an attempt to boost trade with other countries. Liberalizing trade in the form of tariff reduction results in a reduction in the domestic price of imports and an increase in the demand for imported goods. The rise in the demand for imports implies that the demand for locally produced nontradable goods will fall. In response to the fall in domestic demand for nontradable goods, the real exchange rate must increase in order to restore equilibrium in the nontradable goods market. The terms of trade variable was also included in order to capture South Africa's competitiveness in world trade. Most studies on productivity differential and the real exchange rate have failed to capture the effect of trade liberalization and trade competitiveness when exploring the relationship between differences in productivity and the real exchange rate despite the importance of these variables.

Since the VECX* is a modified form of the original VECM, its long-run multiplier deserves some elaboration. Unlike the normal vector error correction model, the long-run multiplier matrix of a VECX* model is a sub-matrix. Π comprises the long-run multiplier of the VECX* model and the multiplier of the augmented VECM or marginal model so that $\Pi' = [\Pi'_y, \Pi'_{x^*}]$. Following Garrett *at al.* (2003), I impose the weak exogeneity restrictions on the VECX* long-run multiplier so that $\Pi_{x^*} = 0$. The basic rational for imposing this restriction is to ensure that the cointegrating vectors of VECX* model are obtained. Because South Africa is a small open economy, it is very likely that the foreign variables are not influenced by the domestic variables and so $\Pi_{x^*} = 0$.

4.4.1 Data Description

For the purpose of estimating the model, quarterly time series data from the period 1993q1 through 2015q3 was collected for all the variables. The data sources for the construction of price indices of tradables, P^T, and nontradables, P^{NT} include the databases of Statistics South Africa, FRED's, National Accounts of the US Bureau of Economic Analysis (BEA) and US Bureau of Labor Statistics (BLS). Unlike Lewis (2007), this paper used the gross value added at current and constant prices to generate the price deflators for tradable and nontradable sectors according to the equations

$$P_{jt}^{T} = \frac{\text{GVA}_{jt}^{T} \quad \text{at Current Prices}}{\text{GVA}_{jt}^{T} \quad \text{at Constant Prices}} \tag{4.35}$$

$$P_{jt}^{NT} = \frac{\text{GVA}_{jt}^{NT} \quad \text{at Current Prices}}{\text{GVA}_{jt}^{NT} \quad \text{at Constant Prices}} \tag{4.36}$$

where GVA_{jt}^{T} denotes the gross value added of the tradable industry or sector for country j in period t, GVA_{jt}^{NT} is the gross value added of the nontradable sector of country j in period t, $j \in$ [D, F], P_{jt}^{T} and P_{jt}^{NT} are the prices of tradables and nontradables respectively. In this paper, real exchange rate is defined both as a ratio of the price tradables to the price of nontradables and as nominal exchange rates adjusted for price variations between South Africa and the United States. The nominal exchange rate (ZAR/US$) data was extracted from IMF International Financial Statistics CD-ROM, FRED's (Federal Reserve Economic Data) database of Saint Louis. Data on consumer price indices—which was used to generate the real exchange rate data—for both South Africa and the United States was obtained from the same IMF IFS CD-ROM and FRED's database.

In this paper, disaggregated total factor productivity by sector was used as a proxy for productivity in the tradable and nontradables sectors. The approach of Apergis (2013) was used in which the *Solow residuals* of each of the two sectors' technology functions was obtained from the estimated Cobb-Douglas production functions of the two sectors. Beckmann *et al.* (2015) acknowledged the fact that this approach is more appropriate in the generation of productivity (TFP) of tradables and nontradables in the literature. Chinn and Johnston (1997) and Kakkar and Yan (2012) also used sectoral TFP measures as proxies for sectoral productivity. According to Kakkar and Yan (2012), if accurate capital stock data is available then the use of TFP is more appropriate than labor productivity because the former is more consistent with the productivity differential hypothesis than the latter.

Employment statistics by industry was extracted from Statistics South Africa and the US

Bureau of Labor Statistics databases. Gross fixed capital formation data came from the OECD statistics department. Both the data on gross fixed capital formation and employment in the tradable and nontradable sectors were used to compute the TFP or *Solow residuals* in the tradable and nontradable sectors[6]. Prior to the computation of the productivity and relative prices, I classify the different sectors of the economy into tradables and sheltered or nontradables sectors[7].

Classifying the sectors into traded and nontraded inappropriately will negatively affect the computation of the productivity differentials and relative prices which in turn affect the analysis of the results. In this study, manufacturing and mining are considered as traded goods sector in both South Africa and the United States. Because the share of agricultural output in total exports is appreciable relative to the output of other sectors—hotels and tourism, construction, transportation—the agricultural output was categorised as tradable. For the US, industrial goods constitute the greatest share of exports in trade and the increasing move towards free trade in agricultural goods in South Africa and other European countries implies that the share of agricultural commodities in international trade have increased. In this regard, the tradable sector comprises agriculture, manufacturing, mining and quarrying and air and sea transport. Together, these sectors constitute the tradable sector. The nontraded sector includes construction, hotels and restaurants, financial intermediation services, wholesale and retail trade, housing and real estate, health and social services, electricity and gas, professional

[6]From the Cobb Douglas production functions of tradables and nontradables, the *Solow residuals* or sectoral TFP is generated by taking the difference between the growth rate of output in each of the sectors and the weighted average of the growth rate of the factor inputs use in the production process. The relevant equations for this procedure can be represented as: $\dot{A}_T$=$\dot{Y}_T$ - $\alpha\dot{L}_T$ - (1- α)$\dot{K}_T$ and $\dot{A}_{NT}$=$\dot{Y}_{NT}$ - $\beta\dot{L}_{NT}$ - (1- β)$\dot{K}_{NT}$. Where $\dot{A}_T$ and $\dot{A}_{NT}$ are the *Solow residuals* in the tradable and nontradables sectors. L_T and L_{NT} denote number of employed persons in the tradable and nontradable sectors, K_T and K_{NT} denotes capital in the two sectors. The parameters $\alpha \in [0, 1]$ and $\beta \in [0, 1]$.

[7]As a rule of thumb, I consider traded sectors as those sectors that produce tradable goods and services and nontradable sectors as those that produce nontradable goods and services. In theory, tradable goods are goods with a higher value per unit weight and can cross international borders unhindered by high tariffs and other trade costs. Some agricultural commodities and minerals like diamond, gold, rutile and bauxite are typical examples of tradable goods. On the other hand, nontradable goods are those goods that are produced locally and consumed in the domestic economy either because the transport cost for exporting them is too high or there are huge tariff barriers that prevent them from being traded internationally. Arts and entertainment, legal services, housing rental, haircut, home construction, electricity, water and gas services are perfect examples of nontradables.

and business services, arts, entertainment and recreation and personal services.

In this study, I define the terms of trade as the ratio of export prices to import prices. This variable captures the effect of competitiveness of the South African economy in world trade. Both the export price index (2005=100) and import price index (2005=100) data were obtained from the IMF IFS CD-ROM and FRED'S website. Regarding the opennes to trade, the variable is defined as

$$OPN_{SA} = \frac{\text{Exports} + \text{ Imports}}{GDP} \tag{4.37}$$

where OPN_{SA} represents openness to trade of the South African economy and GDP is South Africa's gross domestic product. The interest rate differential is defined as South Africa's real interest minus the US real interest rate. The real interest is the nominal interest rate minus inflation. Data for the nominal interest rate for both South Africa and the United States is the three-month treasury bill rate and this data was extracted from the IMF IFS CD-ROM and FRED's website, https://research.stlouisfed.org/fred2/.

4.5 Empirical Analysis of Results

This section provides a comprehensive analysis of the empirical results. Before analysing the results, I perform unit root and cointegration tests on the variables to determine their time series characteristics and long run equilibrium relationships. In general, diagnosing time series data for the presence of unit roots has been a common practice for most researchers in recent years. Basically, this involves exploring the univariate time series characteristics of the data. Understanding the time series behavior of the data is of particular importance to making a decision on whether the estimation of the VECX* model should be done on the variables in their levels or first differences. As was mentioned earlier, the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiathowski-Phillips-Schmidt-Shin (KPSS) tests were carried out since they provide robust estimates on the determination of the time series properties of the variables. The broad objective of these tests is to check whether the steady-state of the series is indeterminate or whether the series gravitates to some steady-state level. If the steady-state of the series is indeterminate, the effect of shocks to the series is permanent. However, if the series gravitates to some steady-state level, then the effect of any innovation in the form of shocks to the series will fade away over time. The unit roots and cointegration tests were carried out in the subsequent sections.

4.5.1 Unit Roots Test Results

Unit roots tests were applied to variables in their levels and first differences for the sample period 1993q1 through 2015q3. Testing for unit roots is of major interest in time series models and cointegration analysis, especially when the goal is to understand the comovement between real exchange rates and productivity differential of tradables relative nontradables. The presence of unit roots in the time series suggest that the mean and variance of the macroeconomic series are changing over time[8]. The augmented Dickey-Fuller, Phillips-Perron and KPSS unit roots test results are presented in Table 4.1. From the ADF and PP test results presented in Table 4.1, it is evident that the null hypothesis that variables possess unit roots in their levels cannot be rejected for all the variables. The KPSS test results suggest that the terms of trade variable is stationary in levels. However, both the ADF and PP tests confirm that the terms of trade is nonstationary in levels. A plot of the time series graph, although not reported here for the sake of preserving space, revealed that terms of trade is nonstationary in levels and so it is reasonable to conclude that the terms of trade variable is nonstationary in levels. In addition, all the tests results indicate that the real exchange rate follows a nonstationary process implying that the null hypothesis of unit roots cannot be rejected at the 5 percent level in the case of the ADF and PP tests[9]. This result appears to corroborate the findings of Wu *et al.* (2004) for countries in the Pacific Basin.

[8]The null hypothesis of this test procedure is that the time series data have unit roots or non-stationary against the alternative hypothesis that the series have no unit roots.

[9]This result is not consistent with the PPP theory that the real exchange rate is mean-reverting or follows a stationary process. This means that random disturbances do have a hysteretic effect on the real exchange since it does not return to its mean value over time after a shock cause it to change termporarily.

On the other hand, the variables in their first difference are stationary suggesting that they are integrated of order 1 or they are I(1) series. This implies that there is no systematic change in the mean and variance of the first difference variables because the periodic variations that may cloud inference have been eliminated following first-differencing.

4.5.2 Johansen Cointegration Analysis

Having conclusively accepted the hypothesis that the time series contain a stochastic trend , the next step is to find out whether this stochastic trend is common among the variables. If the variables share a common stochastic trend then a change in any of the fundamentals will lead to an appreciation or depreciation of the real exchange rate suggesting that real exchange rate and its macroeconomic fundamentals move together in the long run. In the Johansen cointegration tests two main statistics were obtained *viz* the trace statistic (λ_{trace}) and the maximum eigenvalue statistic (λ_{max}). The results of the cointegration test together with the critical values are reported in Tables 4.2. From the reported results in Table 4.2, it is evident that the null hypothesis of no cointegration among the variables is rejected at the 5% level of significance according to the data. This implies that there is a long-run relationship between the real exchange rate and the other macroeconomic variables in the system. Whereas the λ_{trace} statistic reveals the presence of 5 cointegrating vectors among the variables in the cointegrating space, the λ_{max} statistic suggests the presence of 2 cointegrating relationship among the variables in the cointegrating space.

For an r cointegrating relationship among the variables in $\mathbf{Z}_t$, the long run multiplier matrix Π_y is denoted by $\Pi_y = \alpha_y \beta'$. The parameter α_y represents the matrix of error correction coefficients and β is a matrix of long run coefficients in the cointegrating space. In order to test whether there is comovement among the variables, I used the Johansen full information maximum likelihood. In this estimation technique, the Akaike Information Criterion (AIC) was used to determine the order of the lag. The selected lag length is the one that is capable of reducing serial correlation in the model since the lag lenghts were chosen by minimizing the AIC.

4.5.3 Estimated Labor and Capital Shares

A striking difference between this paper and other papers written by Lewis (2007), Berka *et al.* (2012) and Beckmann *et al.* (2015), is that the sectoral productivity was generated by using estimated labor and capital shares obtained from the dynamic least square estimates of the production functions of the tradable and nontradable goods sectors. From the estimated production functions, the sectoral productivity was obtained as the *Solow residuals.* This approach is similar to the one used by Apergis (2013) for the Greek economy. Table 4.3 shows the estimated labor and capital shares for both the tradable and nontradable sectors in South Africa and the US. From the results it is evident that the sum of the labor and capital shares is approximately equal to 1 indicating that the production functions exhibit constant returns to scale as predicted by the BS theory. Although the sum of my labor and capital shares do not exactly add up to 1, the estimates appear to be similar to those obtained in previous studies. From the estimates of the inputs shares, the fitted values of the regressions are subtracted from the actual values of the gross valued added for both the tradable and nontradable sectors to obtain the productivity values. The resulting productivity values are then used to derive the productivity differential between the tradable and nontradable sectors.

4.5.4 ARDL Estimation of the Internal and External Real Exchange Rate

The internal and external real exchange rate equations (Domestic B-S and International B-S models) presented in Section 4.3 show how the relative price of nontradables (internal real exchange rate) and the external real exchange rate are related to sectoral productivity differences in the economy. In this section, I used the autoregressive distributed lag (ARDL) estimation methods to determine the long run coefficients of the internal real exchange rate equation. In order to run the ARDL regressions we must ensure that all the variables in the regressions are nonstationary which implies that the issue of performing unit roots tests becomes redundant[10]. In order to satisfy this condition, both the domestic B-S and international B-S models were estimated with all the variables in their levels. The results are reported in Tables 4.4 and 4.5. In Table 4.4, column (2) represents the long run parameter estimates for the internal real exchange rate equation for South Africa and the parameter estimates in column (3) are the long run coefficients for the United States internal real exchange rate equation. From the results, it is evident that the coefficients of the productivity differential variable and its deviation enter the internal real exchange rate equation with the expected positive sign and are statistically significant at conventional level of significance. The positive coefficient indicate that increases in productivity differential, $a_t^T - a_t^{NT}$, results in an increase in the relative price of nontradables and an appreciation of the real exchange rate in both South Africa and the United States. This finding is consistent with the B-S prediction that increases in productivity in the tradable sector put an upward pressure on wages and an increase in the price of nontradables. Consequently, the increase in the price of nontradables results in an appreciation of the South African internal real exchange rate. De Gregorio and Wolf (1994) obtained similar results in a study conducted on 14 OECD countries. In a different study conducted by Ègert *et al.* (2006), they argued that the rapid technological progress experienced by transition economies in Eastern Europe after the cold war resulted in real exchange rate appreciation.

This finding diminishes the *home bias effect* argument in New Open Macroeconomic models (NOEM) that productivity increases in the tradable sector leads to a depreciation of the internal real exchange rate. The argument here is that a productivity increase in the tradable sector is associated with quality improvement in the production of tradable goods which means that, for a given terms of trade, residents of the home country would be expected to shift consumption towards home produced tradables. The expansion in demand for home produced tradables implies that the demand for home produced nontradables will fall resulting in a downward

[10] Garrett *et al.*(2003) argued that the ARDL approach to estimation is robust to the unit roots characteristics of the macroeconomic time series suggesting that performing unit roots tests on the variables is not relevant in this case.

pressure on the prices of nontradables and a depreciation in the relative price of nontradables or the real exchange rate.

The trade liberalization variable (openness to trade) enters the internal real exchange rate equation with a negative sign and is significant at conventional level of significance. This finding indicates that the recent trade liberalization reforms in South Africa like the reduction of tariffs contributes significantly to the depreciation of the real exchange rate in South Africa. The depreciation of the real exchange rate occur because lower tariffs have the tendency to reduce the prices of goods imported from abroad. The fall in prices of imported goods causes a tilt in spending away from nontradable goods which in turn put a downward pressure on the prices of nontradables. The downward pressure on prices of nontradables depreciates the real exchange rate. My results are in sharp contrast to Obstfeld and Rogoff (2000) theoretical model prediction that higher degree of openness of the economy leads to an appreciation of the real exchange rates.

The coefficient of the terms of trade variable is positive but is not significant. This result indicates that an improvement in the terms of trade leads to an appreciation of the real exchange rate in South Africa. Improvement in the terms of trade leads to two effects—the positive income effect and negative substitution effect.The positive income effect arises because purchasing power of local residents increases following a terms of trade improvement. This increase in purchasing power, all else equal, leads to an increase in demand for nontradables which in turn drives prices up. Consequently, the upward pressure on prices appreciates the relative price of nontradables and the internal real real exchange rate. On the other hand, the negative substitution effect occurs because residents substitute nontradable goods for foreign goods when the terms of trade improves. The shift in demand in favor of imports implies that both demand for nontradables and price will fall. The fall in price reduces the relative price of nontradables and depreciates the real exchange rate. Whether the improvement in the terms of trade leads to an appreciation or depreciation of the real exchange rate depends, to a larger extent, on the magnitude of the positive income effect and negative substitution effect. In our case since the coefficient of the terms of trade variable in the ARDL regression is positive, the income effect surpasses the substitution effect and so the improvement in the terms of trade laeds to an appreciation of the real exchange rate. This means that an improvement in the terms of trade results in an appreciation of the internal real exchange rate via the income effect.

Regarding the United States, the positive and statistically significant coefficient of the terms of trade variable suggests that an improvement in the terms of trade results in an appreciation of the internal real exchange rate. Before I conclude the analysis of the *Domestic Balassa-Samuelson* model, it is important to note that our empirical approach depends on both the internal and external definitions of the real exchange as opposed to the study carried out by Beckmann *et al.* (2015). This enables me to incorporate the effects of changes in the dynamics of exchange rates in the analysis. Overall the results of the ARDL (4,2,1,1) indicate that the model fits very well since the $\bar{R}^2$ is in the neighborhood of 0.79 and 0.65.

Now turning to the international B-S model or the external real exchange rate equation, I estimated an ARDL [5,2,2,1,1,1] in which the domestic and foreign productivity differential variables were included in the model. The results are reported in Table 4.5. Based on the results in column (2) of Table 4.5, it is evident that the productivity differential variable for the domestic economy (South Africa) enters with the expected negative sign and is statistically significant. The regression results indicates that an increase in tradable sector productivity in South Africa, *ceteris paribus*, results in an appreciation of the real exchange rate. The economic implication of this finding is that an improvement in productivity of tradable goods in South Africa, all else equal, leads to an improvement in the quality of tradable goods produced in the home economy[11]. This implies that residents in South Africa would be expected to tilt their spending towards tradable goods and away from nontradables. Consequently, a decline in

[11]In the case of an increase in productivity in a particular sector, new firms producing quality goods are attracted towards the sector and so the quality of goods produced in that sector will improve.

private demand for nontradable goods exerts a downward pressure on the prices of nontradable goods and an appreciation of the external real exchange rate[12]. My results are consistent with those obtained by Lewis (2007) and Ègert *et al.* (2006) and provided strong support for the B-S productivity differential hypothesis that the real exchange rate appreciates following an increase in tradable goods productivity.

Terms of trade enters the ARDL regression with a negative sign and is statistically significant at the 1% level. This result implies that an improvement in the terms of trade, which is an increase in export prices or a fall in import prices, induces both a positive income effect and negative substitution effect. The positive income effect occurs because the rise in purchasing power of the local residents following a terms of trade improvement puts an upward pressure on the demand for nontradables. The rise in demand for nontradable goods implies that prices will increase and the real exchange rate appreciates. The negative substitution effect occurs because the fall in import prices following an improvement in the terms of trade makes foreign tradable goods cheaper. This implies that local residents will tilt consumption spending towards cheaper tradable goods. The increase in demand for tradable goods puts downward pressure on the demand for nontradable goods as residents substitute nontradable goods for tradable goods. Consequently, the fall in demand for nontradables implies price of nontradable goods has to fall. The fall in price of nontradable goods results in a depreciation of the real exchange rate. Whether the improvement in terms of trade leads to an appreciation or depreciation of the real exchange rate depends on the magnitude of the income and substitution effects. If the income effect is greater than the substitution effect, then an improvement in the terms of trade will lead to a real appreciation. On the other hand, if the substitution effect is greater than the income effect, then an improvement in the terms of trade will result in a depreciation of the real exchnage rate. Based on my findings, the substitution effects is greater than the income effect so an improvement in the terms of trade leads to a depreciation of the real exchange rate.

[12]In this case, price of nontradables is regarded as the consumer price index. Since the external real exchange rate is the nominal exchange rate adjusted for price level differences between South Affrica and the United States, an appreciation of the real exchange rate occurs if domestic prices falls.

In other words, an improvement in the terms of trade results in a depreciation of the external real exchange rate through the substitution effect. This result appears to be inconsistent with those of De Gregorio and Wolf (1994).

The foreign productivity differential of tradables relative to nontradables, $a_t^{*T} - a_t^{*NT}$, enters with the correct sign but is not significant. This finding is not surprising since the foreign variable is weakly exogenous. Openness to trade carries a positive sign and is significant at the 1% level of significance. However, the lagged openness to trade variable has a negative sign but is significant at the 5% level of significance. These results suggest that trade liberalization reforms in South Africa result in an appreciation of the external real exchange rate.

Finally, the interest rate differential has the expected positive sign and is significant at the 1% level. This finding implies that an increase in the real interest rate in the home country leads to an appreciation of the real exchange rate. The coefficients of the real interest rate differential and its deviation in the ARDL (5,2,2,1,1,1) model are 0.045 and 0.021. These findings indicate that a small proportion of the real exchange rate appreciation in South Africa is attributable to the increase in real interest rate differential. Campbell and Clarida (1987) obtained similar results in their study, although their estimates were much higher than the estimates reported here. The ARDL (5,2,2,1,1,1) model fits very well as the R^2 (0.82) and $\bar{R}^2$ (0.79) suggest.

4.5.5 VECX* Lag order Selection Criteria

Before estimating the VECX* model and the generalized impulse response functions, the lag order of the VECX* was determined. In our case four different criteria were used *viz* Final Prediction Error (FPE), Akaike Information Criteria (AIC), Schwarz Information Criteria (SIC) and the Hanann-Quinn (HQ) and the results are reported in Table 4.6. Following Garrett *et al.* (2003), I consider a maximum lag length of 4 in order to avoid a situation of an inflated estimated coefficients of the VECX* model[13]. The Schwarz Information Criterion favors a lag order of zero whilst the FPE and AIC suggested about four lags and the Hannan-Quninn favors a lag order of two. Since the data used in this study is quarterly, the results for the Hannan-Quinn criteria is more appropriate and so I use a lag order of p=2 for the estimation of the VECX* model.

4.5.6 Vector Error Correction Estimated Results

Having determined the lag order of the VECX* and discussed the results of the estimated ARDL (4,2,1,1) and ARDL (5,2,2,1,1,1) real exchange rate models, our next task is to estimate the VECX* model. From the model presented in section 4.4, it is clear that the VECX* encompasses endogenous variables and weakly exogenous foreign variables. In order to make the VECX* as parsimonious as possible, I set all the variables at one-period lag. These lagged variables are regarded as the regressors in a system of six reduced-form error correction equations. The results are reported in Table 4.7. Columns (2) and (3) reports the results for the two main equations that form the crux of the analysis in this section.

According to the results, the coefficients of lagged error correction terms, which are derived from the long run equilibrium relations of the variables, have the correct signs and are statistically significant in most of the reduced-form error correction equations. This finding implies that the VECX* model is appropriate and there are cointegrating relations among the variables in the cointegrating equations. From the results in column (2), the lagged productivity differential enters with a negative sign and is statistically significant at the 10% level. This finding lend support to the B-S model that technological progress in the tradable sector results in an appreciation of the external real exchange rate in South Africa. The productivity differential variable enters with a positive coefficient in the relative price of nontradables equation and is statistically insignificant. The positive coefficient indicates that relative price of nontradables

[13] Garrett *et al.* (2003) underscored the importance of using a maximum lag order of 4 for quarterly data. They argued that a higher lag order of the VECX* model has the tendency to increase the estimated coefficients of the underlying variables in the model.

increases with an increase in productivity differential.

Now moving to the effect of the deviation from relative price of nontradables on the real exchange rate, the results indicate that the real exchange rate increases with an increase in the price of nontradables over and above the tradable good price. Our results appear to be consistent with the B-S model. The deviation from the terms of trade enters with a positive sign in the real exchange rate, productivity differential and relative price of nontradable equations and is statistically significant at conventional level of significant. This finding indicates that an improvement in the terms of trade results in an appreciation of the real exchange rate in South Africa through the income effect. The economic implication of this result is that an improvement in the terms of trade increases the demand for nontradable goods because of the increasing purchasing power of local residents. The increasing demand for nontradables triggers an increase in nontradable goods prices and an appreciation of the real exchange rate. Our results are consistent with the findings of De Gregorio and Wolf (1994).

Openness to trade has a positive sign in the real exchange rate, terms of trade and interest rate differential equations but is statistically significant in the real exchange rate equation and insignificant in the other two equations. The VECX* showed mixed results for the effect of trade liberalization on real exchange rate movements. Whereas the external real exchange rate depreciates with an increase in trade liberalization, the internal real exchange rate appreciates as the South African economy becomes more open to trade. With regards to the effect of real interest rate differential, VECX* results in Table 4.7 show that a small proportion of the real exchange rate appreciation is caused by changes in real interest rate differential. The coefficient of the real interest rate in the internal and external real exchange rate equations ranges between 0.001 and 0.008.

The weakly exogenous variables are not significant in most of the reduced-form equations as Table 4.7 suggests. However, the foreign relative price of nontradables and the deviation from the foreign terms of trade enter the real exchange rate equation with a negative sign and are significant at conventional level of significance. The negative coefficient on tot^{*USA}_{t-1} implies that an improvement in the terms of trade in the United States results in a depreciation of the South African real exchange rate through the substitution effect.

4.5.7 Generalized Impulse Response Analysis

In this section attention is directed towards the dynamic responses of both the internal and external real exchange rates to productivity shocks, terms of trade shocks and shocks to the other variables (relative price of nontradables, interest rate differential, foreign productivity differential and openness to trade) in the VAR system. In order to examine the dynamic relationship among the variables, I derive the generalized impulse response functions (GIRFs) on the effects of a particular economic shock to a one standard deviation on the time path of both the internal and external real exchange rate. The graphs of the GIRFs are shown in Figures 4.1, 4.2 and 4.3. The generalized impulse response of the real exchange rate to a positive economic shock is represented as the thick and continuous black line surrounded by blue dotted lines which are the 2 standard error confidence bands. The GIRFs in Figure 4.1 shows that an increase in productivity differential leads to an initial increase in the real exchange rate with the persistence of the shock lasting for only 2 quarters before declining and reaching a minimum in the third quarter. Thereafter, any shock to productivity of tradables results in an increase in the real exchange rate with the increase becoming persistent in quarter 8. This implies that an increase in productivity of tradable goods leads to an appreciation of the South African real exchange rate. This finding provided strong support for the prediction of the productivity differential hypothesis that a positive technological shock on tradable production contributes, although insignificantly, to an appreciation of the real exchange rate.

In response to the terms of trade shock, the real exchange rate depreciates insignificantly on impact and lasted for about 3 quarters. Thereafter, any terms of trade shock results in an appreciation of the real exchange rate, with the persistence in real exchange rate appreciation occurring after quarter 7. The economic implication of this finding is that a terms of trade improvement leads to an appreciation of the real exchange rate via the income effect. My findings are consistent with the results obtained by De Gregorio and Wolf (1994) for the case of 14 OECD countries.

With regards to the response of real exchange rate to shocks in relative price of nontradables (internal real exchange rate) and real interest rate differential, an unanticipated increase in each of the variables results in an appreciation of the real exchange rate. This evidence is shown clearly in Figure 4.1. Turning to the impulse response to the degree of opennness shock, the real exchange rate depreciates with the persistence in real exchange rate depreciation occurring after quarter 3. This implies that trade liberalization in the form of lowering tariffs results in a depreciation of the real exchange rate.

The GIRFs in Figure 4.2 shows the generalized impulse response of the internal real exchange rate, P^{NT}/P^{T}, to a one standard deviation shock in productivity diferrential, terms of trade, degree of opennness and interest rate differential. From the graphs, it is evident that a positive productivity shock in the tradable goods sector initially reduces the relative price of nontradables to quarter 3. Thereafter, relative price of nontradables increases with persistence occurring in quarter 6. This results indicate that an innovation to productivity in the tradable good sector appreciates the internal real exchange rate. This finding provides strong support for the prediction of the B-S model. In response to the terms of trade and real interest rate differential shocks, the internal real exchange rate appreciates albeit insignificantly. The positive response of the internal real exchange rate to terms of trade shocks suggests that an improvement in the terms of trade, all else equal, will lead to an increase in the price of nontradables and an appreciation of the internal real exchange rate. Lastly, the response of the internal real exchange rate to innovations in real exchange rates is positive implying that a real appreciation of the Rand is attributable to increases in real interest rate differential. Campbell and Clarida also obtained similar results on their study.

Next, I focus on the response of the weakly exogenous variables to their own shocks by examining the effect of productivity differential, terms of trade trade liberalization and relative price of nontradables to real exchange rate movements. The results are reported in Figure 4.3. From the GIRFs, it is evident that a productivity shock in tradable goods production appreciates the internal real exchange rates in the foreign country, a result that is consistent with the predictions of the B-S model but contravenes with the prediction of the NOEM. The results also indicate that the internal real exchange rate appreciates following a shock to the relative price of nontradables, terms of trade and openness to trade.

4.6 Concluding Remarks

The primary objective of this chapter is to provide evidence on how the real exchange rate respond to productivity increases in the tradable sector in South Africa using quarterly time series data between 1993 and 2015. Specifically, the study examines the long run equilibrium relationship between productivity differential and the real exchange rate in South Africa. Contrary to Lewis (2007) and Beckmann *et al.* (2015), I decompose the B-S effect into domestic and foreign effects in order to assess the relevance of the productivity differential hypothesis in South Africa *vis-a-vis* the United States. Using a structural cointegrated VAR with weakly exogenous foreign variables (VECX*) in the spirit of Garrett *et al.* (2003), I argue that faster productivity growth in the tradable goods sector relative to the nontradable sector account for the bulk of the differences in prices between the two sectors and an appreciation of the real exchange rate in South Africa.

The Johansen cointegration test results suggest a long run equilibrium relationship between productivity differential and the real exchange rate. My findings provide support for the Balassa-Samuelson proposition that differences in tecnological progress between the tradable and nontradable sectors result in an increase in relative prices and an appreciation of the real exchange rate. Although the methodology used in this paper is different from the analytical techniques in previous papers, the findings in this study are similar to the results obtained in earlier studies. For example, my results are consistent with those obtained by Lewis (2007), Kakkar and Yan (2012) and Beckmann *et al.* (2015) and Ègert *et al.* (2006), but contrast remarkably with those of Asea and Mendoza (1994).

Another important finding of this study is that an improvement in the terms of trade contributes significantly to the real appreciation of the South African Rand through the income effect. However, the effect of trade liberalization on the real exchnage rate showed mixed results. Whereas the ARDL regressions and GIRFs indicate a negative relationship between trade liberalization and the real exchange rate, the VECX* results indicate a positive relationship between the two variables. This implies that the effect of the recent trade liberalization on the South African real exchange rate is ambiguous. My results further show that increases in the relative prices of nontradables led to a real appreciation of the South African Rand. The generalized impulse response functions also provided strong support for the original results of the study. For instance, a productivity shock in the tradable goods sector results in an increase in the relative price of nontradables and an appreciation of the internal real exchange rate.

Finally, although the empirical analysis of the current study help to shed light on the debate regarding the impact of technological progress in the tradable sector on the long run behavior of real exchange rates in South Africa, there remain some areas that deserve some further attention. First, the analysis carried out in this study did not consider heterogeneous households and firrms in the modelling of exchange rates. Future research on exchange rates should consider this in the modelling process. Second, the assumptions of full employment and constant returns to scale are too restrictive. Therfore, future research should consider relaxing these assumptions by incorporating employment frictions and increasing returns to scale into the model.

4.7 Tables and Figures

Table 4.1: Unit Roots Tests on the Variables in the Baseline Model (1993q1-2015q3)

Variable	ADF	Phillips-Perron	KPSS
(1) *Variables in Levels*			
q	-1.682	-1.981	0.211
$a_t^T - a_t^{NT}$	-2.566	-1.170	0.072
$a_t^{*T} - a_t^{*NT}$	-3.841	-1.425	0.414
$p_t^{NT} - p_t^T$	-2.226	-2.120	0.368
$p_t^{*NT} - p_t^{*T}$	-2.010	-1.925	0.044
tot_t^{SA}	-1.053	-2.020	0.503
tot_t^{*USA}	-1.932	-1.984	0.018
opn_t^{SA}	-1.491	-1.375	0.012
opn_t^{*USA}	-1.836	-1.707	0.114
$r_t^{SA} - r_t^{*USA}$	-2.047	-2.195	0.296
(2) *Variables in First Differences*			
q	-8.357	-8.366	0.817
$a_t^T - a_t^{NT}$	-8.021	-4.871	0.508
$a_t^{*T} - a_t^{*NT}$	-4.208	-9.381	0.734
$p_t^{NT} - p_t^T$	-4.315	-7.585	0.604
$p_t^{*NT} - p_t^{*T}$	-6.772	-8.621	0.522
tot_t^{SA}	-9.744	-3.072	0.552
tot_t^{*USA}	-8.401	-7.736	0.487
opn_t^{SA}	-8.733	-8.720	0.602
opn_t^{*USA}	-6.844	-3.947	0.704
$r_t^{SA} - r_t^{*USA}$	-9.891	-9.881	0.647

Notes: The ADF statistic is derived according to the equation $y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=2}^{k} \beta_i \Delta y_{t-i+1} + \varepsilon_t$, where y_t denotes the time series, α_0, γ and β_i are parameters to be estimated, Δy_{t-i+1} was included in the regression to resolve any potential issue of serial correlation and ε_t is the white-noise error term. The main parameter of interest is γ. In the ADF test, the null hypothesis is that the time series has unit roots (nonstationary), that is, $\gamma = 1$ and the alternative hypothesis is that the series is stationary or $\gamma < 1$. The Akaike information criteria (AIC) was used to select the lag length in the unit roots test regression.
Critical value for the ADF test at the 5% level is -2.900
Critical value for the Phillips-Perron Test at the 5% level is -2.897
Critical value for the KPSS test at the 5% level is 0.463

Table 4.2: Trace and Maximum Eigenvalue Tests for Cointegration

Null Hypothesis	Alternative Hypothesis	Test Statistic	Critical Value	p-Values**
Trace Statistic				
$r = 0$	$r \geq 1$	351.348*	239.235	0.000
$r \leq 1$	$r \geq 2$	256.333	197.371	0.000
$r \leq 2$	$r \geq 3$	183.136	159.530	0.014
$r \leq 3$	$r \geq 4$	134.616	125.615	0.013
$r \leq 4$	$r \geq 5$	96.522	95.754	0.044
$r \leq 5$	$r \geq 6$	67.915	69.819	0.070
Maximum Eigenvalue Statistic				
$r \leq 0$	$r = 1$	95.015*	64.505	0.000
$r \leq 1$	$r = 2$	73.197	58.434	0.001
$r \leq 2$	$r = 3$	48.520	52.363	0.118

Notes:*Denotes rejection of null hypothesis of no cointegration among the variables at 5% level.
** p-values are based on Mackinnon-Haug-Michelis (1999) p-values.

Table 4.3: Dynamic Least Square Estimates of Labor and Capital Shares

Parameters	**South Africa**		**United States**	
	Tradables	*Nontradables*	*Tradables*	*Nontradables*
α	0.714**		0.468	
	(0.299)		(0.550)	
$1-\alpha$	0.198		0.532*	
	(0.133)		(0.468)	
β		0.674**		0.667*
		(0.244)		(0.494)
$1-\beta$		0.324		0.362**
		(0.354)		(0.166)
R^2	0.546	0.611	0.741	0.463
$\bar{R}^2$	0.433	0.526	0.658	0.333
p-Value	0.813	0.048	0.458	0.181

Notes: The Table shows the labor and capital shares associated with tradable and nontradable goods production. The Dynamic Least Squares (DLS) estimates were obtained with the aid of the Cobb-Douglas production function. The figures in parenthesis are the robust standard error estimates.
** Denotes significance at the 5% level
* Denotes significance at the 10% level.

Table 4.4: ARDL (4,2,1,1) Estimation of the Domestic Balassa-Samuelson Model (1993q1-2015q3)

Variables	**South Africa**		**United States**	
	Parameter Estimate	T-Ratio	Parameter Estimate	T-Ratio
$p_{t-1}^{NT} - p_{t-1}^{T}$	0.412**	3.458		
	(0.119)			
$p_{t-2}^{NT} - p_{t-2}^{T}$	0.047	0.338		
	(0.138)			
$p_{t-3}^{NT} - p_{t-3}^{T}$	0.091	0.685		
	(0.132)			
$p_{t-4}^{NT} - p_{t-4}^{T}$	0.202*	1.824		
	(0.111)			
$p_{t-1}^{*NT} - p_{t-1}^{*T}$			0.728***	5.968
			(0.122)	
$p_{t-2}^{*NT} - p_{t-2}^{*T}$			0.094	0.638
			(0.148)	
$p_{t-3}^{*NT} - p_{t-3}^{*T}$			−0.299*	-1.999
			(0.150)	
$p_{t-4}^{*NT} - p_{t-4}^{*T}$			-0.078	-0.641
			(0.121)	
$a_{t}^{T} - a_{t}^{NT}$	0.157*	2.039		
	(0.077)			
$a_{t-1}^{T} - a_{t-1}^{NT}$	0.120**	4.286		
	(0.028)			
$a_{t}^{*T} - a_{t}^{*NT}$			0.462*	2.762
			(0.167)	
$a_{t-1}^{*T} - a_{t-1}^{*NT}$			0.321*	1.803
			(0.178)	
opn_{t}^{SA}	−0.140*	-2.121		
	(0.066)			
opn_{t-1}^{SA}	−0.074	-1.088		
	(0.068)			
opn_{t}^{*USA}			−0.206*	-1.907
			(0.108)	
opn_{t-1}^{*USA}			0.001	0.007
			(0.154)	
tot_{t}^{SA}	0.132	0.337		
	(0.392)			
tot_{t-1}^{SA}	0.070	0.770		
	(0.091)			
tot_{t}^{*USA}			0.289*	2.125
			(0.136)	
tot_{t-1}^{*USA}			-0.231	-0.980
			(0.236)	
R^2	0.817		0.694	
$\bar{R}^2$	0.788		0.646	
F-Statistic	27.684		14.258	

Notes: The Table shows the ARDL [4,2,1,1] estimates of the domestic BS model. Selection of the model was based on the Hannan-Quinn criterion. The figures in parenthesis are the robust standard error estimates. All the variables are expressed in logarithmic levels. *** Denotes Significance at the 1% level. **Denotes Significance at the 5% level.* Denotes significance at the 10% level.

Table 4.5: ARDL (5,2,2,1,1,1) Estimation of the Foreign BS Model for South Africa (1993q1-2015q3)

Variable	Parameter Estimate	Robust Standard Error	T-Ratio
q_{t-1}	0.965^{***}	0.139	6.959
q_{t-2}	-0.126	0.199	-0.630
q_{t-3}	0.320^{*}	0.177	1.806
q_{t-4}	-0.316^{*}	0.126	-2.508
q_{t-5}	0.039	0.131	0.301
$a_t^T - a_t^{NT}$	-0.104^{**}	0.031	-3.402
$a_{t-1}^T - a_{t-1}^{NT}$	-0.024^{**}	0.006	-3.934
$a_{t-2}^T - a_{t-2}^{NT}$	0.019^{*}	0.010	1.900
$a_t^{*T} - a_t^{*NT}$	-0.273	0.464	-0.588
$a_{t-1}^{*T} - a_{t-1}^{*NT}$	-0.105	0.471	-0.224
$a_{t-2}^{*T} - a_{t-2}^{*NT}$	-0.101	0.487	-0.207
tot_t^{SA}	-0.043^{*}	0.019	-2.263
tot_{t-1}^{SA}	-0.118	0.269	-0.440
opn_t^{SA}	0.266^{*}	0.131	2.031
opn_{t-1}^{SA}	-0.267^{*}	0.125	-2.136
$r_t^{SA} - r_t^{*USA}$	0.045^{*}	0.016	2.813
$r_{t-1}^{SA} - r_{t-1}^{*USA}$	0.021	0.033	0.636
R^2	0.87		
$\bar{R}^2$	0.83		
F-Statistic	25.369		

Notes:The Table shows the ARDL [5,2,2,1,1,1] estimates of the domestic BS model. Selection of the model was based on the Hannan-Quinn criterion. The figures in parenthesis are the robust standard error estimates. All the variables are expressed in logarithmic levels. *** Denotes significance at the 1% level. **Denotes significance at the 5% level.* Denotes significance at the 10% level.

Table 4.6: VECX* Lag Order Selection Criteria

Lag Order	FPE	AIC	SIC	Hannan-Quinn
0	1.44×10^{-11}	-7.939	-6.489*	-7.359
1	1.05×10^{-11}	-8.276	-5.738	-7.260
2	4.58×10^{-12}	-9.152	-5.526	-7.700*
3	4.13×10^{-12}	-9.345	-4.631	-7.458
4	3.03×10^{-12}*	-9.803*	-4.002	-7.481

Notes: FPE denotes Final Prediction Error, AIC denotes Akaike Information Criterion, SIC denotes Schwarz Information Criterion and * indicates the lag order selected by a given criterion. From the results it is easy to notice that $\tilde{p}^{AIC} \geq \tilde{p}^{HQC} \geq \tilde{p}^{SIC} \quad \forall T \geq 12$ and $\tilde{p}^{HQC} \geq \tilde{p}^{SIC} \quad \forall T$.

Table 4.7: Reduced Form Error Correction Estimation Results of the VECX* Model (1993q1-2015q3)

Variable	Δq_t	$\Delta(a_t^T - a_t^{NT})$	$\Delta(p_t^{NT} - p_t^T)$	Δtot_t^{SA}	Δopn_t^{SA}	$\Delta(r_t^{SA} - r_t^{*USA})$
$\hat{\zeta}_{1,t-1}$	-0.216^*	-0.002^*	-0.215^*	-0.026^*	0.005^*	0.037^{***}
	(0.031)	(0.001)	(0.140)	(0.018)	(0.002)	(0.007)
$\hat{\zeta}_{2,t-1}$	-0.363^{**}	0.035	-0.103	0.321	-0.006^*	0.008
	(0.148)	(0.188)	(0.201)	(0.466)	(0.004)	(0.247)
Δq_{t-1}	0.006	0.024	-0.075^*	-0.057^{**}	0.442^{***}	6.448^{***}
	(0.130)	(0.055)	(0.056)	(0.018)	(0.026)	(0.007)
$\Delta(a_{t-1}^T - a_{t-1}^{NT})$	-0.071^*	0.778^*	0.043	0.371^{**}	-0.240^*	0.140
	(0.042)	(0.084)	(0.086)	(0.108)	(0.119)	(0.249)
$\Delta(p_{t-1}^{NT} - p_{t-1}^T)$	0.498^*	-0.087	-0.346^{**}	-0.205^*	0.044	-1.419^{**}
	(0.273)	(0.115)	(0.107)	(0.015)	(0.163)	(0.245)
Δtot_{t-1}^{SA}	0.077^{**}	0.195^*	0.017^*	-0.054	-0.075	-1.104^{***}
	(0.019)	(0.086)	(0.006)	(0.109)	(0.122)	(0.033)
Δopn_{t-1}^{SA}	0.219^*	-0.039	-0.075^*	0.039	-0.151^*	0.131
	(0.173)	(0.073)	(0.064)	(0.093)	(0.103)	(0.888)
$\Delta(r_{t-1}^{SA} - r_{t-1}^{*USA})$	0.008^*	0.094	0.001	0.006^*	-0.002	0.026
	(0.005)	(0.123)	(0.002)	(0.003)	(0.004)	(0.124)
$\Delta(a_t^{*T} - a_t^{*NT})$	0.013	0.025	0.172	0.557^*	-0.087	1.465^*
	(0.498)	(0.209)	(0.213)	(0.267)	(0.147)	(0.825)
$\Delta(a_{t-1}^{*T} - a_{t-1}^{*NT})$	-0.076	-0.003	0.013	-0.316^*	-0.051	-4.868
	(0.491)	(0.206)	(0.210)	(0.164)	(0.293)	(5.551)
$\Delta(p_t^{*NT} - p_t^{*T})$	-0.639^*	0.010	0.102	-0.026	-0.014	8.970^*
	(0.331)	(0.139)	(0.142)	(0.178)	(0.198)	(3.002)
$\Delta(p_{t-1}^{*NT} - p_{t-1}^{*T})$	0.613^*	0.088	-0.046	-0.033	-0.027	-4.951
	(0.310)	(0.131)	(0.133)	(0.167)	(0.185)	(6.581)
Δtot_t^{*USA}	1.005^*	0.279	0.332^*	0.706^*	0.666^*	-0.031
	(0.369)	(0.291)	(0.195)	(0.271)	(0.313)	(0.641)
Δtot_{t-1}^{*USA}	-0.843^*	-0.172	-0.135	-0.476^*	-0.812^{**}	2.007^*
	(0.656)	(0.276)	(0.280)	(0.352)	(0.229)	(1.867)
Δopn_t^{*USA}	-0.342	0.278^*	0.319^*	0.191	1.137^{**}	-0.790
	(0.467)	(0.096)	(0.103)	(0.251)	(0.279)	(0.823)
Δopn_{t-1}^{*USA}	0.483	-0.304^*	-0.264^*	-0.102	-1.140	0.465
	(0.453)	(0.119)	(0.139)	(0.243)	(0.270)	(0.596)
R^2	0.430	0.835	0.303	0.324	0.460	0.486
$\bar{R}^2$	0.367	0.797	0.143	0.168	0.334	0.342
F-Statistic	1.298	21.894	1.888	2.077	3.698	1.341

Notes: The Table shows the regression results of the VECX* model. Figures in parenthesis are the robust standard error estimates. All the variables are expressed in logarithmic levels. *** Denotes significance at the 1% level. **Denotes significance at the 5% level.* Denotes significance at the 10% level.

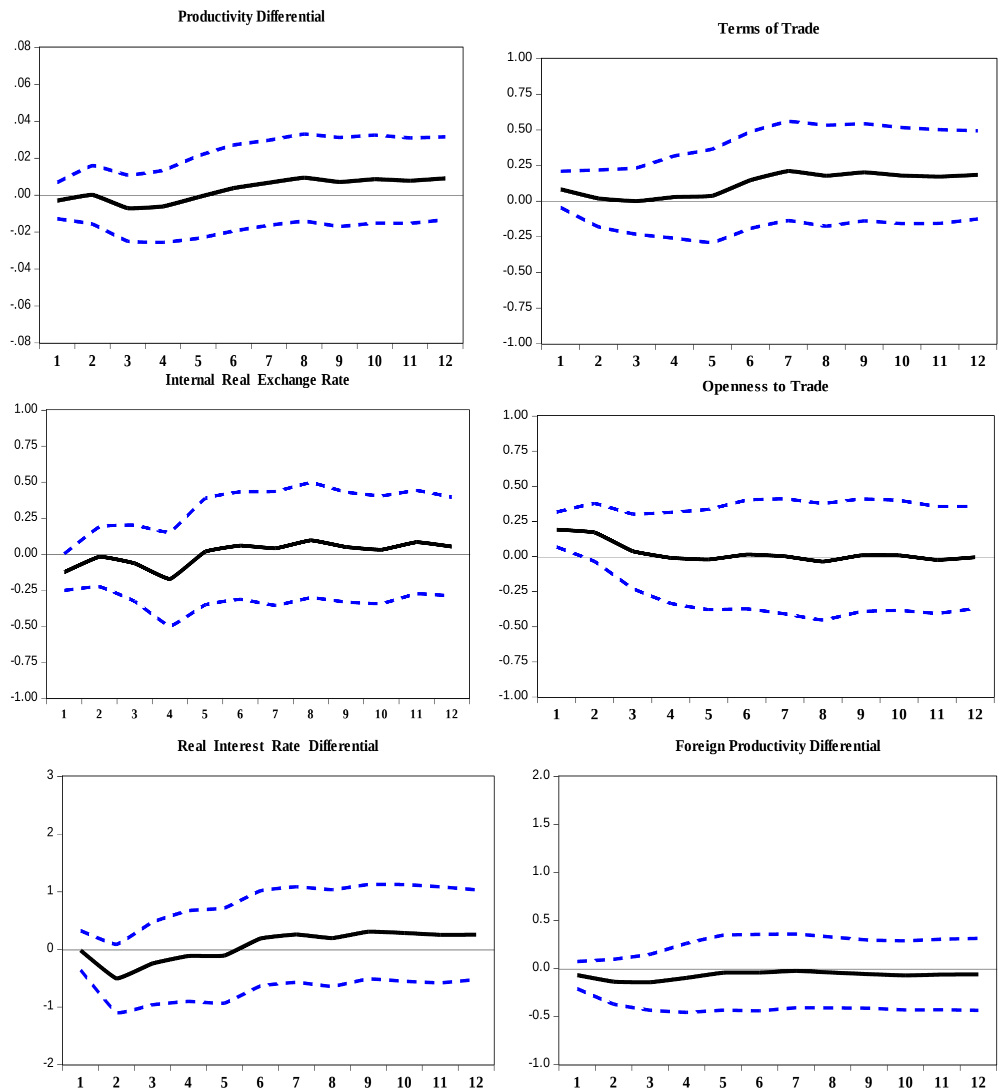


Figure 4.1: Generalized Impulse Response of Real Exchange Rate to Shocks

Notes: The figure shows the generalized impulse responses of the External real exchange rates to a one standard deviation shocks. The generalized impulse response to shocks is represented as the thick and continuous black line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

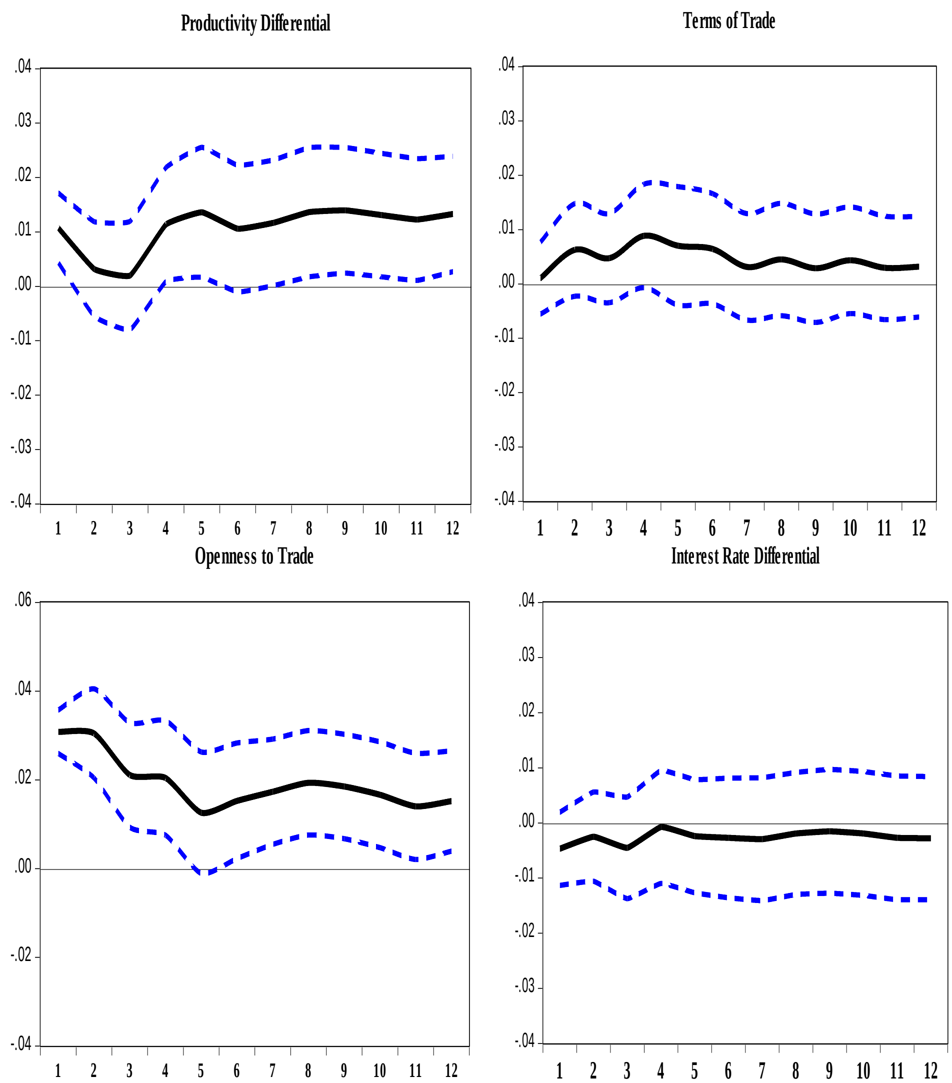


Figure 4.2: Generalized Impulse Response of Relative Prices to Shocks

Notes: The figure shows the generalized impulse responses of the Internal real exchange rates to a one standard deviation shocks. The generalized impulse response to shocks is represented as the thick and continuous black line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

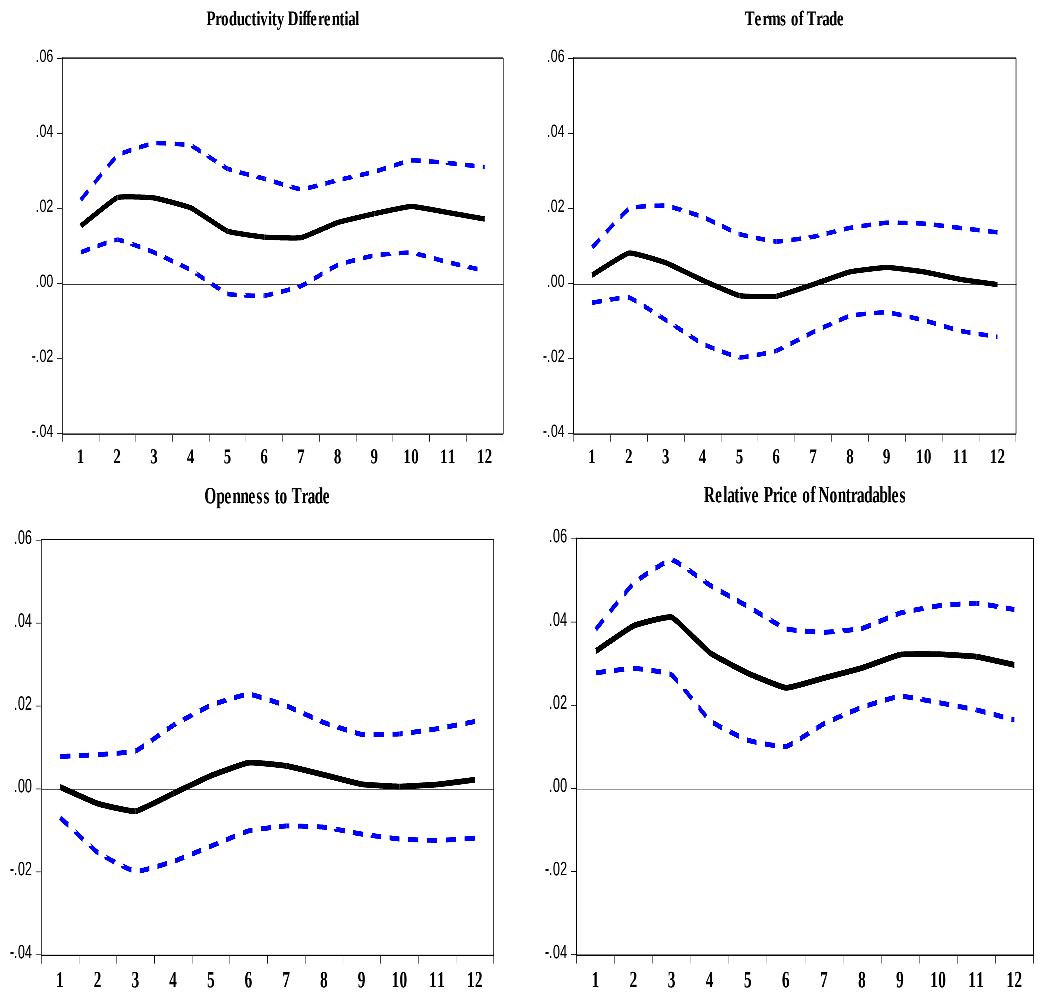


Figure 4.3: Generalized Impulse Response of Foreign Relative Prices to Shocks

Notes:The figure shows the generalized impulse responses of the foreign Internal real exchange rates to a one standard deviation shocks. The generalized impulse response to shocks is represented as the thick and continuous black line, while the dotted blue lines on either side of the impulse response line denote a 2 standard error confidence bands. The significance of the impulse responses depends on the sign of the lower and upper error bands. If the lower and upper error bands have the same signs, then the impulse response is significant; otherwise it is not significant. The forecast horizons is given in quarters along the horizontal axis and the impulse responses on the vertical axis.

Chapter 5

General Conclusion

In this dissertation I have used three different models to address three important issues on international trade and international macroeconomics. Whereas the first chapter focuses on aspects related to international trade, the next two chapters delved into some issues related to international macroeconomics. Specifically, I investigate the effects of latent trade costs —institutional failures and political risks—and trade agreements in regional trade blocs on bilateral trade in chapter 2. In this chapter, I address the question of whether institutional quality, political risk and regional trade agreements play any major role in bilateral trade.

Institutional quality and political risks are important latent trade costs that have not been incorporated into the modeling of the gravity model of trade until recently by Mansfield, Milner and Rosendorff (2000), Anderson and Marcouiller (2002), Levchenko (2007) and Yu (2010). They used models ranging from structural import demand to game theoretic and gravity to analyze the effects of institutional failures and political risks on transaction costs and international trade. As a departure to the previous studies, I embed an index of quality of the product variety into a utility maximization problem of consumers in the exporting and importing countries. The index of quality of the product variety is itself affected by institutional quality and political risks. I used these arguments to derive a novel augmented gravity model of bilateral trade to address the issue at hand. This augmented gravity model was developed from a monopolistic competition model of product differentiation and estimated by using *Poisson Quasi Maximum Likelihood*, *Heckman two-step*, *Tobit* and *Negative Binomial* tehniques in order to address potential problems of overdispersion, heteroscedasticity and zero trade flows. Using a panel data of 36,150 observations for 46 countries, I was able to arrive at results that corroborate the hypothesis that strong institutions and less political risks of trading partners increases bilateral trade. This is so because stronger institutions and less political risks reduce the uncertainty in contract enforcement and transactions costs. The reduction in transactions costs and uncertainty in contract enforcement ultimately leads to an increase in bilateral trade.

In the study, I also find that regional integration leads to an improvement in trade, but there was evidence of trade diversion in some of the small trading blocs like WAMZ (West African Monetary Zones) and MRU (Mano River Union). The results of the study also provide support for the *Natural Trading Partner Hypothesis* by arguing that geographically proximate partners trade more than distant partners because the costs of transporting goods between proximate partners tend to be lower than for distant partners, all else remaining equal. However, there was little support that differences in factor endowments between countries predict patterns of trade.

In the third chapter, I propose an SVAR-AB model to determine how changes in the exchange rates are transmitted to trade prices, producer price inflation and consumer price inflation for a group of OECD and emerging economies in Latin America and Southeast Asia. The motivation for this study is deeply rooted in an understanding of the exchange rate pass-through mechanism in mainly inflation targeting countries. The main idea here is that understanding the exchange rate pass-through process is crucial to the success of any inflation targeting policy because knowing the magnitude of exchange rate pass-through will assist the monetary authorities to determine how much interest rate adjustment—a higher exchange rate pass-through requires a bigger interest rate adjustment while a lower exchange rate pass-through requires a smaller interest rate adjustment to meet the inflation target—to make in order to maintain their inflation targets. In the study, I decompose the exchange rate pass-through into *First*

Stage Pass-Through and *Second Stage Pass-Through* via the use of a simple optimization of the exporting firm's profit function in a partial equilibrium framework. In the first stage, I quantify the effect of exchange rate fluctuations on trade prices while in the second stage I analyze the effects of import prices on consumer prices and producer prices. The main result of the study is that exchange rate pass-through to import prices is lower for OECD and Southeast Asian economies and higher for economies in Latin America. I also find a weak correlation between exchange rate movements and prices for Argentina, Mexico, Sweden and the UK. This result was attributed to the fact that trade prices and consumer prices remain stable in most OECD and some Latin American countries following exchange rate depreciation between 1992 and 2003. In contrast, there was a strong correlation between exchange rate movements and prices in all the Southeast Asian countries in the sample. The results also indicate that pass-through to trade prices is much higher than pass-through to producer and consumer prices for each of the countries in the three regional economies.

Finally, I analyze the long run behavior of real exchange rates by investigating the relationship between productivity differential and the real exchange in South Africa vis-a-vis the United States with the help of quarterly time series data in chapter 4. I develop a model based on the neoclassical framework in which the firm's technology exhibits constant returns to scale and decompose the Balassa-Samuelson effect into domestic and foreign effects in order to assess the relevance of the productivity differential hypothesis in South Africa. Using a structural cointegrated vector autoregressive model with weakly exogeneous variables (VECX*), I argue that faster productivity in the tradable sector relative to the nontradable sector account for the bulk of the differences in prices between the two sectors in South Africa. Both the ARDL and VECX* results indicate that a productivity shock in the tradable sector contribute significantly in the appreciation of the internal and external real exchange rate in South Africa. This finding provided little or no support for the prediction of the New Open Macroeconomic models (NOEM) that a positive productivity shock in the tradable sector drives down the real exchange rate or —rather depreciates the real exchange rate via the terms of trade. Terms of trade improvement and increase in real interest rate differential appreciates the real exchange rate, with the former causing the change through the income effect. The results associated with the effect of degree of openness to trade on the real exchange rate are mixed. Whereas the ARDL regression results and GIRFs indicate that trade liberalization creates a real depreciation of the South African Rand, the VECX* results suggest that trade liberalization causes a real appreciation of the South African currency.

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APPENDICES

Appendix A

Appendix to Chapter 2

A.1 Data Sources

Countries of the Three Regional Trade Blocs

As was mentioned earlier in this paper, data was compiled for a total of 46 countries in three distinct trade blocs. Countries in the North-North regional trade agreements are all from the EURO area while the 15 countries in the South-South trade agreement are from the West Africa subregion. The only North-South RTA considered in this study is the trilateral agreement of NAFTA. Table A.1 shows a list of all the countries in the sample.

Table A.1: List of Countries in the Dataset

Trade Blocs		
European Union (28)	**ECOWAS**	**NAFTA**
Austria	Benin	Canada
Belgium	Burkina Faso	Mexico
Bulgaria	Cape Verde	USA
Croatia	Côte D'Ivoire	
Cyprus	Gambia	
Czech Repubilc	Ghana	
Denmark	Guinea	
Estonia	Guinea Bissau	
Finland	Liberia	
France	Mali	
Germany	Niger	
Greece	Nigeria	
Hungary	Senegal	
Ireland	Sierra Leone	
Italy	Togo	
Latvia		
Lithuania		
Luxembourg		
Malta		
Netherlands		
Poland		
Portugal		
Romania		
Slovakia		
Slovenia		
Spain		
Sweden		
United Kingdom		

Distance Data

The Great Circle distance data between countries capital cities was extracted from the website **https://www.distancefromto.net**. The data obtained from this website was compared with distance data from other sources for consistency.

Trade Statistics

Bilateral exports and imports data came directly from *IMF Direction of Trade Statistics*. All imports data are c.i.f (Cost, insurance, freight) values for all the countries considered in the sample. The aggregate export and import data all in Million US dollars was compiled for all the 46 countries for the period 1996 through 2012.

Governance and Political Regime Indicators

As I mentioned earlier the World Bank WGI developed by Kaufmann *et al* (2010) provides a comprehensive information on all the institutional quality indicators used in this study. They began compiling these indices every two years up to 2002. Thereafter annual data have been made available in six independent clusters.

Index of democratization and autocratization were extracted from the Polity dataset of Polity IV project.

Geography, Cultural and Other Binary Variables

In order to construct geography, cultural and other binary variables, I used maps of the regional trade blocs and the CIA world factbook. The variables are defined below as follows:

- $COMLANG_{ij}$: A dummy variable to control for commn language. The variable equals 1 if both the exporting and importing countries share the same official language in business transactions and 0 otherwise.

- $COMBORD_{ij}$: This is a dummy variable that controls for adjacency or contiguity. It is equal to 1 if the exporting and importing countries are both close to each other or they share the same border and 0 otherwise.

- $COMCUR_{ij}$: An indicator variable that controls for common currency for the trading partners. It is equal to 1 if exporting and importing countries used the same currency to do business transactions. For instance, in the WAEMU regional trade area all the countries in the trade bloc used the CFA Franc in business transactions. The same is true for the EURO area. The binary varibale is equal to 1 if the exporting and importing countries use the same currency and 0 otherwise.

- $LANDLOCK_{ij}$: A dummy variable that is equal to 1 if both the exporting and importing countries have no access to the sea or do not have a seaport and 0 otherwise.

Regional Trade Agreements

To determine whether the pair of countries are RTA members or whether one is a member and the other not a member, I have used the WTO-RTA database to construct the dummy or binary variables. The binary variables were constructed based on the following:

- $ECOWAS_{ij}$: This is a dummy variable that is equal to 1 if both the exporting country i and the importing country j are members of ECOWAS and 0 otherwise.

- $EU28_{ij}$:This is a dummy variable that is equal to 1 if both the exporting country i and the importing country j are members of European Union EU (28) and 0 otherwise.

- $NAFTA_{ij}$:This is a dummy variable that is equal to 1 if both the exporting country i and the importing country j are members of NAFTA and 0 otherwise.

- $WAEMU_{ij}$:This is a dummy variable that is equal to 1 if both the exporting country i and the importing country j are members of WAEMU and 0 otherwise.
- $WAMZ_{ij}$:This is a dummy variable that is equal to 1 if both the exporting country i and the importing country j are members of WAMZ and 0 otherwise.
- MRU_{ij}:This is a dummy variable that is equal to 1 if both the exporting country i and the importing country j are members of MRU and 0 otherwise.

A.2 Equidispersion Property of the Poisson Quasi Maximum Likelihood Estimation

In this section a formal proof of the equidispersion property is provided. To do this, I obtain the moment generating function of the poisson random variable, in our case, X_{ijt}. Consider a poisson random variable X_{ijt} with parameter μ and probability mass function represented as

$$Pr(X_{ijt} \mid \mu) = \frac{e^{-\mu}\mu^{X_{ijt}}}{X_{ijt}!}, \quad \mu > 0 \quad X_{ijt} = 0, 1, 2, 3, ... \tag{A.1}$$

The moment generating function of this poisson distribution is defined as

$$M(t) = E(e^{tX_{ijt}}) \tag{A.2}$$

Since the random variable is poisson, it follows that

$$E(e^{tX_{ijt}}) = \sum_{X_{ijt}=0}^{\infty} e^{tX_{ijt}} \frac{\mu^{X_{ijt}}e^{-\mu}}{X_{ijt}!} \tag{A.3}$$

Solving the moment generating function gives

$$M(t) = e^{-\mu} \sum_{X_{ijt}=0}^{\infty} \frac{e^{tX_{ijt}}\mu^{X_{ijt}}}{X_{ijt}!} \tag{A.4}$$

Rearranging (A.4) gives

$$M(t) = e^{-\mu} \sum_{X_{ijt}=0}^{\infty} \frac{(e^t\mu)^{X_{ijt}}}{X_{ijt}!} \tag{A.5}$$

where $\sum_{X_{ijt}=0}^{\infty} \frac{(e^t\mu)^{X_{ijt}}}{X_{ijt}!}$ is the power series for $e^{e^t\mu}$. Now, plugging for this power series in (A.5) and solving gives the moment generating function as

$$M(t) = e^{\mu(e^t-1)}, \quad \forall \quad t \in \mathbb{R} \tag{A.6}$$

From equation A.6, the conditional expectation and conditional variance of the poisson random variable is obtained by deriving the first and second moments. These moments are the first and second derivatives of the moment generating function. Now, consider the first moments of the MGF (Moment Generating Function) as

$$M'(t) = \frac{\partial M(t)}{\partial t} = e^{\mu(e^t - 1)} * \mu e^t \tag{A.7}$$

At $t = 0$,

$$M'(0) = e^0 * \mu * e^0 = \mu \tag{A.8}$$

Since $E[X_{ijt} \mid \mu] = M'(0)$, it follows that the conditional expectation of the poisson random variable is given by

$$E[X_{ijt} \mid \mu] = \mu \quad \blacksquare$$

The conditional variance of the poisson random variable is defined as

$$Var[X_{ijt} \mid \mu] = E[X_{ijt}^2] - (E[X_{ijt}])^2 \tag{A.9}$$

It is easy to see in equation (A.9) that the first term represents the second moment of the MGF at $t = 0$. From equation A.7, the second derivative of the MGF is represented as

$$M''(t) = E[X_{ijt}^2] = e^{\mu(e^t - 1)} * \mu e^t + e^{\mu(e^t - 1)} * \mu e^t * \mu e^t \tag{A.10}$$

At $t = 0$,

$$E[X_{ijt}^2] = \mu + \mu^2 \tag{A.11}$$

Plugging for equations A.8 and A.11 into equation A.9 and solving gives the conditional variance of the poisson random variable as

$$Var[X_{ijt} \mid \mu] = \mu + \mu^2 - \mu^2 = \mu \tag{A.12}$$

This means that the conditional expectation and conditional variance of a poisson random variable is the same for the PQML and so it exhibits the equidispersion property. Therefore,

$$E[X_{ijt} \mid \mu] = Var[X_{ijt} \mid \mu] = \mu \quad \blacksquare$$

Appendix B

Appendix to Chapter 3

B.1 List of Countries in the Sample

The countries studied in this paper are listed below in the table.

Table B.1: Countries included in the Sample

Countries		
OECD	**Latin America**	**Southeast Asia**
Canada	Argentina	Philippines
Sweden	Colombia	South Korea
United Kingdom	Mexico	Thailand

B.2 Data

Data for the estimation of the SVAR model and analysis of exchange rate pass-through in OECD, Latin America and Southeast Asia was extracted from the International Monetary Fund *International Financial Statistics* CD-ROM of December 2013 for all the sample of countries. Data on some of the macroeconomic indicators for the US were obtainable from the Federal Reserve of St. Louis database website: https://research.stlouisfed.org/fred2/. Quarterly data from 1980q1 to 2012q4 was used. However, this sample size was not the same for all the countries in the sample because of data limitation. In the case of Sweden, the UK, Canada and South Korea, the data spans from 1980q1 through 2012q4. The data for Mexico spans from 1981q1 through 2012q4, Philippines from 1990q1 through 2012q4, Argentina from 1994q1 through 2012q4, Colombia from 1994q1 through 2012q4 and Thailand from 1993q1 through 2012q4.

Exchange Rates

In this study, exchange rate is defined as the amount of local currency exchange per one unit of US dollar and is referred to as the nominal exchange rate. The data is the end of period market rate and was extracted from the International Monetary Fund *International Financial Statistics* CD-ROM. Exchange rates data was seasonally adjusted for all the countries in the sample at the source.

Import and Export Prices

Seasonally adjusted Import and export price indices were extracted from the International Monetary Fund *International Financial Statistics* CD-ROM. The import and export price indices reported for The Philippines was not complete and so I sourced the remaining data series from The Philippines statistical database.

Consumer Prices and Producer Prices

For all the nine countries in the sample, the producer price index (2005=100) was extracted from the *International Financial Statistics* CD-ROM. Like all the other price indices, this price index was also seasonally adjusted. Quarterly data for consumer price inflation as measured by the consumer price index (2005=100) was sourced from the *International Financial Statistics* CD-ROM.

Fuel Commodity Prices

In this paper, fuel commodity prices was used to account supply conditions in the SVAR-AB model. Data on fuel commodity prices is the crude oil prices—Texas spot price (2005=100), UK Brent price (2005=100) and Dubai spot price=2005=100)—reported in the *International Financial Statistics* CD-ROM. Like Ito and Sato (2008), the average crude oil price of the three major oil indices was used as a measure of aggregate supply conditions for all the countries in the sample.

Non-Fuel Commodity Prices

In addition to the crude oil price index, the non-fuel primary commodity prices was used as a proxy for aggregate supply conditions in all the countries included in the sample. The data was sourced from the *International Financial Statistics* CD-ROM.

Monetary aggregates and Interest Rates

Monetary aggregates and interest rates data is country specific because the development of the financial system differ from one country to the other. In the case of the UK, Canada, Argentina and Sweden, I used M2 (broad money) as a measure of money supply and the treasury bill rate as a measure of interest rate.

B.2.1 Plots of Time Series Data

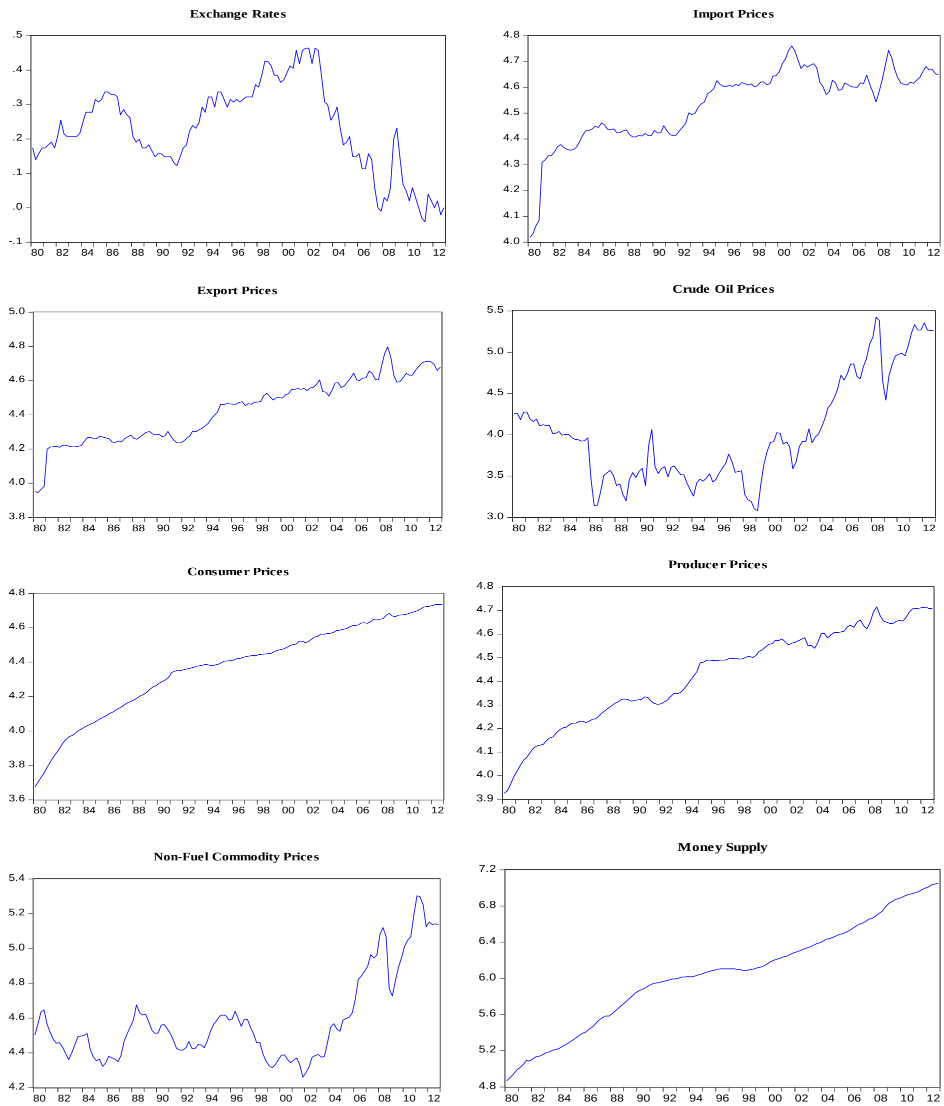

Figure B.1: Time Path of Nonstationary Processes for Canada (in log Levels)

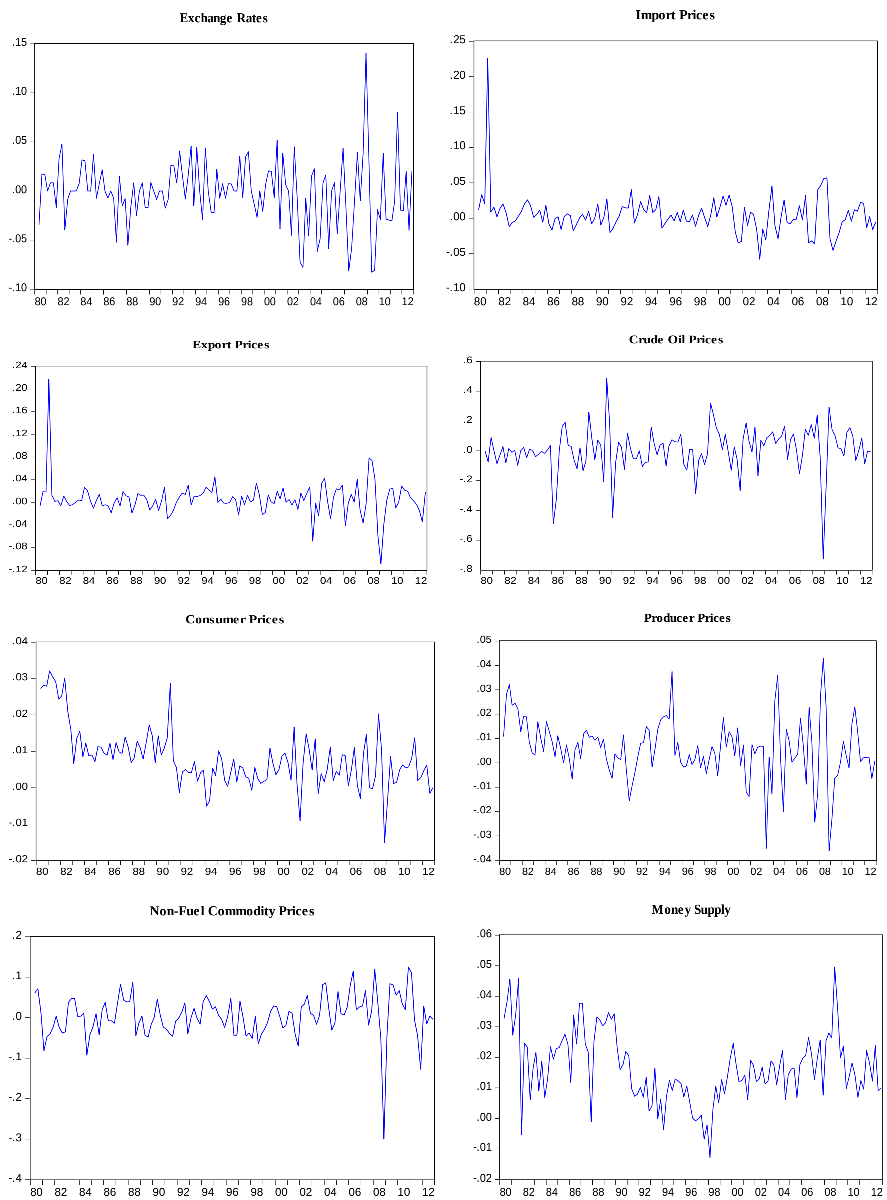

Figure B.2: Time Path of Stationary Processes for Canada (in log First Differences)

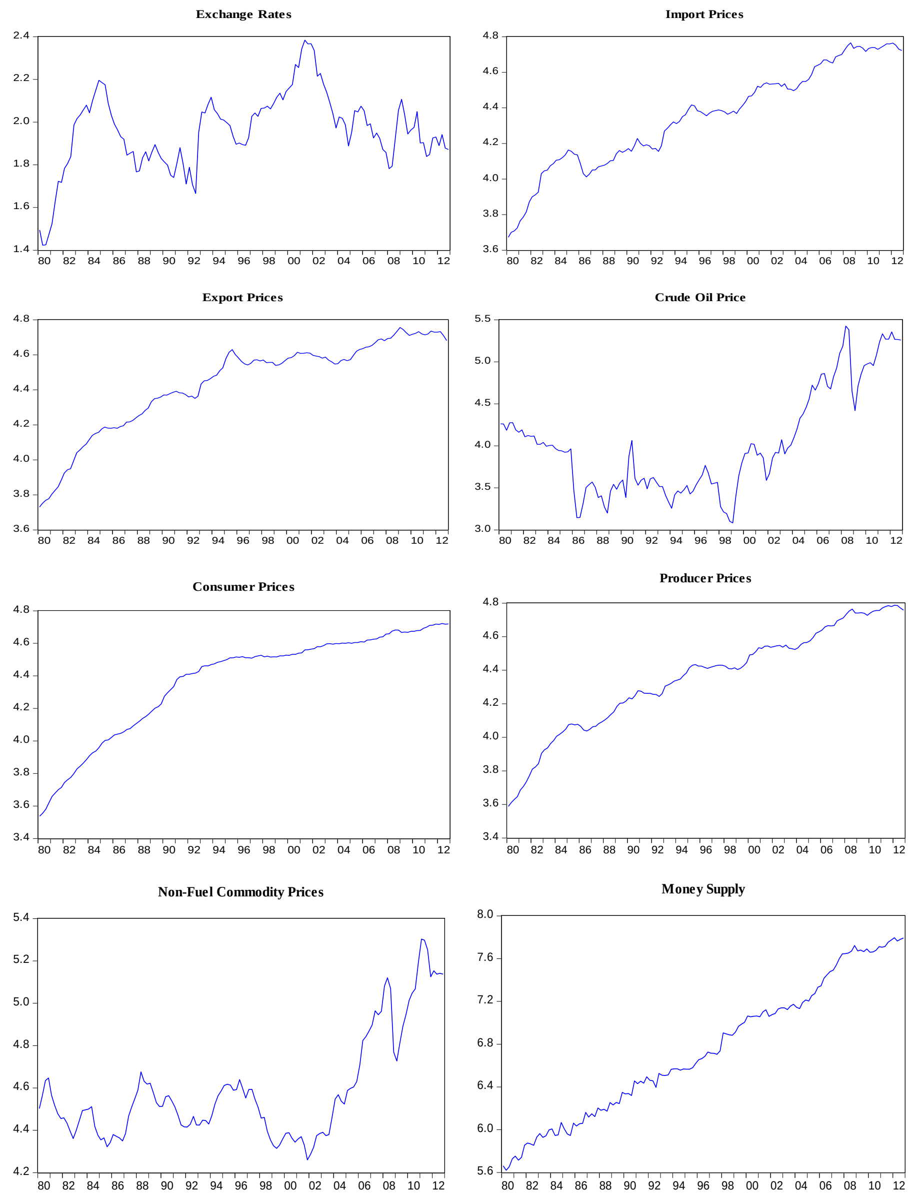

Figure B.3: Time Path of Nonstationary Processes for Sweden (in log Levels)

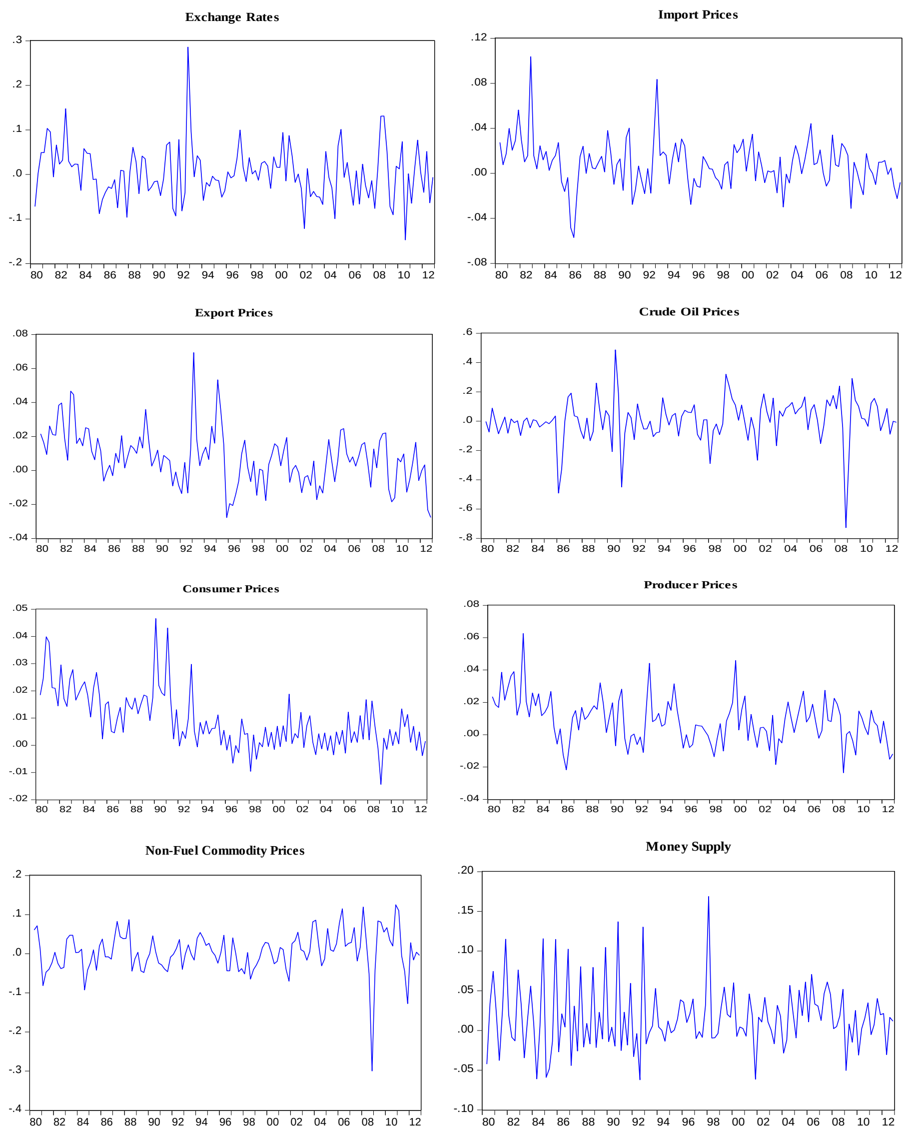

Figure B.4: Time Path of Stationary Processes for Sweden (in log First Differences)

Figure B.5: Time Path of Nonstationary Processes for United Kingdom (in log Levels)

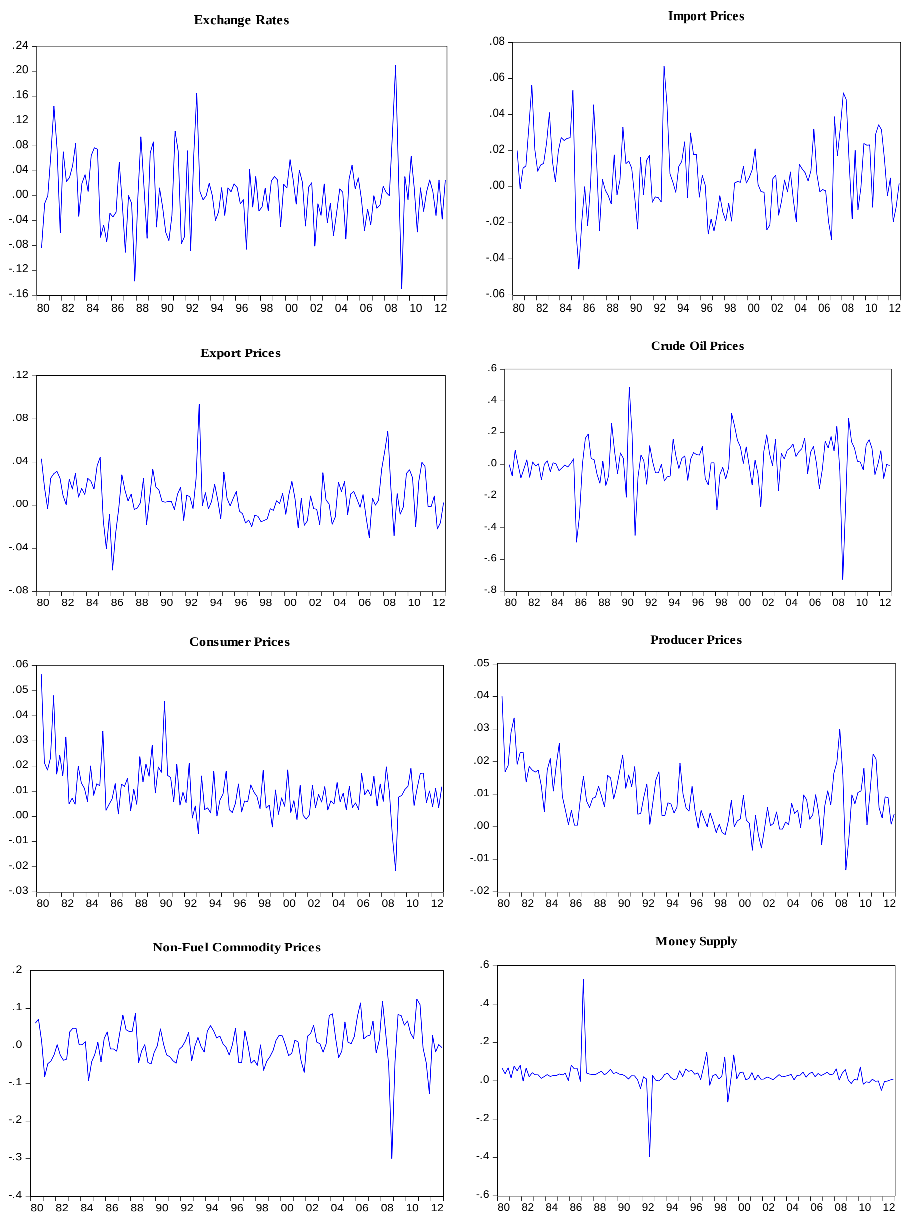

Figure B.6: Time Path of Stationary Processes for United Kingdom (in log First Differences)

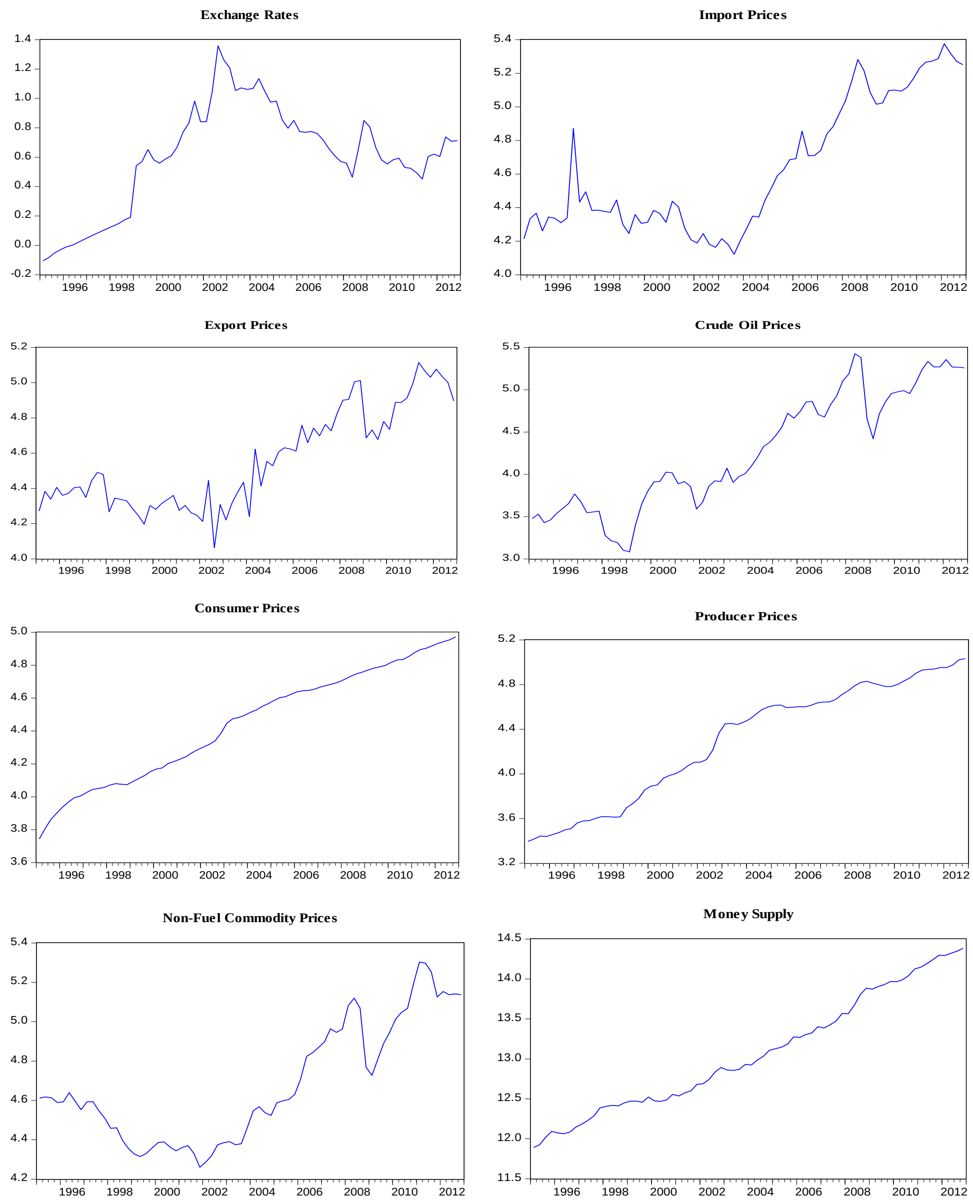

Figure B.7: Time Path of Nonstationary Processes for Argentina (in log Levels)

Figure B.8: Time Path of Stationary Processes for Argentina (in log First Differences)

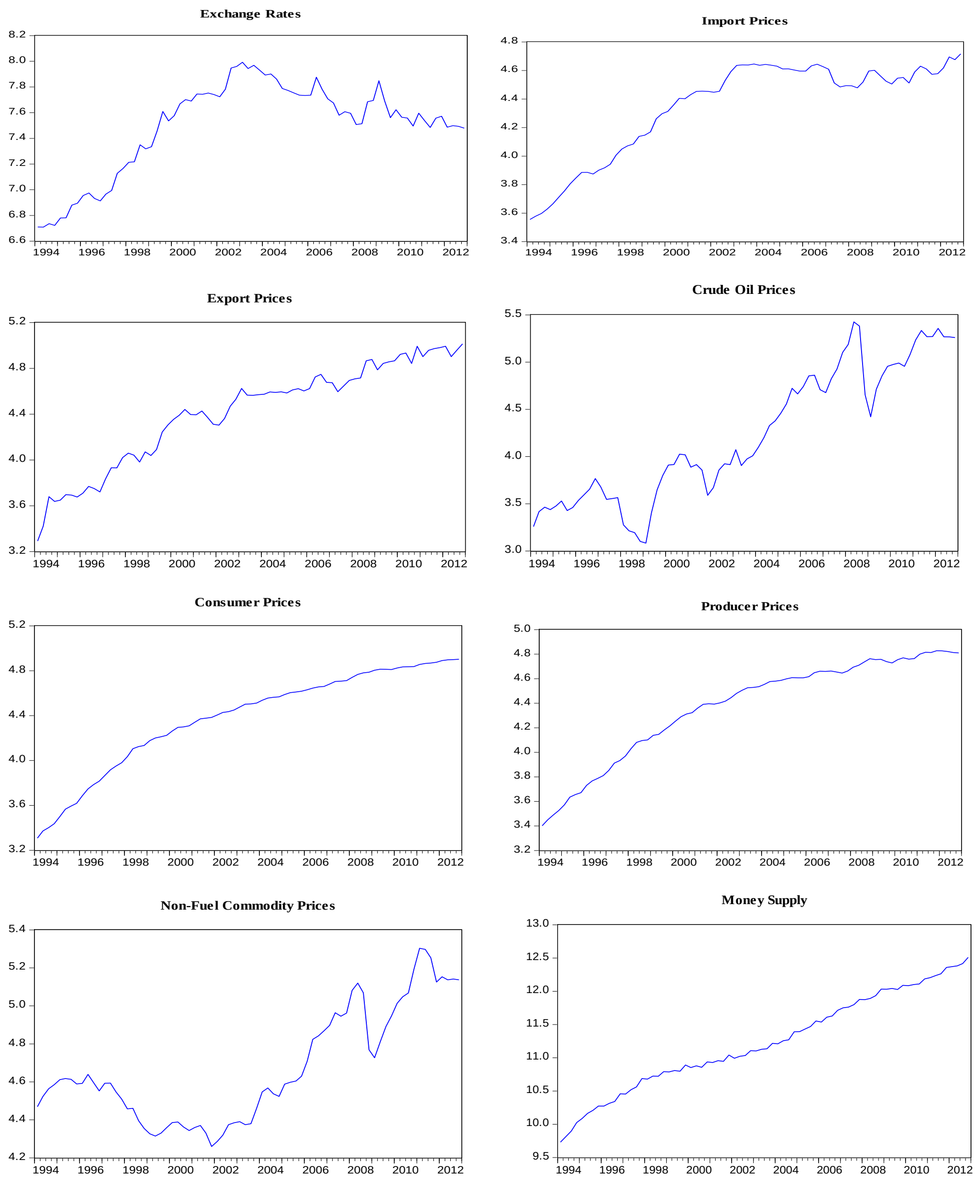

Figure B.9: Time Path of Nonstationary Processes for Colombia (in log Levels)

Figure B.10: Time Path of Stationary Processes for Colombia (in log First Differences)

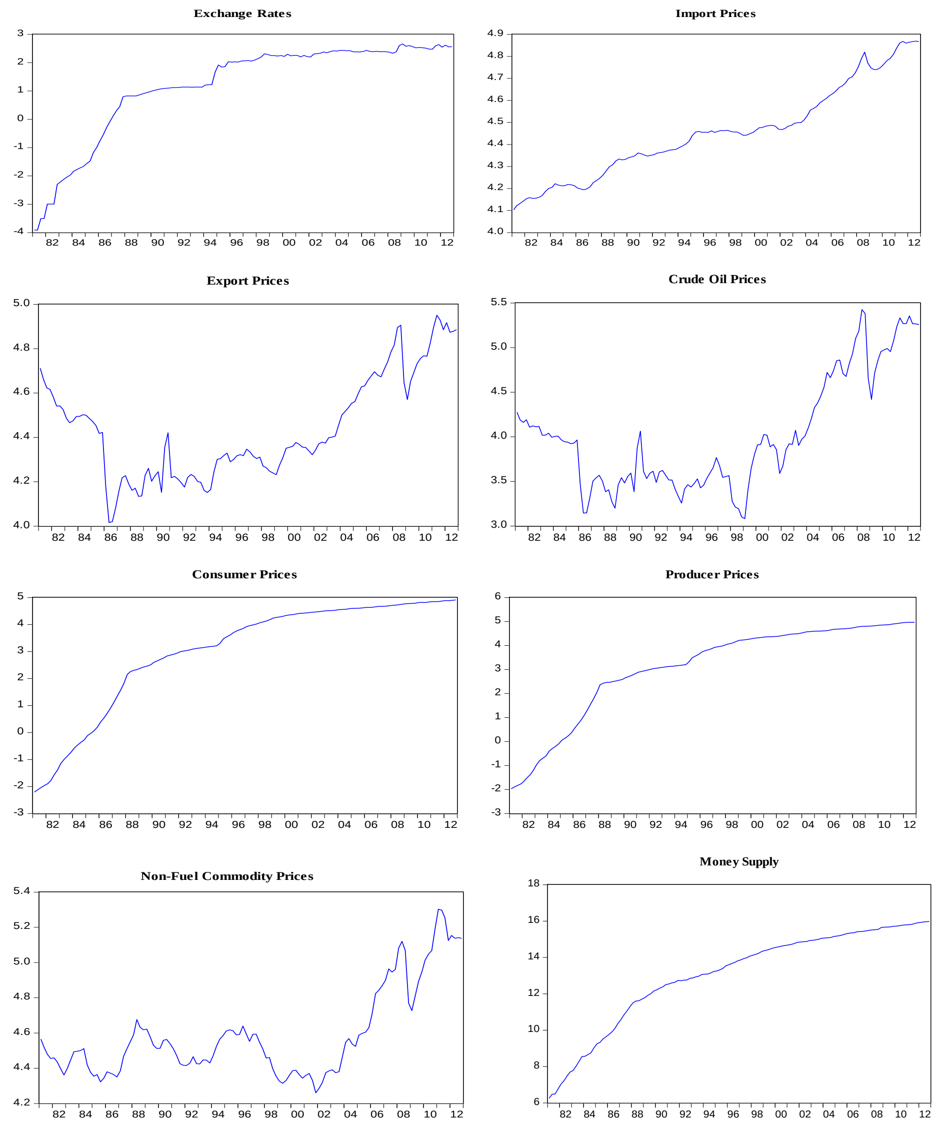

Figure B.11: Time Path of Nonstationary Processes for Mexico (in log Levels)

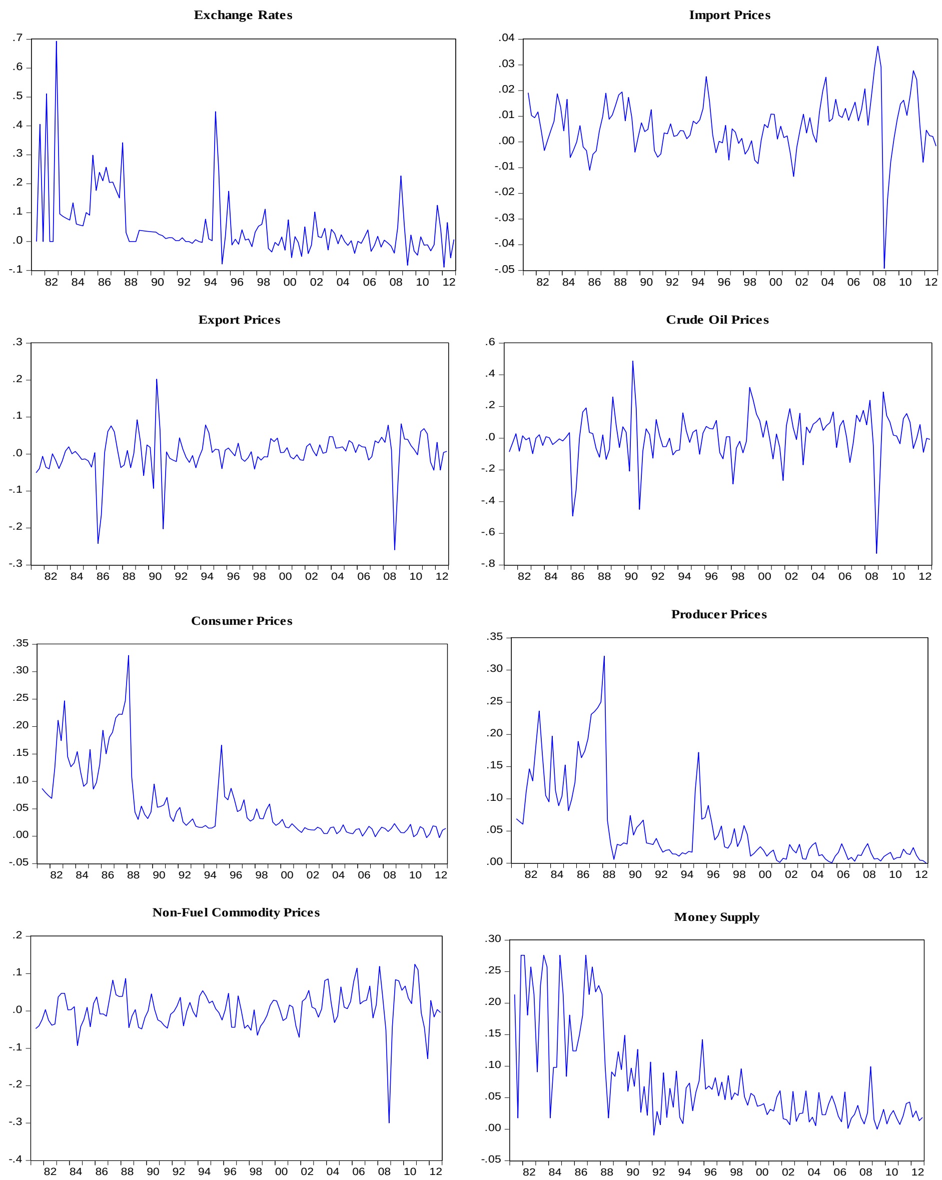

Figure B.12: Time Path of Stationary Processes for Mexico (in log First Differences)

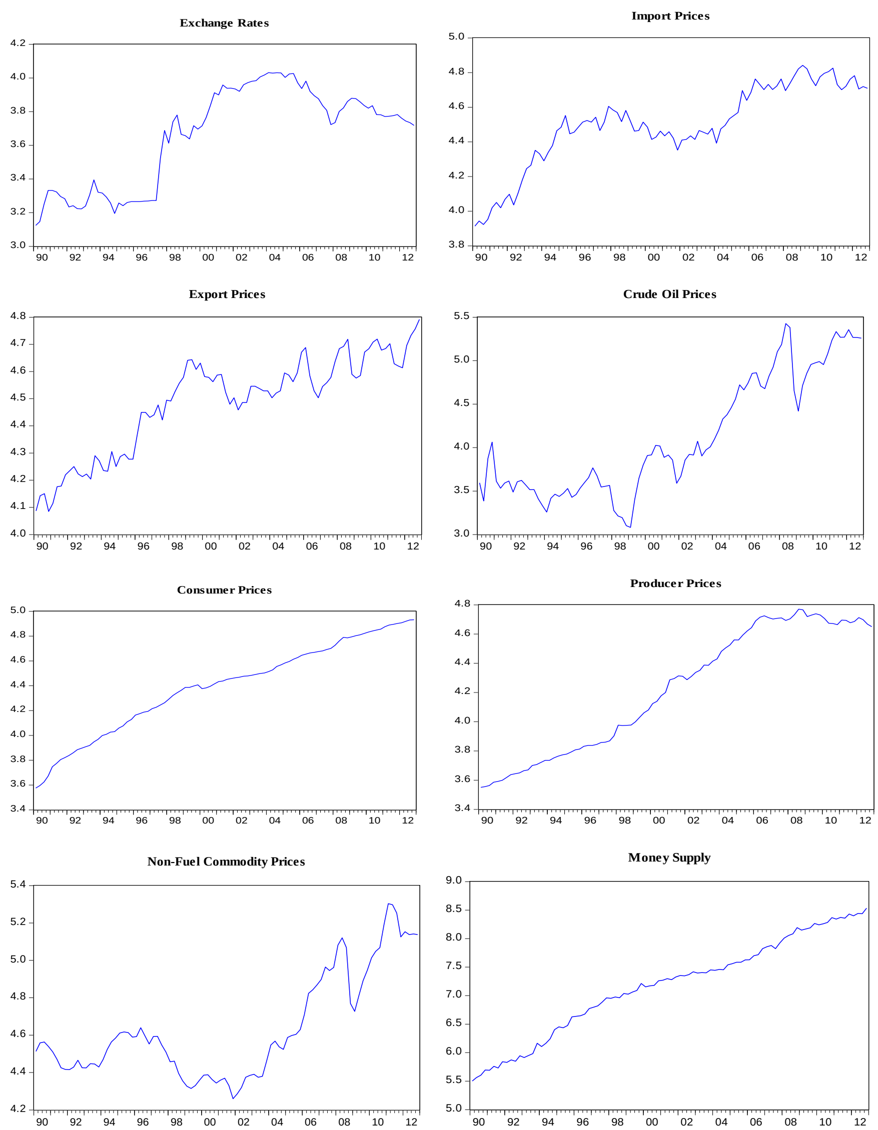

Figure B.13: Time Path of Nonstationary Processes for Philippines (in log Levels)

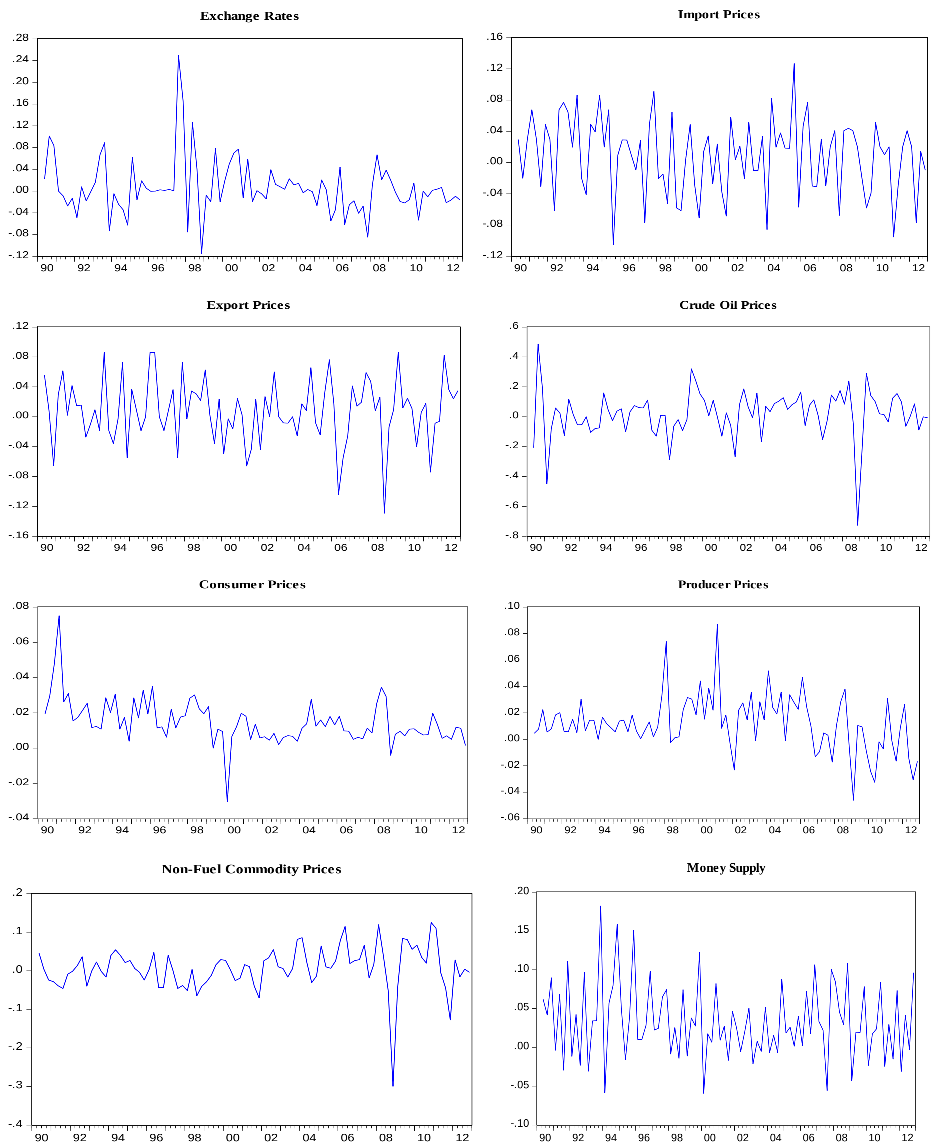

Figure B.14: Time Path of Stationary Processes for Philippines (in log First Differences)

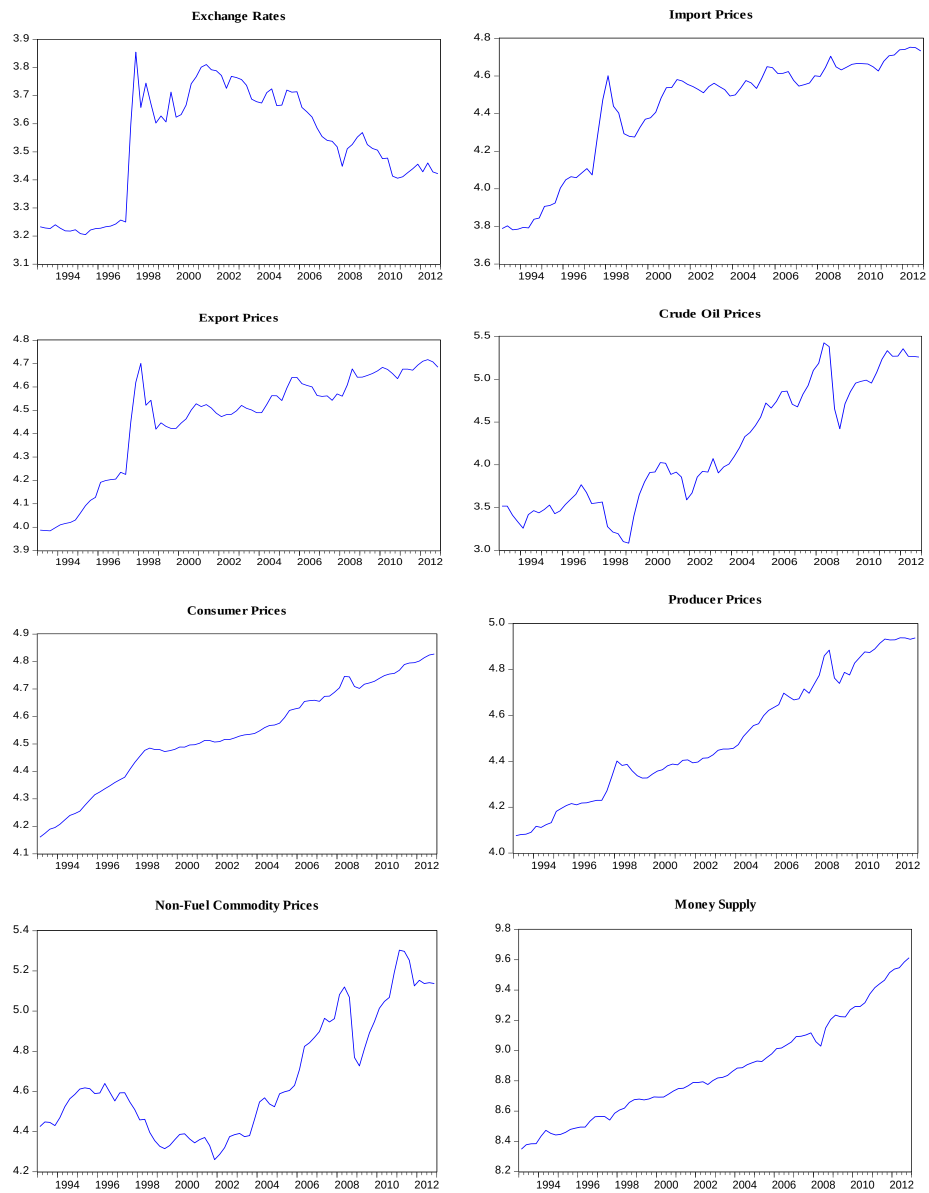

Figure B.15: Time Path of Nonstationary Processes for Thailand (in log Levels)

Figure B.16: Time Path of Stationary Processes for Thailand (in log First Differences)

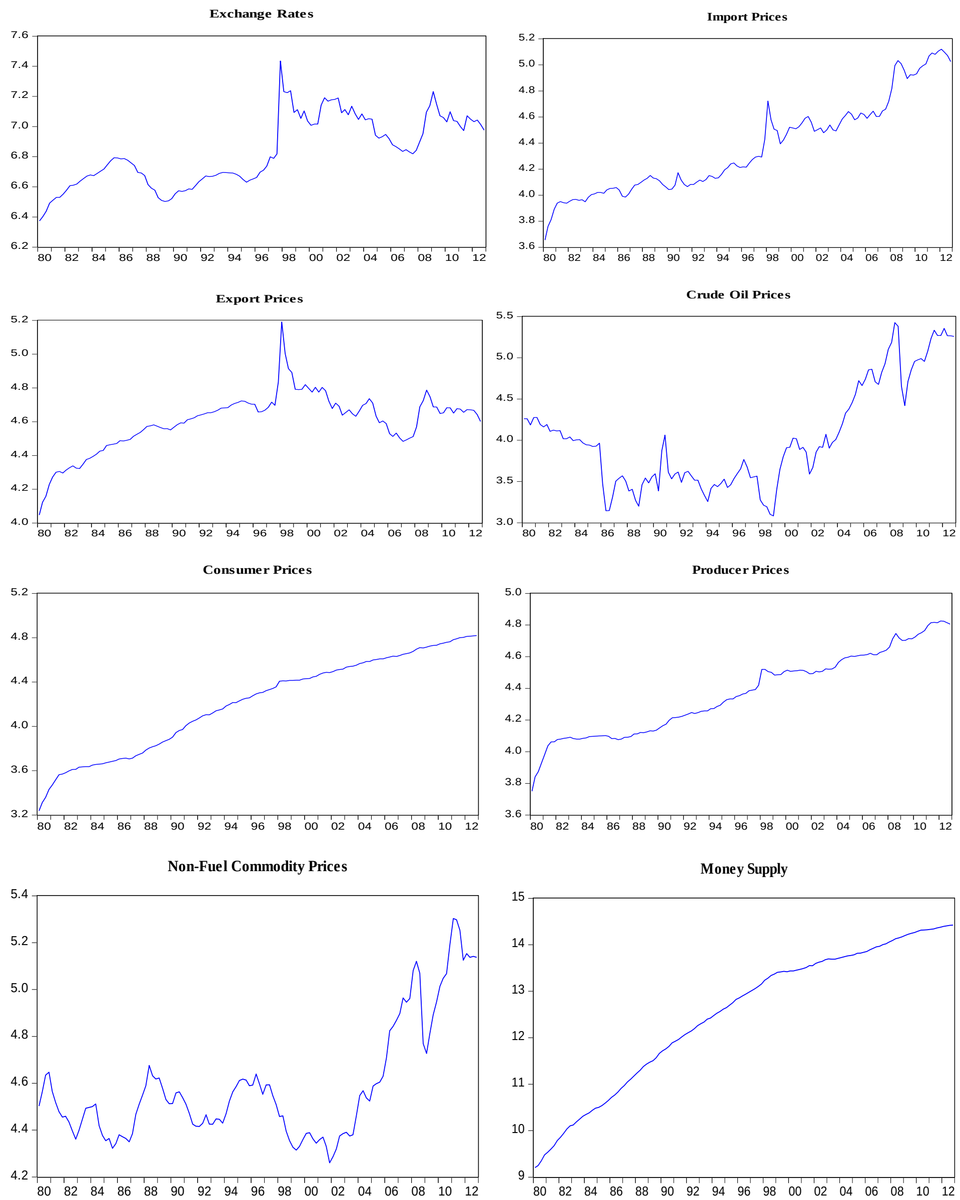

Figure B.17: Time Path of Nonstationary Processes for South Korea (in log Levels)

Figure B.18: Time Path of Stationary Processes for South Korea (in log First Differences)