# EMPIRICAL ESSAYS ON EXCHANGE RATE DYNAMICS IN LARGE EMERGING MARKET ECONOMIES

By

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# ABSTRACT

This study investigates the impact of exchange rate volatility on international trade flows using disaggregated industrial trade data, the effects of nominal exchange rate changes on the validity of real interest rate parity conditions, and the effects of monetary policy responses on real effective exchange rate volatility in large emerging market economies (LEMEs) were also examined.

As part of countries with convertible currencies, the exchange rate plays a vital role in LEMEs' economic activities, including engagement in the global markets. The countries' participation in international trade and financial markets has improved since the liberalisation of global markets at the end of the Bretton Woods era. However, just as they have enjoyed and recorded tremendous successes through economic openness, lack of suitable monetary policy makes LEMEs susceptible to external global contagion shocks ranging from financial crises to interest rate hikes or monetary policy changes in foreign countries. As commodity-dependent countries with increased exchange rate volatility, LEMEs have not benefited profitably from participating in international trade compared to their comparative advantages, such as abundant natural resources, human capacity, skills and production capacity. Moreover, the economies also suffer from internal policy instabilities and other systemic challenges that weaken the institutions and worsen the external challenges faced by LEMEs.

All these problems are believed to result from increased exchange rate volatility prevalent in LEMEs. As such, problems related to exchange rate volatility and its impacts on international trade flows in LEMEs have lingered on for years as economic and financial instabilities widened. These challenges can be viewed from increased levels of current account deficits, the rising balance of payment disequilibrium, market imperfections such as asymmetric information, uncertainties leading to increased risk aversion, and systemic imbalances faced by LEMEs. This implies that growth recorded from economic openness have not shielded LEMEs from exchange rate volatility, monetary policy instabilities and economic sustainability challenges. Therefore, whether LEMEs should adopt unconventional monetary

policies that suit the characteristics of the economies or the fixed exchange rate regime to mitigate exchange rate volatility and the associated negative effects remains conflicted. The way forward can only be determined by examining the impacts of exchange rate volatility on international trade flows in LEMEs.

These unanswered questions have also left the economies hanging as the ripple effects result in real interest rate parity deviations. This reflects the assumption that when financial flows are restricted in economies, the chances of deviation in real interest rate parity increase. Additionally, recorded financial crises since financial market liberalisation also affect exchange rates in countries with convertible currencies. LEMEs are undoubtedly vulnerable to external contagion effects due to the poor-quality financial systems in the economies. Furthermore, research has shown that countries with underdeveloped financial systems remain trapped in vicious cycles affecting their global market performance. However, achieving real interest rate parity conditions is essential and requires standards for adequate capital mobility and efficient market integration. Since achieving real interest rate parity conditions seems implausible due to challenges faced by LEMEs, it would be insightful to explore the possibility of such parity conditions holding amid monetary policy reforms that result in nominal exchange rate regime changes in LEMEs.

The problems related to the impacts of exchange rate volatility on international trade flows and achieving real interest rate parity conditions in LEMEs beg for an answer on how monetary policy should be strengthened to suit LEMEs' financial stability agenda. Over the years, the attempt to restructure LEMEs' financial systems through monetary policy reform has constituted a significant discussion. Considering that LEMEs suffer institutional setbacks caused by increasing price variability, a poor policy framework, underdeveloped financial systems, and institutional imbalances through exchange rate volatility. Adjusting how monetary policy responds to real effective exchange rate volatility vis-a-vis the inflation targeting (IT) framework guided by the Taylor policy rule does not seem to be the answer. Arguments have been presented regarding the practicability of the Taylor rule in LEMEs, considering the developmental level of policies in these economies. Moreover, there are concerns that the Taylor rule is limited, lacks some macroeconomic instruments that cater to the disadvantages associated with LEMEs, and might not adequately capture the relevant factors needed to restructure monetary policy.

This study, therefore, investigates the real impacts of increasing exchange rate volatility on international trade flows in LEMEs using disaggregated industrial-level trade data that factor in the endowment capacity of the economies. Another aspect of the investigation is to apply structural breaks and half-life shocks to measure how different monetary policy regimes in LEMEs impact real interest rate parity deviations considering the economies operate in convertible currencies. Finally, the monetary policy framework plays a vital role in achieving financial stability and mitigating the effects of the real effective exchange rate volatility in open economies. It would be interesting to evaluate the validity of Taylor policy inflation targeting (IT) rule in LEMEs. It is also necessary to know whether an increase in real effective exchange rate volatility can propel policymakers to adjust monetary policies in LEMEs. This study's three main focus areas are based on prior studies' limited, conflicting, and inconclusive results.

To further this research, the study will be divided into three related papers to understand the phenomenon surrounding exchange rates in LEMEs. The first paper comparatively investigates the effectiveness of disaggregated industrial-level trade data to explain the influence of exchange rate volatility on international trade flows regarding prices, volume, and income (real GDP) in 10 LEMEs and their leading trade partner, the US. The second paper applied structural breaks to real interest rate differentials (rdiffs) to examine the validity of real interest rate parity (RIRP) conditions through different nominal exchange rate regimes in seven LEMEs relative to their leading trading partner, the US. An extension of the Taylor policy rule to estimate whether exchange rate volatility plays a role in policy interest rate settings in seven LEMEs is presented in the third paper.

The results from the three papers reveal that only a few industries are negatively affected by exchange rate volatility in international trade flows. Despite having a long-run relationship with exchange rate volatility, other industries show no effects, whereas others are positively affected by exchange rate volatility. There is also evidence that many industries do not have a long-term relationship with exchange rate volatility. In the second paper, the autoregressive (AR) (1) model parameters in relation to estimating rdiffs reveal weak evidence of long-run validity of the RIRP conditions in LEMEs. Finally, findings from the last paper indicate a slight response by policymakers to real effective exchange rate volatility while also showing that

exchange rate target is not the main focus of monetary authorities in LEMEs. Furthermore, adding PPI inflation in the estimation reveals a strong use of inflation targeting in LEMEs, although the economies do not conform to the Taylor policy principles.

The results imply that although exchange rates form a significant part of monetary policy designs in LEMEs, adopting economic policy geared toward adjusting only exchange rates during financial or economic crises might only elevate the challenges of financial and economic instabilities in LEMEs. Therefore, the study recommends a balanced policy approach that suits the structure of LEMEs' economic and financial systems. This could help to control the effects of exchange rate volatility in the economies. The approach might advance LEMEs' aim toward successful transitioning during regime changes and be credible to operate effectively in global markets, even during increased financial tensions.

**Keywords:** Exchange rate volatility, International trade, Interest rate differentials, Exchange rate regime, Monetary policy, Inflation targeting, Output gaps, Central Bank, Large emerging market economies.

**JEL classification:** E31, E42, E43, E48, E52, E58, F31

## CONFERENCE PRESENTATIONS AND BOOKS OF ABSTRACT

### *Conferences*

1. **Iwegbunam, A.I and Odei-Mensah, J.** "Monetary Policy Response to Exchange Rate Volatility in Large Emerging Market Economies." 17th Economics and Finance Conference, International Institute of Social and Economic Sciences (IISES**)**, 5-7 September, 2022, Istanbul, Turkey.

2. **Iwegbunam, A.I and Odei-Mensah, J.** "Real Interest Parity Conditions and Nominal Exchange Rate Regimes in Large Emerging Market Economies." 40th Eurasia Business and Economic Society (EBES) Conference, 6-8 July, 2022 Istanbul, Turkey.

3. **Iwegbunam, A.I and Odei-Mensah, J.** "Nexus Between Exchange Rate Volatility and International Trade Flows in BRICS Economies." 7th International Conference on Applied Theory, Macro and Empirical Finance, 18th April, 2022**,** University of Macedonia, Thessaloniki, Greece.

### *Books of Abstract*

1. **Iwegbunam, A.I. and Odei-Mensah, J. (2022).** Real Interest Parity Conditions and Nominal Exchange Rate Regimes in Large Emerging Market Economies. Abstract book 40th Eurasia Business and Economic Society (EBES) Conference, Istanbul, Turkey. Available on www.ebesweb.org-ISBN: 978-605-71739-0-4.

2. **Iwegbunam, A.I. and Odei-Mensah, J. (2022).** Monetary Policy Response to Exchange Rate Volatility in Large Emerging Market Economies. Abstract book: 17th Economics and Finance Conference, **International Institute of Social and Economic Sciences (IISES)**, Istanbul, Turkey. Available on www.iises.net-ISBN 978-80-7668-008-1.

## DECLARATION

**I, Ifeoma Anthonia Iwegbunam,** hereby certify that the thesis I have presented is my own work except as indicated in the references and acknowledgments. It is submitted in fulfilment of the requirements for the award of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

**Ifeoma Anthonia Iwegbunam**

Signed at: **Wits Business School, Johannesburg, South Africa.**

On the 16th day of November, 2022.

# DEDICATION

**To**

**my family**

**I am forever indebted to you all!!!**

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# TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

## TABLES OF ACRONYMS AND ABBREVIATIONS

| ABBREVIATIONS | MEANING |
|---|---|
| **AD** | After Death |
| **ADF** | Augmented Dickey-Fuller |
| **AIC** | Akaike Information Criteria |
| **AR** | Autoregressive |
| **ARIMA** | Autoregressive Integrated Moving Average |
| **BC** | Before Christ |
| **BIC** | Bayesian Information Criterion |
| **BFGS** | Broyden, Fletcher, Goldfarb and Shanno |
| **BHHH** | Berndt-Hall-Hall-Hausman |
| **BRICS** | Brazil, Russia, India, China, and South Africa |
| **CADF** | Cross-Sectional Augmented Dickey-Fuller |
| **CPI** | Consumer Price Index |
| **DF** | Dickey-Fuller |
| **DFGLS** | Augmented Dickey-Fuller-Generalised Least Squares |
| **DV** | Differing Variable |
| **EMEs** | Emerging Market Economies |
| **ECOWAS** | Economic Community of West African States |
| **FRED** | Federal Reserve Bank of St Louis |
| **GAB** | General Arrangement to Borrow |
| **GATT** | General Agreements on Tariffs and Trade |
| **GDP** | Gross Domestic Product |
| **GFD** | Global Financial Data |
| **GMM** | Generalised Method of Moments |
| **HP** | Hodrick-Prescott |
| **IBRD** | International Bank for Reconstruction and Development |
| **IFS** | International Financial Statistics |
| **IMF** | International Monetary Fund |
| **IT** | Inflation Targeting |
| **IV** | Instrumental Variable |
| **KPSS** | Kwiatkowski-Phillips-Schmidt-Shin |
| **LEMEs** | Large Emerging Market Economies |
| **LYS** | Levy-Yegati and Sturznegger |
| **OCA** | Optimal Currency Area |
| **OECD** | Organisation for Economic Co-operation and Development |
| **OLS** | Ordinary Least Square |
| **OPEC** | Organisation of Petroleum Exporting Countries |
| **PPI** | Producers Price Index |
| **PP** | Philip Perron |
| **PPP** | Purchasing Power Parity |
| **QE** | Quantitative Easing |
| **rdiffs** | Real Interest Rate Differentials |

| | |
|---|---|
| **REER** | Real Effective Exchange Rate |
| **RIRP** | Real Interest Rate Parity |
| **SDR** | Special Drawing Rights |
| **UIP** | Uncovered Interest Parity |
| **UK** | United Kingdom |
| **US** | United States of America |
| **ZA** | Zivot and Andrew |

# CHAPTER ONE

# Introduction

## 1.1 Background to the study

The end of the Bretton Woods era granted countries opportunity to adopt specific independent monetary policy frameworks devoid of mandatory fixed exchange rate system. With effective independent monetary policies, large emerging market economies (LEMEs) have made tremendous progress in global markets' participation and improving economic prospects (Duttagupta & Pazarbasioglu, 2021). This can be seen from the significant roles LEMEs play in the growth of international trade and capital flows across countries since the liberalisation of trade and financial markets. Heroles et al. (2020) believe that countries in emerging market economies represent a significant portion of global trade due to economic openness and have carried out close to 45 per cent of global exports since 2010, compared to 25 per cent in 1996. The growth prospects imply that LEMEs can uphold their presence in the global trade and financial markets. Trade relations in LEMEs range from inter-regional, national, and group trade between LEMEs and advanced economies (AEs), amongst themselves and other emerging market economies, which constitute up to half of the global trade flows.

For trade and financial flows to be efficient, the foreign exchange rate plays an important role in determining the extent of engagements between countries since the end of the Bretton Woods era through market connectedness and increased capital flows (Caporale et al., 2018). This implies that foreign exchange rate helps determine domestic currency rates in the financial markets. This also includes associated bid-ask spreads, especially with LEMEs' currencies that have systemic risks. To this end, financial stability and economic sustainability through effective monetary policy management, exchange rate control, and macroeconomic development are important but pose significant challenges for LEMEs (BIS, 1997; De Bock & de Carvalho, 2015; Choi, 2017; Tobal & Menna, 2020 & Venkatesh & Hiremath, 2020). The challenges arise from effective ways monetary policy targets could be linked in the context of broader macroeconomic considerations. Although LEMEs have achieved significant success through participating in global markets, systemic and institutional imbalances in the countries could be a hindrance. Moreover, the countries are susceptible to external contagion effects from international financial markets' crises causing fluctuations in LEMEs' exchange rates (Svensson, 2014; Rey, 2015; Tobal, 2017; Gurio et al., 2018 & van der Ghote, 2018). This causes the economies to be vulnerable to external shocks. Calvo (2006) indicates that underdeveloped financial systems, monetary and political instabilities and weak systems are part of the problems making LEMEs vulnerable to shocks from international markets. These problems are further worsened by a lack of adequate financial infrastructure to navigate external risks, including global financial risks that could easily be transferred to LEMEs.

The pioneering work of Clark (1973) argues that risks associated with exchange rate volatility, if unchecked, could have damaging consequences on international trade flows and possibly on the entire economic system. The argument is further strengthened by Kohler (2010) with the view that countries with significant exchange rate volatility are vulnerable to increased risk aversion by traders and investors, which decreases investment and reduces the chances of current account balance, financial stability, and economic sustainability. The report from BIS (2019) reveals that exchange rate volatility impacts emerging markets significantly more than advanced economies. This was also presented in the findings of Keefe and Rengifo (2015), concluding that smoothing continuous movement in the exchange rate should be the priority for advancing economic progress. Furthermore, Auboin and Ruta (2011) express that the negative implications of exchange rate volatility can affect the entire macroeconomic prospects, including productivity and investment levels.

More so, findings from Saurabh et al. (2022) conclude similarly that exchange rate volatility in emerging market economies tends to be higher due to susceptibility to contagion exogenous shocks. Therefore, as emerging markets' levels of participation become significant in global markets, there are also struggles within to safeguard the economies from the effects of external shocks. For example, during the global financial crisis, emerging market economies, including LEMEs' foreign exchange volatility rate, were valued at about 40, a rate higher than the advanced economies where the crisis began (Saurabh et al., 2022). This has been the trend in every economic downturn or financial crisis. So far, the relationship between exchange rates and international trade flows in LEMEs remains undetermined, but the negative effects are attributed to the consistent increase in exchange rate volatility. Thus, with enormous risks involved, economies may incur deficits while participating in international trade, as risks related to exchange rate volatility increase with global exposure.

Studies on the relationship between exchange rate volatility and international trade flows related to emerging market economies, which consist of LEMEs abound. However, while Hooper and Kohlhagen (1978), Thursby and Thursby (1987), and Cushman (1983) conclude that there is no impact from exchange rate volatility on international trade flows, Musila and Al-Zyoud (2012) and Takaendesa, Tsheole, and Aziakpono (2021) find a high prevalence of exchange rate volatility in different emerging market economies which have negative implications on international trade flows. The same conclusion was reached by Arize (1998), Darrat and Hakim (2000), Sekkat and Varoudakis (2000), Musonda (2008), Rizov and Willenbockel (2010), and Rose (2000), with studies between emerging market economies and other countries which reveal a significant negative relationship between exchange rate volatility and international trade flows but attribute the negative influence on existing weak financial systems. Considering that LEMEs require substantial economic integration to boost economic growth, the negative impact of exchange rate volatility on international trade flows might be detrimental to growth processes if unchecked. This can be in the form of an increase in inefficient allocation of domestic resources and absorption of gains from trade. It also could impact employment and increase the unemployment rate, reduce participation in the labour markets, decrease productivity, increase prices and heighten inflation rates. All these problems can reduce the rate of consumption and negatively impact the aggregate macroeconomic system and balance account disequilibrium considering the cyclical movements in the economy.

On the other hand, a weak financial system and other institutional imbalances discussed above can affect long-term real interest rate parity (RIRP) convergence to earn foreign investors' confidence in investing in LEMEs. Taylor (2000) argues that an increase in inflation rates in emerging markets could create shocks to investment and net exports, making it difficult to measure real interest rates. The same argument is presented by Singh and Banerjee (2006), Altuntas (2021), and Ferreira and Leon-Ledesma (2003) that deficit growth, underperformance, currency devaluation, and high inflation rates, prevalent in emerging market economies, negatively impact real interest rates to deviate from parity. Moosa and Razzaque (2017) highlight the RIRP hypothesis, which indicates that if the world markets for goods, capital, and foreign exchange are integrated, real interest rates on perfectly comparable financial assets should be equal across countries over time. A similar idea is contained in Dutton's (1993) theory of international finance, which postulates that for international comparisons among countries, an appropriate measure of the real interest rate should include the prices of traded goods. However, studies by Fuijiji and Chinn (2000), Chinn and Frankel (1995), Ong et al. (1999), and Frankel and Okongwu (1995) have mixed and inconclusive results regarding the existence of real interest rate parity differentials in countries. Ideally, the theoretical proposition is that there should be similar long-run real interest rate returns among countries, whereas inflation differentials are measured using long-term nominal interest rate differentials (Frankel, 1999). This implies that country-specific interest rates need to have a long-run convergence trend which might be difficult to obtain in LEMEs due to poor structural features of the countries that create risks, according to Singh and Banerjee (2006). Since international trade and investment are important for sustainable economic growth in LEMEs, maintaining real interest rate parity (RIRP) is necessary to participate in international markets and attract foreign investors effectively.

Moreover, LEMEs still face the problem of adopting suitable monetary policies that fit their economic structures. Therefore, the target is to navigate the challenges related to increases in inflation rates and output gaps owing to increased capital mobility from economic integration. This propels LEMEs to adopt a combination of flexible exchange rate regimes and an inflation-targeting (IT) framework. The policy helps LEMEs to target inflation and output gaps using the IT policy framework and enforces equilibrium in the case of deviations from the target band. Meanwhile, the existing empirical literature, for example, Bernanke (2015) and Hofmann and Bogdanova (2012), criticised the simplicity of the Taylor rule and its inability to capture factors relevant to macroeconomic stability and monetary policy framework in emerging market economies. Khatat et al. (2020) believe that an open economy with increased capital mobility, flexible exchange rates, and inflation targeting protects against real shocks and contagion risks when economies are exposed to global influence. This implies that, although LEMEs adopt a flexible exchange rate regime, there is no need to use the IT framework as an indirect target for exchange rates because the forces of demand and supply in international markets adjust exchange rate volatility. Therefore, policymakers must improve financial stability to have the capacity to withstand external shocks.

### 1.2 The Large Emerging Market Economies (LEMES)

The LEMEs are considered more advanced economies than other emerging market economies because of their growth prospects in terms of GDP and economic maturity. Boyer and Truman (2005) categorise the major economies within the EMEs as large emerging market economies (LEMEs), which consist of 11 countries, namely: Argentina, Brazil, China, India, Indonesia, Korea, Mexico, Russia, Saudi Arabia, South Africa, and Turkey. These 11 economies belong to the Group of Twenty (G-20) countries with improved transitioning, productivity, income per capita, economic expansion, GDP growth, and improved levels of integration and participation in global markets (Boyer & Truman, 2005).

Collectively, they are the primary source of growth for the world economy, providing economic and financial stimulus for businesses and investors' sustainability. They make up about 59 per cent of the world GDP on a PPP basis in 2019 than a decade ago (WEO, 2019). Regarding economic growth, the pace in LEMEs is faster than in the rest of the world, with the highest combined total of international reserves. Boyer and Truman (2005) agree that LEMEs can mobilise real and financial resources sufficient to contribute significantly to global objectives; any disturbance in their economic system reflects on the global economy. Hence, policy adjustments or fluctuations in LEMEs exchange rates tend to inflict adverse effects on the global markets.

Although LEMEs have not fully transitioned to advanced economies (AEs) in GDP per capita and other developmental features, significant progress has been achieved with rapid economic expansion and maturity. Studies by Enderwick (2009), Nolke, Brink, Claar, and May (2020), Tang and Yao (2018), and Olasehinde-William and Bacilar (2020) have also adopted the Boyer and Truman LEMEs categorization approach, which signifies the importance of the economies in the global markets. Despite the improved growth rates and economic transformations LEMEs have recorded over the years, they suffer from problems related to structural underdevelopment. These include a lack of adequate infrastructure, a flawed financial system, and vulnerability to shocks leading to increased exchange rate volatility. So, although positive progress has been made, more efforts are required to stabilise the economies. Evidence from all indications is that exchange rate volatility is the leading cause of struggles to maintain economic and financial stability. Thus, further investigation to measure the impact of exchange rate volatility on international trade flows, achieving RIRP conditions, and formulating appropriate monetary policy frameworks will be insightful in enhancing economic progress in LEMEs.

Studies within this context have loopholes and require further investigation to determine the extent of the relationship.

### 1.3 Statement of the Research Problem

The problems presented in this section focus on three main areas of interest in this study: exchange rate volatility and international trade flows, real interest rate parity and nominal exchange rate regimes, and monetary policy framework, real effective exchange rate volatility, and price stability in LEMEs. For a proper understanding of this study's concept, the research problems for each paper are discussed below.

**Exchange rate volatility and international trade flow:** theoretical models of the effects of exchange rate volatility and international trade flows, namely, risk aversion and risk neutrality, the nature of traders, capital markets, time horizon, and general equilibrium models, postulate the existence of a relationship between exchange rates and international trade flows (Artus, 1983; Brosky, 1984; Chowdhury, 1993; McKenzie, 1999 & Latief & Lefen, 2018). Depending on the direction of the relationship, it can be positive or negative based on several factors related to economic development and the monetary policy targets in the economy. Regarding

LEMEs, studies mentioned above indicate that exchange rate volatility contributed to poor structural framework in the economies together with the underdeveloped financial systems that make them susceptible to shocks within or outside the economies. Consequently, the negative effects of exchange rate volatility affect LEMEs' ability to handle large capital flows and engage profitably in global markets. Therefore, although capital mobility is important for global market participation, the negative effects of exchange rate volatility can outweigh the benefits.

Furthermore, combining a flexible exchange rate regime with an inflation-targeting framework and allowing market forces to determine the exchange rate might increase volatility in LEMEs' currencies due to their vulnerability to external shock effects. The adverse spillover effects from advanced economies might intensify the risks associated with international trade and affect the volume and prices of traded goods.

LEMEs mainly export commodity products and import finished goods from advanced economies, and transactions are usually conducted in foreign currencies. The risks and uncertainties surrounding LEMEs' exchange rates can increase the bid-ask spread to protect traders who trade in LEMEs' currencies. Moreover, commodity product prices are volatile and subject to frequent shocks, so it exposes commodity-dependent countries such as LEMEs to a large balance of trade disequilibrium. This transfers external shocks to other sectors of the economy, compromising financial stability and increasing growth setbacks (Katusiime, 2018). The problem with exchange rate volatility and international trade flows in LEMEs is that although these countries participate continuously in global markets, exchange rate volatility significantly hinders achieving the desired success of increased financial gains from trade.

Considering the abovementioned problems, this study investigates the relationship between exchange rate volatility and international trade flows in LEMEs. The disaggregated industrial trade data from each country was used to determine whether exchange rate volatility negatively affects international trade flows with their trading partner, the US. Considering that LEMEs command significant trade flows globally and contribute significantly to global markets, understanding the impacts of exchange rate volatility on different industries in the economy will be insightful. The results will help related countries design appropriate monetary policies to reduce the negative impacts of exchange rate volatility on the industries studied. It will also offer policymakers ideas on boosting industrial gains from trade.

**Real interest rate parity and nominal exchange rate regimes:** LEMEs need improved investment rates from foreign investors to boost financial stability and economic sustainability. This could be in the form of multinational companies or the purchase of long-term government bonds. However, this can only be achieved when these economies validate real interest rate parity (RIRP) conditions. Considering the problems associated with exchange rate volatility in LEMEs, attracting foreign investors might prove impossible. To curtail the problem of increasing exchange rate volatility in the economies, LEMEs have adopted different exchange rate regimes to curtail the effects on their financial systems, including the external shockwaves from economic openness.

The problem is the belief that exchange rate regime changes can improve RIRP's validity. If RIRP condition is not achievable, foreign investment rates may be affected and, in turn, yield similar negative influence on the aggregate economy, considering other institutional problems existing therein (Skinner & Mason, 2011).

For economies struggling to maintain economic stability, long-term foreign investment might help LEMEs increase aggregate demand and supply by absorbing the workforce and creating more economic revenue. However, this can only be achieved where risks are limited and there is RIRP validity which does not represent the structure of LEMEs. In the views of Orellana and Pino (2021) absence of RIRP can encourage foreign investors to earn money through carry-trade operations by taking out loans from low-interest rates economies and invest in high-interest rates countries to yield huge returns on investment and avoid risks. When the RIRP is not valid in a country as with LEMEs, investors' confidence might be affected, leading to diversion to short-term investments. However, the flexibility of short-term investments might not be suitable for the structure of LEMEs' financial and economic systems. There is also the possibility that short-term investments could be pulled off from the economy when financial and economic crises increase. In this instance, these negative effects could hurt other sectors of the domestic economy if foreign investments are needed for economic boost during crises. The question is, do nominal exchange rate regime changes in LEMEs affect the validity and long-run convergence of the RIRP? Are there other systemic risks within LEMEs that could hinder RIRP persistent convergence in the long-run? When RIRP deviations occur, how long would convergence to the parity take? This study empirically examined the impact of nominal exchange rate regime changes on RIRP validity in LEMEs, comparing the cases of deviations and how long it takes interest rates to adhere to the theoretical convergence framework. The analysis considered the theoretical expectation that countries-specific interest rates should show long-run convergence trends for RIRP. Therefore, analyses include other institutional circumstances that could hinder RIRP conditions from holding in LEMEs. Similarly, the period in which each country adopted the two regimes under consideration was examined as part of the case study.

**Monetary policy framework, exchange rate volatility, and price stability:** the end of the Bretton Woods era in 1972 saw the advent of monetary policy liberalisation for all countries, including LEMEs. Although LEMEs adopted different exchange rate regimes, such as pegged, fixed, freely floating, and managed floating, most economies could not control their financial systems due to unfit policy frameworks and poorly managed regime systems. The proposed theory of optimal currency area by Mundell (1961), cited in Khatat, Buessing-Loercks, and

Fleuriet (2020), indicates that the optimal choice of exchange rate regime should depend on factors such as the nature of shocks, real or nominal, and the degree of capital mobility. Hence, fixed or pegged exchange rate regimes do not align with the structure of LEMEs' financial systems due to currency crises, inflation, overvaluation, and significant external imbalances (Bubula & Ötker-Robe, 2003). However, the adoption of a flexible exchange rate and Taylor's (2000) inflation target (IT) cannot be considered suitable for achieving financial stability due to its simplicity and lack of factors necessary for macroeconomic stability in LEMEs (Bernanke, 2015 & Hofmann & Bogdanova, 2012). Therefore, this study introduced another measure of the inflation rate, the producers' price index (PPI), using different datasets and estimation methodologies to investigate whether the Taylor policy rule is credible in maintaining financial stability in LEMEs. Previous studies within this context were extended to gain full knowledge on whether exchange rates play a vital role in policy interest rate setting in LEMEs. The outcome of the analysis will help policymakers to understand the suitability of Taylor's IT framework in restructuring LEMEs' financial system.

### 1.4 Research Objectives

The main objective of this study is to empirically investigate the linkages between exchange rate dynamics, global integration, and monetary policy formulation in LEMEs. The areas covered are exchange rate volatility and international trade flows, real interest rate parity and nominal exchange rate regimes, monetary policy frameworks, real effective exchange rate volatility, and price stability in LEMEs. From the areas covered, this study seeks to achieve the following objectives:

1.) To comparatively investigate the effectiveness of disaggregated industrial-level trade data in explaining the impacts of exchange rate volatility on international trade flows in 10 LEMEs and their leading trade partner, the US.

2.) To examine whether RIRP holds within different nominal exchange rate regimes in 7 LEMEs using the interest rate of lead trade partner, the US, as the control variable. It will also be interesting to know how long it takes interest rates to adhere to the theoretical convergence framework in the long-run.

3.) To establish comparatively the credibility of the Taylor policy rule in maintaining price stability in LEMEs. This was achieved by incorporating a variable different from the proposed Taylor rule, using different datasets and estimation methodologies to measure the inflation gap. This study further determines whether exchange rate is vital in policy interest rate settings in these countries.

**1.5 Research Questions**

From the research objectives discussed above, the following questions were answered in this study:

1) How useful would disaggregated industrial-level trade data prove in explaining the influence of exchange rate volatility on international trade flows in LEMEs?

2) Do real interest rate parity (RIRP) conditions hold within different nominal exchange rate regimes in LEMEs with their leading trade partner, the US?

3) Is the Taylor policy rule credible for maintaining price stability in LEMEs?

### 1.6 Significance and Contribution of the Study

Understanding the impacts of exchange rate dynamics on global financial market integration and monetary policy formulation cannot be overemphasised. As LEMEs dominate global markets, which increases the rate of financial flows from trade in and out of the economies, an insight into appropriate means to manage increasing exchange rates volatility will benefit the economies and global markets.

Extensive studies have been conducted on the dynamics of exchange rates with international trade flows (Hall et al., 2010; Auboin & Ruta, 2011; Bahmani-Oskooee and Mitra, 2007 and Bahmani-Oskooee, Harvey, and Hegerty, 2014), exchange rate regime changes, RIRP (Ferreira & León-Ledesma, 2003; Dreger, 2010 and Altuntas, 2021), inflation targeting, and price stability (Hoffmann and Bogdanova, 2012 & Caporal et al. 2018). Despite several existing studies, further research is required to proffer lasting solutions to increasing exchange rate volatility in LEMEs.

The contributions of this study to existing literature are as follows. Firstly, to the best of my knowledge, this study represents the first attempt whereby similar industries were specifically considered across countries with similar categorisations and trade partner to investigate how exchange rate volatility impacts exports from LEMEs to their trade partner, the US and imports from the US to LEMEs. This study presents empirical findings on different industrial-level trading sectors for exports and imports in 10 LEMEs to provide insights into how exchange rate volatility impacts the industries studied.

It will also provide knowledge on LEMEs' monetary policy practices, especially with real effective exchange rate control when different measures of inflation rate are applied. Again, since risks associated with exchange rate volatility can negatively affect economic growth and trade flows, findings about the credibility of Taylor's rules will lay the foundation for balanced policy frameworks in the context of macroeconomics. This will help LEMEs to tackle the problems of vulnerability to external contagion shocks and improve the stability of their financial systems. By adopting suitable policies, LEMEs will have the capacity to reduce risks associated with weak financial systems and increase international trade flows. More so, understanding what triggers exchange rate volatility in LEMEs and relationships between the industries studied will help traders to make informed decisions on trading with the countries and offer insights into how policy changes affect different industries. It will also restore traders' confidence in avoiding risky deals while engaging in international trade, especially when unsure of the uncertainties associated with the domestic value of costs and revenue.

Moreover, with improvement in global capital markets and increase in the degree of capital flows, this study will aid countries in understanding the suitability and efficiency of nominal exchange rate regimes in fostering parity conditions in LEMEs against their foreign trade partner, the US. This will help to determine if RIRP validity can be maintained in LEMEs. When achieving RIRP validity becomes implausible, the half-life shocks would inspire policymakers to design balanced policy frameworks that cater to all aggregate macroeconomic variables. In addition, foreign investors who wish to invest, for example, in government bonds or treasury bills in LEMEs, will be able to understand how the policy rates and exchange rate system work and the exchange rate risks involved between long- and short-term maturity deposits. This includes knowing about compensation against risks, such as high-interest rates offered as risk premiums to compensate for risky assets.

Another critical gap this study fills is resolving the mixed conclusions regarding adopting monetary policy frameworks in LEMEs. Since available monetary policies to choose from were designed using the advanced economies' economic structures, which differ from LEMEs, adopting such policies will yield little or no improvement in LEMEs' financial systems. Findings from this study will inspire LEMEs to consider adopting unconventional monetary policies with balanced effects over aggregate macroeconomic variables that will harness the financial and economic needs of the countries.

Overall, this study provides LEMEs with effective means to manage their exchange rates, improve ailing financial and economic systems and enhance the countries' engagements in global markets. Policymakers in LEMEs will also benefit from this study as the countries undergo transformational periods.

## 1.7 Outline of the Study

This thesis comprises six chapters that establish and present this study's motivations, problems, and contributions.

The rest of the study is organised as follows: Chapter 2 reviews the theoretical and empirical literature guiding the three papers in this study. The shortcomings in the theoretical frameworks and empirical studies reviewed were also discussed, which offered insights into this study. Chapter 3 presents the empirical analysis of the relationship between exchange rate volatility and international trade flows using disaggregated industrial-level trade data from LEMEs and trade partner, the US. Chapter 4 examines the effects of exchange rate regime changes in validating real interest rate parity (RIRP) conditions in LEMEs. It also includes the estimation of half-life shocks to measure convergence speed in countries where there is absence of RIRP validity. Chapter 5 investigates the monetary policy response to real effective exchange rate volatility in LEMEs, while Chapter 6 concludes the study and presents policy implications, recommendations, and possible areas for further study.

# CHAPTER TWO

# Literature Review

## 2.1 Introduction

This chapter offers insights into the evolution, theories and empirical analysis of exchange rates, providing the background for subsequent chapters in this study. The literature reviewed reveals structural gaps between the theories and models of exchange rate and LEMEs, indicating that adopting the models into the economies with adjustments could yield positive results. Another finding from the literature is that with increasing uncertainties, high inflation rates and institutional imbalances in LEMEs attaining real interest rate parity in LEMEs is not plausible as contained in the asset market model approach. A similar condition applies to the theories of exchange rate determination since all the LEMEs understudy operates in a flexible regimen structure. Therefore, insights have been offered on the suitability of the theories and models of exchange rates in LEMEs through chapters three, four and five of this study. Sections 2.2 and 2.3 discuss the evolution and history of exchange rate regimes, while section 2.4 contains the exchange rate regime classification theories. The models of exchange rate determination were reviewed in section 3. Section 4 discusses the empirical literature on exchange rate volatility and LEMEs, followed by the chapter's conclusion.

## 2.2 Evolution and History of Exchange Rate Regimes

The section contains the evolution of exchange from the barter system and the history of exchange rate regimes adopted by different economies in the world when money was introduced. The section also discusses the various exchange rate regimes that economies have adopted.

### 2.2.1 The Evolution of Exchange

This subsection looks into the evolution of exchange and how countries came up with different means of exchange until the commodity money was created. It also discusses the other mediums of exchange used before money was introduced.

The evolution of exchange dates back to human existence when man wants to satisfy his needs for different commodities. This led to the introduction of a medium of exchange known as trade by barter which involves an exchange of goods for other goods. The barter economy relies on the double coincidence of unachievable wants, so with human interactions and movements, the barter system became problematic, including the need for a balance in the exchange mechanisms. Therefore, the need for a medium of exchange aside from the barter system grew. Bellis (2011) states that commodity money was created to solve the problems of exchange balance and double coincidence of wants.

From the barter system, other forms of exchange were used, for example, the proto money where various commodities like shells, grains, tobacco, rice, salts and ivory, among others, were used based on their level of acceptability, quality, divisibility and storage as a medium of exchange. Then, the Chinese came up with the idea of using cowry shells in 1200 BC, which changed to livestock from 9000 to 6000 BC. Later, bronze and copper cowry shells were introduced in 1000 BC, and metal tools were used till 500 BC when the first coin existed in China. However, the desire for higher production, distribution and trade efficiency in a monetised economy led to society's demand for money (Lewis & Mizen, 2000). The coins were generally accepted in Europe, Asia and Africa as a medium of exchange since they have attached value and can be easily compared to the cost of items. Not long though, coins' weight and uneasy movement led to the advent of leather currency in 118 BC in China, later recognised as paper money. By 806 AD, banknotes were in use in China, accepted as a medium of exchange from the 9$^{th}$ to 15$^{th}$ century, but circulation stopped in 1455 in China.

The European government printed paper money for economic purposes in the 16$^{th}$ century, and by 1661, the Swedish bank printed its currency (Tong, 2011 & Burange & Ranadive, 2011). The North American Indians used Potlatch from 1500 to exchange gifts and other rituals, which was later abolished in 1535, and wampum became the medium of exchange. Within the period, the gold standard existed in the U.K. but formally became the standard of value in 1816.

In conclusion, the use of money as a balanced medium of exchange for business transactions and other purposes by these economies proved at the time that monetised economy was more efficient than the barter system. It also has lower transactions, savings or investment costs than the barter system.

## 2.3 History of Exchange Rate Regimes

This section discusses the history of various exchange rate regimes that have been in use since money was introduced. The regimes discussed are the bimetallic, Gold classical standard, Gold exchange standard, Bretton Woods era, the Jamaican, Plaza, and Louvre exchange rate regimes.

### 2.3.1 The Bimetallic Exchange Rate System

The system was instituted in 1870 when the double standard, which consists of gold and silver, was legalised and used as a medium of exchange. The double standard was designed to accept gold and silver metals as the monetary standard for exchanging goods and services. However, deviations existed within the system in that while some countries adopted the gold standard, others used the silver standard. The U.S., for example, adopted the double standard in 1792 to minimise the confusion associated with different states using different currency notes from different banks as a medium of exchange. The U.K. followed in 1789 after the Napoleonic Wars. Later, the U.K. discontinued the use of silver but continued with gold, while France, on the other hand, adopted the double standard from 1789 until 1878.

History shows that in 1865, Switzerland, France, Belgium, and Italy came together as the Latin monetary union using the bimetallic system for international trade. For other countries using the double standard, it serves as a medium of payment in the international markets. Meanwhile, each metal's content determined the exchange rate in that period. This implies that the gold content of those countries determined the exchange rates between countries at the time. For example, the exchange rate between the pound sterling in the gold standard and the French Franc in the bimetallic standard were determined by the gold content of the two currencies. In the same way, Franc and German Marks in the silver standard were determined by the silver content of their currencies (Burange & Ranadive, 2011).

Although the system did not impose restrictions on the use of coins, exchange rates were fixed and differently determined in each country, creating the fear of a decrease in the circulation of the two metals. The end of the civil war from 1870-1871 increased the rate of political uncertainties among countries which affected the value of the bimetallic coins. Therefore, considering the demand and supply factors and the high cost of mining and handling bimetallic coins, the exchange rate regime was abolished in 1867 during the international monetary conference in Paris, and many countries opted for the gold standard.

### 2.3.2 The Gold Classical Standard

The use of the Gold classical standard commenced in 1870 after the end of the bimetallic system, and countries preferred using gold as a medium of exchange. It provided balanced access to international capital markets. It maintained gold convertibility, especially for core countries like Great Britain, Netherlands, Germany, British Dominions, the U.S., France and several other Western European countries. Though the U.K. government have been using the gold standard since the end of the Napoleonic Wars in 1816, the core countries joined the system and pegged their currencies to gold which is gold convertibility.

After a while, all the countries using the gold system adopted the mint parity, making them seem promising to foreign investors. The gold classical standard system used a balance of payment mechanism where exchange rates were determined by the intersection of demand and supply between gold points. To maintain stability, countries prevented their exchange rates from moving beyond the gold points through sales and purchases by member countries in the international markets (Bordo & Kydland, 1996). The modus operandi for the system was that the price at which countries could buy or sell any amount of gold was based on how they fixed the gold content of their currencies. This approach used by countries represents the monetary and fiscal policies in place at the time to guide the system, while commitments were based on each country's past performance. Furthermore, the willingness of core countries to abide by the rules of the game and join domestic policy goals to that of external constraints indicated the use of short-term policy flexibility to absorb transitory shocks.

Hume (1752) proposes a simple general equilibrium model known as the price-specie flow mechanism (PSFM) on international trade operations between countries during the gold standard regime. Hume's model assumes that a positive balance of payment due to lower prices and less circulation of money, which is gold, will increase capital inflows due to the relative competitiveness of the economy in the international market. The model also postulates that when economies fluctuate between the positive or negative balance of trade, there will be an automatic adjustment in the money supply equilibrium. Ghosh et al. (2002) express that the success of the gold standard system was possible only because economies discovered the benefits of global trade. Therefore, trade agreements and payment policies helped with the system combined with reduced cost of deflationary pressures from wage flexibility and lack of policy opposition.

Contrarily, Alper (2016) argues that exchange rates within the gold standard's three decades were stable, increasing trade expansions and financial linkages. This supports the views of Krugman (2000) and Rousseau and Sylla (2002) that the rules of the game surrounded the history of financial development, which included the creation and servicing of public debt by the Dutch and Britain in the 17th and 18th centuries, the discovery of the bank of England in 1694, developed the stock markets, banking systems and non-bank financial intermediaries. It also helped to achieve a balance of payment equilibrium among countries in the eighteenth and nineteenth centuries.

However, by 1914 some central banks of the core countries violated the rules of the gold classical standard by sterilising capital flows and part of the economies' deficit which was against the regulations. A combination of violation of the rules and the emergency of the first World War in 1914 led to the end of the gold classical standard system and free capital mobility. There were also shocks and imbalances caused by the demand from the electorate and organised labour to stabilise the business cycle but instead destabilised the system (Obstfeld & Taylor, 2002 & Wang, 2010).

### 2.3.4 The Gold Exchange Standard

The gold exchange system was adopted in the interwar period from World War 1 to 11 and the great depression of 1929. To better handle the effects of war and the great depression, the gold exchange standard was introduced at the Geneva Conference in 1922. As considered by most policymakers, this period was not favourable to countries, especially those that suffered from the war's financial effects and needed to pay for military and other war expenses. Countries agreed on the need for financial and economic stability and adopted the gold exchange system, which got reinstated as the gold exchange in 1925 after money minting was prohibited. According to Bordo (1993), the period was characterised by three different exchange rate regimes, general floating (1919-1925), gold exchange standard (1926-1931) and managed float (1932-1939).

Before the reintroduction, countries struggled with financing accrued expenses from war and participating in international trade that ended due to war and decreased international liquidity. Over the years, the increased money supply in these countries created further problems of increase in inflation rate and exchange rate volatility. The rivalry between core countries, Great Britain, Netherlands, Germany, British Dominions, the U.S., France and a small number of other Western European countries led to the division of the international monetary system into three. The units include the residual gold standard countries, the sterling area and the Central and Eastern European countries.

Despite the division into units, it did not help with the problem of instabilities. Smaller countries wishing to participate in international trade and finance had their reserves in the key currencies rather than gold and pegged to the core currencies (James et al., 2012). Other countries that followed the floating regime were not favoured and were affected due to the persistent instability. In the view of Nurkse (1944), adopting the floating exchange system during the interwar period was not the best idea for struggling economies. More so, considering that the system was characterised by gold and currency convertibles, converting the U.K. sterling into gold during the period was possible. However, it was associated with problems of tight monetary policy, overvaluation of sterling and the inability to maintain the pre-war parity among countries.

The combination of the challenges discussed above created adverse effects in the economies like bank crises, increased job losses and lack of economic control by member countries, which resulted in the great depression. Moreover, lack of cooperation among countries exacerbated the existing issues, led countries to protect their borders and apply the deflationary monetary policy to control the effects of high inflation. Meanwhile, a lack of confidence from some economies using the UK sterling led them to convert their portion of sterling to gold. On the other hand, currency conversion significantly reduced foreign trade in 1933 compared to the rate in 1929. This caused sterling devaluation in 1933 when the UK suspended sterling conversion into gold, ending the gold exchange standard era. With the end of the gold exchange system, countries departed from the international monetary system, adopted the independent monetary policy, and the need for inflation control resulted in using a flexible exchange regime; after that, the inflation targeting (IT) policy.

### 2.3.5 The Bretton Woods Exchange Rate Regime

The desire for a single international monetary system that could aid to minimise the effects of the first and second world Wars and the great depression brought about the Bretton Woods era. The regime also used the gold exchange standard, but with dollars as the intervention and principal reserve currency; the system was known as the gold-dollars standard and was maintained at a U.S. dollar price per ounce, $35 per ounce of gold. For maximum control of the system, two financial bodies were established, namely the International Monetary Fund (IMF), which began its operation in 1947 and the International Bank for Reconstruction and Development (IBRD), also known as the World Bank). The aims of creating these institutions were to have general rules that can guide international trade, promote trade among countries to improve real income and reduce unemployment, maintain financial unity among countries, promote exchange rate stability, establish a multilateral system of payments for current account transactions and lend financial help to countries in need (Hallwood & McDonald, 2000 cited in Alper, 2016). The monetary system also adopted measures to absorb the benefits of flexible exchange rates in the gold standard era and avoid the adverse effects of fixed exchange rates in the same era (Bordo & Eichengreen, 1998).

Though countries fixed their exchange rate to the U.S. dollar and the interactions of demand and supply determined the exchange rate, they can intervene in the foreign exchange market using their monetary tools to curb exchange rate fluctuations above and below the one per cent band. In line with the regulations of the system, member countries were mandated to keep gold and dollars as international reserves so they could revert to them in times of need (Burange & Ranadive, 2011). On the other hand, countries were allowed to sell dollars to the federal government for gold at the stated price.  For example, when countries face problems of disequilibrium in their balance of payment, they can borrow or use part of their reserve with the IMF to finance the deficit.

This was possible since countries have quotas based on their economic importance and the volume of international trade. In addition, countries were mandated to have 25 per cent of gold and 75 per cent of their respective currencies in reserve, determining their borrowing and voting power in the IMF. Again, change in per value, known as fundamental disequilibrium, which helped to improve the balance of payments position without an unnecessarily long process, was solely determined by the IMF (Salvatore, 2002). Furthermore, the era adopted the adjustable par values or fixed peg systems approach to allow flexibility and stability instead of the rigidities in the gold standard era. However, the objective of controlling the money supply by the IMF was affected by strict conditionality measures and the issues of quotas which restricted the availability of capital to some countries in need (James, 2004).

The unfavourable borrowing conditionalities made countries consider other available means, like the Eurocurrency markets, when their capital needs arise. As part of the Bretton Woods method of operations, converting currencies was necessary for multilateral trade between countries. Therefore, the General Agreement on Tariffs and Trade (GATT) was formed by countries involved to prevent trade restrictions due to the inability to convert currencies. To encourage smooth international transactions, the U.S. converted its dollar in 1945, Europe in 1958, and Japan in 1964. Within the process, only the current account in the balance of payment was convertible. However, countries can restrict capital flows to avoid the influence of excess money on economic stability.

### 2.3.6 IMF Method of Operation in the Bretton Woods System Burange and Ranadive (2011)

The primary mission of the IMF during the Bretton Woods era was to maintain stability and regulate the fixed exchange rate system. The reality in the international monetary system regulations regarding IMF operations was that not all countries were willing to abide by the stipulated rules of the organisation, either concerning their economic level or changing their par values. The prevalent problems at the time were compounded by the US refusal to devalue its currency to accommodate changes in the system which did not sit well with other major industrial countries.

The effects of non-compliance by member countries resulted in frequent reductions in capital flows which affected IMF's mandate to control the money supply and made it difficult for countries to access capital. As such, the general arrangement to borrow (GAB) was instituted in 1962 by the G-10 countries, which included: the US, UK, Germany, Japan, France, Sweden, Netherlands, Belgium, Canada, and Italy and was later joined by Switzerland to curb the problem of capital flow this was later followed by the special drawing rights (SDR) programme in 1969.

The Marshall Plan and increased short-term interest rate measures were further implemented to reduce the impacts of the balance of payment deficits, uncertainties and recession in the international monetary system. However, the Vietnam War marred the plans in 1965, the sterling devaluation in 1967, and the gold flight crisis in 1968. In response to the failed plans, the Nixon agreement was reached in 1971 to suspend direct convertibility of the US dollar to gold-de-Jure, increase the surcharge on imports with price and wage controls and close the gold exchange window. Although the agreement intended to unify common goals among member countries, increase capital flows and adjust the balance of payment disequilibrium, contrarily, the adjustable pegging in the face of improved capital mobility and lack of commitment to the convertibility rule led to the collapse of the system. In the views of Hallwood and McDonald (2000), the main conditions necessary for the operations of the Bretton Woods system lasted only from about 1959 to 1971.

### 2.3.7 The Smithsonian Agreement

The disagreement among member countries concerning the devaluing of the US dollar because it was recognised as an international currency and the revaluation of other currencies, increased the level of instabilities in economies. To this effect, an agreement was reached by G-10 countries at the Smithsonian Institute, Washing D.C, in 1971 for the following to be in place: the US dollar was devalued by nine per cent, and the price of gold moved from $35 to $38 per ounce, countries like Japan and Germany revalued their currency against the US dollar while the band was placed between 1 per cent to 2.25 per cent. Despite the agreement, current account disequilibrium in the US lasted from 1972 to 1973. Likewise, the speculative outflows of the dollar and floating of currencies by the US, France, Belgium, Germany, Italy, Luxembourg and the Netherlands, U.K, Japan, Italy, Canada and Switzerland did more harm than good to the international monetary system.

Williamson (1985) believed that high capital mobility within the system made countries vulnerable to speculative attacks when their par values look weak, making them accrue foreign debts with less ability to pursue the sustainable monetary policy. As a result of a lack of commitment, inconsistency in the international monetary system and increased monetary policy instabilities among countries, the Bretton Woods era collapsed in 1973. Bordo (2003) express that although the international monetary system was formulated to bring countries under one monetary policy and guide against financial instability, the Bretton Woods system lacked adequate policy measures to equip countries with the ability to utilise the balance of payments adjustment. On the other hand, Salvatore (2013) believes that lack of confidence, adjustment problems, and liquidity were the main contributors to Bretton Woods's failure.

### 2.3.8 The Jamaican Accord

The economic instabilities that led to the collapse of the Bretton Woods era advanced to other ripple effects, such as high inflation rates, oil prices, economic deficits, reduced trade relations and increased economic recession after the era. To tackle these issues, adjustable macroeconomic policies were implemented for countries to adopt suitable monetary policies to enhance the possibility of stabilising their economies. However, policy changes, including disagreements between power countries-US and France, overturned the adjustment process adopted to amend damages done by the regulations of the Bretton Woods era. Another debate on the best approach to achieve monetary stability and exchange rate regime was held in 1975 by six of the then largest industrial economies, namely the US, Japan, UK, Germany, France and Italy, at Rambouillet in France and the Jamaican agreement was concluded. Within the agreement, article IV of the IMF on exchange rate regime rules was amended to be based on stable but adjustable par values that will enable flexibility and provide room for changes (Bernstein, 1976).

Cooper (1976) specifies that each member country could adopt an independent exchange rate regime system and notify the IMF about their regime choice. In this instance, countries were required to be transparent in managing the process to avoid the problem of balance of payments disequilibrium. The amendment further specified that member countries could adopt par values in SDRs denomination, and G-10 countries could buy or sell gold. In contrast, the IMF can sell one-sixth of its gold holdings to benefit developing economies. Furthermore, as contained in the Jamaican agreement, credit tranches for the IMF were raised to 45 per cent, IMF quotas increased to 32.5 per cent, the share of industrialised countries was reduced to 68 from 73 per cent, organisation petroleum exporting countries (OPEC) member countries' quotas increased from 5 to 10 and borrowing quotas for member countries was increased by 45 per cent (Islam, 1976).

### 2.3.9 The Plaza Accord

Despite the measures stipulated in the Jamaican accord agreement to undo the damages of the Bretton Woods era, the US dollar continued to appreciate with the capital inflows and current account deficits rising alongside. This prompted debate by the G-5 countries- Japan, Germany, US, France and the U.K in 1985 on the need to devalue the US dollar in equivalence to other international currencies and the agreement was reached in 1986 when Canada and Italy joined the G-5 countries to form the G-7 countries (Levi, 2005). Towmey (2011) maintain that while the European countries have thrived and experienced huge current account increases due to cheap importation from the US during the period, Japan, with its own increased surplus, became the manager of the international monetary system. The effects of the corrective mechanisms lasted for a while before the US dollar depreciated further, leading to another meeting to initiate the Louvre accord.

### 2.3.10 The Louvre Accord

The Louvre accord was agreed on at the economic summit of G-7 countries in 1987. The aim was to bring stability into the exchange rate system, cooperation among member countries, stabilise the current exchange levels and adopt a single macroeconomic policy. In connection with the agreement, countries could either float, which comprises managed floating, where the government can use macroeconomic variables such as inflation and interest rates to control exchange rate volatility which should be between 2.5 per cent to 5 per cent margin. On another side, policymakers who see government intervention as unnecessary may opt not to intervene in the floating system.

### 2.4 Exchange Rate Regime

This section explains different exchange rate regimes countries have adopted since the end of the Bretton Woods era when countries were allowed to operate independent monetary policies. The regimes discussed are the pegged/fixed, flexible and intermediate exchange rate regimes.

#### 2.4.1 Exchange Rate Classifications

The initial IMF classification of exchange rate regimes from 1975 to 1998 was based on the de-jure notification of its members on the chosen policy regime by the IMF. However, since the collapse of the Bretton Woods system in 1973 and the aftermath of the 1997 and 1998 currency crises, the call has increased for emerging markets to adopt an exchange rate regime that suits their economies (Daniels et al., 2001). The measure was required for emerging markets to become stable and market-driven and to increase the global markets' stability. The choice of exchange rate debate was on enhancing the adequate performance of emerging economies in the international markets. Frankel (1999) argues that choosing an exchange rate regime for any economy has to be per the country's specific economic circumstances and the period involved. The author further claims that no single exchange rate regime is always suitable for all countries.

It is worth noting, however, that the wrong choice of exchange rate regime could negatively affect other macroeconomic factors in an economy. It can increase the damaging effects of exogenous and internal shocks and make them vulnerable to financial crises. On the contrary, Stockman (1999) suggests that the exchange rate system is unnecessary because the path to a nominal money supply is irrelevant, and different exchange rate systems correspond to different economic paths. Gosh, et al. (2002) support Stockman's view that little evidence supports the conclusion about the substantive consequences of exchange rate regimes on economies. Initially, the pegged or flexible exchange rate regime was the only available exchange rate system for countries to determine the exchange rate between one country's currency and another. As economies continue to transition and integrate into the global financial markets, the need for or against government intervention and economic and policy mismatches in the global economies led to the introduction of other intermediate exchange rate regimes to support existing monetary policies in economies. The following sections discuss different exchange rate regimes that have been in use among countries since the inception of independent monetary policy.

### 2.4.2 The Pegged Exchange Rate Regime

Pegged or fixed exchange rate refers to an exchange rates arrangement where the national monetary authority fixed its currency value against the value of another currency, a basket of other currencies or another measure of value such as gold (Melvin, 1985). The mechanism allows countries to adopt exchange rate management with a band and zero bounds and have long intervals between realignment periods. Considering the type of monetary system in place during the gold exchange standard and the Bretton Woods era, the fixed exchange rate regime was mainly used then. However, it operates by adjusting the domestic price level to bring the real exchange rate into line. The implication for adopting the pegged arrangements is that countries in this category use fiscal policy instead of monetary policy to adjust macroeconomic fundamentals, which align with international capital mobility with all-time fixed in the pegged system.

The fixed exchange rate regime can work in several ways, such as the currency boards, conventional fixed peg arrangements or no separate legal tender with limited flexibility. Heller (1978) characterises countries with the pegged system as small, open to international trade and adopting harmonious inflation rates relative to the rest of the world, including their dominant trade partners in international trade.

More so, Flood (1979) and Aizenman (1983) conclude that countries that minimise domestic prices and money shocks prefer the fixed exchange rate regime. Understandably, countries adopt the pegged regime system mostly to gain profitably from international trade and maintain stability in their exchange rate. However, there could be damaging consequences in the face of financial crises. For instance, some policymakers consider fixed exchange rate regimes as plausible and practical for high credibility and incentive for foreign borrowing. It also accumulates low interest on loans which favours inflation reducing process though not without the risk of excess credit, more significant external imbalances and output fall (Arratibel et al., 2011). Evidence from the global financial crises shows that countries with pegged systems were worst hit than those who received fewer capital flows and fewer imbalances.

Another challenge is the need for adequate and appropriate monetary policy, especially in emerging market economies, that can go well with the pegged regime for government to achieve its monetary targets and favourable exchange rate stability. Findings from Eichengreen and Leblang (2003) indicate that it will benefit sensitive economies prone to exchange rate risks to peg their currencies to their large trading partners to increase the gain from trade and welfare. In support of the views above, Jakob (2016) adds that pegged regime has the benefits of stabilising and predicting the business climate for investments and trade between two currencies when there is no fluctuation as stipulated in market conditions. In as much as some literature has credited the pegged exchange rate regime, Thirlwall (2003) and Frankel (2019) argue that the regime might not allow the government to conduct independent monetary policy and simultaneously liberate the capital market. Nevertheless, the opposite can be possible if capital controls or other impediments are used to break the link between domestic and foreign interest rates.

Furthermore, assumptions of the macroeconomic model from the neoclassical theory suggest that the exchange rate regime is irrelevant in considering parts of the general property of nominal variables for the real economy. In analysing the purchasing power parity theory, Stockman (1999) mentions the popular Balassa-Samuelson effect, where changes in relative prices of non-traded goods cause changes in real exchange rates that only applies to countries at different levels of their development. In effect, Gagnon and Hinterschweiger (2011) recommend that the remedy for risks associated with pegged exchange rate regime should include countercyclical fiscal policy like unemployment benefits and a progressive tax system that increases spending and reduce revenues as an automatic stabiliser to enhance the economy when output slows.

Summarily, despite some negativities associated with the pegged or fixed exchange rate regime, the regime has some advantages. The positive aspects include facilitating international trade and investments, protecting countries from competitive depreciation, providing a nominal monetary policy anchor, and avoiding speculative crises (Frankel, 2011). Hence, the pegged exchange rate regime might yield positive results when combined with available macroeconomic policies and improve economic sustainability depending on the structure of the given economy; otherwise, it could dampen a country’s economic future.

### 2.4.3 Flexible Exchange Rate Regime

Countries that adopt the flexible exchange rate system allow the forces of demand and supply in a private market owned by international banks to determine the value of their currencies in exchange for another. Currencies in the flexible regime have bands with infinite bounds. Melvin (1985) characterise countries that adopt the regime as significant, with divergent inflation rates and diversified pattern of trade. The difference between the pegged and flexible regimes is that the central bank needs to act periodically under the pegged regime. In contrast, in the flexible system, the central bank has no control but allows private transactions to determine the exchange rate.

Flexibility in exchange rates works well with low inflation and hyperinflation, which requires countries to have an inflation band. Therefore, for countries to maintain the inflation band, central banks intervene using the monetary policy as a stabilising tool to control the movements of foreign exchange rates and maintain price stability, unlike the pegged system where the fiscal policy applies. So, flexibility in this regard grants countries monetary policy autonomy.

Nonetheless, countries in this category are susceptible to high exchange rate volatility, but with effective monetary policy, they can stabilise economic output and inflation. Although debates have been presented against the interactions of macroeconomic policy and exchange rates, likewise the importance of foreign exchange rate as an object in monetary policy, the degree of macroeconomic interactions varies across countries and their level of openness, bearing in mind that some countries are yet to balance this relationship evenly. On the other hand, since most emerging market economies with flexible exchange rate regimes do not have the appropriate monetary policy to support their system, adopting the regime will be detrimental to their economic stability.

Gagnon and Hinterschweiger (2011) suggest that developing economies using a flexible approach should prioritise stabilising inflation and economic output instead of designing monetary policy to stabilise exchange rates only. This approach should apply even when the two targets are conflicting. The authors submit that the standard model of exchange rates might not explain the behaviour of exchange rates in a floating regime due to the systemic errors in market expectations of future exchange rates and the absence of risk premium. Frankel (2011) lists the system's benefits as having an independent monetary policy, automatic adjustment to trade shocks through the demand and supply factors, retaining lender-of-last-resort capability and avoiding speculative attacks. Furthermore, Eichengreen and Hausmann (1999) agree that flexibility in the exchange rate system would be beneficial to discourage unhedged borrowing in foreign currency. Coricelli (2002) and Coricelli et al. (2006) argue that flexible regimes might not protect countries from the ripple effects of speculative shocks as predicted by the conventional theorist.

Using a panel data analysis for industrialised and emerging market economies joined with the classification scheme of Levy-Yeyati and Sturznegger (LYS), Levy-Yeyati, Stuzneggar, and Regio (2002) conclude that industrial economies can choose a regime through the optimal currency area (OCA). However, the balance sheet effects, and capital account can determine the choice for emerging economies. Juhn and Mauro (2002) also employed a similar technique by LYS, but their findings reveal that only a robust empirical regularity can explain exchange rate regime choices.

There was also a surprising argument by Ghosh et al. (2002) that there is no difference between pegged and floating exchange rate regimes which tested positive through regressing inflation on exchange rate regime dummies. The findings reveal no significant differences between the regimes for real per capita growth. All in all, despite the problem of instabilities associated with the flexible exchange rate regime, a credible inflation-targeting policy can bring economies to equilibrium.

### 2.4.4 The Intermediate Exchange Rate Regime

As economies in the world evolve toward flexible exchange rate regimes, adopting intermediate regimes also become essential for every economy, especially with increased financial crises globally. The regimes which became popular in the 80s lie at various points along the scale between fixed and floating exchange rates and involve target zones and bands. Williamson (2000) states that Keynes classical view laid the foundation for making exchange rate regimes intermediate between fixed exchange rate and floating exchange rate. The idea behind the regime is for countries willing to revert to prewar parity to adopt a crawling peg band of $\pm$ 5 per cent around a parity that was appropriate to their current price level, which some attribute the idea as a way of maintaining the Bretton Woods spirit.

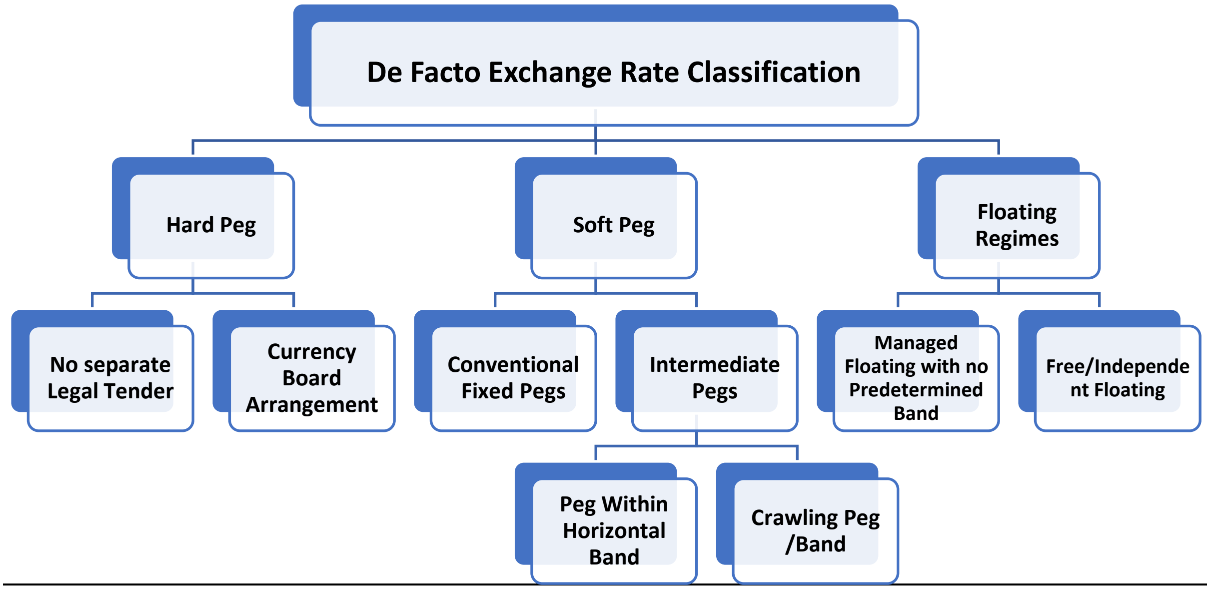



**Figure 2.1: De facto exchange rate regimes classifications**.
***Source:*** Author's compilation with insights from Bordo (2003) and Frankel (2011).

Several emerging economies adopted the regimes in the 90s, making them vulnerable to financial crises. As a result, Eichegreen (1993) proposes the corner hypothesis with the view that intermediate regimes are no longer viable in a world of high capital mobility. According to Frankel (2011), exchange rate regimes from the most flexible to the least can be grouped into three major categories: hard peg, soft peg, and floating regime. Each has sub-categories, as contained in Figure 2.1. Frankel (2019) acknowledged that intermediate regimes allow an intermediate degree of monetary independence in return for an intermediate degree of exchange rate flexibility. Ghosh and Ostry (2009) believe that countries achieve the best results with intermediate regimes, especially those that maintain rigid exchange rates but do not formally peg to anchor currency.

The authors argue that since pegged regimes are susceptible to exchange rate overvaluation, which hurts international competitiveness and growth performance, floating regimes increase volatility and inflation and reduce trade integration. Unlike the downsides of peg or floating regimes, intermediate regimes maintain a balance between the two and can be associated with faster per capita output growth. However, there are some shortcomings in the regimes ranging from increased susceptibility to currency and financial crises, for example, debt crises, decrease in capital flows or crises in financial institutions usually related to emerging market economies with open capital accounts (Ghosh & Ostry, 2009). There is also the notion that intermediate regimes delay timely external adjustment, which can affect the stability of the overall international monetary system.

Considering the discussions presented above regarding pegged, flexible or intermediate exchange rate regimes, there is no one size fits for a country when it comes to adopting a regime system. This is because circumstances among countries differ, likewise the level of financial maturity and development of technological and institutional structures that grant countries the ability to implement the selected regime. Although propositions of exchange rate regimes may look obvious, the application may be challenging. Therefore, economies must understand their macroeconomic and monetary structures and conduct the appropriate costs and benefits analysis using country-specific circumstances before adopting a suitable exchange rate regime. The main point, however, is that no matter the chosen exchange rate regime, which can be pegged, fixed, float or intermediate, increasing exchange rate volatility and shocks are bound to affect the economies if adequate care is not applied.

## 2.5 Models of Exchange Rate Determination

This section discusses the theoretical models of exchange rate determination proposed by classical theorists. This covers the views of the proponents and how the macroeconomic functions in countries could contribute to how the exchange rate is determined. The models discussed are the asset market model approach which comprises the monetary approach and the portfolio balance approach to exchange rate determination.

### 2.5.1 Asset Market Models' Approach

Dornbusch (1980) proposed the traditional flow model of exchange rate determination on the basis that exchange rates adjust to balance a country's demand for foreign currency with the supply of foreign exchange (Ogawa, 1987 & Jarrow, 2018). The theorists of these models assume that the demand for foreign exchange is a function of the domestic country's demand for foreign goods and assets. Likewise, the foreign country's demand for domestic goods and assets determines the supply of foreign exchange. In other words, the rate of domestic currencies is determined by the relative price of foreign currencies at the foreign exchange markets, usually through the exportation and importation of goods and services. Hence, the demand and supply of foreign exchange are determined in the goods markets. The ideology behind the model is that an increased interest rate is the primary determinant of an increase in asset demand unless there are unexpected changes in income or disparities in real interest rate differentials among countries (Frankel, 1983; Mussa, 1984 & Ogawa, 1987).

Adopting the flexible exchange rate regime after the Bretton Woods era exposed economies to increase exchange rate volatility shocks. Therefore, various exchange rate determination theories were formulated to curb the surge in exchange rate volatility in line with the economic factors that can trigger it. This necessitated creation of an alternative model in place of the traditional flows model. So, as an alternative to the views of the traditional flows model, the asset market models approach by Dornbusch (1976), Frankel (1976), Kouri (1976) and Mussa (1976) was adopted as the determinant for the exchange rate. The approach includes other models of exchange rate determination like the monetary approach (flexible and sticky-price model) and the portfolio balance approach were developed.

This follows the reduced form analysis of the balance of payments equilibrium using a two-country setting in international trade. The idea behind the assets market models approaches, according to Levich (1983), is that exchange rates can be determined based on existing similarities between the behaviour of exchange rates and the prices of other assets traded in organised markets. This implies that the purchasing power parity (PPP) always holds if goods prices are flexible. Conversely, when the prices of the goods are sticky, the PPP holds only in the long-run (Dornbusch, 1976 & Frankel, 1976). However, Kouri (1976) expresses that the disequilibrium in market fundamentals or price models might increase due to global wealth's current and expected future distribution.

In effect, the assets market model is centred on the relationship between the spot exchange rate and forward exchange rate, whereby when expected exchange rates are small, significant changes in the exchange rate can result from unexpected factors of the change in the exchange rate system. Therefore, if unexpected factors of change in exchange rates are a function of the weighted average of changes in expectations about all future variables, other significant unexpected changes in exchange rates should occur in similar directions. The assets market model of exchange rate determination explains the rationale behind the combination of various components that affect floating exchange rates in the present and future. The downside of the model is that it does not include the underlying advantages of asset market equilibrium conditions; instead, it adopts the flows in market equilibrium conditions when examining the determinants of exchange rates.

Other components of the assets market approach, the monetary approach and the portfolio balance approach, which have several individual models, were discussed in subsequent sections below.

### 2.5.2 The Monetary Model of Exchange Rate Determination

The monetary model of exchange rate determination by Dornbusch (1976), Frankel (1976), Johnsons (1976) and Bilson (1978) was derived from the asset market model approach. The central assumption of the monetary model is that perfect capital mobility determines the exchange rate through shifts in the demand and the supply of money. Considering that domestic and foreign interest earnings on assets are assumed to be perfect substitutes, asset holders in different countries are indifferent hence the argument that the effects of wealth are not the primary determinant of the exchange rate (Murphy & van Duyne, 1980). As part of the classical monetary model, purchasing power parity (PPP) explains the link between national price levels and nominal exchange rates. This follows the approach of domestic and foreign demand for money functions where income and domestic interest rates determine a country's demand for money (Hoffman & Schlagenhauf, 1985 & Yong & Ling, 1995). On the other hand, Devereux (1997) established that PPP reflects the price of a basket of goods which should be equated across countries when evaluated in a common currency.

Within the monetary model, three other individual models were used to analyse its assumptions. They include the Dornbusch (1976) model that presumes the slow movement in the speed of adjustment of the goods market when compared with the asset market, where prices of goods are fixed in the short-run. Then, the Bilson (1978; 1979) and Frankel (1976) approaches which relate to Dornbusch's (1976) flexible price assumption that associates the purchasing power parity in the long-run and lastly, the combination of the assumptions of Dornbusch and Bilson's models represented in Frankel (1979) model. Considering that countries' demand for money is a function of domestic income and nominal interest rate together with the assumptions of PPP, the uncovered interest rate parity will yield to the spot exchange the relative supply of money, relative income and differences in the expected inflation rate.

In essence, within the monetary model approach, the current exchange rate is expressed as the function of the current stocks of domestic and foreign money, current determinants for the currencies involved then the domestic and foreign interest rates. This includes the price of foreign money in terms of domestic money, the domestic money supply and the demand for domestic money. The monetary model of exchange rate determination concentrates on various factors affecting the demand for money and the impacts of the current exchange rate on the expected future money supplies. Mussa (1984) regards the model as a reduced-form equilibrium condition derived from the goods and asset market equilibrium model.

Nonetheless, Hoffman & Schlagenhauf (1985) believe that an unanticipated increase in domestic nominal money supply relative to foreign money supply will lead to an increase in domestic prices relative to foreign prices. However, an increase in domestic income level will increase the demand for domestic currency leading to unanticipated exchange rate appreciation. In contrast, an increase in the domestic expected inflation rate relative to equivalent foreign variables will decrease the demand for money and unexpected depreciation.

Following this approach, Dornbusch (1976) and Frankel (1979) modified the monetary model by replacing the flexible price model assumptions with the sticky price assumptions where the principles of PPP can apply in the short-run. This lies within the view that the assumptions of flexible price to PPP cannot fit in properly in the short-run model. The result of the modified model is manifested in the exchange rate going beyond the normal rates. It also affects the sticky prices during monetary expansion by assuming that the adjustment speed of asset prices is higher than that of the prices of goods.

In addition, the growth of the current account in the monetary model approach affects the exchange rate without returning to the traditional flows model. Given the crucial roles of the monetary model in determining exchange rates, as discussed above, some studies by Mussa (1984) also pointed out model deficiencies. For instance, there tend to be differences between the PPP assumptions and the determinants of the behaviour of real or nominal exchange rates unless the shifts in the demand to hold different foreign currencies are considered, which might be challenging to analyse using money demand functions.

Furthermore, there needs to be a detailed explanation of the effects of expectations for future economic conditions in determining the current exchange rate. So, as MacDonald and Taylor (1994) suggest, the monetary model of exchange rate determination could have performed better for estimation and out-of-sample forecasts.

### 2.5.3 Portfolio Balance Model of Exchange Rate Determination

This model of exchange rate determination by Kouri (1976), Rodriguez (1980), Branson (1976), and Dooley and Isard (1982) assumes that foreign and domestic bonds are imperfect substitutes. The assumption is that asset holders prefer the duly identified functions of expected rates of return to allocate their portfolio shares. In line with the ideology of the model, which focuses on exchange risks, Ogawa (1987) maintains that investors balance their bonds in sizes dependent on the expected relative rates of return on risk premia. This happens when the need arises to diversify exchange rate variability risks if domestic and foreign bonds differ in currency denomination. Another aspect of the author’s view lies in the assumption that all active market participants have similar portfolio preferences.

Therefore, the stock of domestic and foreign bonds should be considered essential to determine the exchange rate in the portfolio balance approach. Theoretically, Frankel’s (1983) findings challenged the assumptions with the view that the supply of a country's bonds accessible to the private sector should be a function of government debt, collective sale of the country's foreign-denominated assets in foreign exchange intervention, the country's assets reserved in other central banks and its monetary base. Since the flows of foreign assets are reflected in the current account, the availability of foreign bonds to a country using the flexible exchange regime can be a result of the combination of its current account position with sales by other central banks of foreign assets for its currency minus the country's central bank purchase of foreign assets in foreign exchange intervention.

In essence, fiscal deficits serve as a necessary factor that dictates the supply of bonds in a country. In contrast, the current account shows the feasible changes in the availability of foreign bonds supplied to a country. This further addresses Dornbusch's (1980) argument that when individuals in all countries have similar preferences for identical assets, exchange rates can only be determined by government bond supplies. However, assuming the only investors interested in holding domestic-denominated assets within a country are its residents, domestic government bonds and foreign bonds will supply important stock variables to domestic individuals (Branson et al., 1977; Kouri, 1976 & Rodriguez, 1980). The central idea from different views relating to the portfolio balance model is that bonds denominated in foreign currencies should be treated as different assets.

In conclusion, various studies have argued the efficacy of applying the traditional flows model in determining exchange rates in flexible exchange rate regimes and conclude that associated models do not provide adequate insights into the observed movement in nominal and real exchange rates. The findings from MacDonald and Taylor (1994) establish that the advocate for using PPP and payment flows implies that exchange rates adjust immediately or gradually to maintain the balance of payments equilibrium. Likewise, the monetary model that relates exchange rate movements to differential rates of monetary expansion is naive. The author further states that the models could have performed better in explaining the bulk of exchange rate movements besides the ones that have to do with highly inflationary countries.

Extended debate on the effectiveness of traditional models detailed the conception of exchange rate variables as asset prices. Notably, exchange rate characteristics range from common stocks, long-term bonds, metals and agricultural commodities, which depict the behaviour of the prices of assets traded in organised exchanges. Given the characteristics above, changes in the monthly prices of the assets, for example, changes in exchange rates, are random and unpredictable. Therefore, the assumption that a strong correlation exists between changes in spot prices and contemporaneous changes in future prices for assets with quoted spot and future prices is unfounded. This is considering the presumption that monthly changes in the prices of assets in organised markets are not closely correlated with monthly changes in the general price level as estimated by the consumer price index (CPI), indicating that nominal price changes are also real price changes (Mussa, 1979).

Although the traditional model introduced the debate to varying determinants of exchange rates in the long-run, its reliance on macroeconomic fundamentals, which fall short of out-of-sample forecasts, has made the model implausible. Against these backgrounds, the financial liberation after the Bretton Woods era joined with the global market integration, has necessitated the need to understand the link between the models of exchange rate determination and exchange rate dynamics in large emerging market economies, which will be explored in this study's subsequent chapters.

## 2.6 Exchange Rates Volatility in Large Emerging Market Economies (LEMEs)

This section contains the empirical literature on the effects of the dynamic exchange rate on LEMEs. There are also discussions on the relationship between the theories of exchange rate determination, models of exchange rate and the monetary policy frameworks designed in LEMEs. The conclusion of the chapter is also in this section.

### 2.6.1 Empirical Literature on Exchange Rate Volatility in LEMEs

Since adopting floating regimes worldwide after Bretton Wood’s system, increasing financial crises have impacted economies negatively. These crises over the years include the US subprime crisis in 2007, the global financial crisis in 2008, the Great Recession of 2008 through 2012, and Europe’s 2010 debt crisis, among other trade and political tensions. It has also resulted in the inability of economies to prevent macroeconomic build-up and fiscal imbalances, which have affected financial markets and have continued to place undue pressure on global economies. The issue of exchange rate volatility and LEMEs has been ongoing for decades. This is because exchange rate volatility has had significant negative impacts on the economies, likewise, their ability to integrate with the global markets. Over the years, attributes have been made (Katusiime et al., 2016) on how weak financial structures, poor economic policies, and other systemic imbalances in LEMEs contribute to increasing exchange rate volatility in the economies.

As such, discussions have continued on developing effective policies to curb the monetary and macroeconomic instabilities and institutional shocks and alleviate external shocks that could increase exchange rate volatility in LEMEs. This is important for LEMEs considering the adverse shock effects transferred from financial crises to domestic economies and exchange rates and the interconnectedness between exchange rates and international trade flows. The mechanism behind the relationship can be viewed from the Dornbusch and Fisher (1980) flows model, which affirms that exchange rate volatility can impact international competitiveness and the balance of trade position. It can also result in other ripple effects from the real domestic output in an economy to the current and future cash flow of companies, including stock prices and exchange rates (Tang &Yao, 2018).

As LEMEs integrate into the global market for economic development and financial sustainability, export-oriented strategies and import substitution strategies are part of the instruments used by these economies to achieve economic development and sustainability (Cheng & Tang, 1987, Bhamani-Oskooee, Harvey & Hegerty, 2014; Bahmani-Oskooee et al., 2020). The export-oriented strategies promote economic development through improved export-oriented industrial sectors and expansion of foreign trade. On the other hand, the import substitution strategy selects domestic products to replace imported goods by promoting restrictions on imports of foreign industrial products, improving domestic industrialisation.

In recent times, empirical studies (Hall et al., 2010; Chit et al., 2010; Musila & Al-Zyoud, 2012 & Senadza & Diaba, 2018) on exchange rate volatility, financial institutions and international businesses have shifted from the advanced economies (AEs) to LEMEs due to their improved economic performance, output growth and financial integration into the global markets. This follows the latest trend in globalisation, where LEMEs integrate increasingly through financial and economic dealings with the rest of the world and have attracted more foreign investments, and capital flows into their economies. Manzombi (2015) acknowledges increasing evidence of global integration accompanied by increasing international trade flows, more foreign direct investments and trade relationships among AEs and LEMEs.

Although foreign investments undoubtedly benefit LEMEs, the economies' vulnerability to the financial crisis due to weak domestic financial institutions and lack of credibility makes them vulnerable to external shocks (Khan et al., 2014 & Katusiime, 2018). This also increases exchange rate volatility and may affect investors' confidence in engaging with the economies. Higher exchange rates create uncertainties about profit to be made and increase costs for risk-averse traders, which can affect foreign trade since agreed rates during trade contracts might have changed before the payment period due to delays in delivery and other circumstances (Arize et al., 2000). The effects of exchange rate volatility can be felt through financial institutions, remittances, and international trade engagements or balance of trade by LEMEs.

Sgammini (2016) argue that one of the significant issues facing foreign investors in LEMEs is determining the causes of exchange rate volatility over time and the frequency-varying properties. However, studies (Arunachalaramanan and Goliat, 2011, Khosa, Botha and Pretorious, 2015; Odili, 2015 and Latief and Lefen, 2018) that seek to address these issues are inconclusive in that studies have not been related to the structure of LEMEs, especially with the systemic imbalances that exist in the economies which require careful observations using related macroeconomic fundamentals.

Aghion, Bacchetta and Banerjee (2004) establish that financial systems in intermediate phases of development could result in economic instability in capital account liberalisation. This is so, considering that fluctuations in the global market, financial crises and other macroeconomic uncertainties associated with financial undertakings might be more difficult for LEMEs to handle when their financial systems are not adequately developed, joined with the flexible regime adopted after the Bretton Woods era. Frankel (1999) casts doubt on the notion that a single exchange rates regime can be deemed fit for all countries but promote that it is the quality of financial development in a country that determines the appropriate exchange rates system to be adopted (Aghion et al., 2009 & Bristy, 2014).

Related thoughts by Aghion and Banerjee (2005) support the previous views but add that when the financial system is weak, changes in financial relations and capital flows can intensify domestic and economic fluctuations and heighten the risks of crises. In agreement, Keefe (2015) affirms that with increased financial openness, solid domestic financial institutions will ensure that huge capital inflows and emerging economies' integration into the global markets will not adversely affect the domestic economies, such as exacerbating boom-bust cycles. Kose, Prasad and Taylor (2009) also find that strong institutional quality forms the main bases for countries to withstand financial shocks and wedge against economic instabilities.

As already discussed, increasing exchange rate volatility is prevalent mainly in LEMEs due to weak financial institutions, uncertainties, constant exposure to risks, and structural and external shocks, which increases the fragility of LEMEs' exchange rates to the global financial settings. Consequently, the lack of diversified financial instruments in LEMEs only worsens the level of these shocks in the economies. It also increases the level of frequency in their exchange rate volatility. This was reflected in the aftermath of the global financial crisis that affected the financial stability of both the AEs and LEMEs in 2008. To correct the adverse effects of the global financial crisis, the governments of AEs used the expansionary monetary policy where interest rates were reduced to revive the economies.

This led to large flocks of investments from AEs to LEMEs through quantitative easing in LEMEs' secondary market. The approach allows capital inflows such as foreign portfolio equity investments, bank loans and foreign direct investments. However, the monetary policy instruments available in LEMEs were too weak to catch up and absorb the rate of capital inflows. Considering that larger and highly liquid financial markets available in AEs can allow for more diversification of dealers, products and market activities, unlike in LEMEs where economic shocks can trigger capital flights damaging and disruptive to the struggling economies. Capital flight, in this case, can be possible since quantitative investments are in secondary markets and not long-term projects, so investors can quickly sell their shares and bonds.

The limitation of financial development in LEMEs was captured by Fernandez et al. (201), who express that emerging market economies have smaller financial markets, with fewer diversified instruments and intermediaries and their currencies are generally not accepted as a means of payment, collateral for international trade, international lending or borrowing. Furthermore, Bristy (2014) submit that poor financial development adversely affects exchange rates, discouraging innovations and reducing economic growth. A similar panel study by Bist (2018) on 16 African and non-African countries shows a long-run cointegration relationship between financial development and economic growth. However, poor capital accumulation due to weak financial development deters economic growth in the economies studied. Meanwhile, a related panel study by Guru and Yadav (2019) which involves Brazil, Russia, India, China and South Africa (BRICS) economies, confirms a positive relationship between financial development, exchange rates and economic growth.

As LEMEs continue to grow towards economic sustainability, international trade and financial integration link LEMEs and other global economies. A recent proposition is that LEMEs have been situated as the centre for increased global growth and trade in the foreseeable future for better global integration and international trade. Similarly, Kose et al. (2011) argued that trade integration is essential in deterring financial openness crises and could help reduce the associated costs. Though sometimes, a country's access to the global markets could be related to its ability to repay debts, a well-developed financial institution plays a vital role in this instance as a country's exchange rates system. Exchange rate volatility can negatively impact economies in different ways, like decreasing the volume of trade, reduction of profits and the level of investment (Jorge & Habermeier, 2004). As noted by Arize, Osang and Slottje (2000), higher exchange rates create uncertainties about profit to be made and increase costs for risk-averse traders, which can affect foreign trade since rates agreed on at the end of the trade contract could have changed before payment because future delivery takes time.

Due to the underdeveloped nature of LEMEs, exchange rate volatility can hurt exports and imports since nominal depreciation can alter the real exchange rates, directly impacting a country’s trade balance. International trade theorists have maintained that real domestic currency depreciation increases importation costs and reduces exports, improving the trade balance (Arize et al., 2017). Conversely, the authors submit that improvement in a country’s trade balance might not be immediate, considering that previous purchase orders might have been agreed upon in some cases. Still, price changes can be effective in some cases. A Pioneer study by De Grauwe (1988) on whether volatility in the exchange rates system can affect international trade concludes that there is a negative relationship between exchange rates volatility and international trade and related findings from Grier and Smallwood (2013), Khosa et al. (2015) and Sgammini (2016) also conforms to a similar conclusion. Furthermore, results from Hayakawa and Kimura (2017) conclude that exchange rate volatility impacts trade negatively in East Asia, especially with intermediate goods susceptible to exchange rate volatility.

Contrary to previous conclusions, Klein and Shambaugh (2006), Teneyro, (2007) and Qureshi and Tsangarides (2010) express the view that the direction of causality between exchange rates and international trade could result from credibility underlining long-term monetary policies adopted by countries which has nothing to do with the short-term variables. While Broda and Romalis (2010) suggest that since continuous trade flows help to stabilise exchange rate fluctuations, the impact of exchange rate volatility on foreign trade can be attributed to reverse causality. Meanwhile, other associated risks, for example, the sunk cost in exportation, which implies that the higher the fixed cost of exports, the less responsive international trade can be to exchange rate volatility, have proven that it might be impossible for constant causality to run from exchange rate volatility to international trade (Krugman, 1989 and Franke, 1991 cited in Nicita. 2013). Although trade helps mitigate currency mismatch issues in crisis-prone economies, foreign investment flows. International trade reacts to domestic and global economic conditions that can affect business profits and investment returns, such as changes in global interest rates, monetary policy changes, trade tensions between China and the US, and political or institutional risk factors associated with developing economies (Keefe, 2015).

The exact mechanism of impact also applies to remittances which is another part of LEMEs' financial link with the global economy, and it can be through payment for trade transactions or other forms of capital flows into the economies. Analysts predict that the inflows of currencies through remittances yield faster improved economic conditions as a significant source of financial growth compared to foreign direct investments or portfolio investment flows (Keefe, 2015). In a similar light, studies by Stark and Taylor (1989) and Adams and Page (2005) highlight the importance of foreign remittances and propose that a 10 per cent increase in foreign currency inflows into developing countries will improve the lives of a substantial number of individuals receiving the inflows by bridging inequality gap, reducing poverty and improve economic growth. Likewise, remittances can be in the form of swift payment for international trade, especially with the recent innovations in financial technology.

However, partial or fully dollarised economies relying on foreign or local currency might attribute exchange rate reactions to changes in foreign currency inflows. Considering the fragile nature of LEMEs' financial institutions, dollarisation can make the countries susceptible to fluctuations in foreign currency inflows, thereby increasing exchange rates volatility and inflation rates and suffering the risks of currency mismatch. Therefore, high dollarisation levels increase the cost of remittances inflows dominated in foreign currency, which exerts a more substantial influence that might increase exchange rate volatility and possibly make engaging in business with LEMEs not worthwhile.

Contrarily, Alvarez-Plata and Garca-Herrero (2007) affirm that increased exchange rates pass-through in dollarized economies are mostly in non-traded goods in foreign prices, which expose such goods to volatility in foreign exchange rates. Nevertheless, with a solid domestic financial system and trade openness, LEMEs can absorb and navigate the negative influence of remittances on exchange rates. The central banks need to intervene to prevent LEMEs from falling into financial bubbles due to negative externalities associated with excessive foreign (advanced economies) investment inflows that could disrupt the market. This intervention could be done using various monetary policies in connection with the macroeconomic framework that allows emerging economies' central banks to manage and regulate their exchange rate volatility. Chapter five of this study discussed this aspect of government regulatory monetary policy intervention.

## 2.7 Conclusion

This chapter analysed related theoretical and empirical exchange rate models, providing the background literature for this study. Based on the reviews, a critical trade-off has been identified between choices of exchange rate regimes and models of exchange rate determination in LEMEs. These differences identified have been attributed to the fiscal and financial crises in LEMEs as reflected in the relationship between exchange rate volatility and extensive, real interest rate parity conditions and nominal exchange rate regimes and how monetary policy responds to exchange rate volatility in LEMEs. Despite LEMEs' efforts to attain stability and equilibrium within their monetary and macroeconomic factors, the structural gaps between the theories, models of exchange rate and LEMEs trigger shocks that impact the economies negatively. Suffice it to say that the theories and models discussed above are designed to suit fully developed economies with advanced foreign exchange markets that have the structures to withstand exogenous shocks and stabilise systemic imbalances within. These characteristics are different from what is obtainable in LEMEs, and without the ability to withstand external shocks and increasing exchange rate volatility, it will be difficult for LEMEs to engage successfully in international trade. Hence, the need to estimate the disaggregated impacts of exchange rate volatility on international trade in LEMEs.

Furthermore, as LEMEs understudy do not practise the monetary policy of fixed exchange rate but adopt the flexible exchange rate with inflation and output targeting, it is imperative to note that aside from the flexible exchange rate regime, all other theories of exchange rate determination do not apply to the current practice in the economies. Therefore, there is a need for the hypothesis of this study to recognise the structural features of LEMEs which is different from the ones proposed in the theories and include the variables related to the structure of LEMEs in estimating the practicability of the Taylor rule in the economies.

The literature review also reveals that the asset market model's approach, which proposes real interest rate parity among countries' return on investment and assets, does not seem plausible with the circumstances dominating LEMEs. This has to be considered in measuring the real interest rate parity conditions over different nominal exchange rate regimes in LEMEs. This helps to understand if, despite the economic uncertainties, high inflation rates and other institutional imbalances in LEMEs obtaining the real interest rate parity condition against the US was possible.

Based on the three gaps identified from the theoretical and empirical literature reviewed in this chapter, subsequent chapters in this study adjust the models to accommodate the structural differences in the empirical and theoretical literature. This was achieved by including variables that capture the structural gaps in LEMEs in this study. The adjustments approach is tailored towards advancing LEMEs' financial and institutional development that offers the economies the advantages of favourable participation in international trade, improving economic growth and leveraging global financial integrations.

# CHAPTER THREE

## Exchange Rate Volatility and International Trade Flows in LEMEs: a Disaggregated Impact Analysis

### 3.1 Introduction

The relationship between exchange rates and international trade flows in large emerging market economies (LEMEs) remains to be determined due to the increasing level of currency volatility in these economies and mixed conclusions from previous studies (Khosa et al., 2015). Pioneer's work by Clark (1973) on the consequences of exchange rate volatility on international trade flows presents the problems that an increase in exchange rate volatility, if unchecked, can have on the global markets, especially within the floating regime. To monitor the implications of exchange rate volatility on trade since economies shifted to independent monetary policy after the end of the Bretton Woods system, the General Agreement on Tariffs and Trade (GATT) was established in 1984. In the views of Auboin and Ruta (2011), exchange rate volatility can lead to damaging consequences in countries if assessed from macroeconomic context because it can affect the structure of output and investment, increase inefficient allocation of domestic resources and absorption of external trade, influence labour market and prices, and alter external accounts.

For large emerging market economies (LEMEs) largely dependent on commodity exports, the exchange rate is an actual nominal price, so there is a trade-off between domestic inflation performance and real growth that depends on international price competitiveness (Daniels et al., 2001). Theoretical models of exchange rate volatility on global trade flow, namely- risk aversion and risk neutrality, nature of traders, capital markets, time horizon and general equilibrium models, though with diverse views, conclude that increasing exchange rate volatility may or may not have adverse effects on international trade (Artus, 1983; Brosky, 1984; Chowdhury, 1993; McKenzie, 1999 & Latief & Lefen, 2018). The argument is that while risk-averse traders might prefer to trade with caution during exchange rate uncertainty which affects international trade flows negatively, risk-loving traders with a profit-maximising motive might use that as an opportunity to increase their trade volume. They do so to eliminate any possibility of future revenue decline due to rising exchange rate volatility.

In this case, an increased exchange rate volatility can increase trade flows, while Gotour (1985) and Asteriou et al. (2016) find no relationship between exchange rate volatility and international flows. Some consider the endowment capacity that offers countries the comparative advantage to trade better in particular goods and services whilst absorbing the adverse effects of exchange rate volatility. However, Sekkat and Varoudakis (2000) and Rose (2000) argue that the level of financial development of LEMEs, trade partners, and capabilities to withstand direct domestic risks from the macroeconomic factors and indirect external risks associated with monetary policy changes in other countries will affect international trade. This is in cognisance that countries participating in international trade expect positive returns that will improve their balance of payment, enhance the economic system, and help maintain a sufficient current account balance.

With the adoption of a floating regime in LEMEs where the forces of demand and supply determine prices, a weak financial system, in this case, proves how unfit the economies are to handle large capital flows, which might not favour them well in the global markets. It makes the currencies susceptible to external shocks since it is uncontrolled directly. Likewise, the spillover effects from the advanced financial markets intensify the risks associated with international trade, which can affect the volume and prices of traded goods. Furthermore, LEMEs mainly export commodity products and import finished goods from advanced economies (AEs) due to the prevalence of underdevelopment. However, most transactions are done in foreign currency with increased bid-ask spreads due to risks associated with LEMEs' currencies. Moreover, commodity product prices are volatile and subject to frequent shocks, so it exposes commodity-dependent countries like LEMEs to a large balance of trade disequilibrium, which transfers border distress to other sectors of the economy, compromising financial stability and increasing growth setbacks (Katusiime, 2018).

According to Belke (2001) and Mpofu (2015), the interconnectedness of countries and regions from economic openness strengthens the transmission mechanism from exchange rate volatility to international trade flows down to macroeconomic factors. The authors further argue that exchange rate volatility might harm trading when the process cannot be reversed because of an increased exchange rate uncertainty, which increases the value of options for risk-averse traders to wait for the next period. This approach to trading might have detrimental effects on trade flows, especially for the domestic countries, in this case, LEMEs, who need the flow to boost productivity. Katusiime (2015) and Evans (2011), on the other hand, suggest that exchange rate volatility can reflect the price discovery process that manifests in the behaviour of market participants as they attempt to assimilate price-relevant information into exchange rate prices and manage the associated foreign exchange risks considered as a natural part of the information aggregation process in efficient markets.

Bearing the above in mind, the structure of international trade concerning export capacity, openness to trade and human capacity in LEMEs presents the attributes of fast-growing economies willing to dominate the global markets but weakened by increasing variability in their exchange rates. The quest to understand the impacts of exchange rate volatility on international trade flows in LEMEs has produced several empirical research works (Khosa et al., 2015; Muila & Al-Zyoud, 2012; Tobal & Menna, 2020 & Tobal, 2017), yet; the findings are inconclusive in that they present different conflicting evidence that requires further study. This is because as international trade between LEMEs and advanced economies continues to increase steadily, the empirical literature has yet to be able to indicate adequately whether exchange rate volatility influences positively or negatively the aggregate international trade flows. Considering that other factors like the comparative advantage through factor endowments, geographical locations, monetary policy framework in each of the economies or favourable macroeconomic factors could protect some industries from the effects. The motivation for this study is three folds.

Firstly, this study aims to comparatively investigate how effective the disaggregated industrial-level trade data will be in explaining the influence of exchange rate volatility on international trade flows in LEMEs in terms of prices, volume and income (real GDP) in 10 LEMEs and their leading trade partner the US. The industrial-level-trade data is helpful in this study, considering that LEMEs are naturally endowed with different natural resources that give them a comparative advantage in production costs and the ability to absorb shocks even in the international markets. The study also examines the impacts of short-run and long-run exchange rate volatility based on the 3-month and 12-month volatility measures in the same economies and by magnitude across 20 different industries in each of the economies against 20 industries in the US using the same disaggregated industrial-level trade data. The data type used in this study is necessary since the effects of exchange rate volatility risks vary across industries; therefore, using aggregated trade data in such analysis might not identify how exchange rate volatility impacts each industry.

Finally, the study showcases a comprehensive understanding of the effects of exchange rate volatility across countries and industries and possible shockwaves from trade partners. The analysis will enable policymakers in LEMEs to determine efficient and effective ways to boost the balance of payment, increase exports and the overall economic well-being through international trade.

This study significantly contributes to the existing literature in so many ways. To the best of my knowledge, this perhaps represents the first[1] attempt where similar industries were specifically considered across countries with the same trade partner to investigate how exchange rate volatility impacts exports from these economies to their trade partner and imports of the same countries from a similar trade partner. This will present crucial findings on different economies' undue advantages over others regarding policy adjustments and the effect of reactions from other macroeconomic factors. The second contribution is evident since risks associated with exchange rate volatility can negatively affect economic growth and trade flows. The results will help LEMEs develop appropriate macroeconomic policy that can help to avoid or reduce the risks relating to trading time, among other decisions to increase trade flows, especially in exports and trade relations with partners, and accelerate economic growth. This significance will be practical since it is well known that LEMEs struggle with sluggish economic growth, which many have attributed to poor outcomes from participation in international trade.

To achieve improved level of financial and price stability, monetary authorities can apply the findings from this study as part of the macro policy instruments since it has been proven that decrease in exchange rate volatility can boost trade flows. This will help to ensure adequate capital and liquidity guard against shifts in global portfolios, especially during economic and financial crises.

Based on the points above, another significance is that improved risks aversion strategies would mandate proper handling of effects from current trade and technology tensions. This will attract

[1] Other studies have considered different industries for different economic groups or across countries, but this study selected similar industries across countries.

foreign investors into LEMEs and reduce the level of risks that expose LEMEs to financial vulnerabilities and adverse shock effects from the global markets. Furthermore, the knowledge will yield sustainable macroeconomic coordinations and remedy unfavourable economic gaps between LEMEs and advanced economies through structural reforms, adjustment of political instabilities, improved economic conflict resolution and calm uncertainties around trade flows. Using disaggregated industrial-level trade data as part of the main objective of this study will be insightful for LEMEs to improve their industrial and competitive strength by maximising their factor endowment strength for profitability in trade and increase revenue yields for domestic development. With proper economic planning, the disaggregated data used will help LEMEs to differentiate between industries that can withstand the negative effects of increasing exchange rate volatility and those that will be most negatively affected.

Another value added to existing studies is that since the effects of exchange rate volatility can be in the short-run or long-run periods, estimating the impacts of exchange rate volatility on international trade flows in the selected period will be imperative for LEMEs traders. Therefore, this study applies 3- and 12-month volatility measures to analyse the effects of exchange rate volatility on international trade flows, considering that prices can be sticky or volatile in a 3-month period but possibly flexible in a 12-month period. The findings presented might spur traders to adjust their trade engagements or contracts at favourable periods, adopt appropriate risk management strategies, and know the principal indicators for future market variations. Understanding how exchange rate volatility occurs in different industries will also restore traders' confidence to avoid risky deals while engaging in international trade, especially when unsure of the uncertainties associated with the domestic value of costs and revenue.

The rest of the chapter is arranged as follows: the next section provides an overview of the theoretical underpins behind the interactions of exchange rates volatility and international trade flows; section 3.3 reviews the empirical literature on the relationship between exchange rate volatility and international trade flows while section 3.4 contains the data analysis and methodology used in the study. Section 3.5 presents the empirical findings. Section 3.6 analyses the implications of the results with recommendations, while section 3.7 concludes the chapter.

## 3.2 Stylised Facts on the Nexus Between Exchange Rate Volatility and Economic Trade Flows

This section discusses the nature of the relationship between exchange rate volatility and international trade flows. Highlights were made of the opinions in several works of literature that analyse how increasing variability in currency systems, mostly prevalent in LEMEs, has continued to hinder their economic advancement. Previous literature on global trade flows affirms that domestic income and demand for imports and foreign income and demand are the forces behind international trade through export and import channels. Nevertheless, as countries continue to integrate more, like the growth of global demand and supply interactions, studies have countered the belief that foreign exchange rates could be a determining factor. An early study by Hooper & Kohlhagen (1978) acknowledges that the relationship between exchange rate volatility and international trade flows can be traced to the conventional theories of the effects of risk where speculative traders take precautions to navigate exchange rate volatility risks.

According to Mussa (1984) and Dornbusch (1996), the precautionary measures traders adopt to avoid risks lead to weak currency prices favouring exportation through increased competitiveness. However, the reverse is the case for importation, where the traders need to pay more. Artus (1983) and Brosky (1984), in support of the risk aversion and risk neutrality ideology, conclude that unexpected fluctuations in the exchange rate system might impact the decisions of risk-averse community traders, leading to output and volume of trade reduction. Another argument by Kroner and Lastrapes (1993) is that the influence of exchange rate volatility on prices and trade volumes where international transactions involving significant sunk costs can affect traders' behaviour even when agents are risk neutral. However, Senadza and Diaba (2018) contend that the risk-portfolio theory counters the traditional thought by Hooper & Kohlhagen (1978) with the view that since exchange rate volatility is unavoidable, risk-tolerant traders will employ risk-adjustable measures to increase trade and reduce any loss of income in the future. This supports the debate by Hakkio (1984), who argues that adjustable measures will be considered on agreed-on prices, which helps bilateral traders to eliminate the possible effects of exchange rate volatility on trade flows. However, Berganza and Broto (2012) oppose the views that the exchange rate level plays a vital role in international macroeconomics by determining the demand for traded goods, especially when some nominal prices are sticky.

Contrarily to the risk aversion and risk neutrality ideology, De Grauwe (1988) suggests a positive relationship between exchange rate volatility and international trade through the dominance of income effects over substitution effects. A similar argument has been documented differently by Froot and Klemperer (1989), where they express that where market shares matter under the oligopolistic market structure, exchange rate volatility can have negative or positive effects on both price and quantity of trade irrespective of the approach to risk. Therefore, instead of exchange rate volatility to diminish the quantity of goods traded, it increases the volume of trade flows (De Grauwe, 1996) while McKenzie (1999), Senadza and Diaba (2018) and Sharma and Pal (2018) emphasise that the theoretical justification about the positive relationship between exchange rate volatility and international trade flows in some cases can result to no effect at all. This implies that in as much as exchange rate volatility affects international trade positively or negatively in some cases, there is no relationship between exchange rate volatility when it comes to trading in some industries.

Deserving of note is the IMF (1984) theoretical review and surveys by Cote (1994) and McKenzie (1999), which conclude that when it comes to bilateral trading, the relationship between exchange rate volatility and trade flows is not distinct considering that other internal macroeconomic factors might be at play which could influence trade flows negatively or positively as well. More so, the assumptions of the general equilibrium models justify that other macroeconomic variables change along with exchange rates, and a country's comparative advantage can help to absorb the impacts (Clark et al., (2004). Therefore, the assumption that an increase in exchange rate volatility will negatively impact international trade flows might not be the case considering that other internal economic factors might be the cause, as explained in the general equilibrium models. On the other hand, it can boost trade through the predicting behaviour of risk-loving traders and thus favour the economy.

In conclusion, many theoretical and empirical views have emanated trying to aid in understanding the effects of exchange rate volatility on international trade flows; however, as countries, globalisation and specific country structures continue to evolve, so is the link between exchange rate volatility and trade. Therefore, a continuous study to understand the exchange rate dynamics and how it impacts trade will be valuable in formulating policies that will suit every economy.

### 3.3 Exchange Rate Volatility and International Trade Flows: Empirical Review

Few decades ago, studies mainly depended on using aggregate trade data to analyse the impacts of exchange rate volatility on international trade flows. However, the concept of heterogeneity among industries brought the idea that industrial-level trade data can help determine the optimal behaviour of firms regarding specific cost structure, pricing strategy and performance, especially in the face of currency fluctuations (Auboin & Ruta, 2011). Since then, a plethora of literature has emerged using disaggregated trade data from different industries to understand how they respond to exchange rate volatility.  This level of analysis has been conducted extensively by Bahmani-Oskoosee and Wang (2007), Bahmani-Oskooee and Hergety (2009), Rusher and Wolff (2009), Berman et al. (2009), Bahmani-Oskooee, Harvey and Hegerty (2014) and Bahmani-Oskooee and Hegerty (2007) among other studies in advanced and emerging market economies. Therefore, the empirical literature review for this study focuses on studies that employed disaggregated firm-level trade data to analyse the effects of exchange rate volatility on international trade flows in emerging market economies.

The pioneering study that used disaggregated industrial-level trade was carried out by Coes (1981) in Brazil. The study applied the OLS estimation technique on 13 manufactured goods and 9 primary products from 1957-1974. The results show that all manufactured goods are positively affected by exchange rate volatility except 2 that were negatively impacted by exchange rate volatility in Brazil. For the primary products, 6 out of 9 are significantly positively affected by exchange rate volatility, with 3 adverse effects. Coe's (1981) findings imply that manufactured and primary products have different effects from the exchange rate volatility.

With pooled and fixed effects panel model Grobar (1993) examined the effects of exchange rate volatility on 4 different industrial sectors, miscellaneous manufactures, chemical and machinery, manufactures, and transport equipment on LDC, covering the period 1963-1985. The results indicate that while chemicals and manufactures are negatively affected by exchange rate volatility, machinery and miscellaneous manufactures were not significantly impacted.

Chou (2000) combined Engle-Granger and Johansen co-integration and Johansen error correction models to analyse the effects of exchange rate volatility on trade flows in 4 industrial sectors in China from 1981-1986. The models used yielded two different results. For results from the error correction model, the sectors considered foodstuffs, fuels, industrial materials and manufacturing goods; only foodstuffs were not negatively affected by exchange rate volatility. On the other hand, the bounds test results show that industrial materials were positively affected, and the other 3 negatively impacted by exchange rate volatility.

An interesting study by Usman and Savvides (1994) used similar products of coffee and cocoa from different African countries that used similar currencies from 1973 to 1984 to analyse the effects of exchange rate volatility on international trade. Results from OLS model estimation reveal that exchange rate volatility negatively affected the two products in most selected countries. However, the effects were positive for two countries that rigidly pegged their currencies to the French Franc. This supports the views of Aghion et al. (2009) that a fixed exchange rate system protects emerging markets from the external effects of international trade.

Using a bounds-testing approach to the cointegration and error correction model Bahmani-Oskooee and Mitra (2007) investigate the impacts of exchange rate risks on commodity trade between the US and India. The findings from disaggregated industrial-level trade data indicate that among industries that trade between the countries, the positive and negative impacts were mainly noticed in the short-run in 40 % of the industries considered. However, the effects are reflected only in a few industries in the long run.

Another study by Bahmani-Oskooee and Wang (2007) on products level in China and other countries against the US industries where trade flows were divided according to the commodity level in each country to analyse how they reacted to exchange rate volatility from 1978-2002. The findings from China reveal differentiated levels of impact on 88 industries. Due to the appreciation of the US dollar against the China Yuan within the period covered, 18 industries from the US exports to China were negatively affected. There is also an increase in import values of 40 industries in the US. The authors linked the effects to a decrease in price elasticity of Chinese demand for US manufacturing products which seems against the US demand for Chinese manufacturing exports. A similar conclusion was reached by Arunachalaramanan and Goliat (2011) on Chinese trade with India. Although the analysis was based on bilateral trade between the two countries, the authors found that the appreciation of the Chinese Yuan against the Indian Rupee would not favour India's trade balance. This is because the long-run price elasticity of demand for Indian goods in China is lower compared to China goods in India, and Indians also depend more on Chinese intermediate goods and machinery for production. So, an increase in appreciation of the Indian Rupee against the Yuan will hurt the Indian production process and exports.

Another study by Hall et al. (2010) examines the relationship between exchange rate volatility and trade volumes for a panel of countries-10 emerging market economies combined with 11 developing ones using quarterly data from 1980 to 2006. The study's outcome reveals that exchange rate volatility negatively affects exports in developing countries but not in emerging market economies. Unlike the previous ones, the study concludes that increasing interactions of emerging market economies with the rest of the world might help reduce the effects of exchange rate volatility as opposed to that of developing economies.

The implication of the literature reviewed above suggests that although the foreign exchange rate plays a vital role in international trade since currency rate changes can affect market operations, purchasing power and remittances across the globe, the role can be negative, positive, or there will be no relationship at all with trade. However, it is not only the exchange rate that affects international trade flows, especially in LEMEs where other domestic factors, for example, industrial inputs, might be responsible for an increased cost of production which makes the trade for those goods unfavourable to exporting countries in the international markets. There are other factors with manufactured goods, intermediate goods, services or raw materials, as well as the relocation of companies to cut costs which can affect international trade flows negatively. On the positive side, increased production levels in a country due to endowment capacity can lead to cheap production costs and an increase in demand from other countries; the changes in taste and choice and consumer utility can influence trade positively.

Other factors could be the geographical location of countries and the monetary policy in place. For instance, the case of the Chinese Yuan revaluation analysed above affected exports from India. At the same time, the Indians are left with the only option of importing their machinery and other intermediate goods from China. In some cases, exchange rate volatility boosts trade flows or has no relationship with international trade flows depending on the risky nature of the traders involved. Again, different economies in LEMEs go through individual circumstances at different times; therefore, modelling the decision of firm(s) faced with exchange rate risk does not portray the actual problem associated with exchange rate volatility, and trade flows at the time. Furthermore, the relationship between macroeconomic and monetary policy plays a vital role, especially in the case of LEMEs with many structural cracks.

### 3.3.1 Exchange Rate Volatility and International Trade Flows: Theoretical Framework

The theoretical framework to be employed in this study is the Heckscher-Ohlin-Samuelson (HOS) theory for international trade. This model was developed by Heckscher (1919) and Ohlin (1933) who suggest that the prerequisites for initiating international trade stems from different relative scarcities, different relative prices of the factors of production in the exchanging countries and different proportions between factors of production in different commodities (Mikic, 1998). In essence, the Heckscher and Ohlin theory relates bilateral trade between two countries to differentials in factor endowment (Baskaran *et al*. 2011). The ideology is that countries depending on their endowment capacities will produce goods that can afford them the comparative advantage to operate effectively in international markets through exportation. In turn, the countries will import those goods and services that lacks the comparative advantage in the domestic markets. The Samuelson idea was later included to expand the two-factor, two-goods general equilibrium of the HO model, which is considered inapplicable. Samuelson (1953) developed and formalised the 2x2x2 (that is two goods, two factors and two countries) structure model to propose the superiority of an open economy. The work by Samuelson (1953) can also be referred to as the factor price equalisation theorem (FPET).

Therefore, the HOS model captures capital as the primary factor of production and defined the structure of comparative advantage as the difference in countries' factor endowments. According to Kurose and Yoshihara (2018) the assumptions of the HOS theory are that every country is faced with a common set of techniques but differs in terms of factor endowments which includes goods, services, capital, labour, information, and knowledge with regard to the modern economy. In addition, the production function for each good is homogeneous of the first degree which implies that the model's production structure retains constant returns to scale. Given the imperfection of international factor markets, the choice of a technique likewise the pattern of international trade is determined by a country's endowments with factors of production and countries without other relative endowments can navigate the short comings through engaging in international trade including the demand for relatively abundant factors. The comparative advantage is considered as the key principle in international trade and explain the reasons why free trade is beneficial to countries and trading partners and can help to increase gains from trade. Mikic (1998) explain that the HOS model could be derived through four core theorems which include that the HOS theorem determines the pattern of specialisation and trade by comparative advantage based on differences in factor endowments. The second is the factor-price equalisation theorem that examines how common goods prices and factor prices change during trade and become equalised across countries. Thirdly, the Stolper-Samuelson theorem which describes the relationship between goods prices and factor prices holding a given level of factor endowments constant while the link between outputs from goods and factor endowments at constant goods prices, remain the focus of Rybczynski theorem which constitute the fourth HOS theorem. In addition to theories discussed, there is also the Samuelson reciprocity condition which identifies the correspondence between the Stolper-Samuelson and Rybczynski theorems.

The HOS theory has been considered too strict or limited based on the assumption of the two 2x2x2 (two goods, two factors and two countries) and identical production technologies structure (Hakura, 2001 & Baskaran *et al*. 2011). Nishioka (2006) also proposed the need to include a disaggregated concept of factor endowments instead of applying the simple HOS dichotomy between capital and labour. However, Davis, Weinstein, Bradford, and Shimpo (1997) agree that once the assumption of universal factor price equalisation is relaxed, the HO model will perform well in empirical tests. This study therefore adopts the Nishioka (2006) approach of using disaggregated industrial-level trade data and expand the HOS to more than two countries where different factors of production apply to examine the effects of exchange rate volatility on international trade flow. The analysis will help policy makers to understand how different industries respond to exchange rate volatility, the relationship between the variables and the impacts of exchange rate volatility on the industries studied.

## 3.4 Data and Methodology

### 3.4.1 Data

This study used data from 10 LEMEs countries Brazil, China, India, Indonesia, Korea, Mexico, Russia, Saudi Arabia, South Africa and Turkey, according to Boyer and Truman (2005) categorisation. The annual sample period for each country is from 1991 to 2019, except for Russian data that began in 1992 because the country was still the Soviet Union in 1991. Argentina was not selected as part of the 11 LEMEs according to categorisation due non-availability of data for some of the variables needed for analysis. The data used for estimation in this study consists of the volume of exports from 20 industries in each of the countries in LEMEs to the US and the volume of imports from 20 industries in the US to LEMEs, real bilateral exchange rates, LEMEs real GDP, volatility rates and US real GDP that covered 28 years from 1991 to 2019 which gives 400 variables (200 for exports and 200 for imports). Each country has 20 export industries and 20 import industries; in total, each country in LEMEs has 40 industries under consideration. In this case, US imports from the 10 LEMEs are considered as LEMEs exports to the US, while US exports to LEMEs are their imports from the US, and all exports and imports data were sourced from the World Integrated Trade Solutions (WITS).

The industries are categorised into capital goods, consumer goods, intermediate goods, raw materials, animal, chemical, food products, footwear, fuels, hides and skins, mach and elec (machinery and electronics), metals, minerals, miscellaneous, plastic or rubber, stone and glass, textiles and clothing, transportation, vegetable, and wood according to WITS categorisation. Then, there is annual data on real bilateral exchange rates, LEMEs real GDP, volatility rates and US real GDP for each of the countries' real exports and imports that covered a 28-year period, so altogether, there is a total of 480 variables with 12,736 observations (excluding the first year for Russia) for the analysis in this study. The real imports and export prices for all the industries are in millions of US dollars. The data were transformed as follows:

**Real Imports and Exports for LEMEs and the US:** conversion of nominal imports to real imports as well as nominal exports to real exports was carried out to generate real imports from 20 industries in LEMEs to the US and to generate the real exports from 20 industries from the US to LEMEs. This is in understanding that US imports are exports from LEMEs while LEMEs imports are exports from the US. So, considering that the US is a significant trader with LEMEs, the import price index from the US was used to deflate nominal exports from LEMEs to generate real exports from LEMEs to the US. In the same way, the export price index from the US was also used to deflate the nominal imports from the US to LEMEs to generate real imports from the US to LEMEs. The export price index represents all commodity indexes, likewise the import price index. The approach of using import and export price indexes from the US to generate the real imports and exports from LEMEs and the US was considered due to the scarcity of data in LEMEs. The export and price index data were sourced from the International Financial Statistics (IFS).

**Real Exchange Rates for LEMEs:** to calculate the real exchange rates ($REX$) between LEMEs' currencies and the US dollar, $REX$ is derived by the multiple of the $CPI$ for LEMEs with nominal exchange rate ($NEX$) and divide by $CPI$ US, hence:

$$\left(\frac{CPI_{LEMEs}\ X\ NEX}{CPI_{US}}\right) \quad (1)$$

Where $CPI$ is the consumer price index for LEMEs and US, $NEX$ is the nominal exchange rate defined as a unit of each LEMEs currency per US dollar. The $CPI$ data (consumer price index all items 200=100) were gathered from the World Development Indicators (WDI), while data for nominal exchange rate is from IMF-International Financial Statistics (IFS) as national currency per US dollar average rates.

**Volatility Rates for LEMEs:** the volatility rates were calculated using a 12-month nominal exchange rate ($NEX$) as national currency for LEMEs, monthly $CPI$ of LEMEs and monthly $CPI$ of US from 1991M1- 2019M12 to generate the real exchange rates ($REX$). The data for Russia started from 1992M1-2019M12. The CPI was used because the study wants to capture the purchasing power of LEMEs and the US. The CPI data were from World Development Indicators (WDI), while $NEX$ data from International Financial Statistics (IFS). The approach employed in this study to calculate the volatility rates for LEMEs' currencies follows Bahmani-Oskooee and Wang (2007), Bahmani-Oskooee and Mitra (2007), Bahmani-Oskooee and Hegerty (2009) and Bahmani-Oskooee and Hegerty (2014). The volatility measure of real bilateral exchange rates for each country over a year is defined as the standard deviation of 3 monthly real bilateral rates (real exchange) within that year using monthly CPI data and nominal exchange rate data and 12 monthly real bilateral exchange rates with similar data. The monthly data was later averaged to obtain the annual data used in the estimation.

**Real GDP LEMEs and the US:** the real GDP data for LEMEs and the US were from the World Development Indicators (WDI) and only transformed into a log form. All the data are based on 10 LEMEs instead of the 11 countries that made up the LEMEs as categorised by Boyer and Truman (2005), Enderwick (2009), Nolke, Brink, Claar and May (2020), Tang and Yao (2018) and Olasehinde-Williams and Bacilar (2020). However, Argentina was removed due to a lot of missing values.

### 3.4.2 Empirical Strategy

#### 3.4.2.1 Model

The analysis for this research followed the methodology employed by Clark, Tamirisa, Wei, Sadikov and Zeng (2004) and Bahmani-Oskooee, Harvey and Hegerty (2014) and Bahmani-Oskooee and Hegerty (2009), the data was disaggregated to the industrial levels as discussed earlier, and the reduced-form model was used whereby data on each industrial trade flows represent each country's purchasing power as a percentage of real GDP, the real exchange rate for countries considered and a measure of each country's exchange rate volatility. The estimation involves selected LEMEs and the US industrial-level real exports and imports flow. The reduced-form model is used for the analysis in this study, where trade is a function of the purchasing country's real GDP, the real exchange rates for LEMEs and the US, and a measure of volatility for each of the countries considered gives 80 variables. For the chosen countries, 40 industries selected for real exports and real imports were separately estimated for each of the 10 countries, which resulted in 480 estimations altogether.

Since exchange rate volatility in the short-run can impact international trade likewise, the impact might also reflect in the long-run; this study adopted the panel ARDL model of Peseran et al. (2001) for estimation. The technique helps to eliminate the issue of stationarity, which can pose problems when working with a large sample size bearing in mind that most macroeconomic variables are usually not stationary. Moreover, the ARDL model simultaneously provides the coefficient estimates for short- and long-run periods. Although the ARDL model was applied, this study conducted a stationarity test on the data, which will aid in interpreting the estimation results. Again, considering that this study wants to understand the specific interactions between exchange rates and international trade flows in each industry selected in each of the countries under investigation, the ARDL model was applied to the time series data of each of the countries. This approach will help countries have a specific knowledge of what is happening in each industry studied.

The model of the ARDL generalised equation (p, q) can be specified as follows:

$$Y_t = y_{0j} + \sum_{k=1}^{p} \delta_j Y_{t-k} + \sum_{k=0}^{q} \beta_j' X_{t-k} + \varepsilon_t \quad (2)$$

Where $Y_t$ is a vector and variables in $(X_t')$ were allowed to be purely 1(0) or 1(1) or cointegrated; $\beta$ *and* $\delta$ are coefficients; $y$ is the constant; $i = 1, \ldots, k; p, q$ are optimal lag orders-where $p$ lags are used for the dependent variables, $q$ lags are used for the exogenous variables. $\varepsilon_t$ is the vector of the error terms that is the unobservable zero-mean white noise vector process.

Theoretically, short-run effects of exchange rate volatility are not as complicated as it is in the long-run, however, when some prices are sticky in the short-term, fluctuations in the nominal exchange rate can disrupt the relative prices and possibly affect the allocation of resources between non-tradable and tradable goods as well as international trade flows (Auboin & Ruta, 2011). In the same view, Staiger and Sykes (2010) submit that short-run exchange rate volatility can affect trade flows depending on the currency with which the goods are traded. For domestic currency, unanticipated devaluation lowers the price of domestic goods relative to foreign goods. However, when the goods are traded in foreign currency like the US dollar, exchange rate volatility in the short-term might impact trade flows. In the long-run period, prices become flexible to adjust or shift to policy changes.

Price flexibility can also be a reaction to adverse effects of changes in monetary policy around the world, including other factors that contribute to price instability in an economy. Studies like Senadza and Diaba (2018) confirm that the dimension of effects of exchange rate volatility on international trade flows in the short-run and long-run differs likewise in countries. Since there is a considerable difference between the impact of exchange rate volatility on international trade flows in the short-run and long-run, this study will measure both periods to determine how the impact reflects in the countries. So, when the variables–export volume from the US, LEMEs and US income, real exchange rate, the volume of import and exchange rate uncertainty to be considered for analysis are substituted into equation (3), it will yield the short-run disaggregated industrial-level trade model specification which will help to analyse the short-run period and will be written as thus:

$$\Delta VX_t = \alpha_0 + \sum_{j=1}^{n1} \beta_j \Delta VX_{t-j} + \sum_{j=0}^{n2} \gamma_j \Delta Y^{EMEs}{}_{t-j} + \sum_{j=0}^{n3} \delta_j \Delta REX_{t-j} + \sum_{j=0}^{n4} k_j \Delta VOL_{t-J} + \theta_1 VX_{t-1} + \theta_2 Y_{t-1}^{EMEs} + \theta_3 REX_{t-1} + \theta_4 VOL_{t-1} + \varepsilon_t \quad (3)$$

Then, the long-run estimation equation for the same analysis can be written as follows:

$$\Delta VM_t = \alpha_2 + \sum_{j=1}^{n5} \phi_j \Delta VM_{t-J} + \sum_{j=0}^{n6} \varphi_j \Delta Y^{US}{}_{t-j} + \sum_{j=0}^{n7} \pi_j \Delta REX_{t-j} + \sum_{j=0}^{n8} \vartheta_j \Delta VOL_{t-J} + \theta_5 VX_{t-1} + \theta_6 Y_{t-1}^{US} + \theta_7 REX_{t-1} + \theta_8 VOL_{t-1} + \varepsilon_t \quad (4)$$

All the variables, as noted earlier, were transformed into the logarithm form to make them normally distributed for estimation, and equations (2) and (3) are the error correction models (ECM) for the short-run and long-run estimations. The $VX$ in the equations represent the volume of exports from the US industries to LEMEs; $Y^{LEMEs}$ denotes LEMEs income (real GDP); REX is the real exchange rates between the US dollar and LEMEs currencies; $VM$ is the volume of the same industries imports by the US from LEMEs (LEMEs exports to the US); $Y^{US}$ denotes the US income (real GDP US), and the $VOL$ is the measure of exchange rates uncertainty in the economies under study. The STATA15.1 computing technique was used for the estimation in this study.

### 3.4.2.2 Estimation Technique

An autoregressive distributed lag (ARDL) model with $t$ for the number of years and 1(1) cointegrated variables are used for the empirical analysis, indicating an error term integrated of order zero across the analysis. Davidson, Hendry, Serba, and Yeo (1978) aimed to evaluate the short-run and long-run characteristics of economic relationships formulated to work with models in their error correction form (ECM). The approach yielded integrated and co-integrated results jointly generated by ECM. One of the main characteristics of cointegration is the basic response to long-run equilibrium deviations, which suggests an error correction model where short-run dynamics of the variables in the model are affected by deviation from the equilibrium (Blackburne III & Frank, 2007 & Senadza & Diaba, 2018).

The long-run effects were obtained through the coefficient estimates attached to the lagged-level variables after normalisation, an approach also employed by Bhamani-Oskooee and Tanku (2008) and Bhamani-Oskooee, Harvey and Hergety (2014). The unit root test though not a requirement when applying the model of ARDL was performed using the augmented Dickey-Fuller test for unit root on all the industries and other variables analysed to help interpret the results. With Pesaran, Shin, and Smith's (2001) bound testing approach for large samples,[2] the cointegration of the variables was established based on the long-run coefficients-

[2] Narayan (2005) proposed the bound testing approach for a small and large sample size. This study applied that with Pesaran, Shin, and Smith (2001) in selecting the upper and lower bounds critical values.

a 3 step-criteria that uses the critical values. In the model, the ECM is supposed to be negative and statistically significant for cointegration; otherwise, there is no cointegration.

The first step for cointegration was to conduct the bound test using the critical values from the F-statistics for joint significance. In this case, the upper bound for the LEMEs and the US real exports and imports is 3.77, while the lower bound is 2.72. The 10% level in the F-statistics was chosen instead of the 1%, 2.5% or 5% to avoid rejecting most industries that are not cointegrated at those levels. Theoretically, when the F-statistics is greater than the upper bound critical value, the assumption is that there is cointegration. However, there is no cointegration when F-statistics is below the lower bound critical value.

However, when the F-statistics lies between the upper and lower bounds (the intermediate range), this study considered whether the ECM is negative and statistically significant, determining whether there is cointegration. For the ECM to be statistically significant, the coefficient of t-statistics needs to be greater than 1.96. This implies that the industries with F-statistics that is between the upper and lower bounds critical values were re-estimated and labelled $ECM_{t-1}$ on the results table, so if the coefficient t of the t-statistics is greater than 1.96, there is the existence of cointegration (a long-run relationship) among the variables.

The expectation for the analysis is for LEMEs' real exports to the US to have a positive relationship with an increase in US income. However, it reacts negatively to LEMEs' currencies depreciation. In the same way, LEMEs' real imports from 20 industries in the US should increase with the increase in LEMEs' income and appreciation in their currencies. The long-run coefficients, which will be this study's main area of concentration, are expected to be positive.

### 3.5 Empirical Findings

The optimal lag length selection is at level 3 for the difference of volatility, followed by the unit root testing for all the variables. This shows that some variables are stationary at levels while others are at the first difference except for the US real GDP. However, the results were not included due to lack of space. The results from unit root tests validate the need for a cointegration analysis to determine if there are constant co-variances over time. Moreover, the cointegration results reveal the existence of long-run equilibrium relationships between exchange rate volatility and international flows in LEMEs and the US, which suggests the feasibility of a short-run and long-run analysis. Overall, the findings show a stable linear relationship between the dependent variables and their respective explanatory variables in the long-run.

#### 3.5.1 Analysing LEMEs' Real Exports to the US

Table 1A contains the cointegration results on the real exports from LEMEs to the US using a 3-month standard deviation of real bilateral rates. All the results were checked for cointegration using the lower or upper-bound critical values of 2.72 and 3.77, respectively. Of the 20 industries considered in all countries, 5 industries are cointegrated in Brazil while 2 and 13 industries are in China and India, then Indonesia and Korea have 9 industries each.

Table 1B shows that Mexico, Russia and Saudi Arabia have 13, 11 and 11 cointegrated industries, while 5 industries are cointegrated in South Africa, and Turkey has 12. The results indicate that 90 of 200 export industries from LEMEs to the US are cointegrated.

Further cointegration results in Table 2A are the real exports from LEMEs to the US with a standard deviation of 12 monthly real bilateral rates. From the 20 industries estimated for each country, Brazil has 8 cointegrated industries. Interestingly, real exports from China to the US show that all the F-statistics for the 20 industries selected were below the lower bound of 2.72, so all the variables are not cointegrated. For India, 10 industries are cointegrated, while Indonesia has 9 industries and Korea with 11 industries.

For Table 2B, the real exports from LEMEs to the US continued with 11 industries cointegrated in Mexico and Russia. Saudi Arabia and South Africa have 9 and 8 industries that show the existence of a long-run relationship, while 9 industries in Turkey are cointegrated. All the industries with F-statistics above the upper bound or at the intermediate range, which became significant after re-estimation as discussed in the estimation technique, were counted together for all countries.[3] To understand the trends in exchange rate movements in these economies, the short-run volatility from Table 1 to 10 in Appendix C was captured, which shows that 54 out of 200 industries considered in LEMEs' real exports to the US have statistically significant coefficients, which are either positive or negative and were considered across different lags.

[3] All the industries that were above or between the upper and lower bounds critical values were put together as cointegrated for LEMEs real exports to the US in tables 1 and 2. The same applies to LEMEs' real imports from the US in tables 3 and 4.

***Table 3.1A: LEMEs real Exports to the US***

**Country-specific ARDL and Bound testing cointegration results from 3-month volatility measure**

**Source: Authors' computation using STATA15.1**

| **Industries** | **Brazil** | | | **China** | | | **India** | | | **Indonesia** | | | **Korea** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. |
| Capital goods | 1.04 | -0.17(1.17) | No | 3.77 | 0.05(0.26) | Yes | 2.54 | -0.57(2.66) | Yes | 2.86 | -0.31(2.51) | Yes | 8.74 | -1.09(5.40) | Yes |
| Consumer goods | 3.52 | -0.27(2.53) | Yes | 1.82 | 0.009(0.04) | No | 5.82 | -0.55(3.36) | Yes | 2.35 | -0.34(1.39) | No | 6.82 | -0.22(1.84) | Yes |
| Intermediate goods | 1.88 | -0.47(2.28) | No | 1.44 | -0.07(0.25) | No | 6.19 | -0.92(4.22) | Yes | 4.50 | -0.67(3.64) | Yes | 4.47 | -0.78(3.63) | Yes |
| Raw materials | 1.09 | -0.37(1.65) | No | 1.20 | -0.48(1.74) | No | 1.36 | -0.42(2.06) | No | 0.76 | -0.44(1.54) | No | 1.66 | -0.60(2.50) | No |
| Animal | 4.47 | -0.59(3.53) | Yes | 2.51 | -0.06(0.32) | No | 4.66 | -0.12(0.85) | Yes | 5.18 | -0.99(4.38) | Yes | 0.79 | -0.15(0.99) | No |
| Chemical | 2.45 | -0.69(2.64) | No | 2.19 | -0.51(1.97) | No | 1.68 | -0.11(1.02) | No | 1.52 | -0.66(2.36) | No | 2.50 | -0.65(2.85) | No |
| Food products | 2.12 | -0.77(2.86) | No | 1.95 | -0.12(0.50) | No | 0.36 | -0.02(0.12) | No | 1.22 | -0.57(2.07) | No | 2.34 | 0.006(0.04) | No |
| Footwear | 3.80 | -0.23(2.37) | Yes | 2.26 | -0.16(0.75) | No | 3.89 | -0.19(2.07) | Yes | 0.74 | 0.12(1.17) | No | 4.76 | -0.10(1.04) | Yes |
| Fuels | 2.89 | -0.28(2.29) | Yes | 1.94 | -0.85(2.36) | No | 10.29 | -0.48(4.58) | Yes | 2.76 | -1.15(3.06) | Yes | 1.00 | -0.22(0.85) | No |
| Hides & skins | 3.07 | -0.25(1.43) | No | 2.67 | 0.01(0.06) | No | 7.10 | -0.10(0.85) | Yes | 1.85 | 0.25(1.41) | No | 3.11 | -0.11(1.33) | No |
| Mach & Elec | 1.19 | -0.25(1.62) | No | 3.47 | 0.11(0.50) | No | 3.29 | -0.48(2.58) | Yes | 3.14 | -0.34(2.46) | Yes | 6.74 | -1.01(4.76) | Yes |
| Metals | 1.86 | -0.47(2.27) | No | 2.16 | 0.19(0.98) | No | 4.04 | -0.83(3.30) | Yes | 3.04 | -0.45(2.60) | Yes | 2.40 | -0.55(2.57) | No |
| Minerals | 2.42 | -0.54(2.10) | No | 0.55 | -0.32(1.24) | No | 10.19 | -1.19(5.95) | Yes | 6.16 | -0.49(3.17) | Yes | 0.95 | -0.24(1.08) | No |
| Miscellaneous | 1.01 | -0.32(1.42) | No | 2.41 | -0.38(1.37) | No | 1.99 | -0.73(2.62) | No | 3.21 | -0.51(2.73) | Yes | 2.04 | -0.30(1.90) | No |
| Plastic or rubber | 2.90 | -0.73(2.70) | Yes | 1.52 | -0.07(0.25) | No | 1.59 | -0.48(2.24) | Yes | 1.17 | -0.39(1.58) | No | 10.20 | -0.75(3.55) | Yes |
| Stone & glass | 2.24 | -0.39(1.83) | No | 3.29 | -0.04(0.21) | No | 17.06 | -1.15(6.56) | Yes | 0.99 | -0.19(1.46) | No | 2.36 | -0.35(2.14) | No |
| Textiles & clothing | 3.30 | -0.12(1.00) | No | 0.38 | -0.21(0 .77) | No | 2.11 | -0.58(2.08) | No | 5.52 | -0.15(1.23) | Yes | 5.94 | -0.20(2.49) | Yes |
| Transportation | 1.08 | -0.24(1.31) | No | 4.50 | -0.90(3.22) | Yes | 4.67 | -0.81(2.95) | Yes | 1.12 | -0.38(1.95) | No | 6.72 | -0.35(2.95) | Yes |
| Vegetable | 2.00 | -0.75(2.66) | No | 1.20 | -0.54(1.82) | No | 2.04 | -0.74(2.69) | No | 1.23 | -0.15(1.11) | No | 4.10 | -0.90(3.80) | Yes |
| Wood | 2.15 | -0.36(2.02) | No | 3.61 | 0.08(0.57) | No | 0.90 | -0.59(1.78) | No | 2.66 | -0.37(2.27) | No | 1.59 | -0.14(0.73) | No |

**Note:** Estimations were based on annual data from 1991 to 2019. T-statistics ratios in parentheses are in absolute value. The F-statistics with unrestricted intercept and no trend denote statistical significance at 10% instead of 1%, 2.5% or 5% so as not to reject most industries that are not cointegrated at those levels. The upper bound critical value is 3.77, and the lower bound critical value at 2.72.

***Table 3.1B: LEMEs Short-term Real Exports to US***

**Country-specific ARDL and Bound testing cointegration results from a 3-month volatility measure.**

**Source: Authors' computation using STATA15.1**

| **Industries** | **Mexico** | | | **Russia** | | | **South Arabia** | | | **South Africa** | | | **Turkey** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. |
| Capital goods | 1.40 | -0.31(1.74) | No | 6.40 | -1.17(4.90) | Yes | 1.32 | -0.80(1.30) | No | 1.50 | -0.20(1.31) | No | 1.52 | 0.06(0.30) | No |
| Consumer goods | 2.54 | -0.34(1.80) | No | 1.54 | -0.22(1.50) | No | 5.45 | -1.8(4.60) | Yes | 2.15 | -0.34(2.04) | No | 3.80 | -0.28(2.46) | Yes |
| Intermediate goods | 0.81 | -0.33(1.45) | No | 3.06 | -0.79(3.44) | Yes | 2.64 | -2.73(1.39) | No | 1.07 | -0.61(1.90) | No | 7.73 | -1.20(5.44) | Yes |
| Raw materials | 3.08 | -0.41(2.79) | Yes | 0.87 | -0.28(1.44) | No | 1.95 | -0.43(0.19) | No | 1.85 | -0.67(2.22) | No | 4.50 | -0.97(3.58) | Yes |
| Animal | 6.26 | -076(4.34) | Yes | 0.91 | -0.29(1.39) | No | 4.28 | -1.42(3.69) | Yes | 2.42 | -0.36(2.11) | No | 3.42 | -0.76(2.98) | Yes |
| Chemical | 7.23 | -1.18(5.25) | Yes | 1.75 | -0.93(2.63) | No | 2.13 | -1.75(0.75) | No | 1.57 | -0.37(1.84) | No | 2.42 | -0.84(2.86) | No |
| Food products | 2.80 | -0.53(2.36) | Yes | 0.58 | -0.30(1.46) | No | 3.50 | -0.28(1.24) | No | 4.93 | -1.05(3.54) | Yes | 3.41 | -1.01(3.36) | Yes |
| Footwear | 8.33 | -0.36(3.21) | Yes | 5.94 | -0.15(0.96) | Yes | 5.72 | -1.59(3.97) | Yes | 2.31 | -0.57(2.66) | No | 2.35 | -0.59(2.22) | No |
| Fuels | 3.12 | -0.41(2.84) | Yes | 2.37 | -0.21(1.59) | No | 1.93 | -0.55(0.51) | No | 3.63 | -1.06(3.64) | Yes | 1.71 | -0.62(2.52) | No |
| Hides & skins | 12.84 | -0.42(5.76) | Yes | 1.38 | -0.77(2.12) | No | 5.48 | -1.36(3.77) | Yes | 1.66 | -0.53(1.98) | No | 3.42 | -0.27(2.26) | Yes |
| Mach & Elec | 3.77 | -0.81(3.56) | Yes | 9.40 | -0.96(5.69) | Yes | 2.48 | -0.79(3.06) | No | 0.99 | -0.27(1.34) | No | 0.98 | -0.12(0.52) | No |
| Metals | 8.16 | -0.76(5.12) | Yes | 4.38 | -1.07(4.10) | Yes | 2.55 | -1.12(2.44) | No | 9.72 | -1.34(6.06) | Yes | 6.32 | -1.21(4.86) | Yes |
| Minerals | 2.65 | -0.63(2.73) | No | 3.78 | -0.96(3.31) | Yes | 2.95 | -0.93(3.22) | Yes | 2.70 | -0.70(3.14) | Yes | 4.41 | -0.30(2.56) | Yes |
| Miscellaneous | 2.84 | -0.95(3.16) | Yes | 2.68 | -0.88(2.89) | No | 4.24 | -1.08(3.91) | Yes | 2.50 | -1.007(2.77) | No | 2.80 | -0.98(3.20) | Yes |
| Plastic or rubber | 1.23 | -0.64(2.04) | No | 3.93 | -0.82(3.38) | Yes | 3.66 | -0.83(3.07) | Yes | 1.80 | -0.30(1.18) | No | 1.58 | -0.55(2.13) | No |
| Stone & glass | 1.48 | -0.04(0.32) | No | 0.94 | -0.19(0.74) | No | 3.77 | -0.82(2.96) | Yes | 0.30 | -0.26(0.74) | No | 3.94 | -0.24(3.15) | Yes |
| Textiles & clothing | 10.08 | -0.11(1.43) | Yes | 5.65 | -0.20(1.99) | Yes | 2.66 | -0.16(0.49) | No | 2.95 | -0.14(1.18) | No | 6.54 | -0.31(3.88) | Yes |
| Transportation | 1.51 | -0.26(1.50) | No | 7.23 | -1.42(2.51) | Yes | 3.59 | 4.75(2.04) | Yes | 2.85 | -0.23(1.70) | No | 2.17 | -0.42(2.26) | No |
| Vegetable | 6.94 | -0.82(4.26) | Yes | 4.01 | -0.69(3.36) | Yes | 7.92 | -0.97(4.93) | Yes | 4.85 | -1.29(4.31) | Yes | 4.10 | -1.06(3.57) | Yes |
| Wood | 2.79 | -0.44(2.97) | Yes | 4.98 | -0.33(2.41) | Yes | 4.23 | -1.11(3.62) | Yes | 1.49 | -0.28(1.55) | No | 0.74 | -0.51(1.58) | No |

**Note:** Estimations were based on annual data from 1991 to 2019. T-statistics ratios in parentheses are in absolute value. The F-statistics with unrestricted intercept and no trend denote statistical significance at 10% instead of 1%, 2.5% or 5% so as not to reject most industries that are not cointegrated at those levels. The upper bound critical value is 3.77, and the lower bound critical value at 2.72.

Due to the large sample size used in this study, the results of the long-run analysis will be attached to the appendix. The long-run results for all real exports from LEMEs to the US where the 3-monthly standard deviation was used were presented in Appendix A, while the results for LEMEs' real imports from the US are in Appendix C. On the other hand, the long-run results for LEMEs' real exports to the US with the 12-month volatility measure are presented in Appendix B and LEMEs' real imports from the US using the same measure are presented in Appendix D.

With the 3-month volatility measure in Appendix A, where 90 industries are cointegrated for the real exports from LEMEs to the US, the long-run results from all the countries considered indicate that 13 industries are negatively affected by exchange rate volatility. However, 10 industries have a positive relationship with exchange rate volatility. In contrast, 67 of the 90 cointegrated industries are unaffected by exchange rate volatility, implying that although there is a long-run relationship between the industries and exchange rate volatility, currency fluctuations do not affect the industries. The estimation with the 12-month volatility measure in Appendix B presents the long-run results from LEMEs' real exports to the US, where only 11 out of 86 cointegrated industries were significantly affected negatively by exchange rate volatility, and 8 were positively affected. In comparison, 69 industries show no effect, even though they have a long-run relationship with exchange rate volatility.

## ***Table 3.2A: LEMEs' Real Exports to the US***

**Country-specific ARDL and Bound testing cointegration results from 12-month volatility measure.**

**Source: Authors' computation using STATA15.1**

| | **Brazil** | | | **China** | | | **India** | | | **Indonesia** | | | **Korea** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. |
| Capital goods | 1.72 | -0.44(2.59) | No | 1.70 | -0.02(0.10) | No | 1.57 | -0.32(1.62) | No | 3.54 | -0.38(2.09) | Yes | 7.83 | -0.89(5.20) | Yes |
| Consumer goods | 4.03 | -0.36(3.22) | Yes | 1.45 | -0.12(0.67) | No | 1.01 | -0.44(1.74) | No | 2.09 | -0.66(1.98) | No | 2.52 | -0.28(2.13) | No |
| Intermediate goods | 1.82 | -0.52(2.46) | No | 0.86 | -0.09(0.47) | No | 6.44 | -1.31(4.92) | Yes | 6.45 | -1.06(4.47) | Yes | 7.37 | -0.93(4.95) | Yes |
| Raw materials | 1.49 | -0.56(1.99) | No | 0.73 | -0.33(1.36) | No | 3.02 | -0.67(3.34) | Yes | 1.20 | -0.36(1.38) | No | 2.09 | -0.64(2.51) | No |
| Animal | 4.25 | -0.59(3.80) | Yes | 2.16 | -0.00(0.00) | No | 2.71 | -0.21(1.48) | No | 3.40 | -0.92(3.51) | Yes | 0.94 | -0.34(1.71) | No |
| Chemical | 2.58 | -0.78(3.17) | No | 1.54 | -0.48(1.83) | No | 1.86 | -0.16(1.43) | No | 1.76 | -0.57(1.96) | No | 2.98 | -0.74(2.80) | Yes |
| Food products | 1.88 | -0.75(2.53) | No | 1.46 | -0.09(0.42) | No | 1.62 | -0.22(1.24) | No | 1.60 | -0.58(2.26) | No | 1.46 | -0.01(0.02) | No |
| Footwear | 4.58 | -0.28(2.94) | Yes | 1.76 | -0.27(1.85) | No | 4.73 | -0.41(3.36) | Yes | 0.61 | -0.03(0.17) | No | 5.94 | -0.10(1.41) | Yes |
| Fuels | 3.53 | -0.36(2.65) | Yes | 1.66 | -0.56(1.71) | No | 9.60 | -0.44(4.20) | Yes | 2.96 | -1.18(2.81) | Yes | 1.55 | -0.49(2.08) | No |
| Hides & skins | 1.41 | -0.41(2.07) | No | 1.98 | -0.00(0.03) | No | 5.19 | -0.01(0.06) | Yes | 2.99 | 0.03(0.18) | No | 2.51 | -016(1.81) | No |
| Mach & Elec | 1.69 | -0.24(1.65) | No | 1.77 | -0.00(0.02) | No | 2.24 | -0.30(1.73) | No | 3.78 | -0.37(1.76) | Yes | 5.45 | -0.75(4.18) | Yes |
| Metals | 2.50 | -0.61(2.93) | No | 0.89 | -0.00(0.01) | No | 3.66 | -1.05(3.52) | Yes | 4.84 | -0.80(3.72) | Yes | 2.46 | -0.62(2.86) | No |
| Minerals | 2.71 | -0.57(2.75) | Yes | 0.46 | -0.28(1.23) | No | 6.13 | -1.25(4.84) | Yes | 6.17 | -0.77(4.09) | Yes | 4.10 | -0.53(3.12) | Yes |
| Miscellaneous | 1.03 | -0.45(1.90) | No | 1.93 | -0.29(1.50) | No | 4.09 | -0.88(3.64) | Yes | 2.60 | -0.60(2.72) | No | 1.59 | -0.21(0.99) | No |
| Plastic or rubber | 1.45 | -0.34(1.26) | No | 1.13 | -0.28(1.14) | No | 1.70 | -0.71(2.32) | No | 1.65 | -0.43(1.97) | No | 3.96 | -0.55(1.98) | Yes |
| Stone & glass | 2.27 | -0.33(1.51) | No | 2.05 | -0.11(0.67) | No | 8.15 | -1.17(5.52) | Yes | 0.81 | -0.15(0.90) | No | 1.09 | -0.39(2.06) | No |
| Textiles & clothing | 4.17 | -0.19(1.91) | Yes | 1.17 | -0.11(0.61) | No | 4.38 | -0.89(4.01) | Yes | 5.74 | -0.37(2.81) | Yes | 3.56 | -0.18(2.41) | Yes |
| Transportation | 2.80 | -0.69(3.17) | Yes | 1.94 | -0.65(2.10) | No | 2.21 | -0.92(2.92) | No | 0.99 | -0.38(1.91) | No | 3.37 | -0.30(2.07) | Yes |
| Vegetable | 3.88 | -0.98(3.87) | Yes | 0.88 | -0.35(1.51) | No | 1.90 | -0.90(2.60) | No | 2.71 | -0.70(2.74) | Yes | 3.29 | -0.84(3.22) | Yes |
| Wood | 1.46 | -0.36(1.87) | No | 2.17 | -0.02(0.12) | No | 0.77 | -0.36(1.32) | No | 2.04 | -0.37(2.24) | No | 3.19 | -0.45(2.78) | Yes |

**Note:** Estimations were based on annual data from 1991 to 2019. T-statistics ratios in parentheses are in absolute value. The F-statistics with unrestricted intercept and no trend denote statistical significance at 10% instead of 1%, 2.5% or 5% so as not to reject most industries that are not cointegrated at those levels. The upper bound critical value is 3.77, and the lower bound critical value at 2.72.

## *Table 3.2B: LEMEs' Real Exports to the US*

**Country-specific ARDL and Bound testing cointegration results from 12-month volatility measure.**

**Source: Authors' computation using STATA15.1**

| | Mexico | | | Russia | | | South Arabia | | | South Africa | | | Turkey | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. |
| Capital goods | 1.81 | -0.29(1.45) | No | 8.35 | -1.22(5.65) | Yes | 1.21 | -1.11(1.93) | No | 1.74 | -0.18(1.54) | No | 0.77 | -0.34(1.13) | No |
| Consumer goods | 2.54 | -0.43(2.25) | No | 1.79 | -0.21(1.53) | No | 4.66 | -1.05(3.96) | Yes | 1.98 | -0.47(2.08) | No | 2.24 | -0.24(1.24) | No |
| Intermediate goods | 1.30 | -0.48(2.00) | No | 3.31 | -0.73(3.50) | Yes | 1.02 | -2.45(1.05) | No | 1.25) | -0.43(1.56) | No | 3.85 | -0.98(3.80) | Yes |
| Raw materials | 2.29 | -0.40(2.46) | No | 0.79 | -0.28(1.59) | No | 0.87 | 0.62(0.25) | No | 1.17 | -0.32(2.12) | No | 2.09 | -0.11(0.28) | No |
| Animal | 11.03 | -0.75(6.02) | Yes | 0.98 | -0.24(1.14) | No | 3.21 | -1.21(3.17) | Yes | 7.20 | -0.37(3.67) | Yes | 1.61 | -0.66(2.21) | No |
| Chemical | 7.46 | -0.19(5.24) | Yes | 1.70 | -0.86(1.70) | No | 0.81 | 0.74(0.26) | No | 3.09 | -0.64(2.41) | Yes | 4.01 | -1.11(3.71) | Yes |
| Food products | 2.59 | -0.55(2.35) | No | 1.11 | -0.23(1.30) | No | 1.97 | -0.09(0.36) | No | 16.36 | -2.01(7.60) | Yes | 1.87 | -0.87(2.53) | No |
| Footwear | 6.21 | -0.05(0.47) | Yes | 6.53 | -0.18(1.35) | Yes | 6.92 | -1.67(5.01) | Yes | 1.79 | -0.26(1.71) | No | 1.37 | -0.65(1.89) | No |
| Fuels | 2.81 | -0.36(2.51) | Yes | 1.88 | -0.16(1.34) | No | 0.85 | -0.09(0.08) | No | 5.23 | -1.15(4.47) | Yes | 3.23 | -0.92(3.45) | Yes |
| Hides & skins | 4.79 | -0.27(2.56) | Yes | 1.24 | -0.59(1.90) | No | 2.30 | -1.29(2.00) | No | 3.83 | 0.10(0.79) | Yes | 2.87 | -0.18(1.22) | No |
| Mach & Elec | 6.46 | -1.04(4.52) | Yes | 14.23 | -0.92(6.53) | Yes | 5.28 | -1.09(4.29) | Yes | 1.11 | -0.23(1.32) | No | 1.87 | -0.38(1.73) | No |
| Metals | 8.94 | -0.77(5.53) | Yes | 5.55 | -1.07(4.68) | Yes | 4.90 | -1.68(4.17) | Yes | 6.28 | -1.25(4.80) | Yes | 3.51 | -0.96(3.51) | Yes |
| Minerals | 2.62 | -0.62(2.53) | No | 3.60 | -0.99(3.48) | Yes | 5.38 | -1.23(4.28) | Yes | 2.53 | -0.70(3.00) | No | 3.80 | -0.44(2.58) | Yes |
| Miscellaneous | 3.24 | -1.06(3.39) | Yes | 3.50 | -0.72(3.01) | Yes | 5.31 | -1.28(3.51) | Yes | 4.17 | -0.52(3.03 | Yes | 2.84 | -1.05(3.28) | Yes |
| Plastic or rubber | 0.90 | -0.62(1.69) | No | 2.70 | -0.76(3.12) | Yes | 3.45 | -0.84(3.26) | Yes | 1.00 | -0.40(1.60) | No | 1.37 | -0.48(1.85) | No |
| Stone & glass | 0.83 | -0.08(0.62) | No | 1.41 | -0.09(0.36) | No | 2.63 | -0.67(2.58) | No | 0.75 | -0.08(0.40) | No | 1.72 | -0.24(1.89) | No |
| Textiles & clothing | 8.71 | -0.24(2.64) | Yes | 3.88 | -0.26(2.29) | Yes | 1.90 | 0.40(1.27) | No | 2.24 | -0.16(2.41) | No | 6.68 | -0.25(2.39) | Yes |
| Transportation | 1.51 | -0.17(1.05) | No | 6.60 | -1.38(4.44) | Yes | 2.54 | 7.35(2.30) | No | 1.99 | -0.32(1.45) | No | 3.50 | -0.88(3.50) | Yes |
| Vegetable | 2.79 | -0.54(2.33) | Yes | 2.45 | -0.70(3.03) | No | 1.97 | -0.73(2.58) | No | 3.23 | -1.00(3.46) | Yes | 4.44 | -1.03(3.18) | Yes |
| Wood | 3.32 | -0.48(3.41) | Yes | 3.41 | -0.46(3.11) | Yes | 5.68 | -1.19(4.50) | Yes | 3.11 | -0.14(1.43) | No | 1.33 | -0.53(1.96) | No |

**Note:** Estimations were based on annual data from 1991 to 2019. T-statistics ratios in parentheses are in absolute value. The F-statistics with unrestricted intercept and no trend denote statistical significance at 10% instead of 1%, 2.5% or 5% so as not to reject most industries that are not cointegrated at those levels. The upper bound critical value is 3.77, and the lower bound critical value at 2.72.

Since the industries negatively affected are small, exchange rate volatility does not significantly affect real exports from LEMEs to the US. This outcome is inconsistent with the findings in studies by Hall et al. (2010), Musila and Al-Zyoud (2012), Senadza and Diaba (2018) and Bahmani-Oskooee et al. (2020) conducted in emerging market economies or related developing economies. Considering the underdeveloped nature of LEMEs, this conclusion is surprising and contrary to findings by Arize, Osang and Slottje (2000), Chit et al. (2010) and Khan et al. (2014), who find evidence of a significant negative relationship between exchange rate volatility and real exports from emerging market economies. However, it is worth noting that some of these studies used aggregate trade data, which differs from the disaggregated-industrial trade data employed in this study.

The explanation for the findings might be that risk-loving traders with profit-maximising motives from the US prefer to use the opportunity to increase their trade volume to eliminate any possibility of revenue decline since increasing exchange rate volatility usually happens in these economies. So, trading opportunities to avoid unforeseen circumstances will make US traders engage with LEMEs even as volatility in exchange rates continues to increase. This conclusion is similar to the assertion made by Heroles, Traiberman and Leemput (2020) and Fassas (2020) about risk-loving advanced economies' traders engaging in trade with emerging markets despite high volatility risks associated with their exchange rates.

In addition, further findings indicate that in the long-run real exports from LEMEs, the control variable, the US income (real GDP) denoted by $ln\mathrm{Y}^{\mathrm{USA}}$ in the 3-month volatility measure, is positively significant in 37 industries. Although the number of industries positively significant to the US income is smaller than the cointegrated industries, it shows that an increase in income in the US increases imports from LEMEs, though not to a large extent. More so, results from the real bilateral exchange rate ($REX$) also reveal that 11 US industries are negatively affected by real exchange rates. The same approach was used with a 12-month standard deviation, which shows that the US income is positively significant in 38 industries in the long-run, which is close to half of the cointegrated industries and, as expected, conforms to the a priori expectations. Further analysis with real bilateral exchange rate ($REX$) shows that real exchange rates negatively affected 8 out of the 86 cointegrated industries.

***Table 3.3A: LEMEs' real Imports from the US***

**Country-specific ARDL and Bound testing cointegration results from a 3-month volatility measure.**

**Source: Authors' computation using STATA15.1**

| | **Brazil** | | | **China** | | | **India** | | | **Indonesia** | | | **Korea** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. |
| Capital goods | 4.11 | -0.50(2.61) | Yes | 7.74 | -0.20(4.55) | Yes | 2.49 | -0.18(1.68) | No | 2.83 | -0.79(3.08) | Yes | 4.70 | -0.77(3.07) | Yes |
| Consumer goods | 1.55 | -0.01(0.08) | No | 5.25 | -0.65(3.35) | Yes | 4.76 | -0.55(3.50) | Yes | 2.93 | -0.37(1.70) | No | 4.31 | -0.03(0.36) | Yes |
| Intermediate goods | 3.56 | -0.72(3.26) | Yes | 2.17 | -0.46(2.68) | No | 0.86 | -0.21(1.19) | No | 1.07 | -0.32(1.27) | No | 3.33 | -0.81(3.59) | Yes |
| Raw materials | 1.89 | -0.32(1.44) | No | 6.11 | -0.67(4.33) | Yes | 2.57 | -0.80(3.10) | No | 2.27 | -0.61(2.72) | No | 0.84 | -0.17(0.70) | No |
| Animal | 2.31 | -0.44(2.11) | No | 3.27 | -0.79(3.32) | Yes | 2.46 | -0.54(2.45) | No | 3.71 | -0.32(1.92) | No | 1.03 | -0.44(1.91) | No |
| Chemical | 2.23 | -0.50(2.32) | No | 1.59 | -0.43(2.26) | No | 1.88 | -0.48(2.23) | No | 1.80 | -0.70(2.38) | No | 3.81 | -0.81(3.48) | Yes |
| Food products | 2.68 | -0.53(2.89) | No | 2.79 | -0.61(2.25) | Yes | 1.31 | -0.18(1.22) | No | 6.51 | -0.64(4.06) | Yes | 2.76 | -0.10(0.78) | No |
| Footwear | 5.97 | -1.004(4.29) | Yes | 4.38 | -0.39(3.05) | Yes | 1.65 | -0.55(1.94) | No | 0.95 | -0.13(0.81) | No | 1.57 | -0.22(1.27) | No |
| Fuels | 1.59 | -0.09(0.75) | No | 2.83 | -0.93(3.25) | Yes | 2.31 | -0.52(2.33) | No | 1.25 | -0.41(1.46) | No | 0.46 | -0.14(0.80) | No |
| Hides & skins | 3.13 | -1.11(3.30) | Yes | 4.70 | -0.42(1.96) | Yes | 3.62 | -0.21(2.08) | Yes | 0.70 | -0.20(1.12) | No | 0.58 | -0.18(0.79) | No |
| Mach & Elec | 4.58 | -0.41(2.25) | Yes | 3.50 | -0.31(1.51) | No | 4.50 | -0.24(2.22) | Yes | 2.88 | -0.60(2.85) | Yes | 9.10 | -0.62(3.71) | Yes |
| Metals | 7.04 | -0.67(4.07) | Yes | 5.26 | -0.50(2.63) | Yes | 1.05 | -0.20(1.33) | No | 1.23 | -0.36(1.98) | No | 0.76 | -0.33(1.32) | No |
| Minerals | 4.69 | -1.02(3.85) | Yes | 6.02 | -0.62(3.53) | Yes | 2.50 | -0.83(3.03) | No | 2.19 | -0.75(2.76) | No | 1.87 | -0.62(2.43) | No |
| Miscellaneous | 6.88 | -0.68(4.03) | Yes | 2.96 | -0.61(2.92) | Yes | 0.62 | -0.24(1.12) | No | 0.64 | -0.16(0.89) | No | 3.43 | -0.74(3.53) | Yes |
| Plastic or rubber | 5.83 | -0.88(4.14) | Yes | 8.60 | -0.26(1.93) | Yes | 3.45 | -0.05(0.45) | No | 2.86 | -0.43(2.25) | Yes | 3.91 | -0.51(2.52) | Yes |
| Stone & glass | 3.76 | -0.55(2.39) | Yes | 6.81 | -0.96(4.68) | Yes | 1.13 | -0.08(0.53) | No | 3.64 | -0.61(2.76) | Yes | 3.27 | -0.74(3.09) | Yes |
| Textiles & clothing | 6.01 | -1.12(4.70) | Yes | 2.28 | -0.47(2.94) | No | 7.80 | -1.07(4.93) | Yes | 2.42 | -0.75(2.45) | No | 2.14 | -0.56(2.55) | No |
| Transportation | 1.78 | -0.55(2.47) | No | 2.09 | -0.66(2.58) | No | 2.76 | -0.68(3.05) | Yes | 1.89 | -0.62(2.43) | No | 2.53 | -0.55(2.60) | No |
| Vegetable | 3.49 | -0.85(3.50) | Yes | 14.31 | -0.96(6.95) | Yes | 3.78 | -1.18(3.86) | Yes | 3.05 | -0.61(2.75) | Yes | 3.41 | -0.90(3.24) | Yes |
| Wood | 7.76 | -0.81(4.72) | Yes | 2.88 | -0.47(1.55) | No | 2.28 | -0.12(0.56) | No | 1.42 | -0.25(1.27) | No | 7.79 | -0.88(4.77) | Yes |

**Note:** Estimations were based on annual data from 1991 to 2019. T-statistics ratios in parentheses are in absolute value. The F-statistics with unrestricted intercept and no trend denote statistical significance at 10% instead of 1%, 2.5% or 5% so as not to reject most industries that are not cointegrated at those levels. The upper bound critical value is 3.77, and the lower bound critical value at 2.72.

## *Table 3.3B: LEMEs' real Imports from the US*

**Country-specific ARDL and Bound testing cointegration results from a 3-month volatility measure.**

**Source: Authors' computation using STATA15.1**

| | Mexico | | | Russia | | | Saudi Arabia | | | South Africa | | | Turkey | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. |
| Capital goods | 1.24 | -0.33(1.73) | No | 3.11 | -0.66(2.81) | Yes | 1.48 | -0.51(2.05) | No | 3.13 | -0.77(3.13) | Yes | 2.60 | -0.83(2.98) | No |
| Consumer goods | 1.58 | -0.48(2.40) | No | 3.85 | -0.95(3.73) | Yes | 1.94 | -0.61(2.01) | No | 7.29 | -1.06(5.30) | Yes | 6.23 | -0.60(3.72) | Yes |
| Intermediate goods | 1.09 | -0.20(0.95) | No | 1.27 | -0.45(1.91) | No | 2.14 | -0.50(1.90) | No | 5.39 | -0.87(4.18) | Yes | 3.28 | -0.47(2.78) | Yes |
| Raw materials | 5.04 | -0.70(3.95) | Yes | 1.00 | -0.24(1.58) | No | 3.23 | -0.79(3.28) | Yes | 2.51 | -0.65(2.08) | No | 4.07 | -0.43(3.02) | Yes |
| Animal | 9.79 | -0.46(3.14) | Yes | 0.65 | -0.22(1.38) | No | 2.73 | -0.44(1.95) | Yes | 1.64 | -0.41(1.79) | No | 7.52 | -0.70(4.65) | Yes |
| Chemical | 2.29 | -0.13(0.91) | No | 6.99 | -0.99(4.64) | Yes | 3.83 | -1.10(3.79) | Yes | 7.16 | -1.12(5.09) | Yes | 5.72 | -0.93(4.44) | Yes |
| Food products | 2.87 | -0.43(2.12) | Yes | 6.40 | -0.58(2.56) | Yes | 6.41 | -0.51(3.86) | Yes | 4.32 | -0.67(3.20) | Yes | 7.45 | -0.81(3.43) | Yes |
| Footwear | 1.29 | -0.27(1.17) | No | 2.42 | -0.53(2.28) | No | 11.22 | -1.19(5.66) | Yes | 2.53 | -0.18(0.64) | No | 6.86 | -0.59(2.66) | Yes |
| Fuels | 1.07 | -0.39(1.80) | No | 5.52 | -0.69(3.89) | Yes | 4.62 | -1.21(4.25) | Yes | 2.49 | -0.83(3.12) | No | 5.88 | -0.47(2.91) | Yes |
| Hides & skins | 0.71 | -0.28(1.53) | No | 3.51 | -1.12(3.30) | Yes | 4.47 | -1.21(3.69) | Yes | 3.08 | -0.87(3.15) | Yes | 8.31 | -0.75(5.45) | Yes |
| Mach & Elec | 1.15 | -0.35(1.84) | No | 3.32 | -0.47(2.39) | Yes | 4.32 | -1.29(3.62) | Yes | 3.84 | -0.72(2.89) | Yes | 2.59 | -0.63(2.98) | No |
| Metals | 4.96 | -0.79(3.80) | Yes | 8.75 | -1.14(5.51) | Yes | 3.48 | 0.16(0.44) | No | 3.78 | -0.87(3.52) | Yes | 2.74 | -0.31(2.24) | Yes |
| Minerals | 3.21 | -0.50(2.33) | Yes | 7.62 | -1.40(5.33) | Yes | 3.72 | -1.13(3.34) | Yes | 2.22 | -0.53(2.72) | No | 2.38 | -0.70(2.86) | No |
| Miscellaneous | 1.20 | -0.36(1.59) | No | 1.04 | -0.26(1.24) | No | 3.90 | -1.15(3.28) | Yes | 10.63 | -0.55(3.06) | Yes | 0.84 | -0.16(0.98) | No |
| Plastic or rubber | 1.32 | -0.10(0.40) | No | 1.31 | -0.28(1.40) | No | 3.92 | -1.007(3.67) | Yes | 9.54 | -1.09(6.13) | Yes | 5.20 | -0.55(3.62) | Yes |
| Stone & glass | 6.06 | -0.63(3.66) | Yes | 1.39 | -0.52(2.08) | No | 2.40 | -0.93(2.73) | No | 2.27 | -0.44(2.18) | No | 2.82 | -0.65(2.87) | Yes |
| Textiles & clothing | 2.32 | -0.17(1.49) | No | 2.41 | -0.63(2.52) | No | 7.02 | -0.69(3.87) | Yes | 3.73 | -0.71(2.19) | Yes | 6.29 | -0.99(4.82) | Yes |
| Transportation | 1.56 | -0.30(1.69) | No | 1.21 | -0.55(2.13) | No | 2.15 | -0.71(2.63) | No | 3.09 | -0.82(3.13) | Yes | 3.21 | -0.75(3.29) | Yes |
| Vegetable | 3.48 | -0.73(3.48) | Yes | 3.48 | -0.26(0.91) | No | 2.55 | -0.72(2.81) | No | 4.31 | -0.85(2.89) | Yes | 6.10 | -3.66(2.56) | Yes |
| Wood | 3.17 | -0.97(3.44) | Yes | 3.68 | -0.79(3.50) | Yes | 13.81 | -1.36(6.82) | Yes | 1.39 | -0.57(1.92) | No | 3.80 | -0.35(2.14) | Yes |

**Note:** Estimations were based on annual data from 1991 to 2019. T-statistics ratios in parentheses are in absolute value. The F-statistics with unrestricted intercept and no trend denote statistical significance at 10% instead of 1%, 2.5% or 5% so as not to reject most industries that are not cointegrated at those levels. The upper bound critical value is 3.77, and the lower bound critical value at 2.72.

## *Table 3.4A: LEMEs' real Imports from the US*

**Country-specific ARDL and Bound testing cointegration results from a 12-month volatility measure.**
**Source: Authors' computation using STATA15.1**

| | Brazil | | | China | | | India | | | Indonesia | | | Korea | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. | F | $ECM_{t-1}$ | Coint. |
| Capital goods | 5.99 | -0.38(1.78) | Yes | 4.32 | -0.71(3.13) | Yes | 4.22 | -0.49(3.20) | Yes | 1.72 | -0.70(1.81) | No | 6.02 | -0.58(3.93) | Yes |
| Consumer goods | 3.75 | -0.16(1.18) | Yes | 5.27 | -0.74(3.48) | Yes | 2.29 | -0.43(2.28) | No | 2.23 | -0.49(2.63) | No | 3.88 | -0.13(1.10) | Yes |
| Intermediate goods | 5.46 | -0.74(3.21) | Yes | 2.28 | -0.50(2.96) | No | 0.48 | -0.26(1.07) | No | 1.73 | -0.49(2.06) | No | 4.18 | -0.82(3.83) | Yes |
| Raw materials | 0.79 | -0.2 8(1.02) | No | 4.14 | -0.68(3.18) | Yes | 1.67 | -0.57(2.28) | No | 3.53 | -0.98(3.47) | No | 1.16 | -0.18(0.79) | No |
| Animal | 4.87 | -0.58(3.08) | Yes | 1.81 | -0.66(2.45) | No | 2.61 | -0.63(2.71) | No | 1.10 | -0.52(1.53) | No | 2.44 | -0.46(2.45) | No |
| Chemical | 3.16 | -0.65(2.80) | Yes | 2.57 | -0.44(2.80) | No | 1.26 | -0.52(2.05) | No | 2.50 | -0.79(2.79) | No | 3.85 | -0.86(3.55) | Yes |
| Food products | 3.50 | -0.81(3.43) | Yes | 7.00 | -1.21(4.52) | Yes | 1.73 | -0.28(1.63) | No | 3.07 | -0.74(3.17) | Yes | 4.97 | -0.05(0.40) | Yes |
| Footwear | 4.18 | -0.93(3.66) | Yes | 3.53 | -0.36(2.56) | Yes | 3.75 | -1.02(3.80) | Yes | 1.53 | -0.27(1.38) | No | 1.32 | -0.17(1.28) | No |
| Fuels | 1.38 | -0.23(1.26) | No | 3.63 | -0.74(3.27) | Yes | 1.66 | -0.62(2.42) | No | 2.49 | -0.58(2.55) | No | 1.73 | -0.13(0.79) | No |
| Hides & skins | 3.99 | -1.08(3.57) | Yes | 3.33 | -0.32(1.69) | Yes | 3.05 | -0.36(2.46) | Yes | 3.02 | -0.41(2.62) | Yes | 0.76 | -0.06(0.32) | No |
| Mach & Elec | 6.84 | -0.33(1.80) | Yes | 1.81 | -0.14(0.67) | No | 4.01 | -0.24(2.06) | Yes | 2.33 | -0.51(2.58) | No | 8.65 | -0.66(4.58) | Yes |
| Metals | 4.49 | -0.70(3.61) | Yes | 3.67 | -0.43(1.65) | Yes | 1.53 | -0.27(1.63) | No | 1.63 | -0.30(1.31) | No | 1.96 | -0.38(2.18) | No |
| Minerals | 7.12 | -1.08(4.56) | Yes | 6.56 | -0.72(3.25) | Yes | 2.41 | -0.80(2.59) | No | 2.85 | -0.93(3.28) | Yes | 2.80 | -0.71(3.00) | Yes |
| Miscellaneous | 8.90 | -0.82(5.54) | Yes | 5.51 | -0.96(3.50) | Yes | 1.32 | -0.40(1.79) | No | 3.35 | -0.43(2.76) | Yes | 1.07 | -0.45(1.77) | No |
| Plastic or rubber | 5.35 | -0.81(3.50) | Yes | 6.89 | 0.01(0.09) | Yes | 1.56 | -0.11(0.82) | No | 1.90 | -0.51(1.98) | No | 2.13 | -0.58(2.51) | No |
| Stone & glass | 5.66 | -0.83(3.59) | Yes | 12.41 | -1.18(6.24) | Yes | 1.14 | -0.19(0.89) | No | 3.63 | -0.79(3.62) | Yes | 2.80 | -0.74(3.19) | Yes |
| Textiles & clothing | 7.32 | -1.35(5.30) | Yes | 2.79 | -0.56(3.29) | Yes | 2.80 | -0.85(3.01) | Yes | 2.81 | -0.90(2.93) | Yes | 3.15 | -0.33(1.67) | No |
| Transportation | 3.55 | -0.59(2.92) | Yes | 2.25 | -0.64(2.24) | No | 2.36 | -0.61(2.70) | No | 2.04 | -0.69(2.70) | No | 1.89 | -0.56(2.38) | No |
| Vegetable | 2.09 | -0.84(2.79) | No | 9.47 | -0.92(4.60) | Yes | 7.14 | -1.27(4.90) | Yes | 5.09 | -0.81(3.50) | Yes | 2.45 | -0.73(2.98) | No |
| Wood | 7.60 | -0.74(4.88) | Yes | 2.44 | -0.59(1.49) | No | 1.76 | -0.43(1.97) | No | 4.66 | -0.56(3.20) | Yes | 8.78 | -0.84(5.11) | Yes |

**Note:** Estimations were based on annual data from 1991 to 2019. T-statistics ratios in parentheses are in absolute value. The F-statistics with unrestricted intercept and no trend denote statistical significance at 10% instead of 1%, 2.5% or 5% so as not to reject most industries that are not cointegrated at those levels. The upper bound critical value is 3.77, and the lower bound critical value at 2.72.

*Table: 3.4B: LEMEs real Imports to the US*

**Country-specific ARDL and Bound testing cointegration results from a 12-month volatility measure.**

**Source: Authors' computation using STATA15.1**

| | Mexico | | | Russia | | | South Arabia | | | South Africa | | | Turkey | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | F | ECM$_{t-1}$ | Coint. | F | ECM$_{t-1}$ | Coint. | F | ECM$_{t-1}$ | Coint. | F | ECM$_{t-1}$ | Coint. | F | ECM$_{t-1}$ | Coint. |
| Capital goods | 2.05 | -0.24(1.28) | No | 3.04 | -0.56(2.69) | Yes | 1.36 | -0.37(1.63) | No | 3.12 | -0.77(3.03) | Yes | 2.20 | -0.88(2.84) | No |
| Consumer goods | 3.01 | -0.46(2.51) | Yes | 4.67 | -0.77(3.68) | Yes | 2.26 | -0.34(1.14) | No | 3.92 | -0.72(3.87) | Yes | 1.86 | -0.24(0.87) | No |
| Intermediate goods | 1.13 | -0.11(0.52) | No | 1.14 | -0.59(2.04) | No | 2.00 | -0.76(2.68) | No | 1.61 | -0.53(2.16) | No | 1.26 | -0.32(1.64) | No |
| Raw materials | 3.94 | -0.57(3.29) | Yes | 0.58 | -0.15(1.15) | No | 3.55 | -0.97(3.74) | Yes | 1.58 | -0.59(1.99) | No | 2.00 | -0.16(0.81) | No |
| Animal | 7.27 | -0.43(3.09) | Yes | 0.86 | -0.25(1.66) | No | 1.24 | -0.32(1.38) | No | 1.65 | -0.37(1.68) | No | 5.49 | -0.83(3.86) | Yes |
| Chemical | 1.87 | -0.13(1.00) | No | 5.06 | -0.93(3.99) | Yes | 4.44 | -1.11(4.00) | Yes | 5.12 | -1.08(4.13) | Yes | 5.84 | -1.01(4.44) | Yes |
| Food products | 2.34 | -0.31(1.89) | No | 5.97 | -0.64(3.33) | Yes | 7.45 | -0.66(4.48) | Yes | 3.15 | -0.57(2.77) | Yes | 2.41 | -0.74(2.39) | No |
| Footwear | 2.36 | -0.14(0.74) | No | 7.05 | -0.19(0.92) | Yes | 4.69 | -0.86(3.88) | Yes | 2.63 | -0.30(1.24) | No | 4.06 | -0.74(3.27) | Yes |
| Fuels | 1.64 | -0.46(2.36) | No | 3.53 | -0.73(3.50) | Yes | 2.78 | -0.90(3.12) | Yes | 2.43 | -0.42(2.16) | No | 1.73 | -0.27(0.99) | No |
| Hides & skins | 1.89 | -0.35(2.29) | No | 2.42 | -0.84(2.68) | No | 5.98 | -1.15(4.10) | Yes | 5.16 | -1.07(4.13) | Yes | 8.45 | -0.65(5.14) | Yes |
| Mach & Elec | 2.04 | -0.25(1.38) | No | 1.47 | -0.50(2.23) | No | 2.14 | -0.52(1.64) | No | 6.35 | -0.86(3.99) | Yes | 2.38 | -0.58(2.80) | No |
| Metals | 3.45 | -0.81(3.66) | Yes | 1.50 | -0.68(2.37) | No | 1.31 | -0.33(1.16) | No | 4.81 | -0.89(4.25) | Yes | 7.15 | -0.12(1.04) | Yes |
| Minerals | 3.20 | -0.46(2.43) | Yes | 7.77 | -1.56(5.13) | Yes | 2.80 | -0.97(2.87) | Yes | 1.96 | -0.45(2.53) | No | 2.94 | -0.78(3.14) | Yes |
| Miscellaneous | 1.97 | -0.48(1.93) | No | 1.88 | -0.34(1.87) | No | 3.85 | -1.01(3.32) | Yes | 10.34 | -0.66(4.90) | Yes | 1.06 | -0.36(1.54) | No |
| Plastic or rubber | 2.07 | -0.04(0.14) | No | 1.12 | -0.46(1.80) | No | 3.52 | -0.93(3.62) | Yes | 5.56 | -1.04(4.67) | Yes | 2.98 | -0.49(2.82) | Yes |
| Stone & glass | 5.88 | -0.61(3.12) | Yes | 1.91 | -0.52(2.15) | No | 2.53 | -0.83(3.00) | No | 1.39 | -0.40(1.86) | No | 3.15 | -0.79(3.29) | Yes |
| Textiles & clothing | 6.97 | -0.14(1.70) | Yes | 3.71 | -0.37(2.05) | Yes | 1.15 | -0.53(1.46) | No | 2.26 | -0.87(2.63) | No | 5.13 | -1.09(4.46) | Yes |
| Transportation | 1.66 | -0.28(1.99) | No | 1.36 | -0.46(1.65) | No | 1.54 | -0.58(2.34) | No | 3.09 | -0.80(3.29) | Yes | 4.18 | -1.05(3.97) | Yes |
| Vegetable | 3.15 | -0.61(3.14) | Yes | 1.41 | -0.03(0.13) | No | 3.26 | -0.99(3.53) | Yes | 2.82 | -0.75(2.38) | Yes | 5.33 | -0.26(1.56) | Yes |
| Wood | 2.32 | -0.68(2.17) | No | 5.00 | -0.84(3.90) | Yes | 3.27 | -0.99(3.39) | Yes | 3.26 | -0.46(1.95) | Yes | 4.00 | -0.54(2.60) | Yes |

**Note:** Estimations were based on annual data from 1991 to 2019. T-statistics ratios in parentheses are in absolute value. The F-statistics with unrestricted intercept and no trend denote statistical significance at 10% instead of 1%, 2.5% or 5% so as not to reject most industries that are not cointegrated at those levels. The upper bound critical value is 3.77, and the lower bound critical value at 2.72.

Since the negative effects of the real exchange rate on the real exports from LEMEs to the US within the two periods considered are low compared to the number of industries impacted, the result implies that a unit appreciation of the US dollar will not negatively affect US imports from LEMEs**.** This reinforces the findings that exchange rate risk does not reduce US importation from LEMEs.

### 3.5.2 Analysing LEMEs' Real Imports from the US

The results in Table 3A are based on LEMEs imports from the US and a similar approach with a 3-month standard deviation was employed to determine whether there is a long-run relationship between variables. The results indicate that 13 and 14 export industries from the US to Brazil and China are cointegrated. India and Indonesia have 6, each with 10 export industries from the US to Korea, showing long-run relationships. For Table 3B, Mexico and Russia have 8 and 10 cointegrated export industries from the US. Saudi Arabia and South Africa have 13 industries, with 16 cointegrated industries in Turkey. Therefore, for the 3-month volatility measure, real imports of LEMEs from the US have 109 cointegrated industries.

The 12-month volatility measure presented in Tables 4A and 4B shows that real imports from the US to LEMEs have 17 industries cointegrated in Brazil, with 14 in China and 6 in India. Indonesia and Korea indicate a long-run relationship in 8 and 9 industries, respectively. There is also a long-run relationship in 8 industries in Mexico, 10 in Russia and 11 in Saudi Arabia. For the last two countries studied, South Africa and Turkey,12 industries are cointegrated. Therefore, while 86 out of 200 industries are cointegrated in real exports from LEMEs to the US, another 107 industries are cointegrated in real imports from the US to LEMEs, giving a total of 193 cointegrated industries out of 400.

In the short-run real imports from the US to LEMEs presented in the appendix, 72 out of 200 industries have a significant coefficient. Again, these coefficients were either negative or positive or both and were obtained across different lags of the volatility. Meanwhile, the total number of industries with a significant coefficient in the short-run for real exports and imports is less than half of the industries considered. The result implies that although it portrays the *a priori* and theoretical expectation that prices take time to adjust to any monetary policy change due to price stickiness in the short-run, it also reflects that some industries might react to exchange rate volatility in the short-run. This can be possible, especially in LEMEs where economic and external shockwaves can affect prices even in the short-run. However, the limited number of industries with significant coefficients shows a sign of a weak relationship between exchange rate volatility and international trade flows in the short-run in LEMEs. In other words, the impact of exchange rate volatility on international trade flows can be positive or negative, or there might be no effect, only the existence of a long-run relationship.

The long-run results with a 3-month standard deviation for real imports of LEMEs from the US in Appendix C show that from the 109 industries cointegrated, 15 are negatively affected by exchange rate volatility. At the same time, 17 have a positive relationship with exchange rate volatility, but 77 industries are not affected though they have a long-run relationship with exchange rate volatility. Appendix D presents the long-run results on real imports from the US to LEMEs for each country in LEMEs. Of the 107 cointegrated industries for imports from the US to LEMEs, 13 were impacted negatively by exchange rate volatility, and 9 have a significant positive relationship with exchange rate volatility. In comparison, 85 industries, although they have a long-run relationship, are unaffected by exchange rate volatility.

The results above suggest that LEMEs imports from the US are not significantly negatively affected by exchange rate volatility. These results show a different conclusion from Akpokodje and Omojimite (2009) and Khan et al. (2014) with data from ECOWAS and other developing economies in the same group with LEMEs. Another estimation between income and imports shows that using the 3-month volatility measure, LEMEs income as expected has a positive significant coefficient with 70 industries while 30 are affected by real exchange rates. The same positive relationship between imports and income exists in 63 industries, but real exchange rates affected 21 industries negatively when the 12-month standard deviation is applied. The positive relationship between income and LEMEs imports from the US from the two periods conforms to a prior expectation that the long-run coefficient is supposed to be positive and significant, indicating a positive correlation between exchange rate volatility and LEMEs' imports from the US.

On the other hand, the impact of the real exchange rate on 30 and 21 industries (a very low number compared to 109 and 106 cointegrated import industries from the US) indicates that an increase in a unit of each LEMEs currency will not negatively affect their importation from the US. In total, the number of industries negatively affected by exchange rate volatility in the long-run from exports and imports compared to LEMEs' international trade flows with the US is 28 in the 3-month analysis and 26 in the 12-month analysis from 400 industries in each measure. This is relatively low but also an indication that exchange rate volatility in LEMEs has little or no impact on the trade flows with their leading trade partner, the US. All the results from disaggregated industrial-level trade data obtained from the 3-month and 12-month estimates show that exchange rate volatility does not negatively impact international trade flows between LEMEs and the US.

Other factors influencing negative or positive relationships between exchange rate volatility and the industries considered are trade relations, regulations, barriers and tariffs, and risk-averse or risk-loving traders. Additionally, large industries' ability to hedge can protect them from the negative effects of exchange rate volatility which might not be possible for small industries due to the costs and maturity dates associated with financial hedging through forward exchange markets. In addition, trade barriers and regulations can increase exchange rate volatility which negatively affects imports especially when such barriers are placed on importation; risk-averse traders might apply caution due to profit uncertainty. For example, trade barriers placed on the importation of animals, food products, minerals and transportation in Brazil increase exchange rate volatility which negatively impacts the country's real imports from those industries in the US in the 12-month volatility measure.

With a 3-month volatility measure, Turkey's real exports to the US (intermediate goods, raw materials, animals, metals, textiles and clothing, and vegetables) reacted negatively to exchange rate volatility. Still, their real imports of consumer goods, intermediate goods, raw materials, animals, chemicals, food products and fuels from the US show a positive relationship between exchange rate volatility and the industries. This could be due to the US increasing economic growth that improves the country's ability to produce more close substitute goods, so fluctuations of the Turkish Lira can discourage US importation from Turkey. The positive side is that small industries' risk-loving owners might take advantage of increasing exchange rate volatility to maximise their profit with the view that the benefit outweighs the risk of profit variance. So size, trade regulations and rules, trade agreements between countries, weak or advanced financial systems, hedging abilities, risk aversion, and risk loving are all determinants of whether the relationship between exchange rate volatility and industries in LEMEs will be positive or negative.

In terms of the comparative analysis as part of the significance of this study, there are few differences in the results obtained from each of the 10 countries studied using the 3-month and 12-month volatility measures. There are either little or no impacts from exchange rate volatility on the industries considered in LEMEs for real exports to the US and the industries for real imports from the US to LEMEs. The only exception is the real exports from China to the US, where there is no long-run relationship between the 20 industries selected and exchange rate volatility. Although it has been argued that it is because China pegged its currency to the US dollar at some point, trade between China and the US does not correlate with long-term exchange rate volatility. However, real imports from the US to China show the existence of cointegration with some of the industries. The argument still holds, including that China has a high production capacity in different industries that helps them to offset price increases. Likewise, a positive relationship between monetary policy and macroeconomic factors can reduce crisis from exchange rate volatility and make it less likely to be perceived in the economy. Again, considering that the US have a robust financial system that can withstand price shocks, it has the capacity to engage in international trade even amid exchange rate volatility.

The results from Saudi Arabia as one of the top oil-producing countries in the world also show that exchange rate volatility and fuel export from the country to the US are not cointegrated; however, Saudi Arabia's specially processed fuels imports from the US and exchange rate volatility are cointegrated though the fuel price is not affected by exchange rate volatility. This could be because Saudi Arabian income ($LnY^{SAUDI\ ARABIA}$) is positively significant at 2.72(8.19), and the real exchange rate (lnREX) of Saudi Arabian riyal to the US dollar is also positively significant at 1.85(1.96). Therefore, exchange rate volatility cannot hurt Saudi's fuel import from the US since the rate of the Lira is on par with the US dollar. The same results were found in all the countries studied, indicating that with an effort to maximise their endowment and productive capacity, the negative impacts of exchange rate volatility can be absorbed by LEMEs. Therefore, adjusting exchange rates during trade loss or price increases may not necessarily improve LEMEs' benefit from the international markets or make any difference in international trade flows.

Summarily, the results from the two estimates used, the 3-month and 12-month volatility measures, are close, with a slight difference between the two periods. This lies in the number of industries affected positively or negatively and those unaffected by exchange rate volatility from the real exports and imports between LEMEs and the US. For instance, the 3-month volatility results for real exports from China to the US reveal that capital goods and transportation industries are cointegrated with exchange rate volatility. However, there is no effect of exchange rate volatility on the industries. This is different from the 12-month volatility measure, where none of the industries from real Chinese exports to the US shows the existence of a long-run relationship with exchange rate volatility.

Another interesting difference in using 3-month volatility can be seen in real exports from Turkey to the US, which reveals that exchange rate volatility negatively affects intermediate goods, raw materials, animals, metals, textiles and clothing, and vegetables. However, in estimating Turkey's real imports from the US using the same 3-month volatility, a positive relationship exists between exchange rate volatility and some of the real exports industries impacted negatively by exchange rate volatility (intermediate goods, raw materials, animals, food products, fuels, chemical, and consumer goods). This implies that an appreciation in Turkish Lira hurts exportation from the 6 industries to the US in the short-term period. But when Turkey imports from similar industries (intermediate goods, raw materials, and animals) in the US, the fluctuations in the Turkish Lira do not negatively influence the imports.

This conforms to the previous conclusion by Katusiime (2018) regarding the impacts of exchange rate volatility and international trade flows in advanced economies with robust and advanced financial systems when compared to LEMEs with underdeveloped financial systems. Findings from this study reinforce the conclusion that exchange rate volatility does not affect international trade in advanced economies due to the capacity of their financial institutions to withstand external and internal shocks to their currency. However, the weak financial system in LEMEs makes them vulnerable to risks arising from exchange rate volatility. Furthermore, only two industries, chemicals and fuels, are negatively affected by exchange rate volatility for real exports from Turkey to the US in the 12-month volatility results. On the other hand, the industries for raw materials are either not cointegrated or affected by exchange rate volatility in the 3-month and 12-month measures for imports or exports in all the countries. However, the 3-month volatility measure for Turkey is negatively related to exchange rate volatility for real exports from Turkey to the US and positively related to exchange rate volatility for Turkey's real imports from the US.

In conclusion, monetary authorities in LEMEs can improve trade participation by responding systematically to fluctuations in outputs. Again, with consistency in obtaining better control of the domestic monetary conditions, flexible monetary policy in LEMEs might influence their response to external shocks. It can also allow LEMEs to absorb the shockwaves in the economies without generating significant inflationary or deflationary pressures when there is a shift in terms of trade. An effective combination of flexible exchange rates and unconventional monetary policy in LEMEs can favour exchange rates and increase interest rates. This will aid in profitable participation in the global markets and improve overall macroeconomic stability.

### 3.6 Policy Implications and Policy Recommendations

This section discusses the key policy implications and recommendations based on the findings from this study.

For LEMEs, the benefits of engaging in international trade whilst working towards economic and financial sustainability cannot be overestimated. Although overall economic improvement through trade is the primary aim of LEMEs, there have been trade inequalities among advanced economies and LEMEs presumed to result from an underdeveloped financial system with other systemic conditions and ripple effects that lead to increasing exchange rate volatility. Hence, increasing exchange rate volatility, in turn, is the reason for LEMEs' inadequate participation in international markets.

Therefore, this study moves against the theoretical background and some empirical studies' conclusions to reveal that there is more to LEMEs' problem of trade deficit than a reflection of their financial system. Firstly, determining the exchange rate-trade relationship is a complex issue considering that exchange rate depreciation or appreciation could pose a risk for traders, improve traders' confidence to trade, or may not affect trade despite being correlated. In the same way, adjusting monetary policy to favour trade policy might not yield the desired result depending on the approach and economic situation within an economy at a time. As depreciation in the exchange rate is expected to reduce a country's imports, an increase in domestic demand due to monetary policy change may increase imports in an offsetting movement. The same can be the case for exports, especially with a country's trade partner; as the exchange rate depreciates, they would want more of the partner's goods even if there is an appreciation in exporting country's currency and vice versa. There is no one-size-fits-all in determining the relationship between exchange rate volatility and international trade flows.

However, it is essential to note that the transmission of exchange rate risk can be transactional, translational, operational or economic risks. So, it will be imperative to establish the real effects of exchange rate volatility on trade and the degree of risk it poses to ascertain the type of monetary policy suitable for adjustments. Undoubtedly, the impact of exchange rate volatility can be severe not just on trade flows but on the entire macroeconomic system. Therefore, adjusting monetary policy can help LEMEs buffer external shocks, reduce financial and fiscal crises, and achieve overall macroeconomic stability. However, that cannot be possible when there is a disconnection between monetary policy and macroeconomic policy.

Considering the points above, adjusting monetary policy in light of exchange rate volatility might adversely affect an entire economy and trade flows. Mismanaging monetary stimulus in already fractured economies like LEMEs can only worsen the existing conditions. This consequence can spread through all sectors of the economies and continue to set them back in terms of growth and increase trade inequalities.

Therefore, this study recommends that policymakers in LEMEs apply caution when trying to improve the trade deficit using only exchange rate control. Instead, the authorities should consider the real effects and the direction of risks, including the industry(ies) affected, before designing a policy that will work to remedy the situation because other macroeconomic factors unrelated to the exchange rate might be the problem. The authorities in LEMEs should ensure that there is a collaboration between monetary and macroeconomic policy frameworks to achieve the desired results for financial and price stability in the economies and engage in profitable trading with the rest of the world. That is, the macroeconomic policy should have a place in monetary policymaking.

### 3.7 Conclusion and Areas for Further Study

This empirical chapter has investigated the effects of exchange rate volatility on international trade flows in 10 large emerging market economies (LEMEs) that adopted flexible monetary policy and inflation targeting (IT), namely Brazil, China, India, Indonesia, Korea, Mexico, Russia, Saudi Arabia, South Africa and Turkey. The study employed the ARDL and bound testing model using 3- and 12-monthly standard deviation to estimate disaggregated industrial-level trade data from 20 industries for real exports from LEMEs to the US and 20 industries from US exports to LEMEs, real exchange rate, volatility rate and real GDP from 1991 to 2019. The outcome from the long-run estimation reveals that exchange rate volatility negatively impacts a minimal number of exports and import industries from the ten countries considered. This implies that although exchange rate volatility affects some industries analysed for real exports and imports in the trade between LEMEs and the US, other institutional risks could contribute to how well the economies perform in the international markets.

Therefore, adjusting the exchange rate through monetary policy alone might offer many advantages unless the macroeconomic factors are modified too. The short-run analyses also dictate the existence of a weak relationship between exchange rate volatility and international trade flows between LEMEs' industries and the US industries. The result is particularly a positive step toward LEMEs' pursuit of financial stability while still participating profitably in the global markets through trade. As indicated previously, unfavourable participation on the side of LEMEs in international markets is not a result of the increasing exchange rate volatility mostly prevalent in LEMEs. Other macroeconomic factors could hinder the enhancement of LEMEs' productive capacity alongside a weak financial system. The problem of trade deficits in LEMEs should be managed through the combination of monetary and macroeconomic policies that suit the structure of LEMEs for them to gain from trading in the international markets.

Further studies on this topic can consider applying structural breaks on country-specific disaggregated trade data and include another control variable like inflation rates to find out which monetary policy regime increased the level of the negative relationship between exchange rate volatility and international trade flows in LEMEs.

## Appendix 3A: Estimation Variables and Sources

***Table 3A1: Estimation tools, Descriptions, and Sources of variables.***

| VARIABLES | Description | Sources |
|---|---|---|
| $lnEX$ | Log of real exports from LEMEs to the US at time $t$ | WITS |
| $lnIM$ | Log of real imports from the US to LEMEs at time $t$ | WITS |
| $Y^{LEMEs}$ | Real GDP LEMEs | WDI |
| $Y^{US}$ | Real GDP US | WDI |
| $REX$ | Real bilateral exchange rates between LEMEs and US | IFS, WDI |
| $Vol$ | Volatility measure of the bilateral exchange rate (REX) | IFS, WDI |

:

## Appendix 3B: Short-run and Long-run LEMEs real exports to US coefficient estimates specification

***Table 3B1: Short- and long-run coefficient estimates, Brazil real import specification 3-month volatility measure***

| | $\Delta\ln VOl_t$ | $\Delta\ln VOl_{t-1}$ | $\Delta\ln VOl_{t-2}$ | $\Delta\ln VOl_{t-3}$ | $LnY^{BRAZIL}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| ***Negatively affected by volatility*** | | | | | | | |
| Food wear | -0.16(0.68) | 0.40(1.24) | 0.09(0.53) | 0.32(3.22) | 1.15(2.27) | -0.09(0.23) | -1.14(2.11) |
| ***Not affected by volatility*** | | | | | | | |
| Capital goods | 0.14(1.20) | 0.41(2.61) | 0.30(3.43) | 0.07(1.46) | 38.13(0.09) | 25.50(0.08) | -44.48(0.08) |
| Intermediate goods | 0.06(0.74) | 0.09(0.83) | 0.01(0.13) | 0.01(0.14) | 2.20(9.02) | 0.06(0.27) | -0.39(1.30) |
| Hides & skins | -0.01(0.06) | 0.21(0.73) | 0.13(0.84) | 0.18(1.76) | 0.50(1.24) | 0.39(1.27) | -0.38(0.87) |
| Mech & Elec | 0.09(0.93) | 0.13(0.83) | 0.08(0.84) | -0.03(0.51) | 1.36(2.90) | -0.23(0.46) | -0.47(0.54) |
| Metals | 0.15(1.38) | 0.23(1.54) | 0.12(1.36) | -0.01(0.26) | 2.86(8.27) | -0.16(0.51) | -0.67(1.43) |
| Minerals | 0.07(0.35) | 0.13(0.47) | -0.08(0.55) | 0.16(2.03) | 4.30(10.19) | -0.08(0.24) | -0.28(0.62) |
| Miscellaneous | -0.29(1.48) | -0.32(1.16) | -0.16(1.15) | -0.18(2.55) | 6.38(10.37) | -1.70(4.05) | 0.56(0.88) |
| Plastic or rubber | 0.05(0.79) | 0.08(0.93) | 0.01(0.29) | 0.01(0.39) | 2.54(18.02) | -0.10(0.80) | -0.15(0.85) |
| Stone & glass | 0.19(1.55) | 0.36(2.15) | 0.21(2.00) | -0.00(0.05) | 2.25(4.50) | 0.57(0.99) | -1.05(1.29) |
| Textiles and Clothing | -0.21(1.08) | 0.03(0.12) | -0.11(0.74) | 0.18(2.21) | 1.11(2.98) | -0.26(0.89) | -0.37(0.93) |
| Vegetables | 0.64(1.22) | -0.69(0.96) | 0.01(0.01) | 0.35(1.60) | 3.37(2.50) | -1.53(1.44) | 1.38(0.92) |
| Wood | 0.04(0.69) | -0.15(1.50) | -0.04(0.63) | 0.01(0.30) | 1.39(8.84) | -0.76(6.46) | 0.18(1.05) |

***Table B2: Short- and long-run coefficient estimates, China import specification 3-month volatility measure***

| | $\Delta\text{lnVOl}_t$ | $\Delta\text{lnVOl}_{t-1}$ | $\Delta\text{lnVOl}_{t-2}$ | $\Delta\text{lnVOl}_{t-3}$ | $\text{LnY}^{\text{CHINA}}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| ***Negatively affected by volatility*** | | | | | | | |
| Consumer goods | -0.17(2.83) | 0.37(2.83) | 0.32(3.29) | 0.17(2.40) | 1.31(7.96) | -2.07(2.71) | -1.02(2.91) |
| Hides & Skins | -0.27(2.18) | 0.63(1.92) | 0.50(2.09) | 0.22(1.53) | -0.48(0.61) | -6.76(2.26) | -2.45(2.21) |
| ***Not affected by volatility*** | | | | | | | |
| Capital goods | -0.02(0.23) | 0.32(2.48) | 0.16(1.70) | 0.06(0.81) | 0.97(9.85) | 0.62(1.20) | -0.41(1.60) |
| Raw material | -0.04(0.33) | 0.19(0.75) | 0.20(1.08) | 0.12(0.86) | 0.56(1.96) | -6.15(4.53) | -0.22(0.36) |
| Animal | -0.08(0.72) | -0.19(0.90) | -0.18(1.12) | -0.21(1.71) | 1.26(6.60) | -1.83(1.90) | 0.31(0.72) |
| Food products | -0.26(1.12) | 0.22(0.39) | 0.02(0.06) | -0.20(0.79) | 0.31(0.45) | -5.45(1.64) | -0.95(0.76) |
| Footwear | 0.12(0.96) | 0.05(0.18) | -0.09(0.48) | 0.01(0.06) | 1.99(4.09) | 7.82(2.97) | 0.32(0.31) |
| Fuels | -0.18(0.53) | -0.87(0.53) | -0.49(0.95) | -0.28(0.73) | 2.51(5.03) | 2.02(0.83) | 1.10(0.92) |
| Metals | -0.04(0.34) | 0.35(1.69) | 0.38(2.45) | 0.23(1.99) | 0.25(0.64) | -5.77(3.90) | -0.67(0.91) |
| Minerals | -0.05(0.27) | 0.09(0.24) | 0.47(1.57) | 0.27(1.22) | 0.56(0.98) | -7.91(3.13) | -0.27(0.27) |
| Miscellaneous | -0.09(0.65) | -0.04(0.15) | -0.13(0.65) | -0.03(0.23) | 0.53(1.60) | -6.30(3.77) | -0.21(0.30) |
| Plastic or rubber | -0.01(0.29) | 0.22(2.19) | 0.23(3.17) | 0.16(2.91) | 0.57(1.09) | -2.78(1.87) | -0.92(1.08) |
| Stone & glass | -0.24(2.46) | 0.11(0.62) | 0.12(0.89) | 0.06(0.61) | 1.51(12.39) | -.19(0.31) | -0.39(1.22) |
| Vegetables | -0.04(0.21) | 0.17(0.50) | 0.21(0.81) | 0.01(0.07) | 0.27(1.04) | -7.44(5.83) | 0.00(0.01) |

***Table B3: Short- and long-run coefficient estimates, India import specification 3-month volatility measure***

| | $\Delta\text{lnVOl}_t$ | $\Delta\text{lnVOl}_{t-1}$ | $\Delta\text{lnVOl}_{t-2}$ | $\Delta\text{lnVOl}_{t-3}$ | $\text{LnY}^{\text{INDIA}}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Hides & skins | 0.03(0.23) | -0.46(2.22) | -0.07(0.37) | -0.32(2.55) | 2.60(1.91) | -3.46(2.37) | 3.37(1.82) |
| ***Negatively affected by volatility*** | | | | | | | |
| Textiles & Clothing | | | | | | | |
| ***Not affected by volatility*** | | | | | | | |
| Consumer goods | -0.09(0.94) | 0.32(1.78) | 0.22(1.45) | 0.12(1.09) | 0.76(2.13) | 0.62(2.19) | -0.59(1.43) |
| Mach & Elec | -0.04(0.40) | 0.27(1.79) | 0.18(1.33) | 0.19(1.98) | 1.26(1.43) | 0.17(0.27) | -1.59(1.38) |
| Transportation | -1.82(3.55) | -0.52(0.60) | 0.85(1.03) | 0.59(1.05) | 5.29(3.00) | -1.81(1.41) | -2.10(1.11) |
| Vegetable | -0.01(0.06) | -0.02(0.08) | 0.03(0.12) | 0.05(0.26) | 1.59(5.12) | 0.08(0.34) | 0.12(0.33) |

*Table B4: Short- and long-run coefficient estimates, Indonesia import specification 3-month volatility measure*

| | $\Delta \ln VOl_t$ | $\Delta \ln VOl_{t-1}$ | $\Delta \ln VOl_{t-2}$ | $\Delta \ln VOl_{t-3}$ | $LnY^{INDONESIA}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Food products | 0.10(1.23) | -0.76(2.51) | -0.37(2.00) | -0.12(1.16) | 1.80(2.80) | -1.02(1.69) | 1.66(2.56) |
| Mech & Elec | 0.09(1.33) | -0.32(1.48) | -0.18(1.44) | -0.05(0.69) | 1.69(3.32) | -1.37(2.74) | 0.93(1.81) |
| ***Negatively affected by volatility*** | | | | | | | |
| ***Not affected by volatility*** | | | | | | | |
| Capital goods | 0.14(1.50) | -0.31(0.97) | -0.18(0.92) | -0.11(1.03) | 1.40(2.37) | -1.02(1.80) | 0.65(1.10) |
| Plastic and rubber | 0.07(1.12) | 0.64(2.78) | 0.39(2.77) | 0.22(2.73) | 0.67(0.72) | 1.11(1.09) | -1.64(1.46) |
| Stone & glass | 0.04(0.40) | 0.34(0.97) | 0.32(1.38) | 0.16(1.38) | 1.79(2.11) | -0.25(0.27) | -0.71(0.70) |
| Vegetable | 0.11(1.28) | -0.05(0.15) | -0.03(0.13) | -0.01(0.07) | 1.58(2.15) | -0.30(0.43) | 0.34(0.46) |

*Table B5: Short- and long-run coefficient estimates, Korea import specification 3-month volatility measure*

| | $\Delta \ln VOl_t$ | $\Delta \ln VOl_{t-1}$ | $\Delta \ln VOl_{t-2}$ | $\Delta \ln VOl_{t-3}$ | $LnY^{KOREA}$ | LnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Capital goods | 0.12(2.85) | -0.15(1.29) | -0.05(0.57) | 0.03(0.60) | 0.21(1.97) | -0.90(3.72) | 0.44(3.15) |
| ***Negatively affected by volatility*** | | | | | | | |
| Miscellaneous | -0.03(0.35) | 0.52(2.92) | 0.29(2.29) | 0.15(1.53) | 2.16(7.51) | 0.19(0.27) | -0.64(1.90) |
| Plastic or rubber | -0.03(1.19) | 0.09(1.97) | 0.08(2.89) | 0.03(1.17) | 1.09(9.47) | -0.05(0.15) | -0.38(1.89) |
| Wood | -0.01(0.24) | 0.23(2.97) | 0.90(1.83) | 0.06(1.60) | -0.08(0.70) | 0.15(0.54) | -0.36(2.72) |
| ***Not affected by volatility*** | | | | | | | |
| Consumer goods | -0.06(1.84) | -0.01(0.20) | 0.06(1.67) | 0.03(1.16) | 8.53(0.45) | -2.81(0.38) | -1.82(0.33) |
| Intermediate goods | -0.004(0.09) | 0.05(0.63) | -0.001(0.03) | -0.004(0.11) | 0.65(5.89) | -0.26(0.99) | -0.18(1.40) |
| Chemical | 0.03(0.70) | 0.11(1.26) | -0.02(0.35) | -0.04(0.80) | 1.14(8.65) | -0.10(0.30) | -0.14(0.87) |
| Mech & Elec | 0.06(1.51) | 0.0002(0.00) | 0.04(0.47) | 0.11(2.27) | -0.29(2.07) | 0.03(0.08) | 0.05(0.23) |
| Stone & glass | -0.18(1.46) | 0.03(0.15) | -0.02(0.16) | -0.05(0.46) | 0.90(2.51) | -0.31(0.36) | -0.51(1.28) |
| Vegetable | -0.10(0.64) | 0.36(1.18) | 0.36(1.69) | 0.13(0.74) | 1.31(3.55) | -0.45(0.50) | -0.61(1.47) |

*Table B6: Short- and long-run coefficient estimates, Mexico import specification 3-month volatility measure*

| | $\Delta \ln VOl_t$ | $\Delta \ln VOl_{t-1}$ | $\Delta \ln VOl_{t-2}$ | $\Delta \ln VOl_{t-3}$ | $LnY^{MEXICO}$ | LnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| | | | | | | | |
| ***Negatively affected by volatility*** | | | | | | | |
| Wood | -0.03(0.93) | -0.001(0.03) | -0.004(0.14) | -0.01(0.51) | 0.69(2.20) | 0.27(2.24) | -0.15(2.07) |
| | | | | | | | |
| ***Not affected by volatility*** | | | | | | | |
| Raw material | 0.13(2.37) | 0.21(2.73) | 0.08(1.50) | 0.04(0.92) | 2.87(3.74) | -0.28(0.95) | -0.004(0.02) |
| Animal | 0.08(1.82) | 0.10(1.40) | 0.05(1.01) | 0.06(1.34) | 3.24(3.20) | -0.63(1.17) | 0.23(0.70) |
| Food products | -0.002(0.04) | 0.16(1.52) | 0.06(0.69) | 0.02(0.40) | 1.78(0.90) | 0.51(0.83) | -0.29(0.82) |
| Metals | -0.03(0.91) | 0.05(0.89) | 0.04(1.00) | 0.02(0.45) | 3.86(7.98) | -0.30(1.69) | -0.15(1.23) |
| Minerals | 0.23(1.21) | -0.11(0.41) | -0.16(0.83) | -0.02(0.12) | 14.83(2.74) | -3.61(1.74) | 0.74(0.84) |
| Stone & glass | 0.04(0.68) | -0.08(1.07) | -0.14(2.31) | -0.08(1.46) | -2.18(1.96) | 1.21(3.22) | 0.01(0.05) |
| Vegetable | 0.09(1.11) | 0.34(2.84) | 0.15(1.75) | 0.06(0.77) | 2.38(2.26) | -0.69(0.17) | -0.24(0.88) |

*Table B7: Short- and long-run coefficient estimates, Russia import specification 3-month volatility measure*

| | $\Delta \ln VOl_t$ | $\Delta \ln VOl_{t-1}$ | $\Delta \ln VOl_{t-2}$ | $\Delta \ln VOl_{t-3}$ | $LnY^{RUSSIA}$ | LnREX | LnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Chemicals | 0.05(0.40) | -0.47(2.24) | -0.11(0.66) | -0.03(0.25) | 2.38(4.40) | -0.40(1.84) | 0.71(1.94) |
| Food products | 0.13(2.12) | -0.27(3.17) | -0.09(1.20) | 0.33(0.62) | 1.69(2.90) | -0.70(4.73) | 0.58(2.44) |
| | | | | | | | |
| ***Negatively affected by volatility*** | | | | | | | |
| Hides & Skins | -0.11(0.73) | 0.70(2.09) | 0.41(2.00) | 0.22(1.73) | 5.72(10.31) | -0.44(1.94) | -1.05(2.85) |
| Minerals | 0.24(1.01) | 1.23(2.61) | 0.78(2.63) | 0.41(1.96) | 2.63(3.73) | -0.04(0.15) | -1.16(2.60) |
| | | | | | | | |
| ***Not affected by volatility*** | | | | | | | |
| Capital goods | 0.09(0.94) | 0.03(0.18) | 0.08(0.72) | 0.003(0.05) | 2.45(4.15) | -0.36(1.66) | -0.03(0.08) |
| Consumer goods | 0.05(0.42) | 0.04(0.23) | 0.04(0.33) | 0.04(0.48) | 3.74(8.27) | -0.42(2.58) | -0.25(0.87) |
| Fuels | 0.10(0.95) | 0.05(0.28) | 0.21(1.83) | 0.12(1.46) | 4.29(6.39) | -0.81(3.75) | -0.13(0.34) |
| Mach & Elec | -0.05(0.95) | 0.05(0.54) | 0.08(1.32) | 0.09(2.13) | 2.54(5.48) | -0.27(1.60) | -0.28(1.06) |
| Metals | 0.15(2.47) | 0.07(0.78) | 0.21(3.34) | 0.10(2.07) | 3.20(16.00) | -0.33(4.78) | 0.19(1.55) |
| Wood | 0.16(1.58) | -0.08(0.55) | -0.08(0.74) | -0.01(0.15) | 2.19(4.24) | -0.43(2.35) | 0.23(0.72) |

***Table B8: Short- and long-run coefficient estimates, Saudi Arabia import specification 3-month volatility measure***

| | $\Delta\ln VOl_t$ | $\Delta\ln VOl_{t-1}$ | $\Delta\ln VOl_{t-2}$ | $\Delta\ln VOl_{t-3}$ | $LnY^{SAUDI\ ARABIA}$ | LnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Mach & Elec | 0.54(3.84) | -0.15(0.52) | 0.04(0.22) | 0.10(0.73) | 0.83(5.28) | 1.10(2.49) | 0.85(3.32) |
| Wood | 0.13(1.87) | -0.33(2.79) | -0.31(3.25) | -0.19(2.58) | -0.09(1.20) | 1.72(8.75) | 0.25(2.04) |
| ***Negatively affected by volatility*** | | | | | | | |
| Footwear | -0.13(1.07) | 0.98(3.45) | 0.05(2.02) | 0.30(2.20) | 1.03(5.97) | -0.18(0.38) | -1.17(4.27) |
| Textile & Clothing | 0.21(2.33) | 0.68(3.68) | 0.45(3.11) | 0.32(3.04) | -0.06(0.21) | 4.08(6.34) | -0.97(2.43) |
| ***Not affected by volatility*** | | | | | | | |
| Raw materials | -0.07(0.45) | -0.08(0.30) | -0.07(0.31) | 0.19(1.08) | 1.74(5.60) | 1.78(2.14) | -0.46(0.85) |
| Animal | 0.20(0.89) | 0.19(0.47) | 0.14(0.46) | 0.08(0.33) | 2.14(2.53) | -1.01(0.30) | -0.77(0.51) |
| Chemical | 0.06(0.57) | -0.25(1.13) | -0.07(0.42) | -0.03(0.27) | 1.84(11.30) | 0.38(0.88) | 0.24(0.91) |
| Food products | 0.04(0.48) | 0.02(0.12) | 0.15(1.29) | 0.13(1.48) | -0.11(0.41) | 2.71(3.58) | 0.08(0.18) |
| Fuels | 0.18(0.84) | -0.37(0.90) | -0.16(0.52) | 0.03(0.15) | 2.67(9.86) | 2.28(3.19) | 0.67(1.51) |
| Hides & skins | 0.28(1.10) | 0.44(0.98) | 0.39(1.08) | 0.32(1.19) | 1.77(5.39) | 0.72(0.77) | -0.06(0.10) |
| Minerals | 0.14(0.45) | -1.01(1.76) | -0.58(1.24) | -0.10(0.29) | 0.91(1.98) | -0.52(0.43) | 1.39(1.75) |
| Miscellaneous | 0.11(0.46) | 0.50(1.12) | 0.43(1.21) | 0.24(0.93) | 2.05(5.49) | 4.72(4.78) | -0.35(0.63) |
| Plastic or rubber | 0.10(0.94) | 0.05(0.23) | 0.08(0.49) | 0.05(0.44) | 1.45(8.08) | 1.45(3.07) | 0.11(0.38) |

***Table B9: Short- and long-run coefficient estimates, South Africa import specification 3-month volatility measure***

| | $\Delta\ln VOl_t$ | $\Delta\ln VOl_{t-1}$ | $\Delta\ln VOl_{t-2}$ | $\Delta\ln VOl_{t-3}$ | $LnY^{SOUTH\ AFRICA}$ | LnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Consumer goods | 0.08(2.31) | -0.20(2.76) | -0.12(2.40) | -0.05(1.63) | 2.39(15.62) | -0.52(7.03) | 0.33(4.98) |
| Hides & skins | 0.47(1.63) | -0.37(0.69) | -0.19(0.47) | 0.12(0.42) | -0.82(0.52) | -1.28(1.68) | 1.19(1.77) |
| ***Negatively affected by volatility*** | | | | | | | |
| Intermediate goods | 0.02(0.27) | 0.30(2.11) | 0.29(2.52) | 0.16(1.92) | 2.17(4.79) | -0.34(1.58) | -0.44(2.06) |
| Plastic or rubber | 0.04(1.24) | 0.18(2.91) | 0.11(2.02) | 0.04(1.28) | 2.15(15.55) | -0.12(1.81) | -0.13(2.20) |
| ***Not affected by volatility*** | | | | | | | |
| Capital goods | 0.15(1.67) | 0.07(0.49) | 0.05(0.40) | 0.002(0.03) | 2.23(3.90) | -0.64(2.31) | 0.08(0.34) |
| Chemicals | -0.005(0.15) | -0.08(1.43) | -0.02(0.43) | 0.01(0.45) | 1.01(6.86) | -0.09(1.25) | -0.01(0.24) |
| Food products | 0.03(0.24) | -0.17(1.00) | -0.06(0.48) | -0.02(0.22) | 3.36(4.07) | -1.12(2.67) | 0.23(0.73) |
| Mach & Elec | 0.09(2.03) | 0.10(1.37) | 0.07(1.11) | 0.03(0.69) | 2.83(7.77) | -0.79(4.56) | -0.02(0.20) |
| Metals | 0.12(2.52) | 0.05(0.66) | 0.07(1.22) | 0.02(0.36) | 2.92(11.38) | -0.77(6.36) | 0.14(1.36) |
| Miscellaneous | 0.09(1.12) | 0.12(0.92) | 0.09(0.73) | 0.009(0.10) | 5.57(5.73) | -1.78(2.96) | 0.08(0.20) |
| Textiles & Clothing | -0.08(1.30) | 0.23(2.54) | 0.10(1.30) | 0.02(0.34) | -0.14(0.38) | 0.12(0.45) | -0.44(1.58) |
| Transportation | 0.16(0.85) | -0.08(0.25) | -0.06(0.25) | -0.08(0.47) | 0.99(0.97) | -0.27(0.97) | 0.34(0.72) |
| Vegetable | -0.53(1.90) | 0.49(1.14) | 0.53(1.54) | 0.32(1.26) | 0.27(0.18) | 0.68(0.75) | -1.41(1.67) |

*Table B10: Short- and long-run coefficient estimates, Turkey import specification 3-month volatility measure*

| | $\Delta \ln VOl_t$ | $\Delta \ln VOl_{t-1}$ | $\Delta \ln VOl_{t-2}$ | $\Delta \ln VOl_{t-3}$ | $LnY^{TURKEY}$ | LnREX | LnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Consumer goods | 0.52(3.17) | -1.49(3.97) | -1.25(3.85) | -0.58(2.54) | 1.31(2.65) | -1.53(3.27) | 3.24(2.99) |
| Intermediate goods | 0.13(1.47) | -0.63(2.91) | -0.45(2.42) | -0.26(2.11) | 0.60(1.54) | -0.82(2.75) | 1.71(2.38) |
| Raw-materials | 0.24(1.52) | -0.88(2.40) | -0.73(2.35) | -0.44(2.09) | 0.65(0.82) | -1.31(2.50) | 2.81(2.20) |
| Animals | 0.35(1.43) | -1.01(1.67) | -0.90(1.83) | -0.52(1.57) | -0.62(0.91) | -0.96(2.05) | 2.33(2.07) |
| Chemical | 0.10(0.89) | -0.42(1.73) | -0.34(1.73) | -0.18(1.31) | 0.81(3.89) | -0.40(2.51) | 0.79(2.05) |
| Food products | 0.61(2.89) | -1.35(3.38) | -1.32(3.75) | -0.86(3.35) | 0.56(1.27) | -0.94(2.39) | 2.20(2.62) |
| Fuels | 0.99(3.37) | -2.48(3.83) | -2.03(3.71) | -1.21(3.28) | 1.62(1.11) | -3.50(2.81) | 7.72(2.51) |
| ***Negatively affected by volatility*** | | | | | | | |
| Foot wear | -0.55(1.81) | 1.19(2.03) | 1.12(2.25) | 0.66(1.94) | 3.90(3.29) | 1.20(1.47) | -4.09(1.78) |
| ***Not affected by volatility*** | | | | | | | |
| Hides & Skins | 0.04(0.20) | -0.27(0.66) | -0.30(0.85) | -0.14(0.60) | -2.62(5.64) | 0.21(0.62) | 0.08(0.10) |
| Metals | 0.12(0.56) | -0.85(1.67) | -0.48(1.12) | -0.27(0.95) | 1.71(1.00) | -1.75(1.86) | 3.24(1.40) |
| Plastic or rubber | -0.10(0.63) | -0.63(1.69) | -0.36(1.12) | -0.10(0.48) | 2.13(4.46) | -0.69(1.93) | 0.94(1.09) |
| Stone & glass | 0.45(2.41) | -0.37(0.78) | -0.32(0.85) | -0.01(0.06) | 0.62(1.11) | -0.53(1.41) | 1.27(1.41) |
| Textiles & clothing | 0.22(1.02) | -0.72(1.45) | -0.67(1.64) | -0.34(1.22) | 0.04(0.11) | -0.35(1.25) | 1.08(1.60) |
| Transportation | 0.26(0.61) | -0.51(0.55) | -0.12(0.15) | 0.65(1.17) | 0.78(0.77) | -0.15(0.21) | 0.70(0.39) |
| Vegetable | -0.03(0.20) | -0.27(0.86) | -0.32(1.20) | -0.24(1.30) | 0.83(1.21) | -0.65(1.25) | 0.66(0.54) |
| Wood | -0.006(0.04) | -0.28(0.87) | -0.16(0.57) | -0.25(1.38) | 1.23(1.41) | -0.72(1.22) | 1.11(0.81) |

## Appendix 3C: Short-run and Long-run LEMEs real exports to US coefficient estimates specification

***Table C1: Short- and long-run coefficient estimates, Brazil export specification 3-month volatility measure***

| | $\Delta \text{lnVOl}_t$ | $\Delta \text{lnVOl}_{t-1}$ | $\Delta \text{lnVOl}_{t-2}$ | $\Delta \text{lnVOl}_{t-3}$ | $\text{LnY}^{\text{USA}}$ | LnREX | LnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| ***Negatively affected by volatility*** | | | | | | | |
| Plastic or rubber | -19(1.85) | 0.22(1.24) | 0.10(1.27) | 0.02(0.64) | 0.98(1.16) | 0.75(2.17) | -0.99(3.03) |
| ***Not affected by volatility*** | | | | | | | |
| Consumer goods | 0.08(1.06) | -0.02(0.19) | 0.003(0.06) | -0.05(1.74) | -3.81(2.37) | 0.61(0.92) | 0.72(0.85) |
| Animal | 0.10(0.76) | 0.12(0.60) | 0.11(1.07) | -0.07(1.34) | -5.16(4.20) | 1.60(3.01) | -0.17(0.27) |
| Footwear | -0.04(0.43) | 0.06(0.36) | 0.08(1.07) | -0.03(0.69) | -14.58(5.64) | 2.73(2.73) | -0.42(0.35) |
| Fuels | 0.35(1.63) | -0.12(0.35) | -0.12(0.76) | -0.15(1.68) | 2.24(0.41) | -1.62(0.84) | 2.76(1.30) |

***Table C2: Short- and long-run coefficient estimates, China export specification 3-month volatility measure***

| | $\Delta \text{lnVOl}_t$ | $\Delta \text{lnVOl}_{t-1}$ | $\Delta \text{lnVOl}_{t-2}$ | $\Delta \text{lnVOl}_{t-3}$ | $\text{LnY}^{\text{USA}}$ | LnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| ***Negatively affected by volatility*** | | | | | | | |
| ***Not affected by volatility*** | | | | | | | |
| Capital goods | -0.02(0.36) | 0.21(1.44) | 0.19(1.75) | 0.13(1.59) | 21.67(0.34) | 4.27(0.16) | 4.80(0.28) |
| Transportation | 0.07(1.11) | 0.06(0.47) | 0.11(1.14) | 0.06(0.82) | 4.99(13.29) | -1.66(3.50) | 0.09(0.42) |

***Table C3: Short- and long-run coefficient estimates, India export specification 3-month volatility measure***

| | $\Delta\ln VOl_t$ | $\Delta\ln VOl_{t-1}$ | $\Delta\ln VOl_{t-2}$ | $\Delta\ln VOl_{t-3}$ | $LnY^{USA}$ | LnREX | LnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Footwear | 0.12(1.82) | -0.25(1.92) | -0.17(1.47) | -0.15(1.62) | 0.29(0.07) | -0.51(0.51) | 2.45(1.87) |
| Fuels | 0.31(0.58) | -0.71(0.74) | -1.11(1.35) | -0.11(0.17) | -26.31(1.65) | 4.79(1.32) | 5.63(1.88) |
| ***Negatively affected by volatility*** | | | | | | | |
| Stone & glass | -0.05(1.10) | 0.18(2.07) | 0.22(2.79) | 0.20(3.37) | 1.75(3.43) | 0.46(3.12) | -0.25(2.26) |
| ***Not affected by volatility*** | | | | | | | |
| Capital goods | 0.14(1.95) | 0.20(1.56) | 0.22(1.75) | 0.07(0.63) | 8.06(5.95) | -0.64(1.82) | -0.11(0.34) |
| Consumer goods | 0.05(1.32) | 0.19(2.51) | 0.17(2.69) | 0.0791.41) | 1.54(1.45) | 0.57(1.91) | -0.01(0.07) |
| Intermediate goods | 0.17(2.70) | -0.003(0.02) | 0.12(1.19) | 0.18(2.36) | 2.44(3.50) | 0.20(1.03) | 0.08(0.43) |
| Animal | 0.25(1.72) | -0.0002(0.00) | -0.007(0.03) | 0.04(0.20) | -46.24(0.77) | 10.79(0.84) | 4.05(0.70) |
| Hides & Skins | 0.12(1.03) | -0.21(2.68) | -0.21(2.73) | -0.07(1.03) | -8.95(0.71) | 0.94(0.56) | 3.76(0.80) |
| Mach & Elec | 0.16(2.17) | 0.16(1.24) | 0.17(1.26) | 0.0002(0.00) | 9.68(5.39) | -1.27(2.62) | 0.12(0.32) |
| Metals | 0.12(0.86) | 0.33(1.31) | 0.43(1.94) | 0.42(2.36) | 5.96(3.18) | -0.15(0.30) | -0.79(1.58) |
| Minerals | -0.27(1.41) | 0.17(0.48) | -0.007(0.02) | -0.28(1.17) | 11.45(6.40) | -2.03(4.37) | -0.43(1.02) |
| Plastic or rubber | 0.09(1.27) | 0.18(1.27) | 0.08(0.69) | -0.07(0.74) | 5.06(3.04) | -0.34(0.75) | 0.04(0.10) |
| Transportation | 0.17(1.62) | 0.41(2.19) | 0.32(2.00) | 0.24(1.88) | 8.14(5.98) | -0.12(0.28) | -0.51(1.09) |

***Table C4: Short- and long-run coefficient estimates, Indonesia export specification 3-month volatility measure***

| | $\Delta\ln VOl_t$ | $\Delta\ln VOl_{t-1}$ | $\Delta\ln VOl_{t-2}$ | $\Delta\ln VOl_{t-3}$ | $LnY^{USA}$ | LnREX | LnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| ***Negatively affected by volatility*** | | | | | | | |
| ***Not affected by volatility*** | | | | | | | |
| Capital goods | 0.03(0.78) | 0.006(0.04) | -0.01(0.16) | -0.01(0.32) | -1.15(0.58) | 0.01(0.02) | 0.34(0.54) |
| Intermediate goods | 0.07(1.75) | 0.28(1.59) | 0.17(1.75) | 0.08(1.49) | 1.87(1.54) | 0.22(0.53) | -0.38(1.10) |
| Animal | 0.14(2.80) | 0.04(0.21) | 0.06(0.58) | 0.04(0.80) | 4.81(5.44) | -0.35(1.09) | 0.28(1.04) |
| Fuels | 0.26(1.50) | -0.33(0.55) | -0.09(0.25) | 0.09(0.44) | 0.94(0.36) | -0.59(0.63) | 0.61(0.75) |
| Mach & Elec | 0.03(0.76) | 0.03(0.20) | 0.007(0.09) | 0.007(0.15) | -1.81(0.92) | 0.14(0.19) | 0.19(0.29) |
| Metals | 0.03(0.33) | 0.14(0.42) | 0.09(0.52) | 0.10(1.01) | 4.31(1.03) | -0.25(0.18) | -0.12(0.11) |
| Minerals | 0.03(0.06) | -1.78(0.88) | -1.80(1.62) | -1.47(2.29) | -10.25(0.49) | -1.90(0.25) | 9.27(1.34) |
| Miscellaneous | -0.06(1.84) | 0.05(0.48) | 0.04(0.61) | -0.01(0.35) | -0.34(0.30) | 0.51(1.20) | -0.29(0.76) |
| Textiles & Clothing | 0.01(0.42) | -0.22(2.73) | -0.08(1.72) | 0.004(0.16) | 9.72(1.39) | -3.27(1.17) | 2.35(1.20) |

***Table C5: Short- and long-run coefficient estimates, Korea export specification 3-month volatility measure***

| | $\Delta\text{lnVOl}_t$ | $\Delta\text{lnVOl}_{t-1}$ | $\Delta\text{lnVOl}_{t-2}$ | $\Delta\text{lnVOl}_{t-3}$ | $\text{LnY}^{USA}$ | LnREX | LnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Mach & Elec | 0.05(1.00) | -0.15(1.69) | -0.13(1.72) | -0.03(0.52) | 0.29(1.78) | 0.21(0.95) | 0.22(1.96) |
| ***Negatively affected by volatility*** | | | | | | | |
| Plastic or rubber | -0.08(1.82) | 0.24(3.37) | 0.24(2.94) | 0.02(0.43) | 3.07(14.46) | 0.96(2.28) | -0.56(3.38) |
| ***Not affected by volatility*** | | | | | | | |
| Capital goods | 0.05(1.03) | -0.08(1.08) | -0.09(1.40) | -0.006(0.12) | 0.80(5.66) | 0.26(1.34) | 0.12(1.19) |
| Consumer goods | -0.04(0.70) | -0.06(0.75) | -0.08(1.47) | -0.02(0.35) | 0.84(0.90) | 3.26(1.34) | -0.48(0.69) |
| Intermediate goods | 0.01(0.16) | 0.03(0.39) | 0.06(1.02) | 0.02(0.36) | 2.89(12.26) | 0.07(0.19) | -0.05(0.27) |
| Footwear | 0.05(0.48) | -0.02(0.10) | -0.07(0.68) | -0.05(0.62) | 1.87(0.30) | 1.82(0.32) | 1.10(0.55) |
| Textiles & clothing | -0.02(0.36) | -0.12(1.38) | -0.06(0.95) | -0.02(0.44) | -3.20(4.13) | 2.81(1.49) | -0.06(0.08) |
| Transportation | 0.02(0.32) | -0.08(0.85) | -0.16(2.25) | -0.10(1.50) | 1.96(2.31) | 2.34(2.01) | -0.02(0.05) |
| Vegetable | -0.03(0.62) | 0.03(0.38) | -0.04(0.76) | -0.06(1.55) | 2.10(13.38) | 0.27(1.20) | -0.07(0.60) |

***Table C6: Short- and long-run coefficient estimates, Mexico export specification 3-month volatility measure***

| | $\Delta\text{lnVOl}_t$ | $\Delta\text{lnVOl}_{t-1}$ | $\Delta\text{lnVOl}_{t-2}$ | $\Delta\text{lnVOl}_{t-3}$ | $\text{LnY}^{USA}$ | LnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| **Positively affected by volatility** | | | | | | | |
| Footwear | 0.09(2.06) | -0.35(3.42) | -0.21(3.07) | -0.17(3.40) | 1.55(0.94) | -1.65(1.97) | 1.99(3.47) |
| Hides & Skins | 0.20(4.65) | -0.25(2.72) | -0.22(3.68) | -0.19(3.96) | -2.32(2.09) | -0.10(0.20) | 1.36(4.20) |
| Vegetable | 0.01(0.33) | -0.26(2.76) | -0.08(1.47) | 0.0009(0.03) | 3.42(9.35) | -0.30(2.00) | 0.47(4.94) |
| **Negatively affected by volatility** | | | | | | | |
| **Not affected by volatility** | | | | | | | |
| Raw-materials | -0.02(0.24) | 0.21(1.22) | 0.18(1.79) | 0.16(1.93) | 4.59(2.25) | -0.54(0.63) | -0.97(1.70) |
| Animal | -0.03(0.42) | -0.13(0.82) | -0.17(1.74) | -0.02(0.19) | 1.68(1.55) | 0.37(0.80) | 0.09(0.34) |
| Chemical | 0.01(0.47) | -0.04(0.77) | -0.04(1.13) | -0.005(0.20) | 1.94(8.43) | 0.01(0.11) | 0.06(1.02) |
| Foot products | -0.02(0.66) | -0.04(0.49) | 0.02(0.46) | 0.04(1.12) | 2.36(3.17) | 0.36(1.24) | 0.02(0.11) |
| Fuels | -0.01(0.07) | 0.40(1.26) | 0.30(1.60) | 0.21(1.42) | 4.93(1.36) | -1.02(0.68) | -1.48(1.59) |
| Mach & Elec | -0.03(1.00) | -0.07(1.18) | -0.06(1.61) | -0.05(1.96) | 0.63(1.80) | 0.45(3.00) | -0.03(0.29) |
| Metals | -0.004(0.10) | 0.05(0.63) | 0.01(0.23) | 0.004(0.99) | 2.88(5.44) | -0.22(1.04) | -0.16(1.28) |
| Miscellaneous | 0.07(0.73) | -0.24(1.36) | -0.12(1.09) | -0.10(1.16) | 1.63(1.68) | 0.05(0.14) | 0.39(1.66) |
| Textiles & clothing | 0.01(0.40) | -0.21(2.82) | -0.11(3.00) | -0.03(1.19) | -7.69(2.76) | -0.52(0.22) | 2.62(0.96) |
| Wood | -0.03(0.87) | 0.008(0.11) | 0.02(0.39) | 0.02(0.43) | 1.19(1.20) | 0.16(0.42) | -0.16(0.71) |

*Table C7: Short- and long-run coefficient estimates, Russia export specification 3-month volatility measure*

| | $\Delta \ln VOl_t$ | $\Delta \ln VOl_{t-1}$ | $\Delta \ln VOl_{t-2}$ | $\Delta \ln VOl_{t-3}$ | $LnY^{USA}$ | lnREX | LnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Mach & Elec | 0.08(1.43) | -0.37(3.07) | -0.19(2.28) | 0.03(0.54) | 3.78(6.03) | -0.33(3.95) | 0.73(6.56) |
| ***Negatively affected by volatility*** | | | | | | | |
| Intermediate goods | 0.05(0.74) | 0.17(1.19) | 0.16(1.71) | 0.06(0.88) | 1.30(1.12) | 0.12(0.79) | -0.42(2.06) |
| Metals | -0.02(0.16) | 0.32(1.40) | 0.21(1.53) | 0.05(0.58) | 3.30(2.67) | -0.04(0.27) | -0.60(2.76) |
| ***Not affected by volatility*** | | | | | | | |
| Capital goods | 0.02(0.18) | -0.15(0.90) | -0.06(0.50) | 0.2(0.18) | 2.05(1.85) | -0.02(0.16) | 0.11(0.59) |
| Footwear | 0.22(1.40) | -0.51(2.68) | -0.14(0.91) | -0.02(0.15) | -40.44(1.06) | 2.10(1.34) | 5.50(0.76) |
| Minerals | 0.63(1.36) | -0.38(0.53) | -0.67(1.25) | -0.28(0.72) | 10.26(1.68) | -1.11(1.30) | 1.35(1.29) |
| Plastic or rubber | 0.15(1.42) | -0.04(0.25) | -0.04(0.30) | 0.04(0.42) | 8.09(5.10) | -0.44(1.88) | 0.31(1.07) |
| Textiles & clothing | 0.08(0.45) | -0.71(2.65) | -0.33(1.64) | -0.29(2.10) | -42.16(2.81) | 1.46(0.98) | 5.34(1.28) |
| Transportation | 0.13(0.56) | 0.08(0.25) | 0.31(1.25) | 0.01(0.06) | 4.88(2.51) | -0.006(0.02) | 0.002(0.01) |
| Vegetable | 0.24(1.58) | 0.03(0.14) | 0.18(0.99) | 0.08(0.66) | 14.11(4.94) | -0.75(1.92) | 0.21(0.37) |
| Wood | 0.09(1.35) | -0.18(1.72) | -0.16(2.20) | -0.08(1.60) | -6.22(1.91) | 0.82(2.54) | 0.29(0.46) |

*Table C8: Short- and long-run coefficient estimates, Saudi Arabia export specification 3-month volatility measure*

| | $\Delta \ln VOl_t$ | $\Delta \ln VOl_{t-1}$ | $\Delta \ln VOl_{t-2}$ | $\Delta \ln VOl_{t-3}$ | $LnY^{USA}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Miscellaneous | 1.61(1.56) | -2.33(1.01) | -1.29(0.77) | -0.29(0.23) | -0.43(0.17) | 21.88(6.22) | 5.84(2.12) |
| Stone & glass | 0.26(0.26) | -3.53(1.92) | -1.75(1.26) | -2.02(1.93) | -1.70(0.53) | 2.21(0.55) | 6.18(1.98) |
| ***Negatively affected by volatility*** | | | | | | | |
| Hides & Skins | -1.42(1.04) | 7.98(2.52) | 5.77(2.56) | 2.67(1.58) | 5.16(1.61) | -15.09(4.08) | -10.27(3.09) |
| Vegetables | -0.78(2.74) | 2.37(3.28) | 1.70(2.99) | 0.54(1.30) | 7.65(9.99) | 1.21(1.13) | -4.05(4.54) |
| ***Not affected by volatility*** | | | | | | | |
| Consumer goods | -0.36(0.67) | 0.79(0.66) | 0.48(0.55) | 0.16(0.24) | 2.99(2.52) | -10.11(6.04) | -1.82(1.41) |
| Animals | -2.32(1.51) | -2.31(0.70) | -2.35(0.85) | -1.06(0.51) | 3.78(1.28) | -11.36(2.90) | -2.77(0.85) |
| Footwear | -2.87(1.44) | 1.42(0.31) | 1.52(0.46) | 1.34(0.50) | 4.72(1.22) | -3.59(0.78) | -4.87(1.18) |
| Minerals | -1.73(0.83) | -1.22(0.30) | 0.46(0.14) | 0.40(0.17) | 8.48(1.53) | 0.04(0.00) | -0.61(0.10) |
| Plastic & rubber | -0.30(0.42) | -1.97(1.33) | -1.53(1.38) | -0.83(0.98) | 3.18(1.31) | -3.08(1.00) | 1.69(0.61) |
| Transportation | -4.30(0.49) | 2.41(1.32) | 1.98(1.40) | 4.32(0.40) | -10.89(1.30) | 1.58(0.23) | 10.21(1.18) |
| Woods | 0.36(1.09) | 0.16(0.22) | 0.46(0.86) | 0.21(0.54) | 0.41(0.51) | 2.50(2.31) | 0.16(0.17) |

***Table C9: Short- and long-run coefficient estimates, South Africa export specification 3-month volatility measure***

| | $\Delta\mathrm{lnVOl}_t$ | $\Delta\mathrm{lnVOl}_{t-1}$ | $\Delta\mathrm{lnVOl}_{t-2}$ | $\Delta\mathrm{lnVOl}_{t-3}$ | $\mathrm{LnY}^{\mathrm{USA}}$ | LnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Metals | 0.12(1.74) | -0.26(1.97) | -0.22(1.92) | 0.05(0.59) | 3.34(5.94) | -0.65(4.70) | 0.26(2.55) |
| ***Negatively affected by volatility*** | | | | | | | |
| ***Not affected by volatility*** | | | | | | | |
| Food products | 0.03(0.37) | -0.03(0.18) | -0.001(0.01) | -0.17(1.39) | 1.07(0.92) | -0.16(0.58) | 0.16(0.94) |
| Fuels0.01(0.06) | -0.01(0.06) | -0.31(0.63) | -0.26(0.61) | -0.00004(0.00) | 2.27(0.88) | -0.31(0.49) | 0.17(0.38) |
| Minerals | 0.05(0.78) | 0.27(2.04) | 0.17(1.37) | -0.02(0.22) | 2.50(2.44) | -0.46(1.82) | -0.25(1.33) |
| Vegetable | -0.06(0.71) | -0.16(1.01) | -0.04(0.33) | -0.03(0.34) | 4.01(6.81) | -0.31(2.12) | 0.13(1.24) |

**Table C10: Short- and long-run coefficient estimates, Turkey export specification 3-month volatility measure**

| | $\Delta\mathrm{lnVOl}_t$ | $\Delta\mathrm{lnVOl}_{t-1}$ | $\Delta\mathrm{lnVOl}_{t-2}$ | $\Delta\mathrm{lnVOl}_{t-3}$ | $\mathrm{LnY}^{\mathrm{USA}}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| ***Negatively affected by volatility*** | | | | | | | |
| Intermediate goods | -0.20(1.37) | 0.89(1.37) | 0.44(1.59) | 0.24(1.42) | 4.48(6.13) | 0.36(2.38) | -1.03(2.85) |
| Raw-materials | -0.006(0.06) | 0.84(3.19) | 0.39(1.85) | 0.17(1.29) | 2.92(3.77) | 0.35(2.24) | -0.99(2.48) |
| Animals | -0.56(1.74) | 1.79(2.17) | 1.18(1.81) | 0.36(0.84) | 10.77(3.36) | 1.27(2.21) | -3.56(2.41) |
| Metals | -0.33(1.40) | 1.36(2.46) | 0.68(1.47) | 0.30(1.05) | 5.41(4.48) | 0.54(2.18) | -1.63(2.77) |
| Textiles & Clothing | -0.09(1.33) | 0.35(2.16) | 0.20(1.52) | 0.14(1.67) | -1.33(0.91) | 0.98(3.20) | -1.60(2.19) |
| Vegetable | 0.15(1.37) | 0.67(2.47) | 0.36(1.77) | 0.18(1.41) | 4.20(6.09) | 0.23(1.61) | -0.70(2.01) |
| ***Not affected by volatility*** | | | | | | | |
| Consumer goods | -0.10(1.38) | 0.42(2.54) | 0.29(2.06) | 0.17(1.81) | -0.31(0.18) | 1.06(2.30) | -1.76(1.74) |
| Food Products | -0.07(0.48) | 0.43(1.36) | 0.24(0.92) | 0.11(0.64) | 4.30(4.59) | 0.04(0.18) | -0.49(1.01) |
| Hides & Skins | -0.007(0.09) | -0.05(0.27) | 0.002(0.01) | 0.07(0.73) | -3.32(1.62) | 0.45(1.28) | -0.18(0.20) |
| Minerals | 0.078(0.43) | 0.62(1.45) | 0.35(1.01) | 0.27(1.14) | 7.52(1.62) | 1.19(1.47) | -2.50(1.27) |
| Miscellaneous | 0.42(1.04) | -0.10(0.12) | -0.34(0.47) | -0.19(0.40) | 9.83(3.93) | -0.52(1.00) | 0.52(0.41) |
| Stone & glass | -0.07(0.98) | 0.35(2.08) | 0.13(0.92) | 0.12(1.35) | -2.38(1.19) | 1.22(2.39) | -1.87(1.60) |

## Appendix 3D: Short-run and Long-run LEMEs real exports to US coefficient estimates specification

***Table D1: Short- and long-run coefficient estimates, Brazil export specification 12-month volatility measure***

| | $\Delta \ln VOl_t$ | $\Delta \ln VOl_{t-1}$ | $\Delta \ln VOl_{t-2}$ | $\Delta \ln VOl_{t-3}$ | $LnY^{USA}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Vegetable | 0.04(0.33) | -0.25(2.88) | -0.11(2.76) | -0.03(0.77) | 7.17(7.84) | -1.90(4.46) | 0.53(2.39) |
| ***Negatively affected by volatility*** | | | | | | | |
| ***Not affected by volatility*** | | | | | | | |
| Consumer goods | 0.05(0.84) | 0.04(0.96) | 0.02(0.81) | -0.01(0.68) | -4.06(2.73) | 1.20(1.88) | -0.10(0.33) |
| Animal | -0.03(0.31) | 0.11(1.46) | 0.03(0.65) | -0.01(0.39) | -5.43(3.89) | 1.89(3.03) | -0.30(0.95) |
| Footwear | -0.03(0.46) | 0.08(1.42) | 0.03(1.13) | -0.003(0.14) | -15.09(6.15) | 3.22(3.03) | -0.60(1.19) |
| Fuels | 0.33(1.80) | -0.09(0.69) | -0.02(0.30) | -0.09(1.77) | 5.72(1.24) | -2.29(1.25) | 1.41(1.54) |
| Minerals | -0.0005(0.00) | 0.11(1.03) | 0.06(1.17) | 0.05(1.27) | 0.88(0.42) | 0.51(0.54) | -026(0.53) |
| Textiles & clothing | 0.18(1.66) | 0.03(0.44) | 0.11(0.26) | -0.05(1.54) | -14.53(2.30) | 1.40(0.64) | 1.26(0.99) |
| Transportation | 0.23(1.78) | 0.15(1.42) | 0.06(1.20) | -0.06(1.71) | -4.98(3.33) | 1.67(2.42) | -0.07(0.20) |
| ***No cointegration*** | | | | | | | |
| Capital goods | 0.09(1.17) | 0.08(1.39) | 0.02(0.57) | -0.005(0.24) | | | |
| Intermediate goods | 0.04(0.49) | 0.04(0.65) | 0.02(0.48) | 0.02(0.72) | | | |
| Raw materials | 0.17(1.16) | -0.17(1.05) | -0.08(1.32) | 0.01(0.26) | | | |
| Chemical | 0.07(1.60) | -0.03(0.72) | 0.004(0.21) | -0.005(0.38) | | | |
| Food products | -0.009(0.07) | -0.11(1.18) | -0.05(0.99) | -0.002(0.06) | | | |
| Hides & skins | 0.05(0.64) | -0.06(0.92) | 0.02(0.63) | -0.03(1.30) | | | |
| Mach & Elec | -0.03(0.31) | 0.10(1.78) | -0.003(0.11) | 0.04(1.69) | | | |
| Metals | 0.11(0.82) | 0.09(0.95) | 0.05(0.89) | 0.04(0.96) | | | |
| Miscellaneous | -0.04(0.25) | -0.17(1.70) | -0.06(1.23) | 0.001(0.03) | | | |
| Plastic or rubber | -0.006(0.07) | 0.006(0.09) | -0.004(0.13) | 0.004(0.15) | | | |
| Stone & glass | 0.07(0.90) | -0.06(1.05) | -0.009(0.28) | -0.01(0.60) | | | |
| Wood | 0.03(0.36) | 0.03(0.52) | 0.02(0.65) | -0.01(0.60) | | | |

***Table D2: Short- and long-run coefficient estimates, China export specification 12-month volatility measure***

| | $\Delta \ln VOl_t$ | $\Delta \ln VOl_{t-1}$ | $\Delta \ln VOl_{t-2}$ | $\Delta \ln VOl_{t-3}$ | $LnY^{USA}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| ***Not affected by volatility*** | | | | | | | |
| ***No cointegration*** | | | | | | | |
| Capital goods | -0.06(0.96) | 0.04(0.44) | 0.039(0.51) | 0.002(0.03) | | | |
| Consumer goods | -0.06(1.36) | 0.05(0.77) | 0.05(0.85) | 0.01(0.38) | | | |
| Intermediate goods | -0.02(0.29) | 0.06(0.58) | 0.05(0.57) | 0.07(1.33) | | | |
| Raw materials | -0.04(0.60) | -0.03(0.31) | 0.01(0.12) | 0.06(1.04) | | | |
| Animal | -0.06(1.04) | 0.16(1.91) | 0.12(1.85) | 0.07(1.64) | | | |
| Chemical | 0.02(0.35) | -0.08(0.87) | -0.05(0.57) | 0.02(0.31) | | | |
| Food products | -0.07(0.73) | 0.12(0.77) | 0.02(0.92) | 0.10(1.19) | | | |
| Footwear | -0.04(1.33) | -0.03(0.53) | -0.03(1.70) | -0.03(1.14) | | | |
| Fuels | -0.0009(0.00) | 0.30(0.71) | 0.41(1.17) | 0.45(1.88) | | | |
| Hides & skins | -0.09(1.89) | 0.07(0.99) | 0.10(1.64) | 0.06(1.39) | | | |
| Mach & Elec | -0.07(1.23) | 0.06(0.67) | 0.05(1.71) | 0.002(0.03) | | | |
| Metals | -0.03(0.49) | 0.10(1.00) | 0.07(0.91) | 0.06(1.11) | | | |
| Minerals | -0.005(0.03) | -0.03(0.14) | -0.06(0.37) | 0.07(0.59) | | | |
| Miscellaneous | -0.05(0.88) | 0.05(0.67) | 0.05(0.09) | 0.004(0.09) | | | |
| Plastic or rubber | -0.05(1.13) | 0.03(0.44) | 0.3(0.55) | 0.03(0.74) | | | |
| Stone & glass | -0.06(1.08) | 0.10(1.14) | 0.09(1.29) | 0.06(1.31) | | | |
| Textiles & clothing | -0.09(1.40) | -0.03(0.34) | -0.02(0.27) | -0.01(0.28) | | | |
| Transportation | -0.03(0.42) | 0.06(0.67) | 0.05(0.63) | 0.03(1.64) | | | |
| Vegetable | -0.04(0.54) | -0.03(0.25) | -0.07(0.75) | -0.06(1.01) | | | |
| Wood | -0.06(1.08) | 0.15(1.76) | 0.09(1.29) | 0.03(0.57) | | | |

***Table D3: Short- and long-run coefficient estimates, India export specification 12-month volatility measure***

| | $\Delta \ln VOl_t$ | $\Delta \ln VOl_{t-1}$ | $\Delta \ln VOl_{t-2}$ | $\Delta \ln VOl_{t-3}$ | $LnY^{USA}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Intermediate goods | 0.06(1.44) | -0.06(2.16) | -0.05(1.10) | -0.02(0.65) | 2.92(4.25) | -0.005(0.03) | 0.14(4.05) |
| Raw materials | 0.19(1.92) | -0.11(0.91) | -0.20(1.92) | -0.16(2.38) | -2.63(0.80) | 1.08(1.36) | 0.58(3.33) |
| Footwear | -0.04(1.09) | -0.17(2.35) | -0.11(1.82) | -0.06(1.65) | 6.07(2.86) | -1.05(2.03) | 0.45(3.98) |
| ***Negatively affected by volatility*** | | | | | | | |
| Metals | 0.04(0.45) | 0.17(1.31) | 0.20(1.75) | 0.08(1.05) | 4.51(2.14) | -0.13(0.26) | -0.21(1.94) |
| Textiles & clothing | -0.08(3.22) | 0.02(0.58) | 0.04(1.46) | 0.02(1.03) | 3.08(4.85) | -0.10(0.69) | -0.14(4.31) |
| ***Not affected by volatility*** | | | | | | | |
| Fuels | 0.61(1.92) | 0.61(1.42) | 0.59(1.35) | 0.24(1.06) | -47.04(1.85) | 12.27(2.04) | 1.04(1.18) |
| Hides & skins | 0.05(1.78) | -0.007(0.17) | 0.009(0.23) | 0.02(0.86) | -171.59(0.06) | 39.09(0.06) | 14.32(0.06) |
| Minerals | -0.07(0.50) | 0.07(0.45) | -0.02(0.11) | -0.08(0.95) | 10.37(4.45) | -1.92(3.41) | -0.08(0.69) |
| Miscellaneous | -0.07(1.29) | -0.13(1.71) | -0.11(1.67) | -0.08(1.87) | 6.55(3.78) | -0.54(1.27) | 0.10(1.19) |
| Stone & glass | -0.03(0.95) | 0.007(0.16) | 0.03(0.68) | 0.02(0.88) | 2.13(2.98) | 0.27(1.55) | -0.06(1.70) |
| ***No cointegration*** | | | | | | | |
| Capital goods | -0.02(0.47) | -0.02(0.36) | -0.009(0.17) | -0.02(0.63) | | | |
| Consumer goods | -0.03(0.93) | -0.005(0.10) | 0.01(0.34) | 0.004(0.15) | | | |
| Animal | -0.01(0.13) | -0.19(1.60) | -0.10(0.92) | -0.03(0.48) | | | |
| Chemical | -0.02(0.41) | -0.06(0.82) | 0.0003(0.00) | 0.03(0.93) | | | |
| Food products | -0.08(1.69) | -0.15(2.34) | -0.09(1.66) | -0.08(2.34) | | | |
| Mach & Elec | -0.01(0.18) | 0.0009(0.01) | 0.01(0.20) | -0.01(0.28) | | | |
| Plastic or rubber | -0.01(0.18) | -0.08(1.03) | -0.05(0.88) | -0.04(1.01) | | | |
| Transportation | 0.05(0.75) | -0.02(0.22) | -0.03(0.41) | -0.03(0.52) | | | |
| Vegetable | 0.34(2.20) | 0.02(0.14) | -0.04(0.33) | -0.06(0.81) | | | |
| Wood | -0.08(1.48) | -0.08(1.11) | -0.05(0.70) | -0.04(1.00) | | | |

*Table D4: Short- and long-run coefficient estimates, Indonesia export specification 12-month volatility measure*

| | $\Delta\text{lnVOl}_t$ | $\Delta\text{lnVOl}_{t-1}$ | $\Delta\text{lnVOl}_{t-2}$ | $\Delta\text{lnVOl}_{t-3}$ | $\text{LnY}^{USA}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Minerals | 0.63(1.57) | -0.22(0.36) | -1.14(2.81) | -0.33(0.90) | -11.28(0.80) | -0.25(0.06) | 2.63(2.16) |
| Textiles & clothing | 0.02(1.27) | -0.07(3.20) | -0.003(0.24) | -0.02(1.52) | 4.80(3.82) | -1.07(2.72) | 0.34(3.00) |
| ***Negatively affected by volatility*** | | | | | | | |
| Intermediate goods | 0.03(1.41) | 0.16(2.70) | 0.10(2.87) | 0.07(2.25) | 1.24(1.89) | 0.31(1.74) | -0.19(3.48) |
| Vegetable | -0.07(1.52) | 0.24(1.88) | 0.18(2.32) | 0.10(1.88) | 0.77(0.43) | 1.39(2.91) | -0.78(5.60) |
| ***Not affected by volatility*** | | | | | | | |
| Capital goods | 0.03(1.14) | 0.01(1.14) | -0.02(0.59) | 0.01(0.53) | -0.83(0.52) | 0.02(0.05) | 0.12(0.71) |
| Animal | 0.05(1.43) | -0.008(0.16) | 0.02(0.51) | 0.007(0.23) | 5.20(4.82) | -0.40(1.31) | 0.10(1.08) |
| Fuels | 0.0009(0.01) | -0.19(1.10) | 0.13(1.27) | -0.006(0.06) | 0.11(0.05) | -0.11(0.17) | 0.04(0.15) |
| Metals | -0.2(0.38) | 0.20(1.95) | 0.15(2.60) | 0.10(1.89) | -0.21(0.12) | 1.03(2.29) | -0.43(3.25) |
| Mach & Elec | 0.02(0.65) | 0.02(0.38) | 0.008(0.25) | 0.02(0.87) | -1.37(0.77) | 0.11(0.21) | 0.05(0.22) |
| ***No cointegration*** | | | | | | | |
| Consumer goods | -0.02(1.84) | 0.01(0.57) | 0.03(2.77) | 0.003(0.25) | | | |
| Raw materials | -0.01(0.23) | -0.15(1.90) | -0.01(0.24) | -0.06(1.43) | | | |
| Chemical | 0.11(1.28) | -0.06(0.41) | -0.007(0.07) | 0.06(0.82) | | | |
| Food products | -0.02(0.44) | 0.03(0.45) | 0.02(0.41) | -0.04(0.91) | | | |
| Footwear | -0.03(0.57) | 0.04(0.56) | 0.06(1.57) | 0.002(0.06) | | | |
| Hides & skins | -0.02(0.39) | 0.15(1.82) | 0.15(3.01) | 0.06(1.25) | | | |
| Miscellaneous | -0.0009(0.04) | 0.004(0.12) | -0.01(0.64) | -0.03(1.52) | | | |
| Plastic or rubber | -0.07(1.26) | -0.16(1.77) | -0.04(0.64) | -0.06(1.21) | | | |
| Stone & glass | -0.04(1.21) | 0.04(0.71) | -0.04(1.18) | -0.04(1.23) | | | |
| Transportation | -0.09(1.28) | -0.02(0.19) | -0.004(0.05) | -0.06(0.98) | | | |
| Wood | 0.01(0.38) | 0.06(1.21) | 0.03(0.61) | -0.02(0.61) | | | |

*Table D5: Short- and long-run coefficient estimates, Korea export specification 12-month volatility measure*

| | $\Delta \text{lnVOl}_t$ | $\Delta \text{lnVOl}_{t-1}$ | $\Delta \text{lnVOl}_{t-2}$ | $\Delta \text{lnVOl}_{t-3}$ | $\text{LnY}^{USA}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| ***Negatively affected by volatility*** | | | | | | | |
| Wood | -0.06(0.96) | 0.19(1.33) | 0.11(1.28) | 0.05(0.98) | 3.71(2.62) | 2.79(2.91) | -0.87(2.18) |
| ***Not affected by volatility*** | | | | | | | |
| Capital goods | 0.02(0.63) | -0.02(0.26) | 0.01(0.20) | -0.02(0.45) | 0.66(1.36) | 0.48(1.42) | 0.02(0.14) |
| Intermediate goods | 0.07(2.37) | -0.10(1.20) | -0.10(1.68) | -0.02(0.63) | 2.29(5.64) | -2.24(1.00) | 0.18(1.60) |
| Chemical | 0.12(1.51) | -0.14(0.65) | -0.10(0.68) | 0.01(0.13) | 3.83(2.85) | -0.94(1.32) | 0.46(1.30) |
| Footwear | 0.14(1.91) | -0.09(0.73) | -0.08(0.97) | -0.07(1.28) | -3.68(0.54) | 1.002(0.24) | 1.99(0.85) |
| Mach & Elec | 0.01(0.26) | -0.005(0.06) | 0.02(0.30) | -0.009(0.24) | 0.15(0.23) | 0.57(1.53) | -0.01(0.07) |
| Minerals | -0.20(0.83) | 0.36(0.71) | -0.02(0.07) | 0.3(0.14) | 5.93(1.23) | 7.55(2.60) | -1.82(1.40) |
| Plastic or rubber | 0.03(0.60) | 0.16(1.60) | 0.09(1.38) | 0.06(1.40) | 4.30(4.29) | 1.04(1.08) | -0.27(0.87) |
| Textiles & clothing | 0.009(0.20) | -0.06(0.64) | -0.04(0.71) | -0.03(0.88) | -4.51(1.46) | 1.80(1.16) | 0.43(0.48) |
| Transportation | -0.07(1.25) | 0.11(0.71) | 0.04(0.47) | 0.009(0.17) | 4.41(1.83) | 2.75(2.17) | -0.71(1.24) |
| Vegetable | -0.02(0.68) | 0.09(1.04) | 0.05(0.86) | 0.03(0.93) | 2.77(5.89) | 0.42(1.53) | -0.18(1.42) |
| ***No cointegration*** | | | | | | | |
| Consumer goods | -06(1.62) | 0.08(0.76) | 0.02(0.31) | 0.007(0.17) | | | |
| Raw materials | 0.07(1.44) | -0.01(0.12) | 0.02(0.25) | 0.04(0.85) | | | |
| Animal | 0.10(1.13) | -0.14(0.80) | -0.04(0.39) | 0.03(0.45) | | | |
| Food products | -0.001(0.04) | 0.04(0.42) | 0.02(0.40) | -0.01(0.34) | | | |
| Fuels | -0.30(3.06) | -0.08(0.34) | -0.10(0.68) | 0.01(0.12) | | | |
| Hides & skins | 0.15(1.42) | -0.58(1.93) | -0.26(1.61) | -0.20(1.84) | | | |
| Metals | 0.08(1.19) | -0.07(0.43) | -0.08(0.17) | -0.02(0.25) | | | |
| Miscellaneous | -0.03(0.24) | 0.05(0.23) | 0.01(0.10) | -02(0.26) | | | |
| Stone & glass | 0.06(0.68) | -0.10(0.49) | -0.08(0.64) | 0.04(0.47) | | | |

***Table D6: Short- and long-run coefficient estimates, Mexico export specification 12-month volatility measure***

| | $\Delta \ln VOl_t$ | $\Delta \ln VOl_{t-1}$ | $\Delta \ln VOl_{t-2}$ | $\Delta \ln VOl_{t-3}$ | $LnY^{USA}$ | lnREX | LnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Miscellaneous | 0.11(1.59) | -0.22(1.53) | -0.10(1.42) | -0.06(1.26) | 2.36(2.44) | -0.39(0.85) | 0.43(2.30) |
| ***Negatively affected by volatility*** | | | | | | | |
| ***Not affected by volatility*** | | | | | | | |
| Animal | -0.13(2.93) | -0.10(1.15) | -0.08(1.53) | 0.02(0.45) | 0.91(0.95) | 0.88(1.88) | -0.17(0.88) |
| Chemical | -0.001(0.07) | -0.02(0.63) | -0.02(0.84) | 0.00004(0.00) | 1.90(6.92) | 0.04(0.32) | 0.02(0.36) |
| Footwear | 0.08(2.19) | -0.24(3.14) | -0.10(2.42) | -0.06(2.03) | 38.22(0.44) | -22.84(0.45) | 19.18(0.47) |
| Fuels | 0.006(0.05) | 0.04(0.17) | 0.04(0.34) | -0.007(0.07) | 9.009(1.72) | -3.64(1.41) | 0.10(0.10) |
| Hides & skins | 0.12(2.57) | -0.18(1.88) | -0.12(2.15) | -0.06(1.60) | 1.22(0.32) | -1.92(0.92) | 1.56(1.67) |
| Mach & Elec | -0.03(1.56) | -0.05(1.36) | -0.04(2.16) | -0.04(2.73) | 0.33(1.22) | 0.57(4.09) | -0.05(0.81) |
| Metals | -0.0003(0.01) | 0.06(1.07) | 0.01(0.43) | 0.02(1.03) | 2.73(4.94) | -0.14(0.53) | -0.13(1.17) |
| Textiles & clothing | -0.007(0.25) | -0.09(1.40) | -0.05(1.58) | -0.02(1.02) | -8.19(5.17) | 1.46(1.34) | 0.28(0.43) |
| Vegetable | 0.02(0.46) | -0.07(0.85) | -0.006(0.14) | 0.02(0.78) | 3.67(4.05) | -0.29(0.59) | 0.28(1.29) |
| Wood | -0.02(0.85) | 0.05(0.90) | 0.02(0.62) | 0.01(0.65) | 0.50(0.51) | 0.51(1.11) | -0.23(1.20) |
| ***No cointegration*** | | | | | | | |
| Capital goods | -0.02(0.77) | -0.11(2.06) | -0.05(1.62) | -0.03(1.45) | | | |
| Consumer goods | -0.008(0.35) | -0.06(1.07) | -0.03(1.17) | -0.03(1.53) | | | |
| Intermediate goods | -0.04(0.84) | -0.06(0.67) | 0.03(0.57) | -0.009(0.28) | | | |
| Raw materials | -0.006(0.08) | 0.03(0.21) | 0.04(0.50) | 0.008(0.15) | | | |
| Food products | 0.02(0.71) | -0.01(0.22) | 0.00008(0.02) | 0.0004(0.02) | | | |
| Minerals | 0.05(0.50) | 0.04(0.17) | 0.02(0.13) | 0.10(0.34) | | | |
| Plastic or rubber | 0.004(0.17) | 003(0.05) | 0.002(0.06) | 0.004(0.22) | | | |
| Stone & glass | -0.01(0.17) | 0.009(0.07) | 0.008(0.10) | 0.03(0.52) | | | |
| Transportation | -0.0009(0.02) | -0.18(1.99) | -0.08(1.62) | -0.06(1.68) | | | |

***Table D7: Short- and long-run coefficient estimates, Russia export specification 12-month volatility measure***

| | $\Delta \ln VOl_t$ | $\Delta \ln VOl_{t-1}$ | $\Delta \ln VOl_{t-2}$ | $\Delta \ln VOl_{t-3}$ | $LnY^{USA}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Mach & Elec | 0.08(1.72) | 0.01(0.20) | 0.04(1.25) | 0.05(3.09) | 4.68(6.78) | -0.35(1.62) | 0.27(2.71) |
| ***Negatively affected by volatility*** | | | | | | | |
| Intermediate goods | -0.18(2.76) | 0.08(1.02) | 0.04(0.78) | 0.004(1.16) | -0.14(0.12) | 0.58(1.50) | -0.35(1.86) |
| Metals | -2.6(2.95) | 0.13(1.23) | 0.05(0.69) | 0.005(0.16) | 1.56(1.30) | -0.469(1.35) | -0.46(2.63) |
| ***Not affected by volatility*** | | | | | | | |
| Capital goods | -0.14(1.70) | 0.07(0.76) | 0.06(0.86) | 0.03(0.86) | 1.67(1.72) | 0.24(0.84) | -0.9(0.63) |
| Footwear | -0.01(0.09) | -0.02(0.14) | 0.04(0.37) | 0.03(0.62) | -29.66(1.34) | 1.90(0.63) | 1.6(0.98) |
| Minerals | -0.18(0.36) | 0.44(0.82) | 0.41(1.18) | 0.26(1.66) | 13.4(1.99) | 0.40(0.20) | -0.79(0.78) |
| Miscellaneous | -0.12(1.16) | 0.23(1.78) | 0.19(2.19) | 0.11(3.04) | 3.48(1.61) | 0.78(1.20) | -0.51(1.50) |
| Plastic or rubber | -0.008(0.07) | 0.02(0.14) | 0.03(0.43) | 0.04(1.18) | 8.74(4.77) | -0.38(0.66) | 0.04(0.16) |
| Textiles & clothing | 0.07(0.37) | -0.14(0.69) | -0.09(0.62) | -0.02(0.34) | -32.59(2.89) | 0.72(0.24) | 1.71(1.00) |
| Transportation | 0.006(0.03) | 0.22(0.94) | 0.17(1.07) | -0.009(0.12) | 3.12(1.63) | 0.53(0.86) | -0.17(0.56) |
| Wood | -0.06(1.01) | -0.10(1.50) | -0.03(0.66) | -0.001(0.06) | -1.23(0.67) | -0.03(0.05) | 0.14(0.45) |
| ***No cointegration*** | | | | | | | |
| Consumer goods | -0.07(0.55) | -0.11(0.81) | -0.12(1.35) | -0.07(1.51) | | | |
| Raw materials | -0.18(1.01) | -0.04(0.21) | -0.07(0.47) | 0.00008(0.00) | | | |
| Animal | 0.09(1.26) | -0.05(0.61) | -0.03(0.57) | -0.004(0.17) | | | |
| Chemical | -0.17(1.73) | 0.03(0.26) | -0.005(0.07) | -0.02(0.51) | | | |
| Food products | -0.11(1.20) | 0.18(1.67) | 0.11(1.53) | 0.04(1.11) | | | |
| Fuels | -0.07(0.55) | -0.14(0.97) | -0.06(0.68) | -0.02(0.36) | | | |
| Hides & skins | -0.30(1.57) | -0.08(0.33) | -0.16(1.08) | -0.08(1.20) | | | |
| Stone & glass | -0.13(0.96) | 0.22(1.29) | 0.18(1.66) | 0.03(0.70) | | | |
| Vegetable | 0.05(0.34) | 0.22(1.25) | 0.16(1.36) | 0.02(0.36) | | | |

*Table D8: Short- and long-run coefficient estimates, Saudi Arabia export specification 12-month volatility measure*

| | $\Delta \ln VOl_t$ | $\Delta \ln VOl_{t-1}$ | $\Delta \ln VOl_{t-2}$ | $\Delta \ln VOl_{t-3}$ | $LnY^{USA}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| ***Negatively affected by volatility*** | | | | | | | |
| ***Not affected by volatility*** | | | | | | | |
| Capital goods | 0.42(0.89) | 0.88(1.17) | 0.35(0.51) | 0.13(0.32) | 1.75(1.62) | 5.42(3.09) | -1.09(1.18) |
| Intermediate goods | 0.32(0.40) | 0.54(0.50) | -0.15(0.15) | -0.40(0.60) | -0.22(0.17) | -0.99(0.69) | -0.29(0.40) |
| Footwear | -0.32(0.22) | -3.92(1.77) | -1.62(0.82) | 0.23(0.19) | 4.96(2.40) | -0.72(0.20) | 3.66(1.91) |
| Mach & Elec | 0.26(1.00) | 0.41(0.97) | 0.12(0.31) | 0.17(0.76) | 2.69(4.65) | 5.81(5.79) | 0.17(1.23) |
| Metals | -0.03(0.06) | 0.25(0.37) | -0.31(0.49) | -0.32(0.83) | 5.80(8.52) | 3.57(3.03) | -0.44(0.71) |
| Minerals | 1.05(0.74) | -0.07(0.03) | -0.16(0.08) | 0.58(0.51) | 10.42(3.96) | 0.72(0.15) | 3.45(1.31) |
| Miscellaneous | 0.81(0.80) | 2.04(1.62) | 1.72(1.50) | 0.60(0.86) | 1.54(0.85) | 19.64(6.57) | -0.31(0.17) |
| Plastic & rubber | 0.88(1.47) | 0.35(0.42) | -0.06(0.07) | 0.08(0.17) | 5.07(3.19) | -1.22(0.43) | -0.01(0.01) |
| Textiles & clothing | 0.45(1.40) | 0.75(1.40) | 0.75(1.60) | 0.14(0.56) | 6.12(1.55) | -1.05(0.30) | 1.64(0.83) |
| Transportation | 2.11(0.24) | -8.72(0.75) | -5.59(0.53) | -1.39(0.02) | -3.04(0.89) | -3.36(0.72) | -0.42(0.16) |
| Woods | 0.06(0.21) | 0.72(1.88) | 0.52(1.51) | 0.25(1.24) | -0.19(0.38) | 2.45(2.74) | -0.81(1.62) |
| ***No cointegration*** | | | | | | | |
| Consumer goods | 0.09(0.19) | -0.59(0.92) | -0.68(1.14) | -0.53(1.48) | | | |
| Raw materials | 1.61(0.73) | 1.69(0.60) | 0.23(0.09) | -0.33(0.20) | | | |
| Animal | 0.75(0.51) | -3.62(1.77) | -2.24(1.13) | -0.36(0.32) | | | |
| Chemical | 1.02(0.72) | 1.22(0.66) | 0.18(0.11) | -0.07(0.06) | | | |
| Food products | -0.37(0.74) | -0.38(0.49) | 0.63(0.91) | 0.51(1.30) | | | |
| Fuels | 0.79(0.76) | 0.41(0.31) | -0.25(0.21) | -0.36(0.48) | | | |
| Hides & skins | 0.23(0.15) | -0.79(0.31) | -0.08(0.54) | 0.23(0.19) | | | |
| Stone & glass | -0.71(0.96) | -0.53(0.52) | 0.79(0.76) | 0.85(1.36) | | | |
| Vegetable | -0.10(0.25) | 0.10(0.16) | -0.06(0.10) | -0.01(0.05) | | | |

*Table D9: Short- and long-run coefficient estimates, South Africa export specification 12-month volatility measure*

| | $\Delta \ln VOl_t$ | $\Delta \ln VOl_{t-1}$ | $\Delta \ln VOl_{t-2}$ | $\Delta \ln VOl_{t-3}$ | $LnY^{USA}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| ***Negatively affected by volatility*** | | | | | | | |
| Fuels | -0.15(0.80) | 0.68(0.80) | 0.27(0.85) | -0.001(0.01) | 4.99(1.69) | 0.14(0.22) | -0.03(1.98) |
| Miscellaneous | -0.19(1.40) | 0.84(2.36) | 0.65(2.68) | 0.40(3.07) | 16.38(2.66) | -2.09(1.63) | -1.65(1.93) |
| ***Not affected by volatility*** | | | | | | | |
| Animal | 0.08(1.92) | 0.42(3.83) | 0.26(3.56) | 0.11(2.75) | 4.49(1.56) | -0.60(1.11) | -0.67(1.74) |
| Chemical | 0.16(3.08) | 0.02(0.14) | 0.10(1.19) | 0.05(1.13) | 4.79(3.06) | -1.14(3.75) | 0.37(1.36) |
| Food products | 0.33(4.72) | 0.50(3.00) | 0.36(3.04) | 0.08(1.37) | 3.62(6.91) | -0.70(6.21) | 0.03(0.33) |
| Hides & skins | -0.17(3.19) | -0.48(3.41) | -0.43(4.64) | -0.18(3.78) | 30.51(0.80) | -5.39(0.86) | -3.67(0.82) |
| Metals | -0.02(0.27) | -0.05(0.27) | 0.03(0.21) | 0.02(0.34) | 3.88(3.74) | -0.68(3.03) | -0.002(0.01) |
| Vegetable | -0.02(0.27) | 0.02(0.11) | 0.05(0.47) | 0.01(0.24) | 4.23(3.76) | -0.34(1.40) | 0.03(0.16) |
| ***No cointegration*** | | | | | | | |
| Capital goods | -0.001(0.02) | -0.08(0.58) | -0.03(0.35) | 0.04(0.84) | | | |
| Consumer goods | 0.14(1.36) | -0.05(0.16) | 0.13(0.67) | 0.12(1.25) | | | |
| Intermediate goods | 0.04(0.62) | 0.16(0.92) | 0.12(1.11) | 0.02(0.40) | | | |
| Raw materials | 0.07(1.21) | -0.01(0.08) | -0.02(0.16) | -0.04(0.70) | | | |
| Footwear | 0.05(0.43) | -0.23(0.77) | -0.28(1.40) | -0.07(0.66) | | | |
| Mach & Elec | -0.02(0.29) | -0.17(0.94) | -0.09(0.81) | 0.01(0.21) | | | |
| Minerals | 0.03(0.50) | 0.04(0.23) | 0.026(0.22) | 0.007(0.10) | | | |
| Plastic &rubber | -0.04(0.41) | -0.13(0.58) | -0.08(0.50) | 0.009(0.11) | | | |
| Stone & glass | 0.02(0.29) | 0.29(1.36) | 0.18(1.30) | 0.04(0.50) | | | |
| Textiles & clothing | 0.06(0.80) | 0.21(1.08) | 0.15(1.15) | 0.13(1.76) | | | |
| Transportation | 0.17(1.11) | -0.16(0.32) | 0.07(0.23) | 0.12(0.84) | | | |
| Wood | -0.06(1.03) | -0.38(2.29) | -0.19(1.76) | -0.04(0.63) | | | |

***Table D10: Short- and long-run coefficient estimates, Turkey export specification 12-month volatility measure***

| | $\Delta\ln VOl_t$ | $\Delta\ln VOl_{t-1}$ | $\Delta\ln VOl_{t-2}$ | $\Delta\ln VOl_{t-3}$ | $LnY^{USA}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| ***Negatively affected by volatility*** | | | | | | | |
| Chemical | -0.09(1.06) | 0.11(0.85) | 0.06(0.65) | 0.04(0.76) | 4.50(6.22) | 0.27(1.38) | -0.31(1.80) |
| Fuels | 0.72(1.85) | -1.32(1.95) | -0.98(1.92) | -0.63(2.02) | 2.17(0.51) | -2.87(2.39) | 2.88(2.78) |
| ***Not affected by volatility*** | | | | | | | |
| Intermediate goods | 0.06(0.53) | 0.03(0.12) | -0.05(0.32) | -0.006(0.06) | 3.14(2.20) | -0.05(0.12) | 0.02(0.05) |
| Metals | 0.03(0.13) | 0.15(0.43) | -0.002(0.01) | 0.02(0.14) | 2.34(0.38) | 0.25(0.38) | -0.28(0.50) |
| Minerals | 0.15(0.92) | -0.20(0.72) | -0.06(0.34) | -0.02(0.21) | 8.16(2.30) | -1.46(1.50) | 1.37(1.62) |
| Miscellaneous | -0.04(0.13) | 0.52(1.15) | 0.45(1.36) | 0.23(1.09) | 9.34(3.38) | 0.21(0.27) | -0.49(0.75) |
| Textiles & clothing | -0.007(0.11) | 0.11(1.24) | 0.08(1.27) | 0.05(1.29) | -3.55(1.57) | 0.75(0.81) | -0.31(0.40) |
| Transportation | -0.49(2.91) | -0.11(0.48) | 0.08(0.52) | 0.13(1.19) | 10.21(6.15) | 0.48(1.00) | -0.67(1.65) |
| Vegetable | 0.01(0.13) | 0.16(0.94) | 0.24(2.24) | 0.17(2.58) | 4.10(4.03) | 0.003(0.01) | -0.10(0.36) |
| ***No cointegration*** | | | | | | | |
| Capital goods | -0.08(1.16) | 0.01(0.10) | 0.02(0.22) | -0.005(0.09) | | | |
| Consumer goods | -0.03(0.35) | -0.02(0.17) | 0.006(0.06) | 0.01(0.26) | | | |
| Raw materials | -0.15(1.56) | 0.29(1.72) | 0.15(1.36) | 0.14(2.16) | | | |
| Animal | -0.19(0.77) | 0.56(1.26) | 0.47(1.45) | 0.15(0.70) | | | |
| Food products | -0.08(0.81) | -0.08(0.44) | -0.07(0.52) | 0.03(0.37) | | | |
| Footwear | 0.16(0.90) | 0.08(0.20) | 0.16(0.62) | 0.11(0.79) | | | |
| Hides & skins | -0.04(0.63) | 0.01(0.12) | 0.03(0.40) | 0.04(0.78) | | | |
| Mach & Elec | -0.10(1.78) | 0.06(0.54) | 0.06(0.75) | 0.05(0.97) | | | |
| Plastic & rubber | 0.04(0.48) | -0.10(0.66) | -0.11(1.07) | -0.05(0.80) | | | |
| Stone & glass | -0.003(0.04) | 0.03(0.23) | 0.0002(0.00) | 0.03(0.47) | | | |
| Wood | -0.03(0.16) | 0.04(0.12) | 0.27(1.18) | 0.14(1.02) | | | |

## Appendix 3E: Short-run and Long-run LEMEs real imports from US coefficient estimates specification

***Table E1: Short- and long-run coefficient estimates, Brazil real import specifications 12-month volatility measure***

| | $\Delta \ln VOl_t$ | $\Delta \ln VOl_{t-1}$ | $\Delta \ln VOl_{t-2}$ | $\Delta \ln VOl_{t-3}$ | $LnY^{BRAZIL}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| ***Negatively affected by volatility*** | | | | | | | |
| Animal | -0.10(1.64) | 0.21(3.37) | 0.08(2.34) | 0.07(2.76) | 2.03(4.12) | 0.76(2.05) | -0.81(2.92) |
| Food products | -0.28(1.49) | 0.30(1.75) | 0.17(1.85) | 0.19(2.41) | 4.29(4.91) | 1.30(2.28) | -1.14(2.96) |
| Minerals | -0.11(1.32) | 0.11(1.24) | 0.001(0.03) | 0.10(2.05) | 4.32(12.85) | 0.12(0.51) | -0.30(1.90) |
| Transportation | -0.27(1.36) | 0.53(2.52) | 0.15(1.30) | 0.15(1.98) | -0.36(0.25) | 3.08(2.51) | -1.96(2.31) |
| ***Not affected by volatility*** | | | | | | | |
| Capital goods | -0.05(0.76) | 0.10(1.80) | 0.03(0.81) | 0.01(0.54) | 1.52(2.77) | 0.21(0.32) | -0.60(0.98) |
| Consumer goods | -0.11(2.03) | 0.17(3.47) | 0.04(1.33) | 0.06(3.14) | 6.85(2.23) | 1.50(1.16) | -1.72(1.39) |
| Intermediate goods | -0.02(0.51) | 0.07(1.69) | 0.02(0.66) | 0.01(0.53) | 2.23(9.21) | 0.11(0.49) | -0.24(1.54) |
| Chemicals | -0.03(1.19) | 0.01(0.50) | -0.003(0.18) | 0.005(0.49) | 2.49(12.62) | -0.02(0.13) | -0.13(1.34) |
| Footwear | -0.08(0.66) | 0.19(1.53) | 0.02(0.32) | 0.14(2.88) | 1.22(2.15) | -0.44(1.14) | -0.30(1.15) |
| Hides & skins | -0.03(0.35) | 0.15(1.59) | 0.08(1.45) | 0.09(2.11) | 0.54(1.41) | 0.51(1.88) | -0.28(1.54) |
| Mech & Elec | -0.04(0.82) | 0.11(2.00) | 0.02(0.83) | 0.02(0.69) | 1.56(2.74) | 0.20(0.29) | -0.66(1.00) |
| Metals | -0.04(0.16) | 0.09(1.33) | -0.004(0.10) | 0.01(0.52) | 3.01(7.39) | -0.34(1.19) | -0.23(1.10) |
| Miscellaneous | -0.01(0.07) | -0.23(2.39) | -0.07(1.24) | -0.08(2.45) | 5.98(12.48) | -1.59(4.48) | 0.34(1.59) |
| Plastic or rubber | -0.01(0.45) | 0.04(1.29) | 0.01(0.56) | 0.01(0.91) | 2.58(16.46) | -0.07(0.53) | -0.11(1.17) |
| Stone & glass | -0.04(0.53) | 0.13(1.91) | 0.05(1.24) | 0.01(0.37) | 2.54(7.40) | 0.29(0.96) | -0.37(1.74) |
| Textiles and Clothing | -0.21(2.36) | 0.01(0.13) | 0.00(0.00) | 0.06(1.81) | 1.04(3.69) | -0.18(0.92) | -0.23(1.76) |
| Wood | 0.03(1.15) | -0.04(1.07) | -0.02(0.85) | 0.01(1.01) | 1.40(8.58) | -0.78(7.65) | 0.12(1.73) |
| ***No cointegration*** | | | | | | | |
| Raw materials | 0.01(0.11) | 0.09(0.86) | 0.06(1.04) | 0.05(1.39) | | | |
| Fuels | -0.08(0.79) | 0.17(1.99) | 0.08(1.70) | 0.09(2.46) | | | |
| Vegetable | 0.11(0.36) | -0.03(0.09) | 0.01(0.06) | 0.05(0.44) | | | |

***Table E2: Short- and long-run coefficient estimates, China import specification 12-month volatility measure***

| | $\Delta \text{lnVOl}_t$ | $\Delta \text{lnVOl}_{t-1}$ | $\Delta \text{lnVOl}_{t-2}$ | $\Delta \text{lnVOl}_{t-3}$ | $\text{LnY}^{\text{CHINA}}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| ***Negatively affected by volatility*** | | | | | | | |
| Consumer goods | -0.11(2.23) | 0.17(2.25) | 0.17(3.04) | 0.11(2.55) | 1.64(13.20) | -0.002(0.00) | -0.52(3.40) |
| Food products | -0.40(2.68) | 0.22(0.87) | 0.04(0.26) | -0.03(0.28) | 1.52(6.13) | 1.23(0.89) | -0.95(4.10) |
| Minerals | -0.19(1.09) | 0.44(1.67) | 0.50(2.25) | 0.29(1.96) | 1.03(1.75) | -4.34(1.56) | -0.98(1.84) |
| ***Not affected by volatility*** | | | | | | | |
| Capital goods | -0.01(0.14) | 0.08(0.86) | 0.04(0.46) | -0.01(0.10) | 1.06(5.23) | 1.27(0.99) | -0.14(0.66) |
| Raw material | -0.03(0.29) | 0.07(0.42) | 0.03(0.22) | 0.01(0.13) | 0.66(1.64) | -5.59(2.60) | -0.11(0.34) |
| Footwear | 0.10(0.97) | -0.10(0.66) | -0.17(1.32) | -0.10(1.15) | 1.6(3.02) | 6.51(1.83) | 0.55(0.89) |
| Fuels | -0.42(1.70) | -0.36(1.02) | -0.17(0.56) | -0.04(0.17) | 3.27(4.54) | 6.45(1.63) | -0.50(0.74) |
| Hides & skins | -0.10(0.91) | 0.24(1.39) | 0.22(1.58) | 0.10(1.01) | -0.18(0.18) | -3.55(0.86) | -1.31(1.55) |
| Metals | 0.04(0.38) | 0.24(1.50) | 0.16(1.13) | 0.07(0.72) | 1.19(0.26) | -5.32(1.85) | -0.43(0.76) |
| Miscellaneous | -0.15(1.70) | -0.14(0.94) | -0.11(1.04) | -0.12(1.57) | 0.97(5.00) | -3.90(3.23) | -0.20(0.87) |
| Plastic or rubber | 0.01(0.19) | 0.18(2.46) | 0.18(2.92) | 0.09(1.30) | 18.93(0.10) | 28.38(0.09) | 6.48(0.09) |
| Stone & glass | -0.10(1.35) | 0.06(0.51) | 0.15(1.52) | 0.14(1.52) | 1.59(13.08) | 0.25(0.35) | -0.14(0.99) |
| Textiles & clothing | -0.11(0.60) | -0.26(0.94) | -0.21(0.88) | -0.02(0.11) | 0.66(1.04) | -3.20(0.88) | 0.08(0.13) |
| Vegetables | -0.53(0.30) | -0.003(0.01) | -0.05(0.27) | -0.10(0.78) | 0.33(0.80) | -7.15(2.98) | -0.02(0.06) |
| ***No cointegration*** | | | | | | | |
| Intermediate goods | 0.01(0.25) | 0.01(0.10) | -0.03(0.40) | -0.02(0.42) | | | |
| Animal | 0.03(0.32) | -0.01(0.04) | -0.07(0.59) | -0.02(0.30) | | | |
| Chemicals | 0.03(0.38) | -0.15(1.22) | -0.16(1.59) | -0.09(1.35) | | | |
| Mach &Elec | -0.04(0.71) | 0.09(0.71) | 0.09(1.06) | 0.10(1.48) | | | |
| Transportation | -0.01(0.03) | 0.60(1.23) | 0.36(0.90) | 0.26(0.92) | | | |
| Wood | -0.06(1.01) | 0.14(1.50) | 0.10(1.36) | 0.04(0.71) | | | |

*Table E3: Short- and long-run coefficient estimates, India imports specification 12-month volatility measure*

| | $\Delta \text{lnVOl}_t$ | $\Delta \text{lnVOl}_{t-1}$ | $\Delta \text{lnVOl}_{t-2}$ | $\Delta \text{lnVOl}_{t-3}$ | $\text{LnY}^{\text{INDIA}}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Hides & skins | -0.02(0.32) | -0.17(1.68) | -0.16(1.70) | -0.12(1.98) | 1.32(1.18) | -1.36(2.14) | 0.79(1.89) |
| ***Negatively affected by volatility*** | | | | | | | |
| ***Not affected by volatility*** | | | | | | | |
| Capital goods | 0.003(0.04) | 0.28(3.01) | 0.31(3.27) | 0.19(2.84) | 1.75(1.79) | -0.23(0.46) | -0.61(1.72) |
| Footwear | 0.12(0.18) | 0.61(3.26) | 0.39(2.08) | 0.13(1.07) | 1.41(1.87) | -0.76(1.94) | -0.36(1.45) |
| Mach & Elec | 0.009(0.21) | 0.06(1.18) | 0.10(1.94) | 0.02(0.45) | 1.42(1.39) | -0.44(0.76) | -0.45(1.25) |
| Textiles & clothing | -0.05(0.24) | -0.07(0.32) | -0.14(0.69) | -0.11(0.80) | 0.97(0.75) | 0.33(0.49) | -0.12(0.29) |
| Vegetable | 0.37(0.48) | -0.09(1.15) | 0.07(0.95) | 0.007(0.13) | 1.45(4.75) | 0.19(1.26) | 0.09(0.86) |
| ***No cointegration*** | | | | | | | |
| Consumer goods | -0.08(1.76) | 0.01(0.21) | 0.07(1.38) | 0.03(0.76) | | | |
| Intermediate goods | 0.13(1.012) | 0.07(0.56) | 0.07(0.59) | -0.01(0.14) | | | |
| Raw materials | 0.15(1.33) | 0.12(0.78) | -0.04(0.29) | -0.10(1.15) | | | |
| Animal | 0.07(0.56) | -0.35(2.24) | -0.21(1.41) | -0.10(1.03) | | | |
| Chemical | 0.06(0.31) | 0.07(0.40) | 0.11(0.64) | 0.004(0.03) | | | |
| Food products | -0.13(1.09) | -0.19(1.34) | -0.03(0.18) | -0.02(0.19) | | | |
| Fuels | 0.22(1.58) | 0.30(1.51) | 0.09(0.52) | -0.007(0.07) | | | |
| Metals | 0.19(2.29) | 0.16(1.52) | 0.01(0.10) | -0.06(0.85) | | | |
| Minerals | 0.18(0.87) | 0.13(0.66) | 0.17(0.88) | -0.003(0.02) | | | |
| Miscellaneous | 0.10(0.61) | 0.28(1.91) | 0.23(1.51) | 0.09(0.82) | | | |
| Plastic or rubber | -0.008(0.11) | 0.13(1.76) | 0.07(0.96) | -0.007(0.12) | | | |
| Stone & glass | 0.13(0.99) | 0.03(0.23) | 0.05(0.42) | -0.03(0.30) | | | |
| Transportation | -0.31(0.78) | 0.54(1.34) | 0.69(1.74) | 0.60(2.11) | | | |
| Wood | 0.08(1.09) | 0.03(0.42) | 0.03(0.52) | 0.05(1.04) | | | |

*Table E4: Short- and long-run coefficient estimates, Indonesia imports specification 12-month volatility measure*

| | $\Delta\ln\text{VOl}_t$ | $\Delta\ln\text{VOl}_{t-1}$ | $\Delta\ln\text{VOl}_{t-2}$ | $\Delta\ln\text{VOl}_{t-3}$ | $\text{LnY}^{\text{INDONESIA}}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Food products | 0.80(1.27) | -0.28(1.66) | -0.15(1.46) | -0.03(0.50) | 3.09(2.92) | -1.38(1.83) | 0.69(2.45) |
| Miscellaneous | 0.30(1.87) | -0.59(1.96) | -0.13(0.78) | -0.28(2.75) | 12.40(3.08) | -7.96(2.69) | 3.39(2.90) |
| Vegetables | 0.12(1.91) | -0.18(1.38) | -0.13(1.81) | -0.003(0.08) | 3.42(4.11) | -1.57(2.60) | 0.62(2.74) |
| ***Negatively affected by volatility*** | | | | | | | |
| Hides & skins | -0.30(2.39) | 0.67(2.54) | 0.47(3.10) | 0.10(0.99) | -11.55(2.67) | 8.44(2.57) | -3.59(2.82) |
| Wood | -0.04(0.99) | 0.19(2.34) | 0.15(3.10) | 0.10(2.95) | -0.30(0.33) | 1.24(1.85) | -0.65(2.49) |
| ***Not affected by volatility*** | | | | | | | |
| Minerals | -0.10(1.44) | 0.09(0.63) | 0.09(1.15) | 0.02(0.32) | -1.24(1.32) | 0.85(1.24) | -0.39(1.50) |
| Stone & glass | 0.01(0.19) | 0.16(1.19) | 0.14(1.75) | 0.07(1.26) | 1.61(1.45) | -0.32(0.40) | -0.22(0.70) |
| Textiles & clothing | -0.05(0.80) | -0.04(0.30) | -0.03(0.32) | -0.02(0.45) | 0.07(0.07) | 0.29(0.40) | -0.16(0.61) |
| ***No cointegration*** | | | | | | | |
| Capital goods | 0.06(0.65) | -0.09(0.72) | -0.03(0.37) | -0.01(0.23) | | | |
| Consumer goods | -0.009(0.33) | 0.06(1.02) | 0.002(0.07) | -0.009(0.43) | | | |
| Intermediate goods | 0.04(1.11) | 0.05(0.73) | 0.04(1.03) | 0.04(1.56) | | | |
| Raw materials | 0.06(1.14) | -0.10(1.09) | -0.09(1.47) | -0.007(0.18) | | | |
| Animal | 0.13(1.13) | 0.04(0.18) | 0.05(0.36) | 0.01(0.14) | | | |
| Chemical | 0.05(1.16) | 0.0002(0.00) | 0.005(0.10) | 0.03(0.86) | | | |
| Footwear | -0.14(1.57) | 0.20(1.09) | 0.16(1.58) | 0.10(1.48) | | | |
| Fuels | -0.26(1.38) | 0.46(1.23) | 0.08(0.38) | 0.13(0.96) | | | |
| Mach & Elec | 0.04(0.84) | -0.08(1.04) | -0.009(0.20) | 0.0009(0.03) | | | |
| Metals | -0.004(0.04) | 0.07(0.47) | -0.09(0.98) | -0.03(0.45) | | | |
| Plastic & rubber | 0.08(1.52) | 0.03(0.32) | 0.07(1.20) | 0.01(0.36) | | | |
| Transportation | -0.06(0.27) | 0.21(0.49) | 0.01(0.04) | 0.03(0.18) | | | |

***Table E5: Short- and long-run coefficient estimates, Korea imports specification 12-month volatility measure***

| | $\Delta \ln VOl_t$ | $\Delta \ln VOl_{t-1}$ | $\Delta \ln VOl_{t-2}$ | $\Delta \ln VOl_{t-3}$ | $LnY^{KOREA}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Capital goods | 0.05(1.35) | -0.14(2.54) | -0.07(1.76) | -0.05(1.74) | -0.52(1.66) | -0.91(2.43) | 0.36) |
| ***Negatively affected by volatility*** | | | | | | | |
| Intermediate goods | -0.04(1.27) | 0.08(1.70) | 0.06(1.99) | 0.04(1.60) | 1.03(6.27) | -0.32(1.50) | -0.18(1.96) |
| Chemical | -0.06(1.69) | 0.10(1.88) | 0.09(2.31) | 0.05(1.71) | 1.53(8.19) | -0.17(0.66) | -0.21(1.98) |
| ***Not affected by volatility*** | | | | | | | |
| Consumer goods | 0.03(1.10) | -0.02(0.53) | -0.02(0.73) | -0.009(0.38) | 2.44(1.81) | -0.85(1.44) | 0.70(1.19) |
| Food products | -0.04(0.88) | -0.01(0.19) | -0.06(1.35) | 0.0004(0.01) | 8.63(0.43) | -8.16(0.41) | 0.01(0.01) |
| Mach & Elec | 0.02(0.42) | -0.08(1.50) | -0.004(0.11) | -03(1.00) | -0.57(2.07) | -0.16(0.52) | 0.13(0.89) |
| Minerals | -0.19(2.00) | 0.11(0.73) | 0.04(0.38) | 0.06(0.66) | 2.63(4.51) | -0.62(0.78) | -0.47(1.39) |
| Stone & glass | -0.10(1.00) | 0.13(0.86) | 0.04(0.35) | 0.08(0.98) | 1.74(3.01) | -0.71(0.93) | -0.33(1.02) |
| Wood | 0.07(2.29) | 0.09(1.83) | 0.09(2.56) | 0.04(1.37) | 0.05(0.34) | -0.14(0.67) | -0.03(0.39) |
| ***No cointegration*** | | | | | | | |
| Raw materials | 0.12(1.49) | -0.07(0.56) | -0.07(0.73) | 0.03(0.36) | | | |
| Animal | 0.22(1.86) | -0.19(1.07) | -0.17(0.31) | -0.03(0.31) | | | |
| Footwear | -0.04(0.45) | 0.30(2.01) | 0.14(1.33) | 0.09(1.01) | | | |
| Fuels | 0.28(2.33) | -0.07(0.31) | -0.00004(0.00) | 0.11(1.04) | | | |
| Hides & skins | -0.11(1.51) | 0.14(1.18) | 0.08(1.04) | 0.09(1.38) | | | |
| Metals | -0.02(0.30) | 0.17(1.33) | 0.11(1.24) | 0.08(1.00) | | | |
| Miscellaneous | -0.03(0.3) | 0.04(0.28) | 0.009(0.10) | -0.01(0.14) | | | |
| Plastic or rubber | 0.03(1.19) | 0.007(0.17) | 0.024(0.85) | 0.001(0.05) | | | |
| Textiles & clothing | 0.03(0.40) | 0.16(1.56) | 0.20(2.63) | 0.14(2.53) | | | |
| Transportation | 0.17(0.86) | -0.50(1.65) | -0.36(1.66) | -0.18(1.06) | | | |
| Vegetable | 0.16(1.55) | 0.12(0.37) | 0.05(0.39) | 0.09(1.01) | | | |

*Table E6: Short- and long-run coefficient estimates, Mexico imports specification 12-month volatility measure*

| | $\Delta \ln VOl_t$ | $\Delta \ln VOl_{t-1}$ | $\Delta \ln VOl_{t-2}$ | $\Delta \ln VOl_{t-3}$ | $LnY^{MEXICO}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| ***Negatively affected by volatility*** | | | | | | | |
| ***Not affected by volatility*** | | | | | | | |
| Consumer goods | 0.03(1.15) | -0.12(2.77) | -0.05(1.85) | -0.04(1.71) | 2.52(2.97) | -0.46(0.99) | 0.35(1.60) |
| Raw material | 0.09(2.38) | 0.12(1.97) | 0.05(1.37) | 0.03(0.89) | 3.38(3.39) | -0.43(0.94) | -0.01(0.05) |
| Animal | 0.03(0.87) | 0.10(1.74) | 0.06(1.82) | 0.06(2.44) | 3.99(0.87) | -0.65(0.96) | -0.02(0.09) |
| Metals | 0.004(0.17) | -0.006(0.13) | -0.006(0.21) | -0.02(0.86) | 3.72(7.44) | -0.39(1.66) | 0.006(0.06) |
| Minerals | 0.20(1.72) | -0.20(1.06) | -0.19(1.60) | -0.08(0.84) | 16.20(3.00) | -4.61(1.87) | 0.93(1.20) |
| Stone & glass | 0.02(0.54) | -0.14(2.30) | -0.11(2.85) | -0.08(2.49) | -1.81(1.72) | 0.79(1.81) | 0.00(0.96) |
| Textiles & clothing | 0.05(2.37) | -0.19(5.09) | -0.07(2.72) | -0.04(2.15) | -3.12(1.32) | -1.43(0.69) | 1.95(1.43) |
| Vegetable | 0.09(1.81) | 0.20(2.42) | 0.08(1.47) | 0.02(0.61) | 2.69(2.17) | -0.21(0.35) | -0.11(0.43) |
| ***No cointegration*** | | | | | | | |
| Capital goods | 0.01(0.51) | -0.12(2.67) | -0.4(1.33) | -0.03(1.55) | | | |
| Intermediate goods | 0.02(0.76) | -0.03(0.84) | -0.002(0.09) | -0.003(0.20) | | | |
| Chemical | 0.02(1.01) | 0.02(0.42) | 0.02(0.67) | 0.01(0.59) | | | |
| Food products | -0.02(0.44) | 0.10(1.45) | 0.02(0.44) | 0.05(1.49) | | | |
| Footwear | 0.11(1.57) | -0.23(1.77) | -0.06(0.73) | -0.08(1.46) | | | |
| Fuels | 0.09(0.93) | -0.19(1.21) | 0.002(0.02) | -0.01(0.20) | | | |
| Hides & skins | -0.05(0.71) | -0.07(0.63) | -0.01(0.20) | -0.06(1.19) | | | |
| Mach & Elec | 0.007(0.27) | -0.11(2.64) | -0.04(1.26) | -0.03(1.45) | | | |
| Miscellaneous | 0.08(0.84) | -0.04(0.25) | -0.01(0.16) | 0.009(0.14) | | | |
| Plastic or rubber | 0.01(0.70) | -0.06(1.65) | -0.01(0.63) | -0.02(1.00) | | | |
| Transportation | 0.003(0.12) | -0.11(2.54) | -0.05(1.77) | -0.04(1.99) | | | |
| Wood | -0.003(0.11) | -0.04(0.97) | -0.02(1.06) | -0.03(1.54) | | | |

*Table E7: Short- and long-run coefficient estimates, Russia imports specification 12-month volatility measure*

| | $\Delta \ln VOl_t$ | $\Delta \ln VOl_{t-1}$ | $\Delta \ln VOl_{t-2}$ | $\Delta \ln VOl_{t-3}$ | $LnY^{RUSSIA}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Chemical | 0.16(1.40) | -0.18(1.14) | -0.12(1.31) | -0.08(1.75) | 2.69(4.52) | -0.92(1.95) | 0.57(2.17) |
| ***Negatively affected by volatility*** | | | | | | | |
| Minerals | -0.71(3.94) | 0.88(2.70) | 0.41(1.91) | 0.07(0.76) | 1.03(1.82) | 1.61(3.66) | -1.31(5.48) |
| ***Not affected by volatility*** | | | | | | | |
| Capital goods | -0.03(0.38) | -0.008(0.08) | 0.03(0.51) | 0.003(0.10) | 2.62(3.68) | -0.42(0.78) | -0.008(0.03) |
| Consumer goods | -0.12(1.33) | -0.16(1.36) | -0.12(1.47) | -0.04(1.03) | 4.10(6.90) | -0.99(1.92) | 0.20(0.73) |
| Food products | -0.01(0.20) | -0.01(0.46) | 0.003(0.05) | 0.01(0.57) | 2.25(3.73) | -0.87(2.25) | 0.27(1.28) |
| Wood | 0.007(0.07) | -0.03(0.30) | 0.05(0.63) | 003(0.83) | 2.69(5.07) | -0.56(1.43) | 0.10(0.47) |
| Footwear | 0.349(2.53) | -0.46(3.30) | -0.35(3.89) | -0.18(4.13) | 8.31(1.06) | -9.70(0.81) | 5.56(0.79) |
| Fuels | -0.02(0.14) | 0.02(0.14) | 0.04(0.41) | -0.002(0.04) | 4.15(5.81) | -0.82(1.51) | 0.03(0.11) |
| Textiles & clothing | -0.11(1.53) | -0.22(2.16) | -0.22(3.19) | -0.08(2.65) | 3.72(2.92) | -1.67(1.31) | 0.41(0.69 |
| Wood | 0.007(0.07) | -0.03(0.30) | 0.05(0.63) | 0.03(0.83) | 2.69(5.07) | -0.56(1.43) | 0.10(0.47) |
| ***No cointegration*** | | | | | | | |
| Intermediate goods | 0.12(1.28) | -0.06(0.51) | -0.04(0.51) | -0.01(0.40) | | | |
| Raw materials | -0.25(1.94) | -0.01(0.10) | -0.03(0.34) | 0.01(0.23) | | | |
| Animal | -0.16(0.61) | -0.31(1.00) | -0.23(1.13) | -0.08(0.82) | | | |
| Hides & skins | -0.20(1.39) | -0.04(0.19) | -0.14(1.06) | -0.09(1.52) | | | |
| Mach & Elec | -0.002(0.04) | -0.03(0.42) | -0.03(0.75) | -0.01(0.58) | | | |
| Metals | 0.02(0.30) | 0.06(0.66) | -0.005(0.08) | -0.03(0.84) | | | |
| Miscellaneous | 0.18(1.23) | -0.17(1.03) | -0.06(0.59) | -0.006(0.11) | | | |
| Plastic or rubber | -0.01(0.13) | -0.13(1.12) | -0.10(1.45) | -0.05(1.34) | | | |
| Stone & glass | -0.15(1.49) | -0.04(0.30) | -0.01(0.17) | 0.01(0.29) | | | |
| Transportation | -0.31(1.11) | -0.17(0.46) | -0.01(0.04) | -0.03(1.06) | | | |
| Vegetable | -0.34(1.38) | -0.06(0.22) | -0.06(0.32) | 0.06(0.66) | | | |

*Table E8: Short- and long-run coefficient estimates, Saudi Arabia import specification 12-month volatility measure*

| | $\Delta \ln VOl_t$ | $\Delta \ln VOl_{t-1}$ | $\Delta \ln VOl_{t-2}$ | $\Delta \ln VOl_{t-3}$ | $LnY^{SAUDI\ ARABIA}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Vegetable | 0.26(2.16) | -0.11(0.57) | -0.06(0.31) | 0.04(0.40) | 1.40(7.56) | 3.03(0.00) | 0.456(1.79) |
| Wood | 0.08(1.29) | -0.15(1.49) | -0.15(1.47) | -0.02(0.36) | 0.15(1.51) | -0.38(4.63) | 0.28(2.00) |
| ***Negatively affected by volatility*** | | | | | | | |
| ***Not affected by volatility*** | | | | | | | |
| Raw materials | 0.19(1.42) | -0.05(0.22) | -0.0008(0.00) | 0.04(0.36) | 1.72(7.51) | 2.70(3.93) | 0.31(0.99) |
| Chemical | -0.01(0.09) | -0.20(1.47) | -0.15(0.48) | -0.02(0.24) | 2.03(15.78) | 0.08(0.21) | 0.17(0.94) |
| Food products | 0.02(0.32) | 0.20(1.88) | 0.20(1.88) | 0.11(1.91) | -0.35(2.19) | 2.76(5.04) | -0.29(1.29) |
| Footwear | -0.08(0.54) | 0.19(0.43) | 0.03(0.15) | -0.01(0.08) | 0.52(1.79) | 0.54(0.59) | -0.27(0.71) |
| Fuels | -0.09(0.56) | 0.26(0.94) | 0.20(0.72) | 0.09(0.52) | 2.72(8.19) | 1.85(1.96) | -0.22(0.49) |
| Hides & skins | -0.005(0.02) | 0.52(1.69) | 0.28(0.90) | 0.03(0.18) | 1.38(5.02) | 0.77(0.83) | -0.46(1.21) |
| Minerals | 0.03(0.11) | 0.53(1.27) | 0.57(1.39) | 0.20(0.88) | 1.13(2.27) | -0.82(0.60) | -0.39(0.62) |
| Miscellaneous | -0.11(0.60) | -0.02(0.05) | 0.06(0.18) | 0.13(0.76) | 1.80(5.53) | 4.86(4.63) | -0.13(0.30) |
| Plastic or rubber | -0.01(0.15) | 0.005(0.04) | 0.12(0.96) | 0.10(1.42) | 1.39(9.76) | 1.46(3.41) | -0.11(0.58) |
| ***No cointegration*** | | | | | | | |
| Capital goods | -0.12(0.68) | 0.53(1.94) | 0.45(1.60) | 0.11(0.71) | | | |
| Consumer goods | 0.17(1.46) | -0.25(1.45) | -0.30(1.70) | -0.13(1.44) | | | |
| Intermediate goods | 0.06(0.57) | 0.19(1.18) | 0.19(1.13) | 0.10(1.12) | | | |
| Animal | 0.10(0.57) | -0.10(0.36) | -0.09(0.34) | 0.05(0.30) | | | |
| Mach & Elec | -0.13(0.96) | 0.29(1.30) | 0.19(0.85) | 0.09(0.75) | | | |
| Metals | 0.07(0.50) | -0.13(0.54) | -0.21(0.87) | -0.10(0.76) | | | |
| Stones & glass | 0.01(0.10) | -0.28(1.54) | -0.21(1.16) | 0.002(0.02) | | | |
| Textiles & clothing | -0.11(1.03) | 0.19(0.76) | 0.09(0.43) | -0.05(0.41) | | | |
| Transportation | 0.14(0.66) | 0.47(1.41) | 0.39(1.11) | 0.01(0.07) | | | |

***Table E9: Short- and long-run coefficient estimates, South Africa import specification 12-month volatility measure***

| | $\Delta\text{lnVOl}_t$ | $\Delta\text{lnVOl}_{t-1}$ | $\Delta\text{lnVOl}_{t-2}$ | $\Delta\text{lnVOl}_{t-3}$ | $\text{LnY}^{\text{SOUTH AFRICA}}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| Hides & skins | 0.15(0.93) | -1.04(1.85) | -0.70(2.14) | -0.17(0.92) | -4.19(3.19) | -1.15(2.13) | 1.48(2.74) |
| ***Negatively affected by volatility*** | | | | | | | |
| ***Not affected by volatility*** | | | | | | | |
| Capital goods | 0.05(0.84) | 0.03(0.20) | 0.07(0.74) | 0.06(1.03) | 2.18(3.17) | -0.52(2.00) | -0.01(0.04) |
| Consumer goods | 0.03(0.91) | -0.05(0.66) | -0.03(0.57) | 0.0007(0.02) | 2.11(5.9) | -0.41(2.82) | 0.16(1.15) |
| Chemicals | -0.007(0.27) | 0.05(0.71) | 0.04(0.84) | 0.004(1.15) | 1.20(5.89) | -0.05(0.58) | -0.10(1.19) |
| Food products | 0.0002(0.00) | -0.09(0.49) | -0.09(0.87) | -0.07(1.05) | 2.99(3.00) | -0.99(2.26) | 0.05(0.14) |
| Mach & Elec | 0.007(0.27) | 0.10(1.51) | 0.11(2.46) | 0.07(2.35) | 2.88(9.17) | -0.63(5.86) | -0.14(1.30) |
| Metals | 0.05(1.43) | 0.11(1.29) | 0.08(1.40) | 0.04(1.16) | 2.85(9.59) | -0.52(4.27) | -0.10(0.86) |
| Miscellaneous | -0.03(0.60) | 0.08(0.67) | 0.09(1.21) | 0.05(1.10) | 5.19(8.06) | -1.45(5.13) | -0.07(0.33) |
| Plastic or rubber | 0.003(0.09) | 0.09(1.01) | 0.06(0.96) | 0.02(0.46) | 2.25(9.63) | -0.12(1.26) | -0.09(0.99) |
| Transportation | 0.05(0.47) | -0.21(0.67) | -0.07(0.34) | 0.03(0.28) | 0.34(0.28) | -0.22(0.43) | 0.35(0.71) |
| Vegetable | -0.27(1.79) | 0.70(1.68) | 0.62(2.38) | 0.24(1.54) | 3.27(1.64) | 0.49(0.58) | -1.37(1.63) |
| Wood | 0.23(0.72) | 0.20(2.61) | 0.11(2.36) | 0.05(1.60) | 1.86(1.95) | -0.18(0.76) | -0.58(1.70) |
| ***No cointegration*** | | | | | | | |
| Intermediate goods | 0.01(0.26) | -0.03(0.18) | 0.06(0.60) | -0.02(0.28) | | | |
| Raw materials | -0.24(1.98) | 0.29(0.88) | 0.24(1.13) | 0.07(0.55) | | | |
| Animal | -0.25(1.25) | 0.77(1.56) | 0.40(1.28) | 0.08(0.41) | | | |
| Footwear | -0.25(2.01) | 0.31(1.02) | 0.31(1.58) | 0.19(1.72) | | | |
| Fuels | 0.05(0.73) | 0.35(1.71) | 0.27(2.09) | 0.10(1.36) | | | |
| Minerals | -0.08(0.51) | 0.03(0.07) | -0.08(0.36) | -0.16(1.16) | | | |
| Stone & glass | -0.03(0.16) | -0.46(0.96) | -0.03(0.11) | -0.06(0.36) | | | |
| Textiles & clothing | -0.07(1.83) | -0.03(0.29) | -0.01(0.18) | 0.02(0.53) | | | |

***Table E10: Short- and long-run coefficient estimates, Turkey import specification12-month volatility measure***

| | $\Delta\text{lnVOl}_t$ | $\Delta\text{lnVOl}_{t-1}$ | $\Delta\text{lnVOl}_{t-2}$ | $\Delta\text{lnVOl}_{t-3}$ | $\text{LnY}^{\text{TURKEY}}$ | lnREX | lnVOL |
|---|---|---|---|---|---|---|---|
| ***Positively affected by volatility*** | | | | | | | |
| ***Negatively affected by volatility*** | | | | | | | |
| Hides & skins | -0.13(1.0 4) | 0.31(1.41) | 0.21(1.35) | 0.17(1.70) | -3.57(5.39) | 1.41(2.13) | -1.06(1.77) |
| ***Not affected by volatility*** | | | | | | | |
| Animal | -0.18(0.90) | -0.06(0.17) | -0.08(0.34) | -0.03(0.21) | -0.04(0.05) | 0.45(0.61) | -0.46(0.69) |
| Chemical | 0.03(0.40) | -0.25(1.88) | -0.22(2.16) | -0.06(0.98) | 1.29(5.28) | -0.39(1.64) | 0.28(1.28) |
| Footwear | -0.0009(0.00) | 0.79(2.12) | 0.54(1.97) | 0.14(0.79) | 1.08(1.15) | 1.04(1.17) | -0.20(1.47) |
| Metals | 0.32(2.61) | -0.48(2.17) | -0.41(2.75) | -0.35(3.86) | 2.61(0.86) | -8.69(0.86) | 8.18(0.82) |
| Minerals | 0.09(1.17) | 0.02(0.16) | 0.02(0.20) | -0.03(0.46) | 0.15(0.48) | 0.14(0.47) | 0.01(0.05) |
| Plastic or rubber | 0.03(0.27) | 0.08(0.36) | 0.0005(0.00) | -0.02(0.23) | 1.58(1.98) | 0.04(0.05) | -0.22(0.29) |
| Stone and glass | 0.037(0.25) | -0.09(0.34) | -0.04(0.21) | 0.06(0.54) | 1.38(2.37) | -0.07(0.13) | -0.04(0.07) |
| Textiles & clothing | -0.04(0.24) | -0.11(0.39) | -0.18(0.89) | -0.05(0.41) | 0.32(0.74) | 0.11(0.27) | -0.04(0.10) |
| Transportation | 0.72(2.34) | 0.10(0.18) | -0.08(0.20) | -0.18(0.77) | 0.78(0.83) | -0.88(0.96) | 1.03(1.23) |
| Vegetable | -0.06(0.61) | 0.33(2.05) | 0.20(1.75) | 0.05(0.62) | -0.84(0.67) | 1.13(1.09) | -1.38(1.43) |
| Wood | -0.10(0.89) | 0.24(1.16) | 0.11(0.78) | 0.02(0.28) | 0.86(1.31) | 0.82(1.34) | -0.93(1.67) |
| ***No cointegration*** | | | | | | | |
| Capital goods | 0.11(0.75) | 0.30(0.88) | 0.07(0.31) | -0.03(0.28) | | | |
| Consumer goods | 0.35(1.64) | -0.14(0.42) | -0.11(0.50) | -0.08(0.62) | | | |
| Intermediate goods | 0.03(0.39) | -0.05(0.34) | -0.05(0.49) | -0.04(0.76) | | | |
| Raw materials | 0.13(1.01) | -0.10(0.43) | -0.08(0.50) | -0.09(0.95) | | | |
| Food products | -0.11(0.61) | 0.53(1.59) | 0.44(1.76) | 0.20(1.23) | | | |
| Fuels | 0.40(1.19) | -0.50(0.92) | -0.34(0.94) | -0.21(0.96) | | | |
| Mach & Elec | -0.05(0.66) | -0.08(0.58) | -0.05(0.50) | 0.02(0.33) | | | |
| Miscellaneous | -0.43(1.52) | 0.10(0.18) | 0.11(0.29) | 0.05(0.24) | | | |

# CHAPTER FOUR

# Real Interest Parity Conditions and Nominal Exchange Rate Regimes in Large Emerging Market Economies

## 4.1 Introduction

Real interest rate parity (RIRP) is an essential part of international finance which helps economies to determine foreign exchange market operations and relationships with interest rates, spot exchange rates, and foreign exchange rates in various economies (Frenkel,1976; Bilson, 1978 & Dornbusch, 1976). The theory of real interest rate parity was proposed by Keynes (1923) as it relates to international financial relations among countries. The theory assumes that when parity holds among countries, cover yields are identical for similar assets, such as maturity, default risk, exposure to capital controls, and liquidity, except for their currency of denomination (Levich, 2011). This implies that the investment returns in varying currencies should be the same, irrespective of the country's interest rates. Early studies on RIRP assume that non-comparability in assets risks, transaction costs, and taxes are the leading cause of interest rate deviations. However, it has also been discovered that liberalising the global financial markets and capital flows across countries also increases deviations from RIRP, especially in countries with convertible currencies that large emerging market economies (LEMEs) fall under.

The theoretical work of Dutton (1993) on international finance postulates that for international comparisons among countries, an appropriate measure of real interest rate should include the prices of traded goods. Similarly, Moosa and Bhatti (1997) highlight the hypothesis of RIRP, which indicates that should the world markets for goods, capital, and foreign exchange be integrated, real interest rates on perfectly comparable financial assets will, in turn, be equalised across countries over time. The authors further maintain that the RIRP hypothesis depends on the stability of Fisher's closed-condition model equations, whereby the nominal interest rate differential adjusts fully to the inflation differential while maintaining the constancy and equality of real interest rates across countries.

The RIRP assumption combines other parity conditions, such as uncovered interest parity (UIP) and purchasing power parity (PPP), which shows that arbitrage in international financial and goods markets prevents real domestic rates of return from drifting apart from the world real interest rate (Bagdatoglou & Kontonikas, 2009).

Therefore, when domestic real interest rates are equalised with foreign real interest rates in the goods and financial markets, the affected country's ability to use monetary policies to control financial and fiscal crises is limited. Notably, achieved parity conditions can increase domestic investment volume, even with a decrease in domestic savings, disbanding the theoretical link between national savings and investment. Achieving cross-country capital flows and real interest rates parity conditions became possible with liberalised trade and financial markets, which yielded to increase in global integration with the advent of a free-floating exchange rate regime.

Much so, 24-hour screen-based global trading with increased use of national currencies outside the country of the issue was made possible through innovations in internationally traded financial products and the globalisation of capital markets (Moosa & Bhatti, 1997). Therefore, as countries strive to mitigate the influence of external shocks due to economic openness, different exchange rate regimes have been adopted to curtail the contagion effects from the global financial systems. This implies that a change in nominal exchange rate regimes can affect the possibility of achieving RIRP among countries. Although, it does depict that nominal exchange regime changes react negatively toward RIRP. Instead, Gosh et al. (1997) suggest that the relevance of exchange rate regimes for macroeconomic performance remains crucial in building a sustainable macroeconomic foundation. However, unsuitable monetary policy and underdeveloped financial systems can pose challenges toward equal returns on investment. Considering that LEMEs are significant participants in the global goods and financial markets and are exposed to these challenges, achieving RIRP while facing dynamic economic challenges needs to be investigated.

The extent of LEMEs' participation in global financial markets in trade and financial transfers constitutes a large portion of the global trade flows, with an increase in international capital flows (Heroles et al., 2020). However, the exposure of these economies with institutional risks to external financial shocks propels the need to understand the relationship and validity of the RIRP hypothesis and nominal exchange rate regime changes. The nominal exchange rate regimes have evolved over the years since the end of the Bretton Woods era. Chang and Su (2015) express that changes in exchange rate regimes have aided countries to transition into open economies, where improved international capital mobility across markets is possible. Despite the achievements, arguments have been presented on the principles of RIRP and its interactions with financial and economic systems in LEMEs at different levels of policy change.

With poor financial and infrastructural development in LEMEs to withstand external shocks, obtaining RIRP in these economies in line with other advanced economies seems implausible. Additionally, market imperfections, such as asymmetric information, uncertainty, and risk aversion, can minimise the chances of RIRP holdings in LEMEs. Therefore, if an efficient market system that guarantees equal returns on investment is not achievable in LEMEs, the government needs to apply intervention policies to stabilise the financial system. In essence, government intervention in LEMEs will determine what drives interest rate differentials in

LEMEs and whether it is purely a random walk or some systematic factor related to nominal exchange rate regimes in the countries.

Therefore, the absence of arbitrage means no RIRP among countries. The implication is the possibility of RIRP validity in LEMEs or differences in the rate of returns. While the degree of parity deviation portrays the lack of products and financial market integration, as indicated by Dreger (2010), Frankel (1979) considers real interest rate differentials as the main determinant of floating exchange rates and their importance in measuring countries' economic performance suffice it to say that real interest rates due to price stickiness can be steady over time. Meanwhile, Mancuso, Goodwin, and Grennes (2003), Camarero, Carrion-Silvestre, and Tamarit (2006), and Dreger (2010) believe that when there are differences in real interest rates, it takes a gradual process for it to converge to parity condition due to nonlinearities, structural breaks, and maturities.

On the other hand, the validity of RIRP in the long term attracts foreign investors who intend to move countries, especially when limited risks are involved. Orellana and Pino (2021) argue that the absence of the RIRP can encourage foreign investors to earn through carry-trade operations by obtaining loans in currencies with low-interest rates and investing in high-interest rates currencies. More so, the absence of RIRP can also lead to short-term investment in secondary markets, such as purchasing government bonds and treasury bills, which can easily be converted into cash in times of crisis, considering the risks involved. Since extended investment is required for effective economic growth and financial sustainability in LEMEs, the short-term investment approach might not favour the economies.

It can be argued that when a currency has relatively higher ex-ante real returns with lower risk to investment than the average, long-term high real returns motivate international investors to move funds across borders to purchase the lower-risk currency and benefit from excess real returns on investment (Engel, 1996 cited in Chang et al., 2019). However, in cases where high real returns on investment are affected by high currency risks, such as increased exchange rate volatility or high inflation rates, which attract high costs, mostly prevalent with LEMEs' currencies, risk-averse foreign investors might be discouraged. Since risk factors are essential in determining where investors will divert their assets, when the foreign currency is less risky than domestic currency, real interest rate differentials will be more attractive to domestic investors and vice versa.

With the points above, the main question is whether monetary policy framework reform in the form of nominal exchange rate regime change in LEMEs causes the real interest rate to deviate from its parity conditions. Understanding whether this is possible, considering the importance of real interest rates in LEMEs' monetary policy formation and global market participation, is crucial in formulating an appropriate policy framework that will aid in navigating the effects of poor financial development in these economies. Again, when interest rate differentials are not equal to zero, how long does it take to converge to parity? Extensive literature abounds in this context, trying to determine whether the RIRP could hold in economies in the face of nominal exchange rate changes. However, these studies were mainly on advanced economies due to a lack of sufficient data to conduct such investigations in LEMEs, and possibly poor financial development in LEMEs makes it seem that they are not mature enough for such an examination.

Therefore, this study examines whether the RIRP holds within different nominal exchange rate regimes in seven LEMEs–Argentina, Brazil, India, Korea, Mexico, South Africa, and Turkey–relative to their main trade partner, the US. The reason for using seven out of the 11 countries in this categorisation is due to the problem of data availability associated with LEMEs. It will also be interesting to know should real interest rate differentials seize to be equal to zero, how long it takes to cover the long-term convergence from the deviation points for RIRP conditions to hold. The two main objectives of this study are to first apply the autoregressive process of order 1 (AR (1)) to the inflation rates and real interest rates (7–10-year maturity time and 3-month short-term maturity) of LEMEs over the two nominal exchange rate regime periods 1960-1972 and 1973-2019. Then measure the variables from LEMEs against US inflation and real interest rates within the same period to determine whether the long-run real interest rates are equalised in the countries for the conditions of RIRP to be maintained. This is in line with the theoretical expectation that interest rates in countries should exhibit long-run convergence trends, another reason why these two regime periods were selected for the analysis. Secondly, this study uses Rossi's (2005) half-life cycle, also applied by Dreger (2010), to calculate how long it takes to cover half of the distance it will take these economies to converge when real interest rate differentials are not equal to zero, that is when there is a deviation from the RIRP. The data on the interest rate used in this study are crucial because the maturity time for interest rates can be long- or short-term. Although long-term maturity rates are preferable, as Fuijii and Chinn (2001) expressed, evidence of the RIRP is desirable when long-term interest rates are used. However, Wu and Fountas (2000) conclude that there is convergence with short-term interest rates. Therefore, long- and short-term interest rate data will yield satisfactory results. Again, the unavailability of data is a major problem associated with LEMEs, so this study resorted to working with what is available, as done by Skinner and Mason (2011) while working with emerging market economies.

The significance of this study is that, with the increasing development of global capital markets in which LEMEs participate effectively, there is a need to investigate the efficiency of nominal exchange rate regimes in fostering parity conditions in LEMEs against their major foreign trade partner, the US, to see if RIRP conditions can be maintained in these economies. However, in cases where the real interest rate differentials seized to be equal to zero, the monetary policy framework can be restructured for parity conditions to hold in economies. Furthermore, understanding whether the RIRP condition holds in the face of nominal exchange rate regime change or deviates will help LEMEs formulate appropriate and sustainable monetary policy frameworks that can work together with macroeconomic policy. These policies will help LEMEs coordinate the real interest rate conditions in financial markets to align with their economic expectations. It will also help enhance LEMEs' participation in the global market when the leading cause of shocks is identified by analysing the real interest rate reaction to regime changes and applying effective solutions.

Another significant aspect of the study is that foreign investors who wish to invest, for example, in government bonds or treasury bills in LEMEs will learn not only how the policy rates and exchange rate system work in the countries but also whether regime change triggers real interest rate deviations from parity conditions. This knowledge offers opportunities to gain insights into how profitable investing in these economies can be. In addition, foreign investors will understand the exchange rate risks involved in long-and short-term maturity deposits and know that, if it is a high-interest-rate currency, there will be possible premiums to compensate investors for risky investments. Contrarily, information availability can scare possible investors who want to avoid risky investments. At the country level, this study serves as a guide for LEMEs to choose the right exchange rate policy that suits the structure of their economies in terms of improved returns on investment earnings. It will also give countries opportunities to achieve the desired economic growth and sustainability and possibly avoid future losses.

The remainder of this paper is organised as follows. The next section provides an overview of exchange rate regime classifications and the real interest rate parity hypothesis, including the theoretical underpins behind the relationship between real interest rates and exchange rate regimes, with a review of the empirical literature on the context of LEMEs. Section 4.4 contains the data analysis and methodology used in the study. Section 4.5 presents the empirical findings, section 4.6 discusses the implications with recommendations, and section 4.7 concludes the chapter.

## 4.2 Exchange Rate Regime Classifications and Real Interest Rate Parity Hypothesis

### 4.2.1 Exchange Rate Regime Classifications

The history of exchange is as old as humanity because of the need to satisfy various wants, although it began informally when goods were exchanged for goods. However, as the double coincidence of wants and lack of an appropriate measure of value continued to increase, among other problems of the barter system, the need for formal means of exchange that can reduce the difficulty in measurement and improve trade efficiency also increased. To alleviate the problems of the barter system, various mediums of exchange were adopted, such as proto-money, cowries, and shells, and coins were introduced later. Meanwhile, as economic development, productivity, and global integration through trade continued to increase, paper money was introduced as countries' demand for balanced exchange increased due to improved capital flows and reduced disparities in risky transfers, especially for LEMEs with poor financial systems.

At the time, LEMEs relied mainly on advanced economies' monetary policy frameworks for their own monetary decisions, which involved an exchange rate anchoring framework. This makes the exchange rate targeting the main monetary policy instrument for controlling financial instability and improving economic conditions during this period. Therefore, adopting regime systems over time offers emerging market economies opportunities to resolve the disparities in their foreign exchange markets and possibly be on the same pedestal as advanced economies as they participate in international markets. The official adoption of exchange rate regimes began in 1870, with the bimetallic system in the same year, followed by the classical gold standard (1870) and the gold exchange standard (2005).

The Bretton Woods era started in 1947 to correct the price instability problems caused by the Great Depression during World War 1. The regime used a strict unified fixed exchange rate for all countries and established the International Monetary Fund (IMF) and the International Bank for Reconstruction and Development (IBRD) to oversee the functioning of central banks and international financial markets (Burange & Ranadive, 2011). However, when the centre could not hold in international financial markets, and the Bretton Woods System collapsed in 1972, countries worldwide were allowed to adopt independent monetary policies that suited the structure of their economic system. The regime systems adopted in the independent monetary policy were characterised by either fixed, pegged, or floating exchange rates with subsystems in between. Bordo (2003) argues that developing economies, such as LEMEs, struggle to maintain independent monetary policies and fix or stabilise inflation and exchange rates. This is in reference to the trilemma view that open market capital, monetary independence, or belonging to a currency board (pegging) cannot work together and has also led to some of the financial crises witnessed by economies in most LEMEs (Bordo, 2003 & Obstfeld, 2004).

Furthermore, Eichengreen and Hausmann (1999) opine that LEMEs exposing their vulnerable financial markets to shocks from the international financial markets results in increased inflation and fiscal crisis, making it difficult for the economies to access or service external loans. There were also risk factors associated with currency mismatches due to poor financial development, among other problems, that affected LEMEs' financial system in the aftermath of the Bretton Woods era. To adjust and control financial crises and the ripple effects thereof, an inflation targeting (IT) policy was introduced by LEMEs monetary authorities. Each country in LEMEs adopted the IT framework in different periods and years, for example, Brazil-1999Q1, India-2016Q2, KoreaQ1-1998, Mexico-1999Q1, South AfricaQ1-2000, and Turkey-

2005Q1. The inflation targeting (IT) framework uses the policy interest rates as an essential monetary policy tool to adjust deviations of inflation and the output gap from the targets.

As discussed above, LEMEs have witnessed a series of nominal exchange rate regime changes over the years. However, the most significant years are the Bretton Woods era and free-floating regimes, which also reflect the period of increased goods markets and financial liberalisation. Therefore, this study investigates the validity of real interest rate parity (RIRP) conditions in LEMEs amidst nominal exchange rate regime changes, using structural breaks from the Bretton Woods era and the free-floating regime system from 1960 to 1972 and 1973 to 2019.

### 4.2.2 Real interest rate parity hypothesis

Real interest rate parity, as discussed earlier, is an essential part of economic globalisation that helps facilitate international trade, investments, and capital flows. To derive the real interest rate hypothesis, the conditions for Fisher's efficiency of the domestic capital market, ex-ante purchasing power parity (PPP), and uncovered interest rate parity (UIP) need to hold, which yields the equation below, according to Moosa and Bhatti (1997):

$$1 + r_t = \frac{1+i_t}{1+\pi_t} \qquad (1)$$

Where r is the domestic real interest rate, i is the nominal interest rate, and π is the domestic inflation rate at time t. The logs of both sides of Equation (1) are taken, which yields:

$$r_t = i_t - \pi_t \qquad (2)$$

Equation (2) indicates that the domestic real interest rate is generated from the difference between the domestic nominal and domestic inflation rates. Following Dreger's (2010) approach, the rational expectation for each variable is included in the Fisher equation, which results in equation (3) below.

$$E_t r_{t+1} = i_{t,t+1} - E_t \pi_{t+1} \quad (3)$$

$$E_t r^*_{t+1} = i^*_{t,t+1} - E_t \pi^*_{t+1} \quad (4)$$

The Fisher equation for the domestic real interest rate is presented in equation (3), while equation (4) shows that the Fisher hypothesis holds for domestic and foreign countries. The E in equations (3) and (4) is the rational expectations operator, and the foreign country to be measured against in this study, the US, is denoted by the asterisk (*). Therefore, an ex-ante return from an asset must be equal to the nominal interest rate, whereby the nominal interest rate is expected to be greater than inflation. This condition is necessary because when the nominal interest rate is greater than inflation, the real interest rate is positive; otherwise, it becomes negative. From equations (3) and (4), the equation for real interest rate differentials is derived as follows:

$$E_t(r_{t+1} - r^*_{t+1}) = (i_{t,t+1} - i^*_{t,t+1}) - E_t(\pi_{t+1} - \pi^*_{t+1}) \quad (5)$$

One of the assumptions of the hypothesis is that two other conditions must be met for real interest rate differentials to be stationary. For uncovered interest rate parity, volatility in the spot exchange rate is observed in the nominal interest rate differential. In this case, the spot rate denoted by s represents the logarithm of the domestic price of foreign currency.

$$E_t(s_{t+1} - s_t) = i_{t,t+1} - i^*_{t,t+1} \quad (6)$$

The condition for PPP is that a change in the exchange rate system can be reflected in the inflation differential forecast, whereas the expected PPP and UIP will depend on if there is no risk aversion by traders in the products and financial markets.

$$E_t(s_{t+1} - s_t) = E_t(\pi_{t+1} - \pi^*_{t+1}) \quad (7)$$

Together, equations (5), (6), and (7) can be used to generate the real interest rate parity (RIRP) hypothesis, where the difference between the domestic and foreign interest rates is zero. Applying LEMEs to the equations to represent real interest rates for domestic and foreign countries, equation (8) is derived as follows:

$$E_t(r^{LEMEs}_{t+1} - r^{US}_{t+1}) = 0 \quad (8)$$

Where $r^{LEMEs}_{t+1}$ is the real interest rate in LEMEs and $r^{US}_{t+1}$ is the real interest rate for the US. When the difference between the two is equal to zero, the parity condition is validated; otherwise, there is a RIRP in the economies. According to Dreger (2010), for the assumptions of rational expectation in the equations to be achieved, the x-post real interest rate should be the sum of the ex-ante real interest rate and unrelated error term μ with zero mean. If the RIRP hypothesis is validated in countries in the long-run, then ex-post real interest rate differentials will correlate with rational forecast errors, as shown in Equation (9).

$$r^{LEMEs}_{t+1} - r^{US}_{t+1} = E_t r^{LEMEs}_{t+1} + \mu^{US}_{t+1} - (E_t r^{US}_{t+1} + \mu^{US}_{t+1}) = \mu^{LEMEs}_{t+1} - \mu^{US}_{t+1} \quad (9)$$

Equation (9) shows the existence of the RIRP hypothesis in LEMEs in the long-run; therefore, to understand whether there is validity of real interest rate parity in LEMEs, the model of equation (9) is applied in this study using the unit root and autoregressive (AR) linear model of order (1). The process will be insightful to analyse if, within the structural break, changes in the nominal exchange rate regime influenced the validity of the RIRP hypothesis. This approach would be insightful in explaining the relationship between RIRP and exchange rate regime changes in LEMEs.

Several studies have attempted to analyse the relationship between exchange rate regime changes over the years and the validity of the RIRP hypothesis in LEMEs. However, the existing literature on this topic mainly concentrates on advanced economies due to data unavailability in LEMEs. However, related studies on economies within LEMEs' categorisation were based on different classifications of real interest rates, that is, covered and uncovered real interest rate parity. These studies (Sachsida et al., 2001; Francis et al., 2002; Baharumshah et al., 2009; Tse & Wald, 2013; Karahan & Colak, 2012; Skinner & Mason, 2011 & Buberkoku, 2020), although they were based on countries included in the LEMEs categorisation, the authors reached different conclusions in terms of the variables used for estimation, the periods covered, or the methodologies employed. On the other hand, few studies have examined the validity of RIRP in LEMEs, and countries were individually considered; however, for the purpose of this research, the literature review will be based on studies that concentrate on RIRP, which combines both uncovered interest parity (UIP) and ex-ante purchasing power parity (PPP) as the foundation for international finance in LEMEs.

Using the monthly Treasury Bill rates data for Brazil and Mexico and deposit rates for Argentina and Turkey together with other emerging markets and advanced economies from 1991M3 to 2002M5, Ferreira and Leon-Ledesma (2003) investigate the validity of the RIRP condition in these economies. The authors employed the augmented Dickey-Fuller test (ADF), Philip-Perron (PP), Kwiatkowski–Phillips–Schmidt Shin (KPSS), asymmetry unit root tests, and structural breaks as estimation techniques to analyse real interest rate differentials (rdiffs), which show the existence of a positive long-run mean in real interest rates, which is a high level of real interest rate in emerging market economies. However, results from the convergence to equilibrium show that the real interest rate tends to be high when economies record an increase in growth rates. This explains the existence of large risk premia in emerging countries to protect investors against risks. The results from the half-life shocks indicate highly persistent rdiffs for Argentina between 3.4 and 13.1 months, whereas other countries averaged between 0 and 3.2 months and, as such, are not persistent (short-lived). The authors attribute the results for emerging countries to the influence of the increasing global financial crisis, although the risk premium compensates for high-level interest rates in the economies.

Singh and Banerjee (2006) applied the cross-sectional augmented Dickey-Fuller (CADF) time-varying panel unit root to investigate the long-run convergence of real interest rates in Argentina, Brazil, Korea, Mexico, South Africa, and Turkey with other 10 emerging market economies. Using quarterly data of real interest rate differentials (rdiffs) from 1991Q1 to 2005Q4, the results reveal that RIRP does not hold in countries within the short- and long-term periods. Meanwhile, findings from the half-life shocks on the speed of adjustment show that it takes the countries, on average, between six months or higher to converge to equilibrium. The authors conclude that due to the absence of RIRP in the economies, it is likely that most investments in the short term are usually from domestic investors and domestic debt because it will be difficult for countries to attract foreign investors in the absence of RIRP conditions.

Similar to other studies on emerging market economies, Altuntas (2021) estimated the real interest rate differentials (rdiffs) using the Dickey-Fuller (DF), augmented Dickey-Fuller (ADF) Philips and Perron (PP), and Kwiatkowski-Philips-Schmidt-Shin (KPSS) unit root tests without structural breaks. The author further employed Perron and Zivot and Andrew (ZA) (1992) unit root tests with one break, then Enders and Lee Fourier-ADF unit root tests for structural breaks to capture all the breaks that might have occurred throughout the period in the economies. The results from Brazil, India, Indonesia, South Africa, and Turkey indicated that countries reacted differently in all the unit root tests conducted. While some countries validate the RIRP hypothesis in unit root tests with or without structural breaks, others proved the validity of the RIRP in only the unit root test without structural breaks. In contrast, others revealed that the RIRP is valid in unit roots with structural breaks. In essence, different methodologies yielded different results, where some countries positively validated the RIRP method, and others did not.

In summary, it can be seen from the literature that the RIRP hypothesis is rarely valid in LEMEs, as shown in previous studies. Although different methods of testing for validity are used, some allow for structural breaks, and others do not also lead to variability in the outcome. The studies also indicate that ripple effects from external forces, such as financial crises and an increase in the inflation rate, among other causes, can prevent RIRP conditions from holding in the economies.

Although the validity of the RIRP hypothesis indicates the degree of market efficiency in a liberalised financial system, it is worth emphasising that the validity of the RIRP limits the ability of LEMEs to implement independent monetary policies efficiently. This might also affect the economies, especially LEMEs, where government intervention is usually needed due to poor financial development to curtail the impact of shocks in the economies.

## 4.3 Data and Methodology

The data used in this study are annual data on real interest rate differentials and inflation rates in seven LEMEs. Due to the unavailability of data, inconsistency, and missing values among the 11 countries in LEMEs, seven out of the 11 countries with complete values were used for this study. The study also uses real interest and inflation rates for the US. The two periods covered are the Bretton Woods era (1960-1972) and the managed-float regime era (1973-2019) when LEMEs could formulate their monetary policies and become an open economy while participating fully in global markets. Although LEMEs have adopted other exchange rate regimes within the two periods considered in this study, these are the main periods in history that can provide robust data to analyse long-run convergence trends, as per the requirement of the theory of real interest rate (RIRP). Another reason the two regime periods were selected is the theoretical expectation that countries-specific interest rates should exhibit long-run convergence trends. Therefore, a long period between regimes is necessary, as was adopted in this study.

Burange and Ranadive (2011) maintain that most LEMEs were still under colonial administration and, therefore, do not have a sustainable financial system or monetary policy framework in place between the interwar period from 1918-1939, which consists of the Gold Standard era 1870-1914, general floating 1919-1925, gold exchange standard 1926-1931, managed floating 1932-1939 and the interwar float regime period 1920-38. Later, the Bretton Woods system began in 1947 because of unfavourable economic conditions in the interwar period. With this in mind, obtaining data on LEMEs' real interest and inflation rates will be difficult, which is the case in this study. As stated earlier, the LEMEs countries considered in this study are Argentina, Brazil, India, Korea, Mexico, South Africa, and Turkey, and the US is added as their foreign trade partner. The two periods under study give 59 years per country, and the real interest rate differentials and inflation rates result in a total of 118 observations for each country, which gives 708 observations for all the countries. The data were transformed as follows:

**Inflation rates for LEMEs and the US:** The CPI was used to calculate the inflation rates for all countries using the following formula:

$$Inflation_t \left(\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}}\right) X\,100 \tag{10}$$

CPI is the consumer index for LEMEs and the US, and the difference in current $CPI_t$ from the previous $CPI_{t-1}$ is divided by the previous CPIt-1 and multiplied by 100. The CPI data for all countries were sourced from the Global Financial Data (GDF) website.

**Real interest rates for LEMEs and the US:** the inflation rates generated from the CPI were differentiated from the nominal interest rates to generate real interest rates *(nominal interest rate-inflation = real interest rate).*

**Real interest rate differentials:** each LEMEs' real interest rate differentials (rdiff) were calculated using the real interest rate of a particular country minus the real interest rate of the US ($r_t^{LEMEs} - r_t^{US}$), which was applied to all seven countries used in this study.

The annual data for nominal interest rates were sourced from the Global Financial Data (GDF) website, except for Mexico, where short-term interest rates, 3-month or 90-day rates, and yields were sourced from FRED Economic data. The data for Korea were interest rate-discount rate, annual data, and Korea and South Africa were also from FRED Economic data. The reason for employing short-term interest rates in Mexico is the unavailability of data, a problem usually associated with LEMEs. All missing values were obtained from the International Financial Statistics (IFS). All data used were transformed into a log form.

Considering that this study aims to examine whether the RIRP conditions hold within different nominal exchange rate regimes in LEMEs against the US, this study applied real interest rate differentials for all LEMEs relative to the interest rate of the US, which is the difference between the real interest rates of LEMEs and the US real interest rates. However, the result interpretation for LEMEs is against the real interest rate in the US.

## 4.4 Methodology

The estimation technique used in this study is the autoregressive AR method of order (1) with the ARIMA package from the STATA5.1 regression and which was divided into two different nominal exchange rate periods: the Bretton Woods system (1960-1972) and the flexible exchange rate system (1973-2019). Although LEMEs have adopted other exchange rate regimes within the two periods considered in this study, these are the main periods in history that can give robust data to analyse the long-run convergence trends as per the requirement in the theory of real interest rate (RIRP). First, the following unit root tests were conducted on the two periods, and each method had its lag length selection criteria: Dickey GLS-lag length 10 chosen by the Schwert criterion. The data for Argentina had some missing series, so the DF-GLS unit root test could not be carried out because a complete series was required, but all the variables were stationary. This satisfies the condition stated by Dreger (2010) that all the variables need to be stationary for this analysis to be suitable for the AR regression. The AR time-series regression for different exchange rate regimes was then done by optimising the Berndt-Hall-Hall-Hausman (BHHH) and Broyden, Fletcher, Goldfarb, and Shanno (BFGS) settings.

The estimation equation for the AR (1) model of real interest rate differentials can be written as follows:

$$rd_t + \beta_0 + \beta_1 rd_{t-1} + \varepsilon_t \tag{11}$$

Where $rd_t$ represents the real interest rate differentials at time (t), $\beta_0$ is the intercept, $\beta_1 rd_{t-1}$ is the real interest rate differentials at time $(t-1) and\ \varepsilon_t$ is the stationary errors. Recall the rational expectation for the Fisher equation in equations (3) and (4), which can be applied to calculate the mean for the real interest rate differentials. Thus, the mean of $rd_t$ is:

$$E(rd_t^{LEMEs}) = E(rd_{t-1}^{LEMEs}) = \mu \tag{12}$$

therefore,

$$E(rd_t^{LEMEs}) = E(\beta_0 + \beta_1 rd_{t-1}^{LEMEs} + \varepsilon_t) \tag{13}$$

Equations (11) and (12) show the rational expectation for obtaining the mean of the real interest rate differentials (rdiffs) for LEMEs, whereby the expected real interest rate differentials at time $(t)$ are the same as the expected real interest rate differentials at time $(t-1)$.

Diagnostic tests were conducted using Akaike's information criterion (AIC), Bayesian information criterion (BIC), and Eigenvalue stability conditions to measure whether the AR parameters satisfied the stability condition.

Finally, to measure how long it takes to cover half of the distance when there is a deviation, the results from the AR parameter show that the RIRP does hold in specific periods for some countries. The model of half-life shocks was estimated, followed by computations of half-life parameters and standard errors, as presented in Table 2. The equation for estimating the half-life shocks can be written as follows:

$$h = \frac{ln(^1/_2)}{ln\beta_1} \tag{14}$$

The half-life estimation considers the period $t + h$ where the process is expected to halve its distance to the interest rate parity of $rd_t = 0$, that is, interest rate differential = 0. Equation (13) is used to compute the half-life shocks, where $ln\beta_1$ is the autoregressive (AR) parameter from the regression of real interest differentials. The standard errors from the half-life computations are shown in parentheses. To calculate the half-life, standard errors were approximated using the delta approach proposed by Rossi (2005).

### 4.5 Empirical Findings

The unit root test results presented in Table 4.1 shows that all the variables are stationary in different tests conducted except for Argentina, where the DF-GLS test cannot be carried out because of missing series in the data used for the country; hence, the space for the variable is vacant in the table below. The stationarity results from the unit root indicate that the necessary condition for autoregressive (AR) model regression and the computation of half-life shocks are fulfilled.

#### 4.5.1 Autoregressive (AR) Model Results for Parity Condition

The conditions for parity require that if rdiff = 0, the real interest rate in LEMEs equals the real interest rate in the US, which implies that the RIRP condition holds. However, if rdiff is not equal to zero, the real interest rate in LEMEs differs from that in the US. This implies that the RIRP condition does not hold. Therefore, for the parity condition to hold, the AR parameter should be less than one and, at the same time, statistically significant; otherwise, there is no parity condition. That is, $r_t^{LEMEs} = r_t^{US}$ then, $r_t^{LEMEs} - r_t^{US} = 0$ implying that there is RIRP where $rdiff_t = 0$. This can be achieved by comparing values from the t-statistics (that is, the AR parameter divided by the standard error of the AR parameter) against the t-critical values from the t-distribution table for the two-tailed test. This study compares two periods of exchange rate regimes in LEMEs. The periods were the Bretton Woods era and the floating regime system from 1960 to 1972 and 1973 to 2019. Using the degrees of freedom, t-critical values for the two periods were obtained as 2.179 for 1960–1972 and 2.021 from 1973 to 2019 at the 5% significance level.

Applying the approach to LEMEs, using t-statistics values shows that during the Bretton Woods era, which is from 1960 to 1972, the RIRP condition did not hold in Argentina, India, Mexico, South Africa, and Turkey, but the parity condition held in Brazil and Korea.

***Table 4.1: Unit Root Tests for Real Interest Rate Differentials (rdiffs)***

| | **Argentina** | **Brazil** | **India** | **Korea** | **Mexico** | **South Africa** | **Turkey** |
|---|---|---|---|---|---|---|---|
| **DF** | -3.030** | -7.550*** | -5.891*** | -3.611*** | -8.019*** | -2.962** | -9.576*** |
| **ADF** | -2.813* | -5.066*** | -5.062*** | -4.272*** | -5.890*** | -2.197 | -6.341*** |
| **PP** | -3.109** | -7.555*** | -5.869*** | -3.660*** | -8.069*** | -2.752* | -9.693*** |
| **DF-GLS** | ------- | -4.678*** | -4.776*** | -5.178*** | -5.500*** | -2.239 | -6.060*** |

**Note:** All variables for the seven countries are stationary. The data for Argentina have some missing series; therefore, the DF-GLS unit root test could not be carried out because a complete series is required to do that. For Brazil, India, Korea, Mexico, South Africa, and Turkey, the DF-GLS test was conducted where the maximum lag length was 10, chosen by the Schwert criterion, and the t-statistics from the first lag were used to determine whether the variable was stationary. ***, **, * indicates significance at 1%, 5% and 10%, respectively.

Then, within the floating exchange rate regime period from 1973 to 2019, the RIRP condition did not hold in Brazil, India, Korea, Mexico, and Turkey but in Argentina and South Africa. These results imply that given the two nominal exchange rate regime periods compared in the seven LEMEs, the RIRP condition did not hold in five out of seven LEMEs in each period considered-1960 to 1972 and from 1973 to 2019, which is an indication that the RIRP condition did not hold in most of the countries studied. Therefore, this study concludes that the two nominal exchange rate regime changes, namely the Bretton Woods system and the floating exchange rate regime, created deviations in real interest rate parity in LEMEs except in Brazil and Korea. Although the findings in this study have some similarities with previous studies Ferreira and Leon-Ledesma (2003); Singh and Banerjee (2006), and Altuntas (2021), however, there are some differences in the presence of the RIRP hypothesis in some of the countries studied. Several factors surrounding the structure of LEMEs' financial and economic systems might have contributed to the real interest rate differentials not being equal to zero.

From the Bretton Woods era (1960–1972), the absence of RIRP conditions in the five economies could be due to a lack of effective monetary policy to protect the economy from shocks, bearing in mind that the adoption of independent monetary policy to suit countries' economic structure was not in existence. For Brazil, the validity of the parity condition from 1960 to 1972 might be due to the new government's structural reform of public finance in the 1960s, which led to a change in monetary policy guided by experiences from advanced countries (Alfonso et al., 2016). The parity condition also held in Korea from 1960 to 1972, which can be attributed to economic turnover resulting from the big push to resuscitate the economy after the civil war, as indicated by Kim and Cho (2011). The presence of the RIRP in Argentina from 1973 to 2019, the era of a free-floating exchange rate regime, might be because the economy pegged the Argentina Peso to the US dollar one for one (Argentina was part of the US currency board).

*Table 4.2: Results for Times Series AR Regression and the Half-Life of Shocks*

| Countries | 1960-1972 | | 1973-2019 | |
|---|---|---|---|---|
| | **AR parameter** | **Half-life of shocks** | **AR parameter** | **Half-life of shocks** |
| **Argentina** | -0.607<br>(1.079) | 1.388<br>(4.944) | 0.610<br>(0.135) | 1.402<br>(0.628) |
| **AIC** | 135.822 | | 326.656 | |
| **BIC** | 137.517 | | 330.652 | |
| **Eigenvalues** | -0.607 | | -0.610 | |
| **Brazil** | 0.758<br>(0.198) | 2.502<br>(2.359) | -0.007<br>(0.640) | 0.140<br>(2.574) |
| **AIC** | 117.678 | | 944.805 | |
| **BIC** | 119.373 | | 950.356 | |
| **Eigenvalues** | 0.758 | | -0.007 | |
| **India** | 0.126<br>(0.537) | 0.335<br>(0.688) | 0.273<br>(0.154) | 0.534<br>(0.232) |
| **AIC** | 84.078 | | 289.164 | |
| **BIC** | 85.772 | | 294.714 | |
| **Eigenvalues** | 0.126 | | 0.273 | |
| **Korea** | 0.724<br>(0.202) | 2.146<br>(1.854) | 0.056<br>(0.084) | 0.240<br>(0.125) |
| **AIC** | 97.866 | | 251.320 | |
| **BIC** | 99.560 | | 256.871 | |
| **Eigenvalues** | 0.724 | | 0.056 | |
| **Mexico** | -0.159<br>(0.334) | 0.377<br>(0.431) | -0.068<br>(0.211) | 0.258<br>(0.298) |
| **AIC** | 65.244 | | 66.939 | |
| **BIC** | 462.598 | | 467.760 | |
| **Eigenvalues** | -0.159 | | -0.068 | |
| **South Africa** | 0.372<br>(0.392) | 0.701<br>(0.747) | 0.718<br>(0.118) | 2.092<br>(1.038) |
| **AIC** | 53.965 | | 232.598 | |
| **BIC** | 55.659 | | 238.148 | |
| **Eigenvalues** | 0.372 | | 0.718 | |
| **Turkey** | 0.192<br>(0.335) | 0.420<br>(0.444) | -0.231<br>(0.199) | 0.473<br>(0.278) |
| **AIC** | 79.851 | | 472.397 | |
| **BIC** | 81.546 | | 477.947 | |
| **Eigenvalues** | 0.192 | | -0.231 | |

**Note:** The AR (1) estimations results are based on annual data from two nominal exchange rate regime systems in LEMEs for 1960-1972 and 1973-2019. The values in parentheses are standard errors, whereas AIC, BIC, and Eigenvalue diagnostic tests were used to check whether the AR parameters satisfied the stability conditions.

South Africa also witnessed significant improvement in its financial structure and monetary policy framework, which could be the reason for the presence of the RIRP hypothesis from

1973 to 2019 in the economy. Frankel and Okongwu (1995) emphasise that deviations from the RIRP conditions could also be due to the US interest rates' influence on all emerging markets' interest rates, including LEMEs, regarding portfolio capital flows and the effects on local interest rates. Therefore, adjusting US interest rates could lead to disparity in RIRP conditions.

Another reason the RIRP condition did not hold in most of these economies could be other macroeconomic problems and the negative effects of the series of financial crises. This included the Latin American crisis of 1982-1989, the dot-com bubble in 1995, the Asian crisis in 1997, the 2001-02 Argentina crisis, the global financial crisis of 2007-09, and the 2011 Greek crisis. Others are the Russian crisis 2014, which rocked international financial markets, ultimately affecting trade and economic sustainability and negatively affecting LEMEs. As part of the damage control measures, interest rates are usually restructured through monetary policy easing, irrespective of the exchange rate regime in place in the economies.

In addition, Ferreira and Leon-Ledesma (2003) acknowledge that asymmetries induced by either risk perception change or transaction costs, financial crises, and inflation increases might influence the real interest rate hypothesis from not holding, especially in emerging economies. The diagnostic test results from the Akaike information criterion (AIC) and Bayesian information criterion (BIC) indicate that the model is a good fit, and the AR parameters satisfy the stability condition from the Eigenvalue results for all countries selected.

### 4.5.2 Results of Half-Life Shocks

The AR parameters were used to compute half-life parameters and standard errors. Half-life parameters are needed to measure how long it will take to cover half of the distance when real interest rate differentials are not equal to zero in all the countries studied. The methodology for measuring half-life requires that the smaller the values of the half-life shock, the faster it returns to the RIRP condition. During the Bretton Woods era from 1960 to 1972, the real interest rate in India took the shortest time to converge to parity, followed by Mexico, Turkey, South Africa, Argentina, and Korea, while Brazil took the longest time among the countries to converge to parity. In comparison, it takes three and a half less time for South Africa to converge to the parity condition than it will take Brazil in the same period. The same applies to other countries where the differences are five and a half times less to converge compared to Korea, while India and Turkey took 4 and 3 less time, respectively, compared to Argentina.

For the floating regime period from 1973 to 2019, Brazil's real interest rate differentials took the shortest time to converge to the parity condition. This is followed by Korea, Mexico, Turkey, India, Argentina, and South Africa, which took a long time compared to other countries to converge to parity conditions. Comparatively, South Africa will take four times more than Turkey to converge to the parity condition. This implies that once real interest rate differentials existed among the seven LEMEs from 1973 to 2019, South Africa took a long time to converge to the parity condition.

The difference in the distance between other countries includes five and half times less for Korea and Mexico to converge to parity condition when compared to Argentina. At the same time, India and Turkey take about two times less to converge than Brazil in the same period. Therefore, when deviation occurs in real interest rate parity, countries converge within less time in the Bretton Woods era than in the free-floating regime. The reason could be that most LEMEs anchor their monetary policy framework to advanced economies, thereby making convergence easy when the RIRP condition does not hold. Another reason might be the massive capital restrictions during the Bretton Woods era, as noted by Dreger (2010). Moreover, the financial crises mentioned above occurred after the Bretton Woods era, which had strict rules guiding monetary policy, unlike the free-floating regime, where the forces of demand and supply determine prices and interest rate is used to control when prices become too high.

Overall, it is worth emphasising that interest rates play vital roles in forming a monetary policy framework in LEMEs, mainly when they include incentives that attract foreign investors to the country. Therefore, deviations in real interest rate parity might be risky to the economies if persistent, considering that investment catalyses economic growth and financial stability in LEMEs. It is important for LEMEs to adopt an effective management approach to their monetary policy, probably an unconditional monetary policy that will yield RIRP compared to their US counterparts.

### 4.6 Policy Implications and Policy Recommendations

The real interest rate is crucial to LEMEs' economic progress and financial stability, especially as economies continue integrating into global markets through international trade and capital flows and for investment purposes. Considering that foreign investors are enticed more by the validity of real interest rate parity conditions in their countries of interest, it is expected that these conditions should be fulfilled in LEMEs, where foreign investments are required for sustainable economic progress.

Although the RIRP is a necessary condition, external influences and institutional imbalances have made achieving the RIRP conditions somewhat impossible, as shown in the AR parameter results obtained in this study; even in some countries, it takes a long time before the real interest rate converges to equilibrium when there is deviation. This study, therefore, suggests that to maintain the validity of RIRP amid excessive economic boom or shocks, a sustainable monetary framework needs to be designed whereby all the macroeconomic and monetary factors, such as inflation and exchange rate volatility, that can trigger deviation of the real interest rate from the parity condition can be controlled. Moreover, appropriate regulation of the financial and economic system should be placed to put the economy in check and help curb the adverse effects of increasing financial crises on LEMEs' financial institutions.

Achieving RIRP conditions in LEMEs will help these economies to participate efficiently in global markets. It can also help them to rebuild their economies and open them for investment opportunities from foreign investors who wish to invest in LEMEs. It is important to note that achieving RIRP conditions in LEMEs can limit the ability of monetary authorities to adopt independent monetary policies efficiently through interventions.

### 4.7 Conclusion and Areas for Further Study

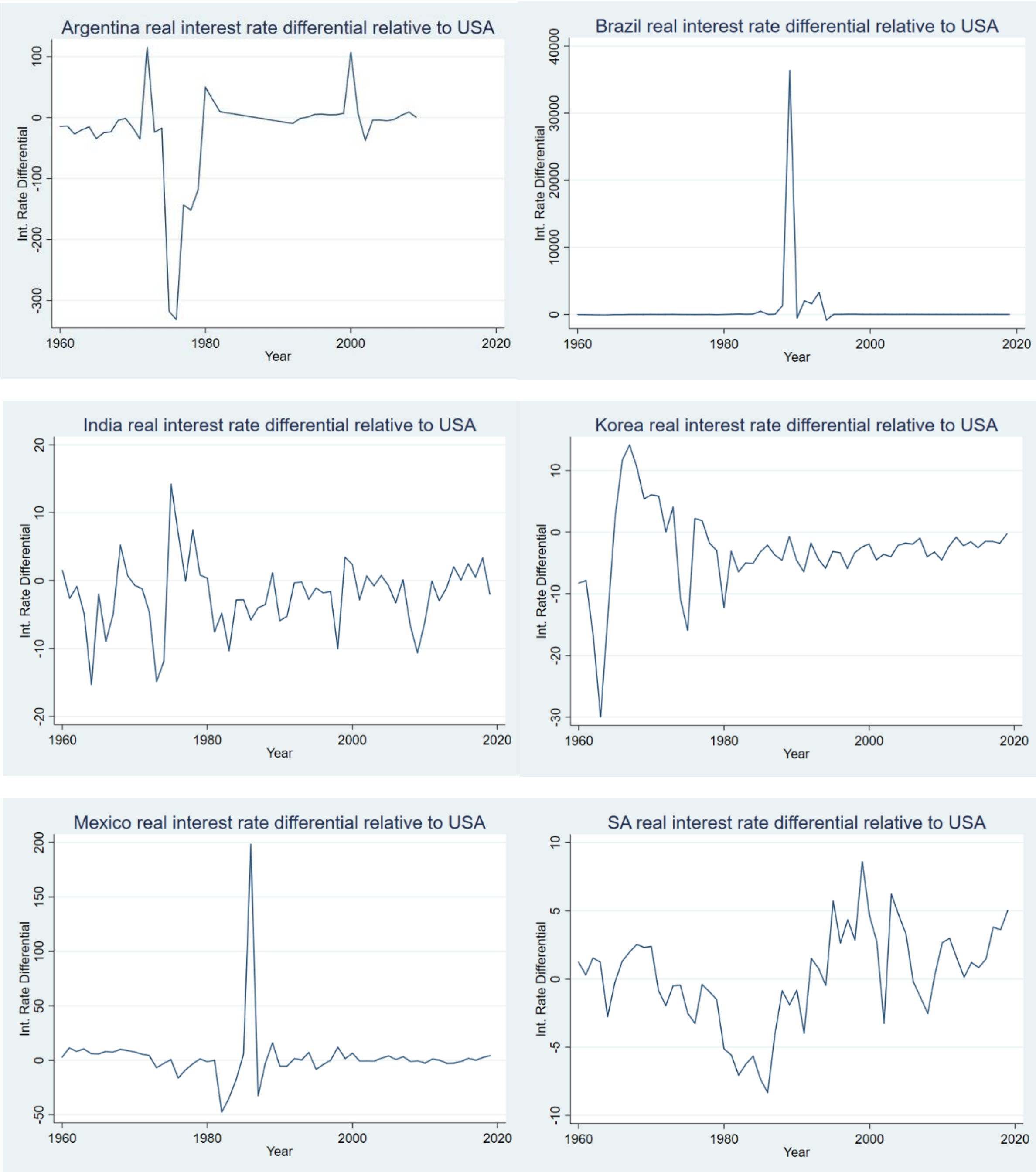
This study examined the validity of the real interest parity (RIRP) condition in seven LEMEs, Argentina, Brazil, India, Korea, Mexico, South Africa, and Turkey, over two nominal exchange regimes, the Bretton Woods era and the free-floating regime from 1960 to 1972 and 1973 to 2019. The variable used for regression is the interest rate differentials (rdiffs) generated from the difference between the nominal interest rate and inflation and the difference between the real interest rate for each economy selected and the real interest rate for the US. To determine whether the RIRP condition holds in these economies, different unit root tests were first conducted on the rdiffs, which revealed that the variable is stationary in all the tests except for the DF-GLS result for Argentina, a necessary condition for further estimations in this study.

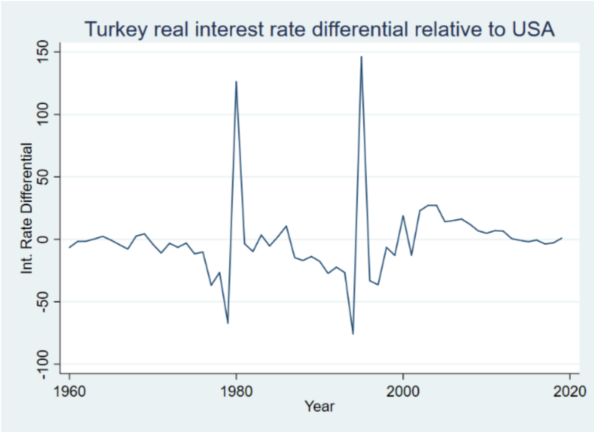
This was followed by the autoregressive (AR) linear model of order (1) regression, where the AR parameters show weak evidence of the long-run validity of the RIRP condition in the economies. Thereafter, the half-life shock was computed with the AR standard errors, and the results indicated that countries converged faster to RIRP conditions in the Bretton Woods era than in the free-floating regimes; however, the time it took to reach the parity point differed from country to country. The results imply that although there is weak evidence of real interest rate parity in the economies studied, achieving parity conditions is essential for the economies to attract foreign investors that will help LEMEs rebuild their economies and financial systems. This will be possible when all the external contagion effects and internal shocks to the economies which act as stumbling blocks are taken care of through the implementation of suitable monetary policies. This study, therefore, suggests the application of effective monetary policy which suits LEMEs structures to improve the validity of RIRP and smoothen the operation of financial systems.

Researchers who wish to investigate this context further can expand the estimation to measure different aspects of the real interest rate, such as the uncovered and covered real interest rates with other macroeconomic variables, to have appropriate knowledge of what leads to deviations from RIRP conditions. Moreover, an interest rate with short-term maturity can be employed instead of the long-term rate to determine if mid-term monetary policy changes affect the RIRP conditions.

## Appendix 4.1: LEMEs and the US Real Interest Rate

### Figure 4.1: LEMEs Real Interest Rate Differentials Relative to the US, combined periods 1960-2019





Turkey real interest rate differential relative to USA
Int. Rate Differential
-100
-50
0
50
100
150
1960
1980
2000
2020
Year

# CHAPTER FIVE

# Monetary Policy Frameworks and Taylor Rule Validity in Large Emerging Market Economies

## 5.1 Introduction

Economic stabilisation through monetary policy reforms has constituted a significant debate in central banks' attempt to restructure the large emerging market economies' (LEMEs) financial systems. More so, due to the institutional setbacks caused by variability in their exchange rates from poor monetary policy framework, underdeveloped financial systems, and systemic imbalances that characterised the countries. The breakdown of the Bretton Woods system in the 1970s ushered in the advent of liberalised monetary policy and, by extension, the Taylor interest rate rule, which involves a strict anti-inflation policy that satisfies sufficient conditions for the Taylor principle (Divino, 2009). To mitigate contagion effects and stabilise their financial systems, LEMEs adopted the modified Taylor (2000) rule, also known as the inflation targeting (IT) policy. The motivation for adopting the inflation targeting (IT) framework by emerging market economies emanated from introducing a flexible exchange rate regime which increased the level of volatility in their currencies. Hammond, Kanbur, and Prasad (2009), Carare et al. (2003), and Katusiime and Agbola (2018) express that increasing financial globalisation joined with a high degree of pass-through from exchange rate swings to inflation rates in the global financial markets have made monetary policy formulation in emerging market economies increasingly complicated. In a similar view, Bordo and Meissner (2016) suggest that the emergence of recurrent and systemic financial crises as the side effects of the modern process of financial development disrupts the independent financial system in place and increases exchange rate volatility in emerging markets.

Therefore, to control the negative effects of increasing exchange rate volatility on inflation and the shock waves from global financial crises on emerging markets' financial systems, LEMEs adopted the inflation targeting (IT) approach. The initial work of Taylor (1993) for policy rates provides the links between interest rates, inflation, and the output gap in stabilising the economy. The ideology behind the policy is that for a country's monetary authorities to achieve financial stability, their aim should be to stabilise inflation around its target level and output around its potential target. This implies that countries tighten or loosen their monetary policy to adjust interest rates according to the deviations of the inflation gap from the target and the output gap from the potential target (Taylor, 1993; Mohanty & Klau, 2005 & Hofmann & Bogdanova, 2012). However, while Taylor's (1993) policy rule benefits some advanced economies with fully developed long-term assets markets for debt, impressive foreign exchange markets, and a high degree of capital mobility, applying a similar rule to emerging market economies with the opposite of what is obtainable in the advanced economies will yield no result (Taylor, 2000 & Caporale et al. 2018).

The problem is that the financial systems in emerging market economies cannot withstand or absorb external contagion shocks to the systems. Similarly, the monetary policy in emerging market economies is designed differently from the advanced economies. So, if Taylor (1993) is adopted, there will be a mismatch with the structural differences in LEMEs among other systemic imbalances that could affect their ability to adapt to the policy. Hence, the Taylor (1993) rule was modified by Taylor (2000) to accommodate those differences that separate emerging markets from advanced economies. The Taylor rule (2000) was perceived as suitable to the dynamic nature of emerging market economies given the limited market depth, underdeveloped financial system, and other systemic problems associated with the countries. This new policy rule recognises, among other things, the role of exchange rate in formulating a workable monetary policy, the effects of underdeveloped long-term bond markets in policy decisions, and the desirable monetary policy instruments related to the financial structures in emerging market economies.

In LEMEs' context and relationship to the Taylor rule, it is important to note that LEMEs have strong links with the rest of the world through trade and global financial integration. This helps to facilitate capital flows from international trade, foreign investment financing, and other global links through which financial contagion from external sources can penetrate the countries. The effects of policy instabilities and underdeveloped infrastructural and financial systems are that adopting a flexible exchange rate system without the necessary protective framework exposes and increases related countries' vulnerability to external contagion effects.

Therefore, adopting an independent monetary policy to complement the economies' structural needs, and boost financial stability and economic sustainability, has yielded minimal positive results due to the negative effects of financial liberalisation and globalisation. In addition, Katusiime and Agbola (2018) recognise the exchange rate as the main factor for economic stabilisation in LEMEs. Therefore, increased exchange rate volatility can destabilise the economic system, especially when connected to other countries with different monetary policy frameworks. This supports the theoretical view of Mussa (1984) that the exchange rate is significantly affected by current and future economic conditions. Therefore, expectations should not be to adjust nominal or real exchange rates to eliminate current account imbalances without modifying macroeconomic policy. More so, exchange rate volatility contributes as a possible trigger to loss of competitiveness in international markets, increased bid-ask spreads, decrease in foreign investment, fluctuation of currencies, and affect the entire economic outlook.

A further submission by Rey (2013) in support of Mussa's theory indicates that adopting independent monetary policy alone cannot shield economies from the global financial cycles when the capital account is highly open and financial flows are driven by monetary conditions, including policies in advanced economies. With exchange rate depreciation, Pordeli, Schofer, and Sutton (2021) indicate that although it has some benefits like favouring net exports, it can also increase the repayment cost of unhedged debt, reduce the confidence of investors with unhedged LEMEs' currencies and increase capital outflows.

Considering the argument above, a contested view about the usefulness of the Taylor policy framework in measuring monetary policy interventions in LEMEs was presented by Hoffman and Bogdanova (2012). The authors argue that the Taylor rule might contain a downward or upward bias because it fails to capture the financial cycles in emerging economies, the stability risks, and other macroeconomic and monetary policy instruments. Bernanke (2015) also countered Taylor's rule policy by stating that it fails to proffer solutions on what central banks should do when the predicated rate is negative. The author further argues that there is no straightforward approach to measuring the output gap, and Taylor's rule on inflation and output gap is not clearly specified. The conclusions of Hoffman and Bogdanova (2012) and Bernanke (2015) beg the question of how suitable the Taylor (2000) policy rule is in the formulation of monetary policy framework in LEMEs. Again, how valuable will including additional variables to measure the policy rule be in explaining the efficacy of the Taylor rule in LEMEs? If positive, will it be appropriate for a comparative analysis between countries in LEMEs categorisation based on the year each country adopts IT?

The discussion above indicates the need for comprehensive research on this topic because previous research remains inconclusive in explaining the validity of the Taylor rule in LEMEs. More so, considering that there is a difference between the advanced economies where the validity of the Taylor rule is most suitable and LEMEs with limited financial systems.

Therefore, identifying the applicable monetary policy rule[4] that conforms to LEMEs' financial system structure requires careful observations and evaluations. Hence, this study wants to understand how the Taylor policy rule works in LEMEs likewise, its influence in adopting monetary policy frameworks in the economies. Extensive empirical literature abounds within this context that employed LEMEs but with mixed conclusions. For example, Hoffman and Bogdanova (2012) believe that the Taylor rule cannot capture other macroeconomic variables that can influence financial stability and the outcome of the policy rule in emerging market economies. Moreover, studies that comparatively measure the Taylor rule's validity in LEMEs are scarce. Divino (2009) shared a similar view about the lack of other macroeconomic variables in the Taylor rule and applied other alternative measures of price variability. This involves using two inflation gap measures, which include the consumer price index (CPI) and producers price index (PPI), to investigate the validity of the Taylor monetary policy rule across OECD countries. Divino's approach not only helps with comparing the variability in inflation measurement but reaffirms the importance of recognising the extension of Taylor's monetary policy instruments.

Cecchetti (2009) maintains that price measurement is essential for designing an appropriate monetary policy that will help to stabilise the economy; however, a lack of an adequate measure of inflation can affect the short and long-term policy framework. Within a similar view, Moreno (2009) indicates that understanding the macroeconomic factors that determine the behaviour of price indicators will be helpful for monetary authorities, especially with CPI, where PPI can help to predict price behaviour. The author further explains that in tracking the

[4] Monetary policy rule specifies the condition with which the monetary authorities are allowed to change the instruments of monetary policy (Taylor, 2000). This in essence does not include the inflation or nominal GDP targeting proposals but defines the way instruments of policy are to be changed.

output prices, considering prices charged by producers for goods and services should be a good reflection of the final prices paid by consumers, that is, the CPI.

This study aims to empirically investigate using different price variabilities, which are the CPI and PPI inflation, whether the monetary policy framework in LEMEs follows the Taylor policy rule and if the real effective exchange rate (REER) plays a vital role in the conduct of policy interest rate settings in the selected economies. The estimation techniques employed are the ordinary least squares (OLS) and the generalised method of moments (GMM) models. The study controls for policy variables that can affect inflation targeting by including PPI as part of the measurement for inflation gap and real effective exchange rate (REER) as an instrument included in the modified Taylor (2000) policy rule.

Formerly, the PPI inflation captures only tangible goods but currently applies to non-tangible goods and non-tangible sectors of the economy like health, services, manufacturing, finance, real estate, and construction (Statistics South Africa, 2013). Monetary authorities in LEMEs, therefore, need to use PPI inflation as an alternative instrument while trying to analyse whether the variability in either PPI or CPI could lead to monetary policy easing or otherwise.

This study makes three significant contributions to existing literature. Firstly, it uses comprehensive data set to investigate whether LEMEs follow the Taylor policy rule. This is done using data from the period each country adopted the IT policy framework with the flexible exchange rate regime. Then, the study analyses the effects of monetary response to exchange rate dynamics in LEMEs. Thirdly, the study will incorporate the PPI inflation as an alternative to measuring the inflation gap regarding producers’ price influence on CPI to examine how they apply in each country comparatively. This approach followed the recommended need to use varying measures of the inflation gap and understand how they influence policy rate changes.

The significance of this study is threefold. Firstly, the problem of designing an appropriate monetary policy framework that will suit the economic structure of LEMEs has been an ongoing struggle since the inception of the independent monetary policy era. Therefore, careful analysis to know if the economies follow the Taylor policy rule and how well it works for them will help LEMEs to make informed decisions about the suitable monetary policy framework to adopt to improve their financial structures.

Another significance of the study is that the knowledge will be insightful for LEMEs to find ways to balance the trade-off between inflation and output variabilities while stabilising the economies. The demand and supply shocks during the IT process require careful evaluation of the transmission into the economy to avoid unsustainable shocks; for instance, short-term changes in policy rates can influence the exchange rate, leading to increased prices. Likewise, when much emphasis is placed on stabilising the output gap, a decrease in policy rates will help to stabilise the output gap but increase the variability in inflation above the target band, which might not favour LEMEs as open economies and internally. Although this is not to discredit the importance of stabilising the output gap when necessary, but economies need to know their limit. So, findings from this study will equip monetary authorities in LEMEs with the knowledge of how to bring the economy to equilibrium by reducing the trade-off in outputs and inflation variabilities.

Thirdly, it has been argued that the Taylor policy rule is limited and cannot possibly capture the monetary and macroeconomic factors related to the structure of LEMEs. Therefore, it might not be a suitable policy for LEMEs. To make up for the deficiency, this study extended the factors in the Taylor policy rule by using two measures of inflation gap, the consumer price index (CPI) and the producers' price index (PPI), to investigate the influence of Taylor's monetary policy rule across LEMEs. This approach will help policymakers in LEMEs to understand which inflation measure-CPI or PPI applies more to the economies. It will also allow the countries to divert to unconventional monetary policy if the Taylor policy rule becomes ineffective after considering the effects of the findings on the economies.

Considering the argument raised above, it is evident that there are divergent views on the validity of the Taylor policy rule in LEMEs due to the underdeveloped nature of the economies and whether extending the model to include other macroeconomic variables can improve the efficacy of the policy rule in LEMEs, hence the need to embark on this study.

The rest of the chapter is arranged as follows: the next section provides an overview of the Taylor policy rule and the improved policy rule for emerging market economies. Empirical and theoretical literature related to the efficiency of Taylor policy rule in emerging market economies will be reviewed in the section. Section 5.3 contains the data analysis and methodology used in the study, while section 5.4 details the empirical findings. Section 5.5 analyses the implications of the findings with recommendations, while section 5.6 concludes the chapter.

## 5.2 Literature and Theoretical Framework on Taylor Policy Rule in Large Emerging Market Economies

### 5.2.1 Linear Taylor Policy Rule

The linear Taylor rule is an algebraic rule that specifies the approach taken by monetary authorities to stabilise the economic and financial systems by targeting the inflation rate and output gap (Peterson, 2007). The model was proposed as countries struggled to control and protect the economic and financial systems from the contagion effects of external shocks and systemic challenges emanating from liberalising the financial system. Following the approach by Caporale et al. (2018), the Taylor (1993) monetary policy rule is given as follows:

$$r_t = p_t + 0.5y_t + 0.5(p_t - 2) + 2 \quad (1)$$

For equation (1), $r_t$ represents the federal fund rate while $p_t$ denotes the rate of inflation rate for the previous 4 quarters. Then, $y_t$ is the percentage deviation of real GDP from the target. So, when inflation increases above the 2% band, the policy rate will increase more than the inflation rate. The same applies to increases in the output gap; when the actual output is bigger than the potential output, the policy rate will be increased to bring the demand and supply to equilibrium. Thereafter, the model was upgraded to include the monetary authorities' inflation target rate $\pi^*$ and the real interest rate equilibrium $r_t^f$ which can be put together to formulate another equation below as proposed by Taylor (1998).

$$r_t = \pi_t + gy_t + h(\pi_t - \pi^*) + r_t^f \quad (2)$$

The $\pi_t$ is the inflation rate introduced into equation (1) to cater for the equilibrium real interest rate. However, considering that the first Taylor rule was designed following the structure of advanced economies, the Taylor rule (2000) was proposed to include the monetary instruments related to the underdeveloped nature of the emerging market financial systems. Hence the real effective exchange rate (REER) was introduced into the model. The equation for Taylor's (2000) policy rule can be written thus:

$$i_t = f\pi_t + gy_t + h_0e_t + h_1e_{t-1} \quad (3)$$

Where $i_t$ is the short-term nominal interest rate at time $t$, $f\pi_t$ is the inflation rate at time $t$ and $gy_t$ is the output gap at time $t$. Equation (3) above implies that the interest rate at time $t$ is a function of the inflation rate at time $t$ and the output gap at time $t$. The $e_t$ in equation (3) represents the real effective exchange rate (where an increase represents the appreciation of the domestic currency). The content of the Taylor (2000) policy indicates that the financial structure in advanced economies where the first Taylor policy rule was formulated differs from LEMEs.

### 5.2.2 Theoretical Framework

The theoretical framework adopted for this study is the augmented Taylor (2000) rule. The idea behind augmenting Taylor's (1993) rule is to include exchange rate, which plays a vital role in policymaking, especially for emerging market economies that practice the floating regime. Taylor (2000) argues that policy rule based on inflation targeting combined with flexible exchange rates would be suitable for emerging market economies. This is considering the underdeveloped structure of emerging markets' financial systems.

Following the approach, Mohanty and Klau (2004) estimated the augmented Taylor rule to review the conduct of monetary policy and central banks' interest rate behaviour in 13 emerging market economies. The ordinary least square (OLS) method was employed to test whether changes in inflation, output gaps and lagged real exchange rates in emerging market economies are consistent and predictable. The results indicate that while interest rate responds strongly to exchange rate in 10 out of the 13 countries studied. However, the policy response to exchange rate changes seems higher than changes in output gaps and inflation rates in 3 out of the 13 countries. The study shows that exchange rate stabilises the economy during shocks and fear of hypothesis; inflation and output gaps are controlled as well.

Similarly, the augmented policy rule was also applied by Aizenman et al. (2011) to investigate the outcome of inflation targeting in 16 emerging market economies. The economies were categorised as commodity and non-commodity exporters with inflation and non-inflation targeting (IT) regimes. Using the panel data estimation technique, the authors find that only commodity-intensive countries follow the IT regime and policy response, though constrained, but stronger in responding to real exchange rate changes than in non-IT countries. The study concludes that some countries adopt IT due to a higher dependence on the exportation of basic commodities than in non-IT countries, which conforms to the theoretical expectations.

In two targets and two policy instrument analyses, Ostry et al. (2012) examined the effects of using interest rate and sterilised foreign exchange market intervention to control inflation and real effective exchange rate movements in 14 emerging market economies under IT and 10 in non-IT regimes. The results from the panel data estimation reveal that inflation-targeting countries do not follow the freely floating exchange rate regime. However, the countries intervene actively in the foreign exchange market but not as aggressively as the non-IT countries. Another interesting study that adopted the Taylor (2000) augmented policy rule was conducted by Hoffmann and Bogdanova (2012) in 17 emerging and 11 developed economies to assess the level of Taylor policy rule prevailing in the economies from 1995 to 2012. Different inflation measures, such as the current headline CPI inflation rate, the current GDP deflator inflation rate, the current core CPI inflation rate and the consensus forecast of CPI inflation for the next four quarters as a forward-looking inflation measure, were considered in the study. The findings from the analysis show that, on aggregate, policy rates were well below the levels stipulated by Taylor in both advanced and emerging market economies. The authors further argue that the systematic deviations of policy rates from the Taylor rule since the early 2000s are a result of a global phenomenon.

Caporale et al. (2018) examine whether monetary policy in five emerging market economies can be described by an augmented rule including exchange rate and a nonlinear threshold specification instead of a baseline linear rule. The results indicate that the augmented nonlinear

Taylor rule accurately captures the behaviour of monetary policy in the countries where there is a reaction to deviation from the target of inflation or output gaps. It was also dictated that the countries indirectly control exchange rates, especially in times of increased movements, while maintaining the floating exchange rate regime. The outcome differs depending on the statistical significance or size of the coefficients in high and low inflation regimes in all the countries studied.

Based on the literature reviewed for the theoretical framework adopted for this study, which relates to the accuracy of augmented Taylor rule in emerging market economies. It is obvious that the countries studied do not conform to Taylor principles since none of the inflation coefficients is greater than 1. Although the countries observed the Taylor rule in some cases, but that comes with opportunities forgone based on adjusting either inflation rate, real effective exchange rate or output gaps in the economies when they are not within the stipulated bands. More so, it could be seen from the work of Caporale et al. (2018) and Ostry et al. (2012) that despite the adoption of a floating exchange rate regime where the forces of demand and supply determine prices in emerging economies studied, indirectly policymakers intervene when there is an increase in exchange rate volatility especially as it relates to participating in the global markets.

The bottom line is that the effectiveness and accuracy of using Taylor's (2000) rule to adjust inflation and output gaps in emerging market economies remains unanswered. This study, therefore, employed the augmented Taylor (2000) rule as the theoretical framework and included producers' price index (PPI) as an alternative variable to inflation measures in emerging market economics. This study aims to measure by how much the conduct of monetary policy related to augmented Taylor's (2000) rule will help bring the LEMEs to equilibrium by adjusting inflation and output gaps within countries' targets.

### 5.3 Data and Methodology

#### 5.3.1 Overview of Data

The data set used in this study consists of quarterly time series data that covered the period from which each of the 7 LEMEs selected adopted inflation targeting (IT) and a floating exchange rate regime. Although there are 11 countries in LEMEs, 7 were selected for this study due to the problem associated with data availability in LEMEs. The countries under study and the years covered are Brazil-1999Q1, India-2016Q2, KoreaQ1-1998, Mexico-1999Q1, Russia-2014Q1, South AfricaQ1-2000, and Turkey-2005Q1 and the end year for all the variables is 2019Q4. The variables considered were interest rates, the inflation gap for CPI, the inflation gap for PPI, the output gap, and the real effective exchange rate.

The interest rate data for all countries were sourced from FRED; while federal funds rates were used for Brazil; India, Russia, and South Africa interest rate is the central bank rate, and the interest rate for Korea, Mexico, and Turkey was given by call money or interbank rates. The inflation gap comprises the consumer price index (CPI) and the producers' price index (PPI). The CPI and PPI inflation rates were generated using the quarterly CPI and PPI, a 3-month leading average. The inflation gap for CPI and PPI was obtained by calculating each country's CPI inflation difference from their inflation target and then the PPI inflation difference from the inflation target, respectively. The real effective exchange rate (REER) data for the 7 seven countries is a 3-month leading average, and the data is sourced from FRED. The data for the output gap was generated using the log of the real GDP[5] to extract the cyclical component from

[5] Different components of real GDP were used for some of the countries due to the availability of data, for example, GDP domestic currency was used for Brazil. However, real GDP was generated for India, Russia, and South Africa using nominal GDP and GDP deflator while data on real GDP was used for Korea, Mexico, and Turkey.

the trend using the HP filter; after that, the output gap was calculated. The Hodrick-Prescott[6] (HP) (1997) filter was applied to reduce the sum of the residuals in the variable. All data on real GDP were sourced from FRED, and all the series used were seasonally adjusted. All in all, there are 5 variables for each country, but 4 were used in each regression because the inflation target was used to generate the CPI and PPI inflation gaps, and the REER data was transformed into a natural log form.

### 5.3.2 Empirical Strategy

### 5.3.3 Model Specifications

The methodology applied in this study is the linear Taylor (2000) rule that relies on the trinity of the flexible exchange rate, inflation targeting, and monetary policy rule. Taylor's (2000) monetary policy rule was modified from Taylor's (1993) policy rule, which did not recognise the underdeveloped financial system in LEMEs, likewise how fiscal and financial crises mostly prevalent in LEMEs could lead to increasing exchange rate volatility. As discussed earlier, for monetary policy rules to be effective toward financial and economic sustainability in LEMEs, real effective exchange rates as part of the monetary policy instrument need to be included in Taylor's rule. This recommendation was proposed by Ball (1999), Debelle (1999), Svensson (2000), and Taylor (1999) that the exchange rate forms part of the global financial transmission mechanism related to net exports and the transfer of imported goods prices to domestic prices. The mechanism indicates an essential link between exchange rates and interest rates in the

[6] Hodrick-Prescott (1997) applied a decomposition approach to adjust time series data into permanent and cyclical seasonal components. The approach computes a stochastic series in order to minimise the sum of square deviations of the original time series from its trend, whereby the goodness of fit is subject to the constraint that the squared sum of dynamic differences of the permanent component and the measure of the degree of smoothness is not too large (Choudhary et al., 2013).

capital markets. Therefore, appreciation and depreciation of exchange rates, given the circumstances in LEMEs' economic structure, could lead to interest rate cuts or hikes, indirectly affecting exchange rate movements. With this level of importance and the increasing level of volatility in LEMEs' exchange rate system, it will be imperative to include the variable in the analysis. Another essential variable included in this study is the producers' price index (PPI) which measures price changes in the direction of domestic producers in an economy. This variable will be crucial in interpreting the relationship between inflation and interest rate adjustments as part of the monetary policy rules in LEMEs.

Considering the above, the first estimation technique adopted for this study is the ordinary least square (OLS) model. The technique was applied to fit the model of the relationship between one or more explanatory variables and the interval outcome variable that minimises the sum of square errors, which is the difference between the actual and predicted value of the outcome variable (Zdaniuk, 2014). To estimate if LEMEs' monetary policy is effective in anchoring inflation expectations, the OLS simple linear regression equation is substituted into the interest rate reaction function in equation (3) to yield the equation below:

$$r_t = \alpha_0 + \alpha_1 r_{t-1} + \alpha_2\, infgap_t^{CPI} + \alpha_3 output_t + \alpha_4 REER_t + \varepsilon_t \quad (4)$$

Other OLS estimation using the producers' price index (PPI) inflation is shown thus:

$$r_t = \alpha_0 + \alpha_1 r_{t-1} + \alpha_2\, infgap_t^{PPI} + \alpha_3 output_t + \alpha_4 REER_t + \varepsilon_t \quad (5)$$

Equation (4) above is the OLS simple linear regression equation for CPI inflation. Where $r_t$ *and* $r_{t-1}$ is the vector of interest rate component with one period lag for each; $infgap_t^{CPI}$ is the CPI inflation gap and $output_t$ is the output gap. The $REER_t$ represents the real effective exchange rates while $\varepsilon_t$ is the error term and $t$ shows the time indices for all the variables. Although the vectors in equation (5) represent similar variables in equation (4), however, $infgap_t^{PPI}$ is the PPI inflation gap. All the variables stated in equations (4) and (5) are represented for all the countries under study.

The estimation results from the OLS regression presented in Tables (5.2) and (5.3) show that the assumptions of OLS were violated in that the explanatory variables correlated with the error term. Likewise, the zero conditional means and homoskedasticity conditions are not satisfied. In the views of Williams (2020), applying the OLS estimator when heteroskedasticity is present is not optimal because it gives equal weight to all observations even though observations with larger disturbance variance have less information than observations with smaller disturbance variance.

The implication is that the OLS estimator is not suitable for analysing the variables in this study; therefore, another model of estimation that can resolve the consistency issue will be preferred. This study employs the times series generalised method of moments (GMM) estimator by Hansen (1982) due to the conditional heteroscedasticity and volatility clustering usually present in foreign exchange data. Wooldridge (2001) expresses that to obtain an efficient estimator using the time series GMM model, there should be overidentifying restrictions, and moment conditions can be added based on the assumption that past values of explanatory variables are uncorrelated with the error term. Chauss´e (2021) also indicates that the model is flexible and requires some assumptions about moment conditions, which allows estimation of the structural model equation by equation. This same approach was used by Clarinda et al. (1998; 2000), Divino (2009), and Caporale et al. (2018) in related studies. So, from equations (4) and (5), the GMM framework equation is specified as thus:

$$r_t = \alpha_0 + \alpha_1 r_{t-1} + \alpha_2 \sum_{k=1}^{3}(E_{t-1}\pi_{t+k}^{i} - \pi^{t}) + \alpha_3 \sum_{k=1}^{3}(E_{t-1} - iy_{t+k}) + \alpha_4 \sum_{k=1}^{3}(E_{t-1}reer_{t+k}) + \varepsilon_t \quad (6)$$

Where $r_t$ denotes the short-term interest rate, $\pi_{t+k}$ represents the inflation that is $i = \{CPI\ inflation, PPI\ inflation\}$, $\pi^t$ represents the inflation target and $y_{t+k}$ is the output gap calculated as the difference between the log of output from its potential, and $reer_{t+k}$ is the log of real effective exchange rate. The error term $\varepsilon_t$ will be decomposed into an unobservable country's specific heterogeneity.

### 5.3.4 Estimation Techniques

As noted previously, the time series GMM estimator is adopted as the suitable model for this study. Since the estimation approach uses time series data which requires all variables to be stationary, the unit root tests were first carried out using the Augmented Dickey-Fuller (ADF, 1981). However, with the short-period dataset used in this study which ADF have low power over, the Philip-Perron (PP, 1988) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS, 1992) tests were also conducted. It is important to note that as opposed to the ADF test, the KPSS test has stationarity as the null hypothesis and a unit root as the alternative hypothesis, and the KPSS test allows for drift but not a trend (Culver & Papell, 1997).

All the stationarity tests were based on intercept or intercept and trend levels, with the results expected to be stationary 1(1). The descriptive statistics, which include the mean, standard deviation, minimum, maximum, kurtosis, and skewness, were applied to summarise the characteristics of the variables used in the study and how they are distributed.

After that, the model of the relationship between the explanatory variables was estimated using the OLS estimator for the CPI and PPI analysis. However, with the assumptions of the OLS-best linear unbiased estimator not being fulfilled from the results, the time series GMM was applied for exact estimation instead. Finally, the Breusch-Pagan (1979) and Cook-

Weisberg (1983) test for heteroskedasticity and Breusch-Godfrey (1978) test for autocorrelation were used as the post-estimation diagnostic tests. Williams (2020) indicates that any time a high value for an instrumental variable (IV) is a necessary but not sufficient condition for an observation to have a high value on a differing variance (DV), heteroskedasticity is likely hence the need for the test in this study. For Breusch-Pagan/Cook-Weisberg test for linear heteroskedasticity with the null hypothesis that variances in the error term are equal. So, a large chi-square and significant test statistics reveal the presence of heteroskedasticity. The same approach also applies to the Breusch-Godfrey test for serial correlation, which can work for some lags instead of just one lag and has the advantage of extension up to the $12^{th}$ lags.

## 5.4 Empirical Results

The unit root test results for each of the 7 countries-Brazil, India, Korea, Mexico, Russia, South Africa, and Turkey are in Appendix A, and the variables in the result table are denoted by $r_t$ interest rates, $\pi_{t+k}^{cpi}$ CPI inflation gap, $reer_{t+k}$ real effective exchange rate, $y_{t+k}$ output gap, and $\pi_{t+k}^{ppi}$ PPI inflation gap. The results from the Augmented Dickey-Fuller, Philips-Perron, and Kwiatkowski-Phillips-Schmidt-Shin series tests reveal that all the variables are stationary at level in either intercept or intercept and trend at 1%, 5% or 10% significance except for CPI inflation in India. Although, arguably, time series variables need to be stationary to avoid bias in the results, the high-order Philips curves of Calvo (1983) and Ball (1993), as cited in Culver and Papell (1997), allow for a unit root in prices.

Moreover, it is common knowledge that the unit root test cannot work properly or loses its power with short-period data hence the need to apply caution while analysing the results of the accepted null hypothesis in this scenario. This also applies to the data used for India that covered from 2016Q2 to 2019Q4, bearing in mind that this study only considered that this study is based on the respective year the countries understudy adopted inflation targeting (IT). The descriptive statistics presented in Table 5.1 shows the characteristics of the variables used in this study and how they are normally distributed, which satisfy the need to continue with further estimation. The line graphs in Figures 1 to 7 detail the variations in the variables and how each variable reacts over time to monetary policy changes in the economies.

### 5.4.1 OLS Results for Linear Taylor Rule with CPI and PPI Inflation

The important variables of interest for Taylor's rule analysis are the coefficients of inflation and the output gap. The standard for the analysis is that the Taylor rule targets both inflation and output gaps; therefore, for countries that practice Taylor rule with inflation targeting, the coefficients of the two variables need to be positive and statistically significant. Furthermore, the Taylor rule principle requires inflation coefficients to be greater than 1 because when inflation increases, the monetary authority will increase the interest rate by a value more than the inflation rate. Countries with flexible exchange rate systems usually adopt this measure for a fast transition to curb inflation.

The OLS estimation results for linear Taylor rule with CPI and PPI inflation presented in Tables 5.2 and 5.3 are similar to the GMM results for linear Taylor rule with CPI and PPI presented in Tables 5. 4, and 5.5, but the difference is in the standard errors.  This is because the GMM considers the robustness of the standard errors. As explained previously, this renders the OLS estimator unfit for the analysis in this study, hence the need to elaborate on the GMM estimator results for CPI and PPI inflation below.

*Table 5.1: Descriptive Statistics*

| | | CPI inflation | PPI Inflation | Interest Rate | Output Gap | REER |
|---|---|---|---|---|---|---|
| **Brazil** | **Mean** | 0.355 | 2.384 | 13.616 | 0.000 | 78.018 |
| | **Std. Dev.** | 6.441 | 3.409 | 5.830 | 0.017 | 15.075 |
| | **Min** | -20.367 | -2.309 | 4.59 | -0.045 | 44.217 |
| | **Max** | 17.725 | 20.873 | 43.25 | 0.033 | 107.917 |
| | **Kurtosis** | 4.531 | 14.973 | 9.377 | 2.668 | 2.285 |
| | **Skewness** | -0.420 | 2.893 | 1.716 | -0.429 | -0.112 |
| | **Obs.** | 83 | 83 | 84 | 84 | 84 |
| **India** | **Mean** | 0.298 | 1.207 | 6.416 | 0.025 | 100.462 |
| | **Std. Dev.** | 1.660 | 1.990 | 0.464 | 0.015 | 2.371 |
| | **Min** | -2.305 | -1.522 | 5.4 | 0.004 | 96.89 |
| | **Max** | 3.021 | 4.799 | 7 | 0.043 | 103.887 |
| | **Kurtosis** | 2.054 | 1.905 | 2.844 | 1.380 | 1.774 |
| | **Skewness** | 0.097 | 0.124 | -0.769 | -0.059 | 0.070 |
| | **Obs.** | 14 | 14 | 15 | 15 | |
| **Korea** | **Mean** | 0.110 | 0.367 | 3.055 | 0.002 | 109.054 |
| | **Std. Dev.** | 3.522 | 1.899 | 1.295 | 0.011 | 9.878 |
| | **Min** | -19.170 | -6.981 | 1.22 | -0.037 | 84.723 |
| | **Max** | 9.539 | 5.879 | 5.37 | 0.025 | 131.703 |
| | **Kurtosis** | 13.321 | 5.879 | 1.715 | 5.098 | 3.518 |
| | **Skewness** | -1.965 | -0.784 | 0.159 | -0.784 | 0.495 |
| | **Obs.** | 79 | 80 | 80 | 80 | 80 |
| **Mexico** | **Mean** | -0.114 | 1.260 | 5.638 | 0.003 | 101.682 |
| | **Std. Dev.** | 3.789 | 0.840 | 3.996 | 0.019 | 13.412 |
| | **Min** | -14.293 | -0.067 | 2.11 | -0.067 | 75.907 |
| | **Max** | 8.644 | 0.034 | 22.84 | 0.034 | 132.693 |
| | **Kurtosis** | 4.361 | 4.279 | 8.261 | 4.279 | 2.432 |
| | **Skewness** | -0.583 | -0.734 | 2.312 | -0.734 | -0.034 |
| | **Obs.** | 83 | 84 | 84 | 84 | 84 |
| **Russia** | **Mean** | 1.593 | 1.760 | 9.239 | 0.000 | 83.842 |
| | **Std. Dev.** | 1.632 | 2.955 | 2.511 | 0.014 | 8.632 |
| | **Min** | 0.126 | -3.607 | 6.25 | -0.019 | 67.497 |
| | **Max** | 8.099 | 6.720 | 17 | 0.031 | 101.363 |
| | **Kurtosis** | 12.156 | 2.121 | 5.024 | 1.961 | 2.905 |
| | **Skewness** | 2.860 | -0.247 | 1.439 | 0.219 | 0.432 |
| | **Obs.** | 23 | 23 | 24 | 24 | 24 |
| **South Africa** | **Mean** | 1.300 | 1.139 | 7.922 | 0.002 | 86.014 |
| | **Std. Dev** | 0.903 | 1.673 | 2.468 | 0.012 | 10.665 |
| | **Min** | -1.927 | -5.024 | 5 | -0.023 | 63.027 |
| | **Max** | 3.418 | 4.975 | 13.5 | 0.029 | 106.34 |
| | **Kurtosis** | 4.430 | 6.194 | 2.398 | 2.793 | 2.104 |
| | **Skewness** | -0.057 | -1.305 | 0.816 | 0.489 | -0.057 |
| | **Obs.** | 79 | 79 | 80 | 80 | 80 |
| **Turkey** | **Mean** | -0.375 | 2.323 | 10.222 | 0.005 | 85.349 |
| | **Std. Dev** | 4.968 | 2.843 | 5.760 | 0.033 | 11.651 |
| | **Min** | -14.678 | -2.017 | 1.5 | -0.103 | 54.95 |
| | **Max** | 10.051 | 13.756 | 22.5 | 0.070 | 102.23 |
| | **Kurtosis** | 2.999 | 6.438 | 2.269 | 4.277 | 3.142 |
| | **Skewness** | -0.528 | 1.629 | 0.582 | -0.938 | -0.917 |
| | **Obs.** | 59 | 59 | 60 | 60 | 60 |

### 5.4.2 GMM Results for Linear Taylor Rule with CPI Inflation

Table 5.4 provides results for the linear Taylor rule, which shows that the coefficients of the 7 countries estimated are the same in terms of significance, sizes, and signs. Apart from Russia, all other coefficients of lagged interest rates in Table 5.4 are significant for Brazil, India, Korea, Mexico, South Africa, and Turkey. On average, the significant coefficients are closer to 1, which implies that monetary authorities in these economies adjust their policy rates with smoothing parameters respectively. The results also indicate that monetary policy is highly persistent in the 6 economies with significant interest rates showing that the interest rate in the past period is correlated to the interest rate in the current period. The coefficients of the inflation gap are significant for all countries except Brazil and Russia but only positive in Korea and South Africa. An indication that these economies with positive and significant coefficients adjust their monetary policy whenever there are deviations from inflation targets.

Furthermore, the monetary authorities also respond to the output gap in Korea, Mexico, South Africa and Turkey, where the coefficients of $\propto_3$ are positive and significant. In the case of India and Russia, the output gap is negative and significant but statistically insignificant in Brazil. Finally, there is evidence of policy rate response to REER movements in other countries except Mexico, Russia, and South Africa. Using the GMM on the CPI inflation gap, there is evidence of Taylor rule only in Korea and South Africa. However, although these economies- South Africa and Korea, follow the Taylor rule, the magnitude of the coefficient of inflation gap is not greater than one. The results do not fulfil the Taylor principle assumptions that require the coefficient of inflation gap to be statistically greater than one in the interest rate rule for a sufficient condition of equilibrium to be determined, as explained by Divino (2009). Thus, when inflation increases, there will be an increase in interest rate greater than the increase in the inflation rate (that is inflation targeting) to reduce the rate of aggregate demand and inflation and bring the economy to equilibrium.

The results in Table 5.4 imply that although LEMEs use the IT monetary policy in a flexible exchange rate system, most of these economies do not follow the Taylor rule nor comply with the Taylor principle. Interestingly, Brazil's output and inflation gaps do not have any relationship because their coefficients are positive but not statistically significant, probably because the monetary authorities in the country do not follow the Taylor rule.


Figure 5.1: *Time series graph Brazil*

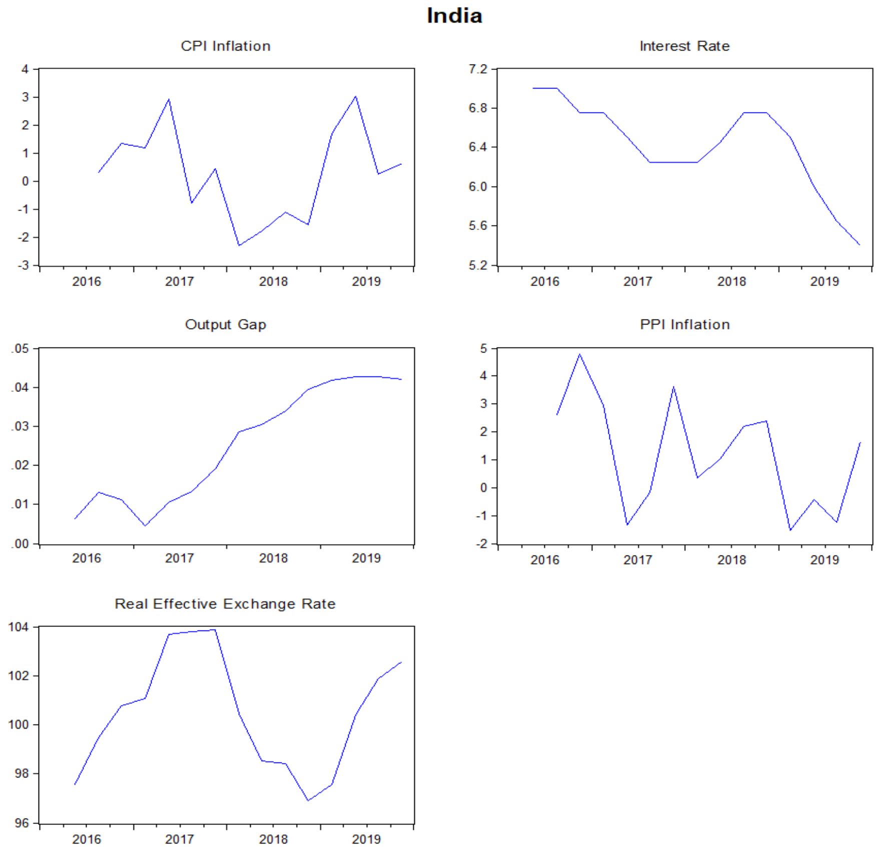



Figure 5.2: *Time series graph India*

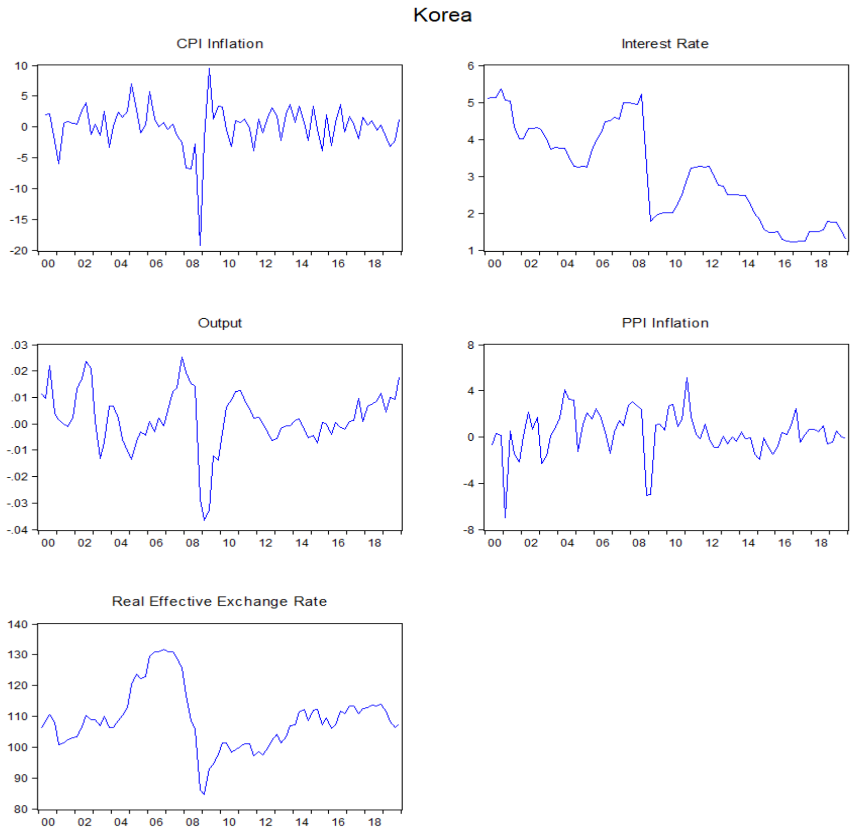


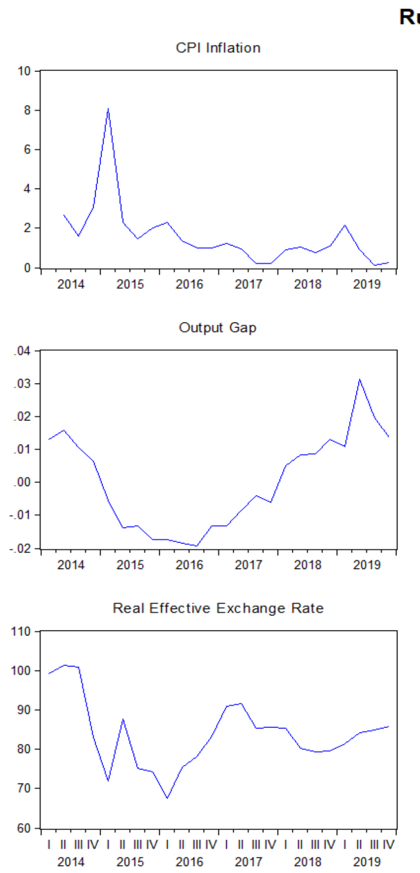

*Figure 5.3: Time series graph Korea*


*Figure 1.4: Time series graph Mexico*

Thereafter, the Breusch-Pagan/Cook-Weisberg test for heteroskedasticity was conducted where the Chi-square values for Brazil, Mexico, South Africa and Turkey are large and statistically significant. Therefore, we reject the null hypothesis of no heteroskedasticity. The values of Russia and Korea are small and insignificant. Hence the study fails to reject the null hypothesis of no heteroskedasticity. The Breusch-Godfrey LM test for autocorrelation reveals that the Chi-square and p-value for Brazil, India, South Africa and Turkey are large and statistically significant, so the null hypothesis of no serial correlation is rejected. However, Korea, Mexico, and Russia's values are small and insignificant.

### 5.5.3 GMM Results for Linear Taylor Rule with PPI Inflation

The results in Table 5.5 contain the linear Tylor rule using the PPI inflation gap, which presents different significant levels, sizes, and signs. Contrarily to the coefficients of the lagged interest rate obtained in Table 5.4, it is statistically significant in all the economies-Brazil, India, Korea, Mexico, Russia, South Africa, and Turkey and is closer to 1 except for India. The results imply that the monetary authorities consider the influence of PPI on price variability, which is also persistent in the economies, and therefore employ strict IT monetary policy to respond when PPI inflation deviates from the target points through the adjustment of interest rates.



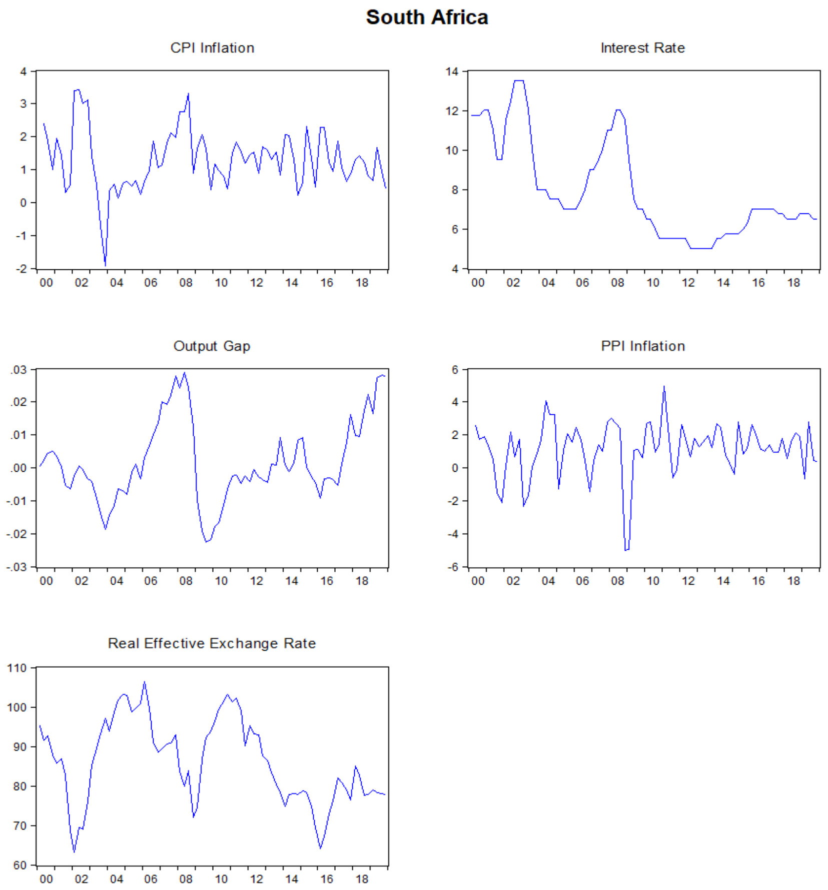




*Figure 5.5: Time series graph Russia*

*Figure 5.6: Time series graph South Africa*

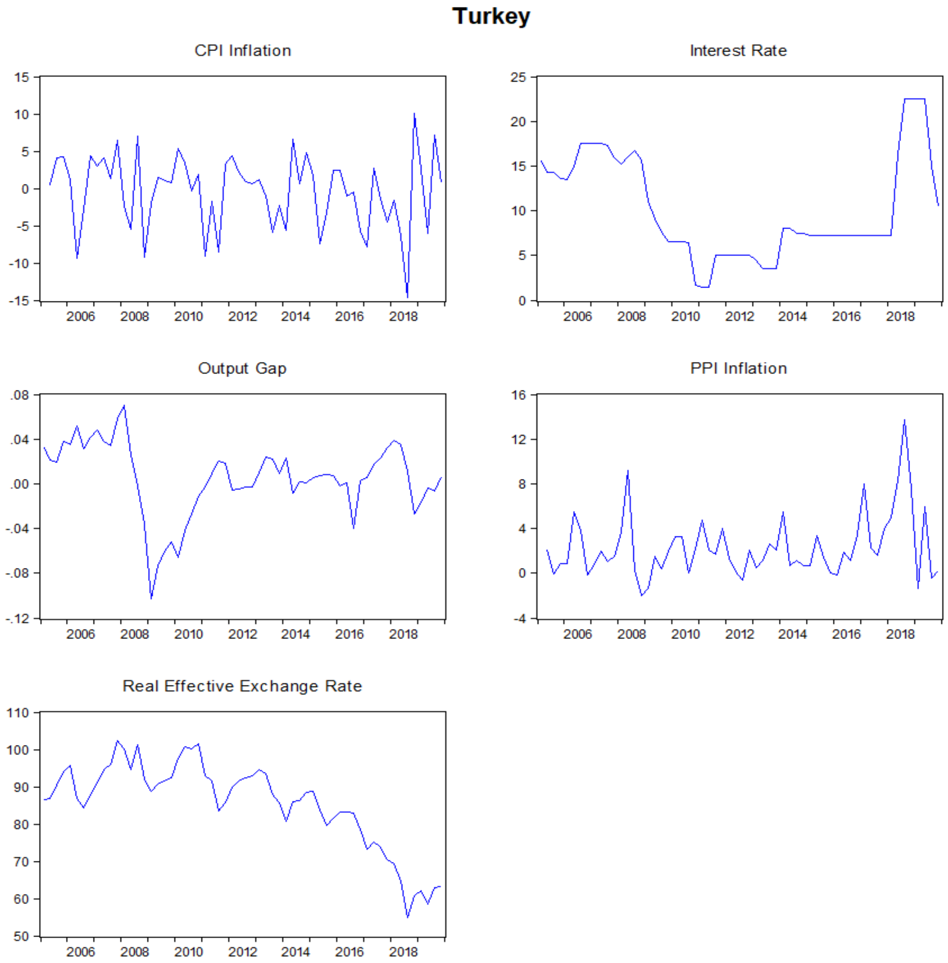



*Figure 5.7: Times series graph Turkey*

The coefficients for the inflation gap are significant and positive in Korea, Mexico, and South Africa but not in Brazil, India, Russia, and Turkey. More so, the central banks in these countries respond to significant positive deviations in the output gap in Korea, Mexico, South Africa, and Turkey but not in India, which is negatively significant, or Brazil and Russia, which are neither positive nor significant. The results further reveal that monetary authorities in these countries react more to deviations from the inflation target than to the output gap. Although the REER target is not included as part of the IT framework in these countries, REER movements lead policymakers to respond by increasing interest rates in India, Korea, and South Africa. The GMM results for the linear Taylor rule with PPI inflation show that Korea, Mexico, and South Africa follow the Taylor rule. Again, the results in Table 5.5 do not follow the Taylor principle.

The post-estimation test for the PPI inflation gap was conducted using the Breusch-Pagan/Cook-Weisberg test for heteroskedasticity. This result shows that the models for Brazil, Mexico, Russia, South Africa, and Turkey are well-specified without evidence of heteroskedasticity. However, this study fails to reject the null hypothesis of no heteroskedasticity in India and Korea. Further autocorrelation test with Breusch-Godfrey LM led this study to reject the null hypothesis of no serial correlation for Brazil, South Africa, and Turkey. In contrast, India, Korea, Mexico, and Russia have insignificant and small values.

The presence of heteroskedasticity and serial correlation in the diagnostic test of linear Taylor rule in Tables 5.4 and 5.5 can be attributed to the short period covered in the data, which is the time each of the countries studied adopted IT monetary policy, especially with India and Russia whose data started from 2016Q2 and 2014Q1 respectively.

***Table 5.2: Linear Taylor Rule based on OLS with CPI Inflation***

| | Brazil | India | Korea | Mexico | Russia | South Africa | Turkey |
|---|---|---|---|---|---|---|---|
| Constant | 38.375*** | 49.264** | -3.581** | 0.680 | 21.673 | 2.643 | 21.848*** |
| | (6.521) | (17.964) | (1.511) | (2.958) | (20.811) | (2.174) | (8.233) |
| $r_{t-1}$ | 0.585*** | 0.538** | 0.969*** | 0.853*** | -0.183 | 0.916*** | -0.852*** |
| | (0.051) | (0.226) | (0.022) | (0.023) | (0.347) | (0.024) | (0.048) |
| $\pi$ Gap | 0.057 | -0.037 | 0.038*** | -0.035* | 1.049** | 0.369*** | -0.069* |
| | (0.035) | (0.032) | (0.008) | (0.021) | (0.395) | (0.072) | (0.035) |
| $y$ Gap | 8.516 | -17.025*** | 14.834*** | 14.518*** | -83.672* | 15.119*** | 17.262** |
| | (13.456) | (5.784) | (2.528) | (4.341) | (44.186) | (4.813) | (8.620) |
| REER | -7.582*** | -9.988** | 0.789*** | -0.045 | -1.840 | -0.110 | -4.757** |
| | (1.388) | (3.570) | (0.324) | (0.652) | (4.537) | (0.501) | (1.826) |

***Table 5.3: Linear Taylor Rule based on OLS with PPI Inflation***

| | Brazil | India | Korea | Mexico | Russia | South Africa | Turkey |
|---|---|---|---|---|---|---|---|
| Constant | 33.585*** | 61.548*** | -4.288*** | 2.171 | 12.189 | 7.320*** | 15.955 |
| | (7.052) | (14.741) | (1.559) | (2.874) | (25.381) | (2.418) | (9.783) |
| $r_{t-1}$ | 0.610*** | 0.378* | 0.962*** | 0.840*** | 0.585** | 0.966*** | 0.893*** |
| | (0.052) | (0.183) | (0.023) | (0.021) | (0.274) | (0.026) | (0.054) |
| $\pi$ Gap | 0.036 | 0.010 | 0.063*** | 0.274*** | -0.076 | 0.128*** | 0.033 |
| | (0.075) | (0.023) | (0.017) | (0.089) | (0.167) | (0.041) | (0.040) |
| $y$ Gap | 3.555 | -19.778*** | 9.132*** | 13.099*** | -14.509 | 17.384*** | 25.849*** |
| | (14.187) | (5.784) | (2.914) | (4.234) | (42.346) | (5.227) | (8.444) |
| REER | -6.596*** | -12.376*** | 0.957*** | -0.223 | -1.926 | -1.511*** | -3.349 |
| | (1.536) | (2.974) | (0.332) | (0.633) | (5.489) | (0.533) | (2.170) |

Another problem could be the missing series in this study's data used for estimation. For instance, Korea and Mexico have a lot of missing values in the data used. For this reason, this study includes the scatter plots of all the data used in Appendix 5B to show their trend. As explained earlier, the unavailability of data is the main problem encountered in this study while working with LEMEs. Moreover, diagnostics tests that can work with missing values are limited. An attempt to fix the residuals in either of the diagnostic tests affected the outcome of the other and did not yield positive results; hence, this study decided to keep the results as they are.

Comparatively, there is only a slight difference in the CPI and PPI results in Tables 5.4 and 5.5. The inconsistencies lie in the number of countries with positive and significant coefficients in the variables estimated, the level of relationship between the inflation gap and the output gap, how the interest rate reacts to deviations from inflation, and the number of countries that react to REER movements. The interesting part of the analysis is how PPI inflation seems to lead more to price increases than CPI inflation which is not observed by studies that used only the CPI inflation gap in their estimation. This reflects well in the results from Russia, where the country does not target an inflation gap or output gap with CPI inflation. The positive and significant lagged interest rate with PPI inflation shows that the economy also targets inflation but uses a different approach to measuring the inflation gap.

One common factor in Table 5.4 and 5.5 results is that none of the inflation coefficients is greater than 1. This implies that whether the monetary authorities target the CPI or PPI inflation in these economies, they do not conform with the Taylor principle. Another similar outcome is the negative relationship between interest rates and the output gap in India and Russia. An indication that when the interest rate increases, it will be expensive for consumers to borrow and spend, resulting in a decrease in consumption.

***Table 5.4: Linear Taylor Rule based on GMM with CPI Inflation***

| | Brazil | India | Korea | Mexico | Russia | South Africa | Turkey |
|---|---|---|---|---|---|---|---|
| Constant | 38.375**<br>(14.988) | 49.264***<br>(11.687) | -3.581**<br>(1.657) | 0.680<br>(2.511) | 21.673<br>(13.447) | 2.634<br>(2.270) | 21.848*<br>(12.905) |
| $r_{t-1}$ | 0.585***<br>(0.175) | 0.537***<br>(0.111) | 0.968***<br>(0.021) | 0.853***<br>(0.034) | -0.183<br>(0.534) | 0.915***<br>(0.023) | 0.851***<br>(0.056) |
| Inflation Gap | 0.056<br>(0.035) | -0.037**<br>(0.017) | 0.038***<br>(0.011) | -0.035*<br>(0.019) | 1.049<br>(0.665) | 0.369***<br>(0.074) | -0.068*<br>(0.038) |
| Output Gap | 8.515<br>(13.612) | -17.025***<br>(2.716) | 14.834***<br>(3.710) | 14.517***<br>(2.976) | -83.672*<br>(42.896) | 15.119**<br>(6.015) | 17.262***<br>(6.073) |
| REER | -7.582**<br>(2.927) | -9.988***<br>(2.381) | 0.788**<br>(0.353) | -0.045<br>(0.557) | -1.839<br>(2.381) | -0.199<br>(0.505) | -4.756*<br>(2.865) |
| BP/CW | 58.65*** | 0.02 | 0.24 | 64.59*** | 2.90* | 16.21*** | 8.46*** |
| BG LM | 28.01*** | 3.80* | 1.90 | 2.54 | 1.57 | 11.75*** | 12.40*** |

**Note:** ***, **, * indicates significance at 1%, 5% and 10%, respectively. BP/CW is the Breusch-Pagan / Cook-Weisberg test for heteroskedasticity. BG LM is the Breusch-Godfrey LM test for autocorrelation.

***Table 5.5: Linear Taylor Rule based on GMM with PPI Inflation***

| | Brazil | India | Korea | Mexico | Russia | South Africa | Turkey |
|---|---|---|---|---|---|---|---|
| Constant | 33.585<br>(15.743) | 61.548***<br>(11.335) | -4.288**<br>(1.737) | 2.170<br>(2.580) | 12.189*<br>(6.264) | 7.321**<br>(3.001) | 15.955<br>(13.199) |
| $r_{t-1}$ | 0.610***<br>(0.183) | 0.378***<br>(0.116) | 0.961***<br>(0.026) | 0.840***<br>(0.036) | 0.585***<br>(0.071) | 0.966***<br>(0.026) | 0.893** *<br>(0.053) |
| Inflation Gap | 0.036<br>(0.106) | 0.010<br>(0.020) | 0.063***<br>(0.021) | 0.273***<br>(0.086) | -0.076<br>(0.083) | 0.128***<br>(0.044) | 0.033<br>(0.027) |
| Output Gap | 3.555<br>(13.592) | -19.778***<br>(3.745) | 9.133**<br>(4.413) | 13.099***<br>(3.033) | -14.509<br>(12.877) | 17.385***<br>(6.123) | 25.849***<br>(6.202) |
| REER | -6.596<br>(3.129) | -12.376***<br>(2.327) | 0.957**<br>(0.376) | -0. 224<br>(0.565) | -1.926<br>(1.277) | -1.511**<br>(0.670) | -3.349<br>(2.937) |
| BP/CW | 79.90*** | 0.01 | 1.65 | 74.31*** | 2.72* | 13.82*** | 10.07** |
| BG LM | 26.81*** | 0.30 | 3.55 | 1.13 | 1.25 | 12.48*** | 9.68** |

**Note:** ***, **, * indicates significance at 1%, 5% and 10%, respectively. BP/CW is the Breusch-Pagan /Cook-Weisberg test for heteroskedasticity. BG LM is the Breusch-Godfrey LM test for autocorrelation.

On the other hand, the decrease in consumption might enhance the increase in the output gap. Within this framework, it is imperative to note that even when the output gap coefficients are positive and significant, the magnitude determines whether policymakers in a country are dovish or hawkish. The bigger the magnitude, the more policymakers are concerned about unemployment due to an increased output gap. More so, when actual output is bigger than the potential output, the economy operates beyond its capacity, which creates pressure and increase in prices and inflation rates. Considering that the main aim of these economies is to target inflation and bring the economy to equilibrium, therefore, the central banks will increase interest rates to reduce consumption and inflation rates.

However, when actual output is below the potential output, policymakers would want to bring the economy to full employment to increase outputs to a potential level. In other words, whether the economy is below or at full employment, policymakers will be pressured to bring the economy to equilibrium and stability. Furthermore, there is evidence of indirect smoothening of REER by policymakers in some of the LEMEs studied, like Brazil, India, Korea, and Turkey, for CPI inflation. Then, India, Korea, and South Africa for PPI inflation. As can be seen from the results, although the REER target is not included as part of the IT framework in these countries, REER movements lead central banks to respond by increasing interest rates. The combination of policy interest rates and foreign exchange market intervention in these economies conforms to the two-targets-two instruments policy proposed by Ostry et al. (2012) for emerging market economies. The approach allows policymakers in fully discretionary monetary and exchange rate policies the flexibility to respond to unexpected shocks through inflation and exchange rate targets. For open economies like LEMEs with a significant history of exchange rate volatility, targeting only inflation will be detrimental to progress in international markets. A high exchange rate passthrough to inflation increasing the domestic prices creates risks for the entire macroeconomy, especially for LEMEs characterised with imperfect capital mobility. Again, with LEMEs' substantial dependency on commodity products, volatility in commodity prices can impact the economies negatively if policymakers do not include foreign exchange intervention as part of a monetary policy framework. Foreign exchange market intervention can also help to reduce capital flow shocks and external contagion effects. Therefore, central banks in LEMEs cannot afford to ignore exchange rate volatility and concentrate only on inflation targeting because of the challenges it poses for these economies. The same conclusions about indirect foreign exchange rate control were also reached by Aizenman et al. (2011), Mohanty and Klau (2013), Ghosh et al. (2016) and Caporale et al. (2018), who also adopted REER in measuring the validity of Taylor rule in emerging market economies.

In conclusion, the findings obtained in this study imply that exchange rate volatility does not have a significant role in the conduct of policy interest rate settings in the 7 LEMEs studied. Instead, the countries are more interested in targeting inflation and the output gap. Another input from the result considering the outcome of the PPI inflation is that much effort is required to extend the synergy between macroeconomic factors and monetary policy instruments other than using only the variables recommended by the Taylor rule. An underdeveloped financial system in LEMEs with policy and economic instabilities can prevent these economies from reaching their targets. This study agrees with the conclusion made by Hoffman and Bogdanova (2012) that the assumptions of the Taylor rule are limited and do not fit into the structure of LEMEs. The factor bias is extended as inflation risks continue to grow due to LEMEs' economic openness to the world but lack the capability to contain inflationary pressure emanating from increasing financial crises. So, to reduce the pressure, LEMEs policymakers need to adopt strict monetary policy related to their structure to control the inflation rate within the target band. This includes adopting unconventional monetary policy when necessary, without sticking to the conventional policy, especially when it is not working for them.

Applying these measures to ensure an effective macroeconomic and monetary policy relationship will balance all economic areas for efficient monetary policy operations. More so, considering the structural imbalances in LEMEs, an increase in exchange rate depreciation, though it favours net exports, can de-anchor the long-term inflation expectations, and decrease the actual output in an economy, which can negatively affect the business cycle. This further informs the need for monetary policy easing relative to a country's structure.

The findings above portray the structure and monetary policy framework of LEMEs, which shows that structural improvement is needed as the economies continue to gain credibility in the international financial market. Much so that as the global financial crisis increases, efforts should be geared toward reducing the effects of external and internal shocks on the inflation expectations of these economies. This, in effect, will lower the exchange rate pass-through and prevent shocks from the previous inflation period from affecting the current inflation; meanwhile, monetary authorities will have more control over improving outputs without deviating from the inflation targets.

### 5.5 Policy Implications and Recommendations

Globalisation and increasing interconnectedness in international financial markets have continued to expose the vulnerability of LEMEs' financial structure leading to economic and financial shocks. To control the negative influence of global financial crises to improve financial and economic conditions in LEMEs, including their participation in international markets, monetary authorities in these economies have adopted various monetary policy responses. The most popular amongst these economies is output and inflation targeting relative to Taylor's rule. The approach uses policy rates to regulate the financial system in times of boom or during economic and financial crises through an increase or reduction of policy rates when needed. However, for the adopted monetary policy framework to be effective, there needs to be synergy between the exchange rate regime pursued, macroeconomic factors in the economy, regulatory process, and foreign exchange markets to achieve the desired results. However, with LEMEs, as deduced from this study, such is not the case in that the monetary policy framework operates in isolation from all the other macroeconomic factors, thereby rendering it mostly ineffective, which is the main limitation of the Taylor policy rule.

Although the Taylor rule was influential in the advanced economies, the disparities in the structure of advanced economies and LEMEs render the policy a not so fit for LEMEs due to the inability of the policy to recognise other macroeconomic factors that can affect financial stability. The central banks ' reserves and balance sheet policies and other macroeconomic factors not captured by the Taylor rule can increase financial risks due to poor financial structure in LEMEs. Therefore, this study recommends that for monetary policy in LEMEs to become more effective, appropriate policy should include all areas of the economy to avoid deviations due to internal spillovers or external shockwaves since LEMEs are connected to the global market. Therefore, instead of focusing on how monetary policy response to exchange rate volatility or policy interest rates as proposed by Taylor (2000), this study suggests an all-inclusive approach to designing monetary policy frameworks in LEMEs.

Furthermore, there are increasing suggestions, for example, Li (2021), that LEMEs need to be open to alternatives like unconventional monetary policy considering that its application in the past has yielded positive results like a decrease in government yields, reduction in financial market stress, prevention of excessive financial outflow and exchange rate depreciation in other not to de-anchor inflation expectations. All in all, monetary authorities in LEMEs need to ensure a relationship exists between monetary policy and related macroeconomic factors so that adjusting the effects of financial pressure on the economy will not lead to deviations in the monetary policy targets.

## 5.6 Conclusion and Areas for Further Study

This study examined whether exchange rate volatility plays a role in the conduct of policy interest rate settings in 7 LEMEs that adopt output and inflation targeting while using the flexible exchange rate regime. The countries studied are Brazil, India, Korea, Mexico, Russia, South Africa, and Turkey, and the approach employed the revised Taylor monetary policy rules for emerging market economies. The study used the OLS and GMM models to estimate CPI inflation, interest rate, output gap, PPI inflation, and real effective exchange rate in LEMEs. Then, the years covered are from when each of the selected countries adopted their IT regime Brazil-1999Q1, India-2016Q2, KoreaQ1-1998, Mexico-1999Q1, Russia-2014Q1, South AfricaQ1-2000, and Turkey-2005Q1 and the end year for all the variables is 2019Q4. The findings indicate no strong evidence of the Taylor policy rule in LEMEs. Moreover, the exchange rate does not influence policy change in most countries studied. However, the positive and significant results of the lagged interest rate reveal strict inflation targeting though the economies do not adhere to the Taylor principle.

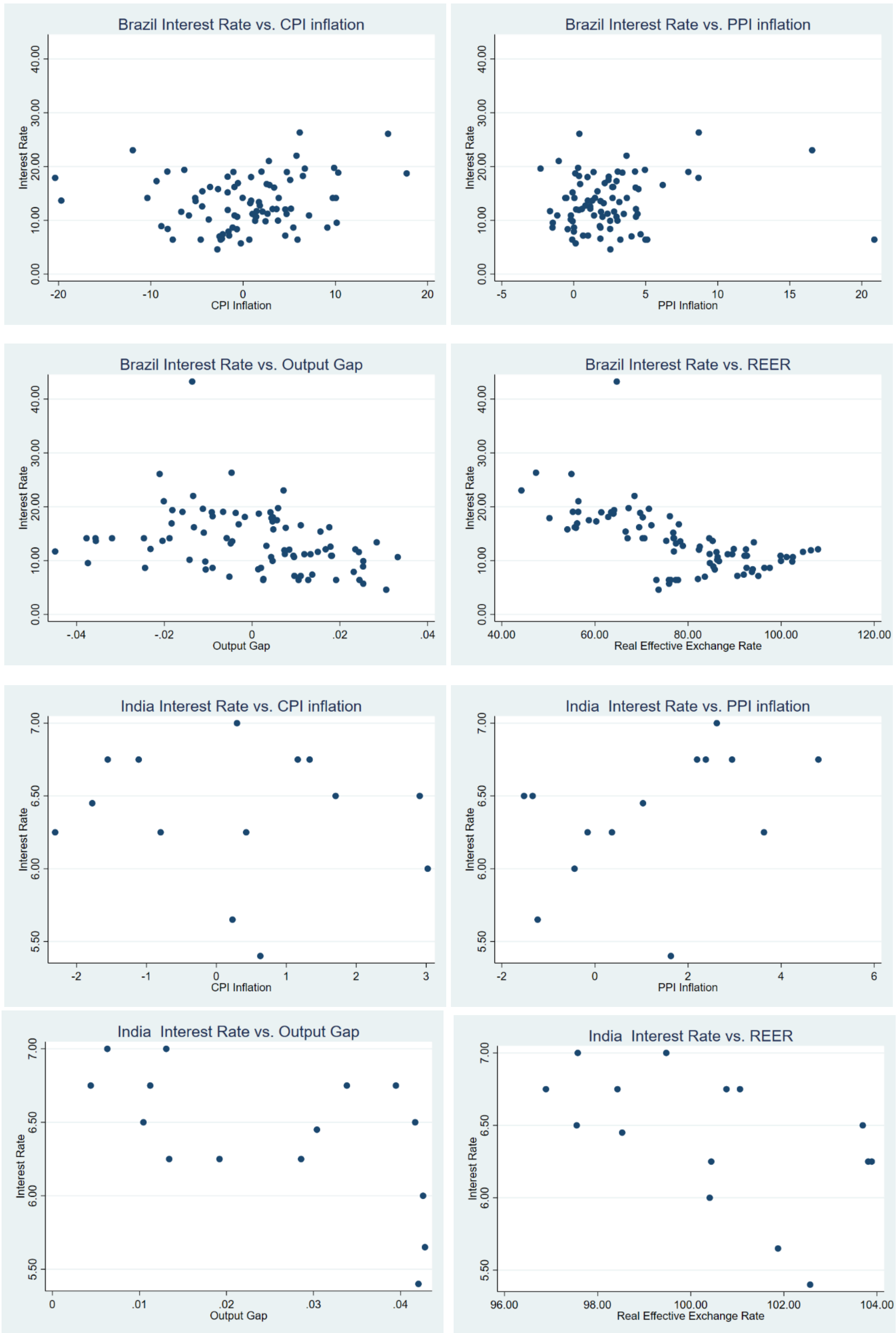
Another outcome of the study is that considering the poor financial structure in LEMEs, the techniques of the Taylor rule are limited in that it fails to capture other macroeconomic factors that can influence financial instability in these economies. As stated previously, this implies that conventional monetary policy might not be suitable for protecting LEMEs from financial risks and external contagion shocks as the economies continue to integrate into the global economies, especially in times of crisis. Therefore, switching to an unconventional monetary policy should be considered since it offers excellent chances of recovery after financial stress and reduces exchange rate depreciation, among other benefits.

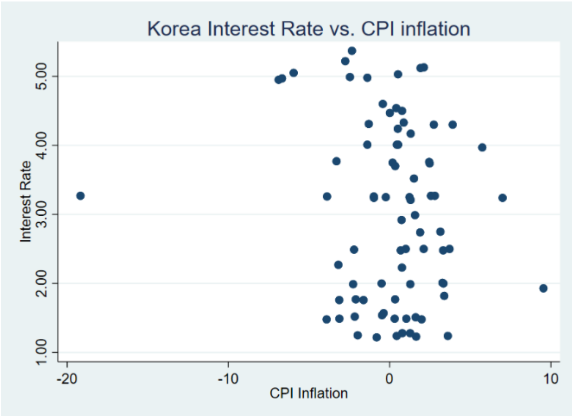
Further studies in this context can adopt other methods of decomposing the real GDP to get a trend. This will help to check if different results will be obtained since it has been argued by

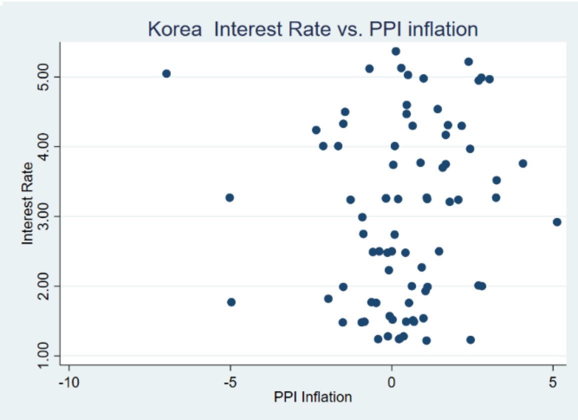
Hamilton (2017) that Hodrick and Prescott (HP) filter produces spurious trends unrelated to the data-generating process. In addition, it will be insightful to see what the outcome will be when other macroeconomic factors that can trigger financial risks and instability in LEMEs are included as part of the estimation variables, likewise how they will help in designing an appropriate monetary policy framework that can cater for the structural needs of LEMEs.

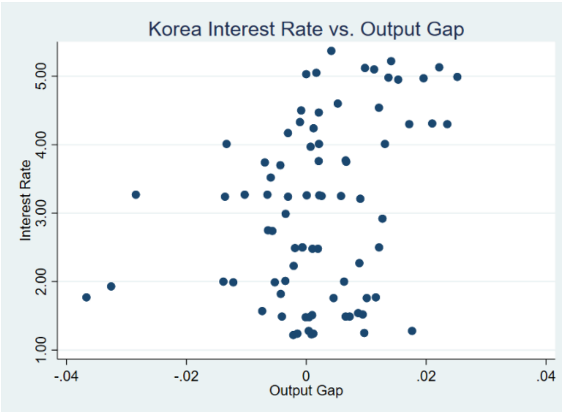
*Appendix 5A: Scatter Plot of all the Variables used in the Study*

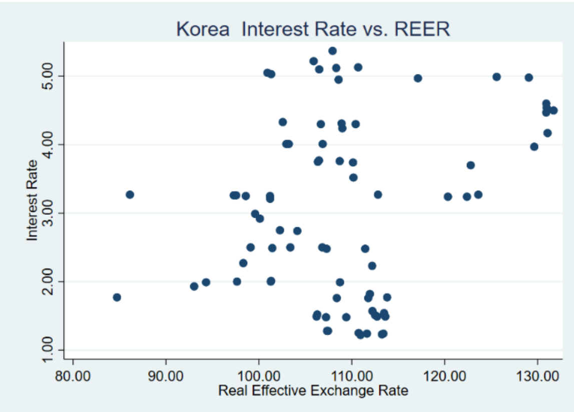
**Figure 5.1: Variables Scatter Plots**

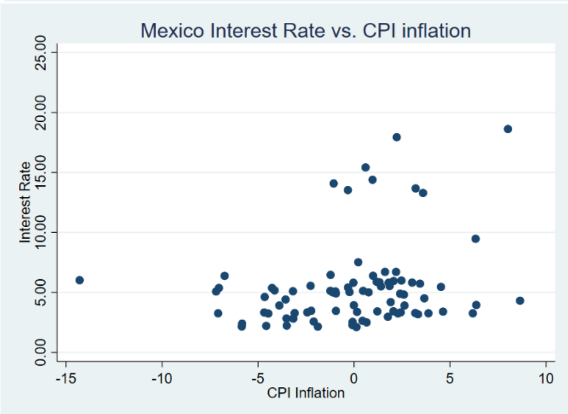


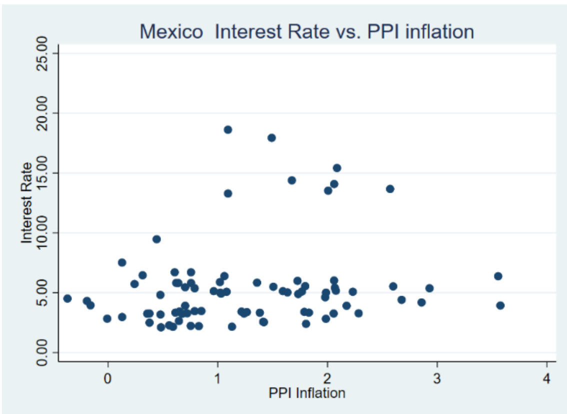

Korea Interest Rate vs. CPI inflation
Interest Rate
1.00 2.00 3.00 4.00 5.00
-20 -10 0 10
CPI Inflation

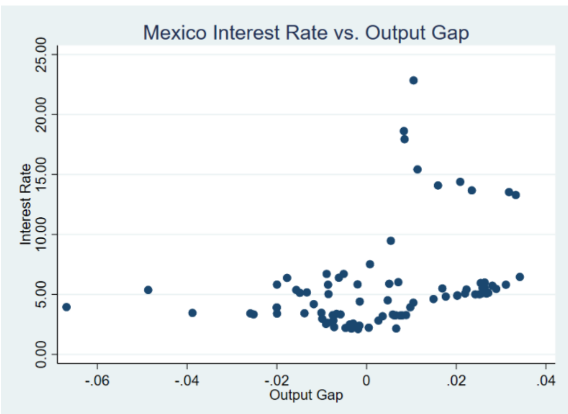

Korea Interest Rate vs. PPI inflation
Interest Rate
1.00 2.00 3.00 4.00 5.00
-10 -5 0 5
PPI Inflation

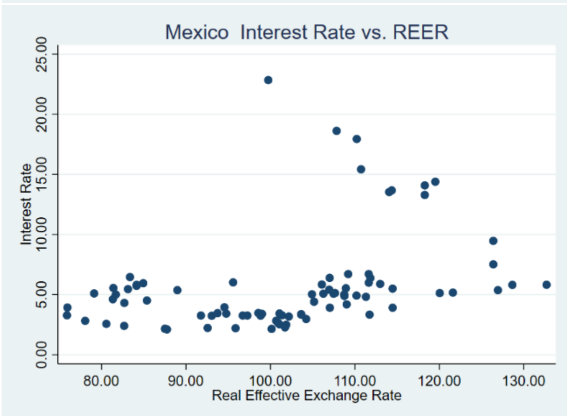

Korea Interest Rate vs. Output Gap
Interest Rate
1.00 2.00 3.00 4.00 5.00
-.04 -.02 0 .02 .04
Output Gap

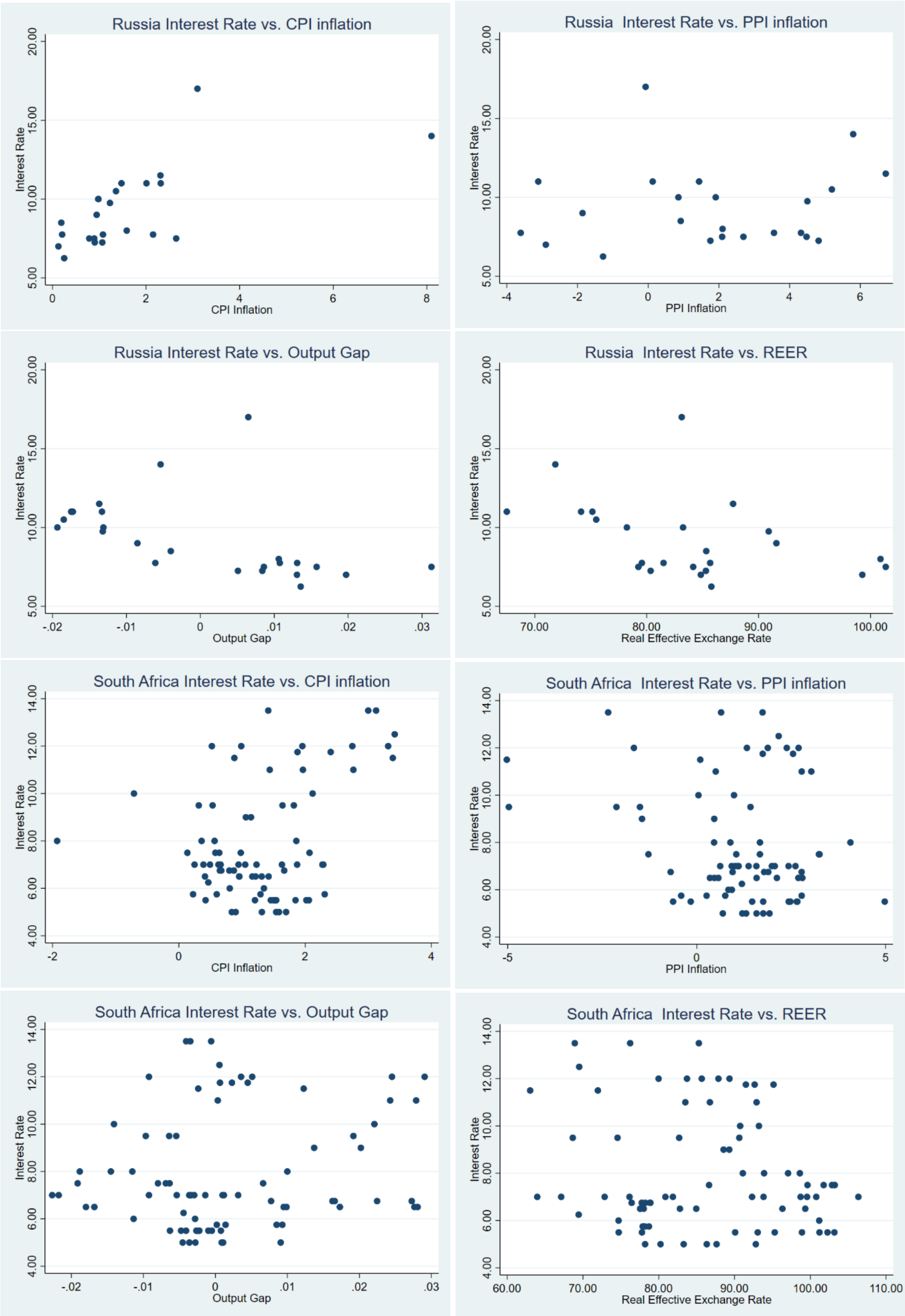

Korea Interest Rate vs. REER
Interest Rate
1.00 2.00 3.00 4.00 5.00
80.00 90.00 100.00 110.00 120.00 130.00
Real Effective Exchange Rate

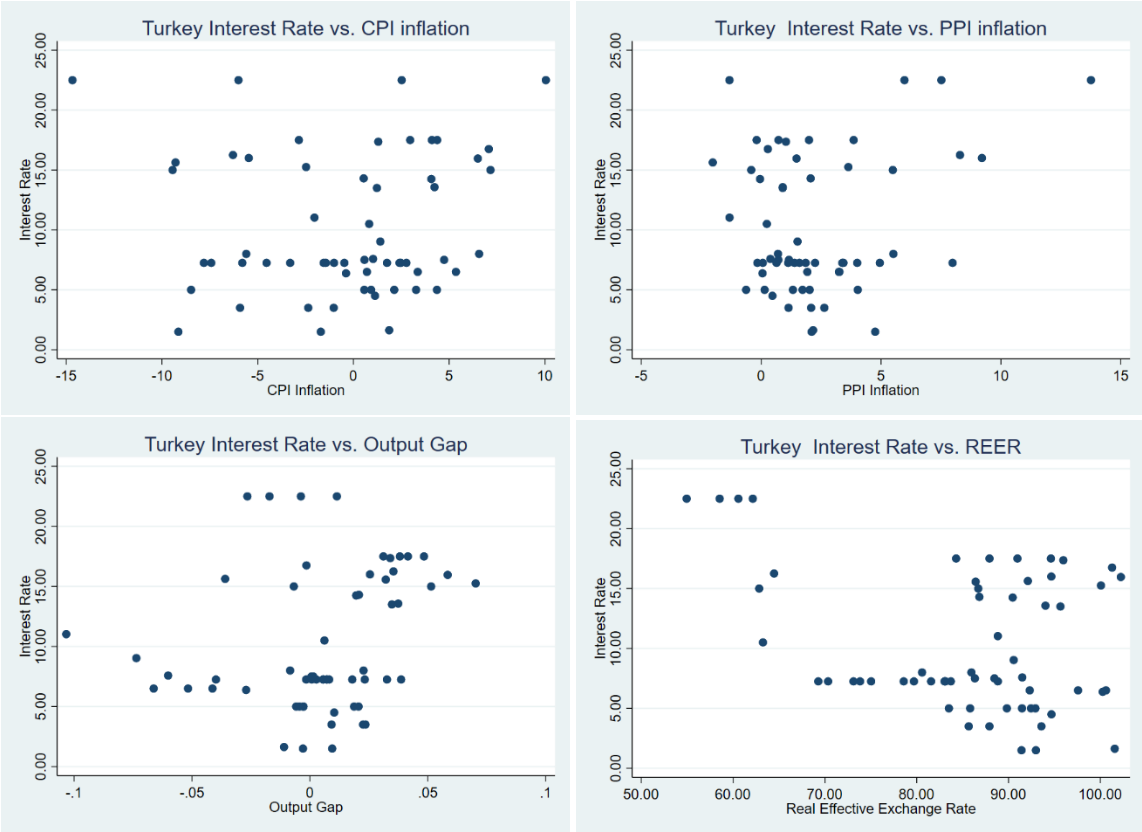

Mexico Interest Rate vs. CPI inflation
Interest Rate
0.00 5.00 10.00 15.00 20.00 25.00
-15 -10 -5 0 5 10
CPI Inflation


Mexico Interest Rate vs. PPI inflation
Interest Rate
0.00 5.00 10.00 15.00 20.00 25.00
0 1 2 3 4
PPI Inflation


Mexico Interest Rate vs. Output Gap
Interest Rate
0.00 5.00 10.00 15.00 20.00 25.00
-.06 -.04 -.02 0 .02 .04
Output Gap


Mexico Interest Rate vs. REER
Interest Rate
0.00 5.00 10.00 15.00 20.00 25.00
80.00 90.00 100.00 110.00 120.00 130.00
Real Effective Exchange Rate


Russia Interest Rate vs. CPI inflation
Interest Rate
CPI Inflation
Russia Interest Rate vs. PPI inflation
Interest Rate
PPI Inflation
Russia Interest Rate vs. Output Gap
Interest Rate
Output Gap
Russia Interest Rate vs. REER
Interest Rate
Real Effective Exchange Rate
South Africa Interest Rate vs. CPI inflation
Interest Rate
CPI Inflation
South Africa Interest Rate vs. PPI inflation
Interest Rate
PPI Inflation
South Africa Interest Rate vs. Output Gap
Interest Rate
Output Gap
South Africa Interest Rate vs. REER
Interest Rate
Real Effective Exchange Rate


Turkey Interest Rate vs. CPI inflation
Interest Rate
CPI Inflation
Turkey Interest Rate vs. PPI inflation
Interest Rate
PPI Inflation
Turkey Interest Rate vs. Output Gap
Interest Rate
Output Gap
Turkey Interest Rate vs. REER
Interest Rate
Real Effective Exchange Rate

**Appendix 5B: Unit Root Test Results**

***Table 5.6: Unit root test***

| | | ADF Test | | PP Test | | KPSS Test | |
|---|---|---|---|---|---|---|---|
| | | Intercept | Intercept & Trend | Intercept | Intercept & Trend | Intercept | Intercept & Trend |
| **Brazil** | $r_t$ | -1.818 | -2.331 | -1.492 | -1.969 | 0.495** | 0.119* |
| | $\pi_{t+k}^{cpi}$ | -5.388*** | -5.684*** | -5.199*** | -5.414** | 0.527** | 0.060 |
| | $reer_{t+k}$ | -2.669* | -2.616 | -2.414 | -2.468 | 0.233 | 0.221*** |
| | $y_{t+k}$ | -2.880* | -2.862 | -2.406 | -2.402 | 0.065 | 0.062 |
| | $\pi_{t+k}^{ppi}$ | -4.184*** | -6.952*** | -6.688*** | -6.952*** | 0.280 | 0.083 |
| **India** | $r_t$ | -1.591 | -5.599** | -0.511 | -1.372 | 0.417* | 0.087 |
| | $\pi_{t+k}^{cpi}$ | -2.352 | -2.241 | -2.340 | -2.230 | 0.110 | 0.109 |
| | $reer_{t+k}$ | -3.440** | -3.994** | -1.857 | -1.842 | 0.093 | 0.090 |
| | $y_{t+k}$ | -3.637** | -1.502 | -0.728 | -1.695 | 0.564** | 0.100 |
| | $\pi_{t+k}^{ppi}$ | -3.512** | -3.762** | -2.760* | -4.160** | 0.317 | 0.500 |
| **Korea** | $r_t$ | -1.575 | -3.609** | -1.317 | -2.614 | 0.703** | 0.050 |
| | $\pi_{t+k}^{cpi}$ | -3.745** | -3.706** | -5.927*** | -5.871*** | 0.070 | 0.071 |
| | $reer_{t+k}$ | -2.745* | -2.814 | -1.837 | -1.900 | 0.213 | 0.168** |
| | $y_{t+k}$ | -3.971** | -4.057** | -3.051** | -3.121 | 0.110 | 0.056 |
| | $\pi_{t+k}^{ppi}$ | -5.373*** | -5.590*** | -5.091*** | -5.175*** | 0.255 | 0.059 |
| **Mexico** | $r_t$ | -2.215 | -0.367 | -1.283 | -0.385 | 0.302 | 0.215** |
| | $\pi_{t+k}^{cpi}$ | -7.464*** | -7.402*** | -7.458*** | -7.394*** | 0.062 | 0.054 |
| | $reer_{t+k}$ | -1.288 | -2.758 | -1.322 | -2.877 | 0.778*** | 0.074 |
| | $y_{t+k}$ | -2.216 | -2.328 | -2.313 | -2.411 | 0.199 | 0.135* |
| | $\pi_{t+k}^{ppi}$ | -5.328*** | -5.303** | -5.191*** | -5.158** | 0.141 | 0.111 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Russia** | $r_t$ | -1.594 | -3.104 | -2.071 | -6.256** | 0.416* | 0.103 |
| | $\pi_{t+k}^{cpi}$ | -5.641** | -3.780** | -2.820** | -3.705** | 0.515** | 0.110 |
| | $reer_{t+k}$ | -4.492** | -5.531** | -2.533 | -2.226 | 0.143 | 0.116 |
| | $y_{t+k}$ | -2.932* | -5.749** | -1.247 | -1.797 | 0.265 | 0.172** |
| | $\pi_{t+k}^{ppi}$ | -4.231** | -4.419** | -4.231** | -4.410** | 0.189 | 0.075** |
| **South Africa** | $r_t$ | -2.017 | -2.257 | -1.654 | -1.844 | 0.333 | 0.119* |
| | $\pi_{t+k}^{cpi}$ | -2.405 | -2.316 | -5.010*** | -4.996* | 0.115 | 0.083 |
| | $reer_{t+k}$ | -1.934 | -2.632 | -2.021 | -2.397 | 0.570** | 0.071 |
| | $y_{t+k}$ | -2.071 | -2.119 | -1.834 | -1.892 | 0.154 | 0.134* |
| | $\pi_{t+k}^{ppi}$ | -6.462*** | -6.459*** | -5.724*** | -5.718*** | 0.090 | 0. 049 |
| **Turkey** | $r_t$ | -2.443 | -2.445 | -1.984 | -1.919 | 0.250 | 0.222** |
| | $\pi_{t+k}^{cpi}$ | -4.616*** | -4.514** | -7.579*** | -7.707*** | 0.170 | 0.0306 |
| | $reer_{t+k}$ | 1.100 | -0.423 | -0.655 | -2.497 | 0.716** | 0.242** |
| | $y_{t+k}$ | -2.419 | -2.373 | -2.625* | -2.587 | 0.115 | 0.104 |
| | $\pi_{t+k}^{ppi}$ | -5.184*** | -5.360*** | -5.184*** | -5.325*** | 0.306 | 0.086 |

# CHAPTER SIX

# Summary, Conclusions, and Policy Recommendations

## 6.1 Introduction

This chapter is divided into different sections, which include the summary, conclusions, and recommendations based on the findings from this study. Section 6.2 contains the overview of the study, while section 6.3 presents a summary of all chapters and the general conclusion. The policy recommendations from all the chapters are in section 6.4, followed by the areas for further research in section 6.5.

## 6.2 Summary and Conclusions

This study investigated the linkages between exchange rates' dynamics and monetary policy frameworks in large emerging market economies (LEMEs). The main focus of the study is to understand the role of exchange rates in LEMEs' global integration and monetary policy formulation. As part of improving the economic conditions in LEMEs which have the potential for increasing productivity and attaining financial stability, exchange rates are the major determinant of how well the economies will participate in the global markets. This transcends from how exchange rate volatility impacts international trade flows to if changes in exchange rate regimes can affect the validity of real interest rate parity conditions in LEMEs. Another aspect of the influence of exchange rates in LEMEs is the response of monetary policy to increasing exchange rate volatility in the economies. Considering that these areas of exchange rate dynamics are not well represented in studies related to LEMEs, this study, therefore, decided to answer the questions below across the chapters.

1.) How effective would disaggregated industrial trade data prove in explaining the influence of exchange rate volatility on international trade flows in LEMEs?

2.) Do real interest rate parity (RIRP) conditions hold within different nominal exchange rate regimes in LEMEs relative to their main trade partner, the US?

3.) Is the Taylor policy rule in LEMEs credible in maintaining price stability in the economies?

### 6.2.1 Exchange Rate Volatility and International Trade Flows

The autoregressive distributed lag (ARDL) model and bound test for cointegration were applied to investigate the impacts of exchange rate volatility on disaggregated industrial-level exports from 20 industries in LEMEs to the US and imports from 20 industries in the US to LEMEs. The findings based on 3 and 12-monthly standard deviations reveal that exchange rate volatility negatively impacts a minimal number of exports and imports industries from the 10 countries considered for imports and exports. The short-run analysis also dictates a weak relationship between exchange rate volatility and international trade flows between LEMEs and the US. The main conclusion drawn is that exchange rate volatility has an insignificant effect on real exports and imports in the trade between LEMEs and the US, so adjusting the exchange rate can barely improve the economies' trade balance.

### 6.2.2 Real Interest Rate Parity Condition and Nominal Exchange Rate Regimes

The autoregressive (AR) linear model of order one was employed to examine the relationship between exchange rate regime changes and the real interest rate parity (RIRP) in LEMEs. The study uses a structural break for the most active periods in LEMEs' monetary policy cycle: the Bretton Woods era and the free-floating exchange rate regime. After that, the half-life shocks were computed from the AR standard errors to measure how long real interest rates took to converge to parity conditions in cases where RIRP did not hold. The results from the AR parameters indicate evidence of weak long-run validity of RIRP conditions implying that exchange rate regime changes do not influence the validity of RIRP in LEMEs. Then, the results from the half-life shocks indicate that real interest rates in LEMEs converge faster to parity conditions in the Bretton Woods era than in the free-floating regime system. This implies that LEMEs are free to adopt any monetary policy framework that suits the need of their economic structures, especially during internal or external financial crises, without any ripple effects that could affect the validity of RIRP.

### 6.2.3 Taylor Policy Rule and Price Stability

Using the consumer price index (CPI) and producers' price index (PPI) to measure the inflation gap, the generalised method of moments (GMM) was employed to study the credibility of the Taylor policy rule in maintaining price stability in LEMEs. The results from the CPI inflation reveal that although 2 out of the 7 LEMEs selected follow the linear Taylor rule, the countries do not conform to the Taylor principle. The study further indicates that using PPI, 3 out of 7 LEMEs, follow the Taylor rule but do not adopt the Taylor principle. Comparatively, it was discovered that PPI inflation leads more to price variability than CPI inflation. All countries react to deviations in the output gap with PPI inflation than in the CPI inflation estimation. It was also observed that although targeting real effective exchange rate (REER) was not part of the monetary policy plans for the countries, however, increases in REER volatility led monetary authorities in LEMEs to respond by raising interest rates in some countries. This study concludes that LEMEs follow the inflation targeting (IT) monetary policy framework without conforming to the Taylor principle.

### 6.3 Policy Implications and Recommendations

To stabilise financial and economic conditions in LEMEs through stabilising exchange rates, the economies have adopted various monetary policies to absorb the contagion effects from the global financial markets and internal institutional imbalances. However, the increasing financial crisis in the international financial markets comes with growing instability in LEMEs' financial system. Over the years, studies have emerged trying to analyse and proffer the best monetary policy approach that could help manage the challenges of financial instability and improve LEMEs economies. Although this approach was practical for some period, little or no progress has been recorded in LEMEs' financial system, implying that more is required to curb the increasing monetary policy challenges LEMEs face.

Regarding measuring the impacts of exchange rate volatility on international trade flows using disaggregated industrial-level trade data, the findings from this study moved against the theoretical background and some empirical studies' conclusions to reveal that there is more to LEMEs' problem of trade deficits than just the increasing rate of exchange rate volatility in the economies. Although exchange rate volatility has a role, other economic factors resulting from underdevelopment in LEMEs might be at play. As depreciation in the exchange rate is expected to reduce a country's imports, an increase in domestic demand due to monetary policy change may increase imports in an offsetting movement. The same can be the case for exports, especially with a country's trade partner; as the exchange rate depreciates, they would want more of the partner's goods even if there is an appreciation in exporting country's currency and vice versa. Therefore, a proper understanding of the economic condition in LEMEs might help monetary authorities design an appropriate monetary policy to guide against the ripple effects of economic underdevelopment and other external shocks. Adjusting monetary policy alone or targeting exchange rate movements by increasing interest rates to favour trade policies might not yield positive results. This study, therefore, suggests that for effective monetary policy that will benefit LEMEs and increase positive trade participation, all aspects of the economy need to be considered. This includes uniting the macroeconomic and monetary policy instruments by the need and conditions of the economies. There is no one-size-fits-all when determining the relationship level between exchange rate volatility and international trade flows.

On the other hand, the belief that exchange rate regime changes can affect the validity of RIRP was countered by further findings from this study. Given that achieving RIRP is necessary for attracting investors into LEMEs, other contributing factors might be why RIRP conditions are not holding in the economies. Firstly, financial underdevelopment and institutional setback can affect the validity of RIRP. Other problems can be from external shockwaves related to monetary policy changes in the global economies, financial crises which have rocked international financial markets over the years, or inappropriate implementation of monetary policies, as the case may be. So, in as much as RIRP is necessary for the economies, the evidence from this study point to the overall improvement of the economic conditions in LEMEs to shield them from bearing the brunt of every financial crisis in the world. Hence, broader macro-microeconomic interactions are necessary to protect the economies.

Another crucial finding with LEMEs' adoption of inflation targeting (IT) and flexible exchange rate regimes is that inflation has been persistent over the years across the countries selected using the PPI and CPI inflation. The classical theories of economics stipulated that several factors, including macro or microeconomics, can lead to an increase in inflation rates. Considering those factors, an inflation increase could be temporal, while an increase in the output gap might be long-term; therefore, targeting the inflation increase using the policy rates could widen the output gap and vice versa. Regarding targeting the output gap simultaneously with the inflation gap, the process requires a balance whereby monetary authorities will outline the economy's needs. What is required is finding the optimal need of a given economy using continuous assessments of different areas of the economy, including the cost-benefit analysis of foregoing one necessity for the other. Then, the findings of the evaluations become the monetary policy tool (employing unconventional monetary policy) for effective results other than adopting any available policy that is not tested within the economies. In conclusion, it is essential to emphasise that LEMEs have the potential for financial and economic stability. But the approach of copying and pasting in designing and adopting monetary policy hardly meets the economies' need for financial stability and urgent economic improvement.

### 6.4 Areas for Further Research in the Context of the Study

The findings from this study have provided room for further research on the dynamic impacts of exchange rates on the monetary policy formulation of LEMEs. Based on the evidence deduced from the estimations, the following further research can be conducted in the study; firstly, there is the need to apply structural breaks on country-specific disaggregated industrial-level trade data since these economies have been on the receiving end of the various global financial crisis. Secondly, further studies can include other control variables related to trade aside from those used in this study to determine whether there will be changes in how international trade flows react to exchange rate volatility.

Another area that can be accessed is the macroprudential framework. Over time, the monetary policy framework in LEMEs has been operating in isolation without considering the macro-microeconomic synergy. Future studies could incorporate the macroeconomic variables in the monetary model; there might be a different outcome.

Fourth, considering that the HP filter used in this study for GDP decomposition produces spurious trends unrelated to the data. Future studies need to consider using an alternative method of decomposing the GDP. The same applies to using short-term interest rates instead of long-term treasury bills employed in this study to know if the validity of real interest rate parity can be obtained.

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