College of Business and Economics

School of Graduate Studies

Department of Economics

Exchange Rate Pass-Through and Inflation Dynamics in Selected Sub- Saharan African Countries: A Panel NARDL Approach

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October, 2020

Addis Ababa, Ethiopia

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A Thesis Submitted to the of Department of Economics Presented in Partial Fulfillment of the Requirements for the Degree of Master of Science in Economics (International Economics)

Addis Ababa University

Addis Ababa, Ethiopia

October, 2020

Statement of Declaration

I, the under signed, declare that, this research paper is my original work, has never been presented in this or any other university, and that all resources and materials used herein have been duly acknowledged.

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Statement of Certification

This is to certify that **Mnshir Geto Teferra** has carried out his research work on the topic entitled **"Exchange Rate Pass-Through (ERPT) and Inflation Dynamics in Selected Sub-Saharan African (SSA) Countries: A Panel NARDL Approach."** The work is original in nature and is suitable for submission for the award of Master's of Science Degree in Economics.

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Advisor: Girma Estiphanos (PhD)

Date: ________________________

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Abstract

This study examines Exchange Rate Pass-Through and Inflation Dynamics in 14 Selected Sub-Saharan African Countries with special focus on the asymmetrical relationship between exchange rate and consumer prices. The study estimate exchange rate pass-through (ERPT) including the macroeconomic determinants of consumer prices by using the nonlinear autoregressive distributed lag (NARDL) framework of both time series, and panel fixed effect model taking in to account cross sectional dependence. The study findings suggests world oil price and output gap have significant effect in the long-run whereas the effect exchange rate depends on the direction and size of exchange rate changes. The study also reveals significant adjustment speed which converges to equilibrium slowly. The study found an asymmetrical ERPT in the entire sampled SSA and fixed exchange rate regime subgroups during the long-term, whereas symmetrical effect observed during short-term across subgroups. The result suggest complete and significant ERPT to consumer prices in the entire SSA region, which is higher during appreciation of the local currency than after depreciation in the long-term, especially in the fixed exchange rate regime subgroups. Further, the result confirms the non-zero incomplete ERPT over the short-term and the nonlinear ERPT with respect to the size of the exchange rate change. The pass-through is found to be higher in countries with fixed exchange rate regimes in a high inflationary environment than in countries with floating exchange rate regimes and low inflation levels which supports Taylor hypothesis. Pass-through is greater during small exchange rate changes than after large changes. Finally, the result of time series analysis suggests mixed result which demands country specific policy implications are inevitable. Therefore, the policy implication of both panel and time series analysis is to take in to account various asymmetries of exchange rate on consumer prices when formulating exchange rate and the monetary policy rules.

Keywords: Exchange Rate Pass-Through; Inflation; Asymmetries; NARDL; Sub-Saharan Africa

Acknowledgement

I am highly indebted to thank my advisor Girma Estiphanos (PhD) for his unreserved effort to correct my report, providing constructing comments and advising me for the better improvement of this thesis.

My wife, Fantaye Nigus, thank you for your patience and assistance in the whole process. God bless you. This work couldn't have been possible without you. I dedicated this paper for you. I would like to thank my kids; you gave me strength and hope every day.

I am also grateful to Atnafu Gebremeskel (PhD) and Fantu Guta(PhD) for their useful suggestions. They were very honest and cooperative when the need for any help arises.

Finally yet importantly, those friends and individuals who have been contributing a lot for the entire work, either directly or indirectly deserve to be acknowledged.

THANK YOU ALL!!

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Acronyms and Abbreviations

AD: Aggregate Demand

AfDB: African Development Bank

AIC: Akakie Information Criteria

APSP: Average Petroleum Spot Price

AR: Autoregressive

ARDL: Autoregressive Distributed Lag

BIC: Bayesian Information Criteria

BLS: Bureau of Labor Statistics

B-P LM: Bruesch-Pagan Lagrangian Multiplier

BRUEGEL: Brussels Based Economic Think Tank Database

CEMAC: Central African Economic and Monetary Union

CFA: African Financial Community/Financial Community of Africa

CIPS: Cross Sectionally Augmented Im, Pesaran and Shin(2003) test

CPI: Consumer Price Index

CSA: Central Statistic Agency

CSD (CD): Cross Sectional Dependence

CS-NARDL: Cross Sectional Nonlinear Autoregressive Distributed Lag

CS-NDL: Cross Sectional Nonlinear Distributed Lag

CVAR: Cointegrated Vector Autoregressive

DFE: Dynamic Fixed Effect

DOLS: Dynamic Ordinary Least Square

EA: Euro Area

ERPT: Exchange Rate Pass-Through

FE.D._K.: Fixed Effect Driscoll-Kraay

FE: Fixed Effect

FGLS: Feasible Generalized Least Square

FMOLS: Fully Modified Ordinary Least Square

GDP: Gross Domestic Product

GMM: General Moment Method

HQ: Hannan –Quin information criteria

IC: Information criteria

IFS: International Financial Statistics

IMF: International Monetary Fund

IPI: Import Price Index

LCP: Local Currency Pricing

LOOP: Law of One Price

LSDV: Least Square Dummy Variable

MG: Mean Group

MS: Money Supply (M2)- Broad Money as % of GDP

MSIAH: Markov Switching Intercept Autoregressive Heteroskedasticity

NARDL: Nonlinear Autoregressive Distributed Lag

NBE: National Bank of Ethiopia

NEER: Nominal Effective Exchange Rate

NER: Nominal Exchange Rate

NOEM: New Open Economy Macroeconomics

OECD: organization for Economic Co-operation and Development

OLS: Ordinary Least Square

PCP: Producer Currency Pricing

PESCADF: Pesaran Cross Sectionally Augmented Dickey Fuller

PMG: Pool Mean Group

POLS: Pooled Ordinary least Square

PPI: Producer Price Index

PPP: Purchasing Power Parity

PTM: Price to Marketing

RBM: Reserve Bank of Malawi

RE: Random Effect

RER: Real Exchange Rate

RMB: Real Money Balance

SC: Schwarz Information Criteria

SD: Standard Deviation

SP: Sticky Price

SPMM: Sticky Price Monetary Model

SSA: Sub-Saharan Africa

SVAR: Structural Vector Autoregressive

UIP: Uncovered Interest Parity

UK: United Kingdom

USA (US): United State of America

USD: United State Dollar

VAR: Vector Autoregressive

VEC: Vector Error Correction

VECM: Vector Error Correction Mechanism

VIF: Variance Inflation Factor

WAEMU: West African Economic and Monetary Union

WBDIDB: Work Bank Development Indicator Database

YGAP: Output Gap

CHAPTER ONE
INTRODUCTION

1.1 Background of the Study

In modern era-where international finance get more interest in the global economy, exchange rate (the price one currency in terms of another)[1] play a decisive role in international financial stability. Movement in exchange rates affects the price of commodities in the world market and even in a given country under consideration. Due to this, it's crucial to look at its impact on inflation for policy perspectives- to design appropriate monetary policy which considers the effect of exchange rate fluctuation on inflation. This can be analyzed through exchange rate pass-through (ERPT-here after) (Gandolf, 2016).

The responsiveness of price to exchange rate movements(ERPT) holds a central place in international macro economics and much debated issue among academician, researchers and policy makers(Gandolf,2016;Helen,2012, and Khemiri & Ali, 2012). Indeed there is a large body of both theoretical and empirical studies which affirms that the degree of exchange rate pass through has an essential implication for the timing of current account adjustment (Kurgman&Obstfeld,2003), for conception and control of monetary policy(e.g. Oladipo,2017;Wimalasuriga,2009;Gangon& Ihirg,2004; and Adolfson,2001),for the choice of exchange rate regime and imported shocks(see for example: Helen, Mohammednur and Razafimahefa,2012;Bett & Devereux,2001 cited in Bouakez&Rebei,2006).

ERPT can be defined as the change in price due to the change in nominal exchange rate (Aliyu *et al*., 2008). Specifically, the percentage change in domestic price when home currency changes by one unit is called degree of ERPT (Mumtaz *et al*.,2006). If the percentage changes in exchange rate results in exactly the same percentage change in prices, it called the complete ERPT while a less than proportionate change is termed as incomplete ERPT. Further, if prices are unresponsive to the change in exchange rates then the pass through is zero.

The change in exchange rates may be transmitted to consumer prices through direct and indirect channels (Lafleche, 1996). The direct channel movement in exchange rate on domestic price is through price of imported goods or domestically produced goods in foreign currency while

[1]This paper employed the volume (quantity) definition: which defines nominal exchange rate as foreign currency units per unit of domestic currency – an increase (positive change) in exchange rate indicate appreciation (revaluation) of local currency (Pilbeam, 2006).

indirect channel is through the price of imported intermediate goods used as inputs in production as the change in exchange rate affects the cost of production (Anguyo & Opolot, 2013).

The concept of ERPT has been known a long time ago[2], in spite of this it attracted great interest after the plaza accord of 1985(an agreement between France, West Germany, Japan, UK and USA to depreciate dollar in relation to Japanese yen and German Deutsche Mark) in which after it Japanese import in US dollar expected to be more expensive (Obstfeld, 2009) which was not in effect that is it rose slightly or remain unchanged or in some cases increases (Goldberg & Knetter, 1997). Thus, it is after this empirical observation that economists try to predict the degree of ERPT as well as its determinants and the corresponding Price-to-Marketing (PTM-here after) behavior (Ghosh & Rejan, 2006).

The traditional international macro economics paid little attention to the degree of ERPT as these models are based on perfectly competitive market, fully flexible prices, Law of One Price(LOOP) and hence Purchasing Power Parity(PPP) holds all the time which implies complete ERPT(Gandolf,2016). However, there is a large literature which shows the ERPT is incomplete[3]. In connection to this the New Open Economy Macroeconomics (NOEM) literature, which was based mainly on the works of Obstfeld & Rogoff(1995), introduced nominal rigidities and market imperfections in to a dynamic general equilibrium (DGE) open economy model with a well specified micro foundation. Although the original framework of Obstfeld & Rogoff (1996) and Betts & Devereux (2000) consider PPP holds and pass-through is complete, the model is extended to allow PTM and hence incomplete pass-through (Baillu & Fujii, 2004).

Large amount of studies have been done on ERPT from both micro and macro foundations, though ERPT is a main stream open economy macroeconomic concept and the focus is on micro at firms level (Aron, McDonald & Muellbauer, 2014). The idea is that pass-through is associated to “macro” variables such as inflation was primarily advocated by Taylor (2000). He argued that the responsiveness of price to exchange rate fluctuation depends positively on inflation, that is, low inflationary environment results in a decline in ERPT. Likewise, most macro evidence suggest that ERPT to import price is incomplete and there is small degree of consumer price responsiveness to exchange rate fluctuation (Bouakez & Rebie, 2008; Compa & Goldberg, 2005;

[2]The term “pass-through” was first used in economics by Steve Magee (1973) in explaining the impact of currency depreciation

[3] The details of review of literature of this part is presented in chapter 2

Frankel *et al*., 2005; Baillu & Fujii, 2004; Gagnon &Ihrig,2004; and, Choudhri & Hakura,2001) to mention a few.

The micro literature on ERPT basis their analysis of the degree of pass-through: on firms or industry level and imperfect competition (such as product differentiation), and firm's behavior of PTM as explanation for incomplete pass-through. Factors such as product market structure, imperfect competition , market share (importer size), markup adjustment and local costs are important factors in explaining incomplete pass-through of exchange rate to prices(Pennings, 2017;Devereux *et al*., 2017; Auer & Schoenle,2016; Cao *et al*., 2015; Berner, 2012;Compa & Goldberg;2002;Smets & Wouters,2002;and Garcia and Restrepo,2001).

Other forms of literature on ERPT explain whether the response of prices to the direction and the magnitude of exchange rate change is non linear price adjustment to price or asymmetric (Pollard & Coughlin, 2004). Empirical literatures assumed that there exists symmetrical long-run relationship between price level and exchange rate, that is, appreciations and depreciations and large and small changes in exchanges rate are transmitted in the same magnitude to final prices. However, the hypothesis of a symmetric pass-through is unrealistic and too restrictive (Bussiere, 2013; Bejaoui, 2013; Frankel *et al*., 2012; Delatte & Lopez-Villavcencio, 2012 and 2010; and, Goldberg & Knetter, 1997).

Even though there is an extensive literature on ERPT in the case of developed, emerging and relatively low in developing countries, very scanty studies have been conducted using nonlinear ARDL approach (Faryan, 2016; Baharumshah, Sirag & Soon, 2017; Kassi *et al.*, 2019). But, for developing countries in general and SSA in particular- whose import is significantly large and has experience repeated currency devaluation; examination of ERPT using varying approach is more appealing. The reason is level of ERPT has an important implication for international macroeconomic shock transmission, adjustment for current account and monetary policy intervention. That is, the degree and speed of pass-through is important for predicting inflation and formulating monetary policy. Therefore, the main purpose of this study is to examine the impact of ERPT on inflation using NARDL approach in selected SSA countries.

1.2 Problem Statement

Developing countries have been characterized with higher inflation (GudinaGodaKorsa *et al*., 2018).Despite the continued economic growth (IMF, 2019), SSA countries have manifested by higher inflation (10.8% in 2017 and 8.5 % in 2018). Among the other things exchange rate is one of the determinant of inflation, that is, the change in exchange rate affects the price level. The responsiveness of prices to the change in exchange rates positively relies on inflation (Taylor, 2000). This implies that a decrease in exchange rate (devaluation) lead to an inflationary environment and vis-à-vis an increase in exchange rate(revaluation) though the pass-over effect is incomplete due to un-fulfillment of Marshal Lerner condition at least in the short-run(Pilbeam, 2006). African countries lose about 20%-40% of their currency value against dollar beginning from 2015 (AfDB, 2018). For example there was 40% pass-through exchange rate depreciation to inflation for countries under fixed exchange rate regime in SSA countries (IMF, 2019)

SSA countries have repeated experience of devaluation of their currencies and it was observed that in time of devaluation inflation has been roused. For example , after Ethiopia has devalued its currency in October ,2017(NBE,2017) and September ,2010(NBE,2010) by 15% and 16.5% respectively; consumer price index rose by 3.4% and 5.3% (CSA,2018 and 2011). Kenya after moved to floating exchange rate in early 1990 has experienced volatility in exchange due to its exposure to domestic and external shock. And this volatility contributed to instability in inflation. Further in 2011, in Kenya, a 23% depreciation of shilling explained 17% of observed inflation (AfDB, 2012).

Similarly, a 1% decrease in exchange rate leads to .15% rise in price level in Mozambique (Vicente, 2007) and in mid-2012 inflation in Malawi has rose up to 37% while currency depreciated by 49% (RBM, 2015). Above all, it is logical to presume movement in exchange rate affects the change in inflation rate in same direction except in period special macro economic reform such as in Tanzania (Mwase, 2006). Thus, the other sampled SSA countries share this relationship of economic variables since they have some common macroeconomic features.

Despite the extensive empirical works on ERPT of which most of them were focused on developed and emerging economies but relatively small in developing countries, very few studies were done in SSA (most of them country specific) which were based their analysis on models such as VAR (Vector Autoregressive), SVAR (Structural Vector Autoregressive), linear ARDL (Autoregressive Distributive Lag) etc. However, few of them consider the nonlinearity of ERPT and its asymmetrical effect with respect to cross sectional dependence. Therefore, this study aim to examine the relationship between ERPT and inflation using Nonlinear

Autoregressive Distributive Lag model (NARDL) frame work of fixed effect model in the presence of cross sectional dependence in selected SSA countries.

1.3 Objective of Study

The main objective of this study is to examine the relationship between of ERPT and inflation in selected SSA countries.

Specific objectives are:

i. To identify the macroeconomic and policy related determinants of inflation
ii. To investigate the relationship between ERPT and inflation by distinguishing two exchange rate regimes
iii. To check whether there exist asymmetry in ERPT with respect to direction and size of exchange rate
iv. To check whether the Taylor hypothesis hold
v. To identify the type of pass-Through that SSA could experience.

1.4 Significance of the Study

For developing countries in general and SSA countries in particular- whose import is significantly large (manifested with huge trade deficit), change in exchange rate has an important implication. As the result, examination of ERPT to inflation is valuable. The reason is, the level of ERPT has an important implication for international macroeconomic shock transmission, adjustment for current account and monetary policy intervention. That is, the degree and speed of pass-through is important for predicting inflation and formulating monetary policy response to inflation shocks. And as SSA is (experienced with repeated currency devaluation) highly dependent on large amount of imports of intermediate inputs, consumer goods and capital goods which become more expensive at the time when it devalues its currency, understanding the impact of exchange rate fluctuation on price help to determine appropriate monetary policy.

1.5 Limitation of the Study

The availability of data continues to be an obstacle for researchers, as it appears in this study. As the result some important variables such as producer price index and import price index were excluded from empirical test which might reduces the quality of estimated results. Further, the limited sample used(based on data availability); small number of countries with relatively large time period make the inference with the fixed effects estimator sensitive to non-normality, heteroskedasticity, and serial correlation in the idiosyncratic errors.

1.6 Organization of the study

The rest of the thesis organizes as follows: the next chapter, chapter two deals with theoretical and empirical literature followed by chapter three which focus on methodological framework. Chapter four present the data and estimation result. And chapter five concludes the thesis.

CHAPTER TWO

LITERATURE REVIEW

This chapter is assembled in the following sections: section 2.1 reviews theoretical literatures followed by section 2.2 reviews of empirical evidence and section 2.3 evaluations and summary of the theoretical and empirical evidence in context of ERPT.

2.1 Theoretical Literatures

The definition of ERPT can be categorized in two ways: the narrower and the broader definitions. The narrower definition states that ERPT is the percentage (change) in local currency (import prices) resulting from the percentage (change) in exchange rate (Goldberg & Knetter, 1997; Adolfson, 2001; and Compa & Goldberg 2002[4]). However the broader definition deals with the change in domestic (general) price due to the change in exchange rate (e.g. Devereux &Yetman, 2002; and Aliyu *et al*., 2008).The following section portrayed some of the theoretical models of exchange rate determination.

2.1.1 PPP, LOOP and Exchange Rate:

There has been a tremendous development in exchange rate models from 1970s to recent period. Models from 1970s to 1980s were based fundamental theories such as PPP, sticky price (SP), Uncovered Interest Parity (UIP), Monetary and Balanced portfolio. Nonetheless the empirical break-down of these models leads to using more dynamic models, (Seddha-udom, 2014).

A preliminary point to examine the relationship between exchange rate and price is the law of one price (LOOP) which states that states that assuming free trade with perfectly competitive market which excludes transaction cost such as tariffs, taxes, perfect goof arbitrage and transportation costs; the price of internationally traded good in one country should have identical price in another country, once the price is adjusted to a common currency (Pilbeam, 2006; and Sarno & Taylor, 2002).

The law of one price is the fundamental building-block of the PPP condition. The PPP exchange rate as defined by Sarno & Taylor (2002) is "*the exchange rate between two currencies which would equate the two relevant national price levels if expressed in a common currency at that*

[4]Argued that Pass-through is dependent on whether the definition is direct(effects on price but ignore its impact on other variables or total(effects on the full sample variable)

rate, so that the purchasing power of a unit of one currency would be the same in both economies". Mathematically the absolute version of LOOP can be written as:

$$P_t = E_t P^* \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (2.1)$$

Where $P_t$is the domestic price index,$E_t$is s the nominal exchange rate (defined as domestic currency per unit of foreign), and P^*represents foreign prices. If the logarithmic form consider the LOOP yields the following;

$$p_t = \alpha + \beta p * + \gamma e_t + \varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (2.2)$$

Where: p_t, e_t and p* are the natural logarithm of P_t, E_t and P* respectively.

If we suppose PPP holds in equation (2.2), then α=0, β=1 and γ =1. Hence there is a complete pass-through- implying the long-run pattern of ERPT.

Based on the above basic relationship Knetter(1994) and Compa & Goldberg (2002), by applying indices of industrial concentration or market power, extend the definition of ERPT to pricing behavior PTM -the extent to which exchange rate movements are passed-through into traded goods prices, versus absorbed in producer profit margins or markups[5]. They formulate the following important equation to test the relationship which depends on the estimate of δ:

$$p_t = \delta e_t + \varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (2.3)$$

Where all lower-cased variables are in logs and ε is an error term. If δ=1, ERPT is complete and if δ<1, ERPT is partial. Despite its popularity, this reduced form equation (whether in log levels or growth rates) is problematic for hypothesis testing because it represents a non-structural statistical relationship (lacks an economic interpretation)[6].

2.1.2 Uncovered Interest Parity (UIP)

The Model of UIP states that an exchange rate between currencies is the rate that equates the expected return of holding domestic and foreign asset. If the UIP holds, the expected percentage change in exchange rate equal to the difference between domestic and foreign interest rate (Seddha-udom, 2014; and Gandolf, 2016). If equation (2.1) is log form;

$p_t = e_t + p *$Then the UIP is given by

$$E\lfloor e_{t+1} - e_t \rfloor = i - i * \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (2.4)$$

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[5]Dornbusch (1987) justifies the incomplete Pass-Through ,because of that firms not only adjust the cost structure (prices) but also their mark-up when there is an exchange rate shock

[6]Compa&Goldberg (2002,2003)

Where E (.) expectation at time t, $e_t$is nominal exchange rate at time t and i and i* are domestic and foreign interest rate (all variable in log form).

2.1.3 Stick price monetary model (SPMM):

Under this model, exchange rate is determined by the equilibria of the three markets (namely goods and service market, money market and currency market). Because in the short-run real sector's prices are sticky when a monetary shock occurs, an exchange rate level will fully overshoot its long-run level and backs to its long-run level after the prices of goods and services fully adjusted. The model also termed as exchange rate overshooting models as Dornbusch (1979) and Frankel (1976) cited in Sarno & Taylor (2002). Mathematically its can stated as:

$$e = m - m* - \emptyset(y - y*) + \alpha(i - i*) + \beta(\pi - \pi*) \ldots\ldots\ldots\ldots \ldots\ldots\ldots\ldots\ldots (2.5)$$

Where e normal exchange rate at time t, m and m* are domestic and foreign money supplies

y and y* are domestic and foreign income, i and i* are domestic and foreign interests rate, π and π* are expected domestic and foreign inflation and ∅, α and β are parameter to be estimated.

2.1.4 Microstructure

The micro-foundations of pricing behavior by exporters are a better starting point for generating more meaningful specifications based on economic theory that are appropriate for hypothesis testing. Hooper & Mann (1989), Goldberg & Knetter (1997) and Barhoumi (2006) considered a representative foreign firm having some degree of control over the price of its goods in an importing country. They assume that this representative firm establishes the price of its exports to country i in its own currency P_{it}^{xi}at a markup (λ_{it}) over its marginal cost of production (C_{it}^{*}), that is:

$$P_{it}^{xi} = \lambda_{it} C_{it}^{*} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.6)$$

Import price in domestic currency P_{it}^{mi} can be obtained by multiplying export price ($Pt^{x,i}$)by the exchange rate of importing country i E_{it}

$$P_{it}^{mi} = P_{it}^{xi} E_{it} = E_{it} \lambda_{it} C_{it}^{*} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.7)$$

The markup is assumed to respond to both demand pressure for the exporting country Yit^{*}* and competitive pressure in the importing country. Competitive pressure in the importing country is measured by the gap between the competitor prices in the importing country market (P_{it}) and the production cost of exporting firm. Therefore, Hooper and Mann (1989) formalize the markup in the following form; $\left\lfloor \frac{P_{it}}{E_{it}C_{it}^{*}} \right\rfloor^{a}$

$$\lambda_{it} = \left\lfloor \frac{P_{it}}{E_{it}C_{it}^{*}} \right\rfloor^{a} {Y_{it}}^{\beta} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (2.7)$$

Where 0 < a < 1 and 0 < ß <1 substituting (2.7) in to (2.6) yields

$$P_{it}^{mi} = [E_{it}C_{it}^{*}]^{1-a} {P_{it}}^{a} {Y_{it}}^{\beta} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.8)$$

Taking log of (2.8) yields, the ERPT, the partial elasticity of import price with respect to exchange rate, is (1-α). The model doesn't hold in practice because it assumes ERPT and foreign cost as same. However some argue that change rates are more variable than costs and a reasonable conjecture is that exporters will be more willing to absorb into their markups changes in exchange rates than change in costs, which are likely to be permanent and fixed coefficient may not hold (Barhoumi, 2006:928). Campa & Goldberg (2002, pp5-6) hypothesized a similar, yet more general, model by making the importing country's price as dependent variable.

To overcome the problem of the previous model, the general equilibrium approach come into place –pioneered by Obstfeld & Rogoff(1995) which incorporate price stickiness and market imperfection in a micro based general equilibrium analysis-assumes PPP holds all the time. Later on, Betts & Dereveux (1996,2000) cited in Baillu & Fiji(2004) extends the model by introducing PTM(firms pricing behavior). Despite the two models are similar with price stickiness approach, they vary on where in the prices should be set. In the original Obstfeld-Rogoff[7] model prices are set in producers currencies (PCP) while in later model it sets in importers currencies (LCP).These models, assuming sticky price and exchange rate being endogenous variable, demonstrates ERPT as the function of the existing economic disturbance and competitive structure of industries[8].

[7]Choudhri et al.,(2006) explains ERPT with different prices with variety of new open economy macroeconomic models based on VAR approach and shows that the best-fitting model incorporates a number of features highlighted by different strands of the literature: sticky prices, sticky wages, distribution costs and a combination of local (LCP) and producer currency pricing (PCP)

[8] Dixit(1989) investigate the non linearity of ERPT to domestic prices using entry and exit(market structure)

2.1.5 Asymmetry and Determinants of ERPT

Theories of exchange rate evolved over time, they have been extended to incorporate new change (variables)[9] and move from symmetric pass-through to asymmetric (non linear pass-through). What makes ERPT to be asymmetric?[10]Factors that contributes to make asymmetry relationship between exchange rate and inflation also determine ERPT - they are interrelated which includes, variables such as, export pricing(PCP), import pricing(LCP), market share, binding quantity constraint, product switching and menu cost (or generally referred to as pricing strategy) are identified as causes of asymmetric pass through (Pollard and Coughlin 2003), PTM Knetter (1994) greater pass-through during episodes of appreciation than depreciation. Thus, market shares as factor, industries respond asymmetrically to appreciations and depreciations, but the direction of asymmetry varies-they adjust their markup price depending on the change in exchange rate. Likewise, most firms respond asymmetrically to large and small changes in the exchange rate with pass-through positively related to the size of the change (Pollard & Coughlin (2003).

Another explanation for ERPT asymmetry is production switching. Like consumers do for depreciation- expense more for domestically produced good, producers do for appreciation that is they shift their production to home –no pass-through implying high in devaluation than appreciation (Helen, 2012, and Ware &Winter, 1998).

Other factor that makes ERPT asymmetric and in complete in relation to inflation includes; the type exchange rate regime, the size of exchange rate, trade openness, business cycle, size of economy and monetary policy (Frankel *et al*., 2012)

Firms may also respond asymmetrically with respect to the size of the change in the exchange rate. For example, the presence of menu costs may result in asymmetric pass-through of large and small exchange rate changes. The cost of changing prices increases the likelihood that firms only adjust the invoice price if the change in the exchange rate is above some threshold.

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[9]E.g. ; Bobb & Sonnyal (2018) introduce government expenditure, Berigno and Faia (2016) globalization, price adjustment, Aron et al.,(2014) summarizes the methodological and conceptual framework of ERP on developing countries, Devereux and Yetman (2008,2010).

[10]Delatte & López-Villavicencio (2010) ,Pollard &Coughlin (2003), and Knetter (1994)examine how asymmetry might arise in the case of ERPT

The direction of the asymmetry in pass-through will depend on the currency of invoice (Pollard & Coughlin 2003and, Cao, Dong & Tomlin, 2015).

More openness to trade will rise the degree of pass-through to import prices due to high competition that exporting firm face and low capability to absorb exchange rate change in their markups. But, Aliyu *et al* (2010) discloses the negative correlation between inflation and openness which implicitly mean opposite movement to pass-through and hence the direct and indirect channel goes in opposite direction.

Another factor that may determine the degree of pass-through is the size of the economy. Traditionally, large economies experienced lower effect of import price shock (currency depreciation) than small economies. Because, the rise in domestic price is counterbalanced by a decline in Crude oil due to lower demand implying small pass-through while small economies have no effect on Crude oil which in turn higher pass-through (McCarthy, 2000). However, some studies showed that no significant variation between them in terms of pass-through (Franket *et al*., 2012).

Furthermore, short-run asymmetry in the pass-through would results from monetary policy and business cycle. A transparent active monetary policy for exchange rate which insulate consumer price from the effects exchange rate fluctuation might has a pivotal role in the short-runthat is depreciation may affect less than appreciation in the short-run (Baharumshah, 2017; López-Villavicencio& Mignon,2017; Choudhri & Hakura, 2015,Bejaoui, 2013).

Last but not least, Delatte&López-Villavicencio (2010) identified the position in the business-cycle when the exchange rate variation takes place clearly triggers asymmetric responses. Devaluation often results from a reduction of domestic aggregate demand in the context of a balance of payment adjustment. The resulting recession could act to depress domestic prices, hence implying that a devaluation results in limited inflation.

In sum, even though there have been many models to explain effect and predict the degree of ERPT to prices, recent development has been made on use of NARDL model to analyze the non linear ERPT to prices.

2.2 Empirical Literatures

There are large literature on the influence of exchange rate on prices based on different data sources and sets, methodology, methods and study periods. To have a better understanding about what have been done before on the subject, this study classify the literatures in to, Comprehensives (in essence large sample), developed countries, emerging countries, and developing(and SSA African) countries. Then, the study also presents a short review of literatures on ERPT that has been done NARDL.

2.2.1 Review of Comprehensive studies (studies with large sample size)

Comprehensive studies were conducted on effect of ERPT to different prices (see for example; Choudhri & Hukura, (2015, 2001); Devereux & Yetman (2010, 2008, 2002); and Goldfajn & Werlang, 2000).

A study by Goldfajn & Werlang (2000) estimates the pass-through from depreciation to inflation in a panel data framework using monthly data (from 1980 to 1998) of 71 countries with 14,013 valid observation in approximation identifies; cyclical components of output, the extent of initial overvaluation of real exchange rate (RER), initial rate of inflation and the degree of openness of the economy as the main determinants of ERPT from depreciation to inflation. They also found that pass-through coefficient increase with larger horizon (ERPT on consumer prices increase over time and reach a maximum after 12 months), real exchange rate (RER) misalignment as most significant determinant of inflation in developed countries but it is that the initial inflation matter most for developing countries. Further, this study implied that large depreciation may accounts for higher inflation (at this time caution in policy formulation required).

Further, Choudhri & Hakura (2001) using NOEM models and large data which include (1979-2000) a sample of 71 countries to test the Taylor (2000) hypothesis. They found similar conclusion as Taylor-low inflationary environment leads to lower ERPT-positive and significant association between pass-through and inflation rate and give emphasis to inflation rate is the dominants macroeconomic variable in explaining the cross region differences in the pass-through.

Following a large debate on the causes of low ERPT to consumer prices, Devereux & Yetman (2002) develop simple model of a small open economy in which ERPT is determined by frequency of price changes of importing firm but ,this is in turn depends on monetary policy –

implying that ERPT is endogenous to monetary policy. They propose that 'looser' monetary policy will end up with higher pass-through. They argued that ERPT is slow, at least partly, due to short-term price rigidities. In their argument of higher inflation leads to higher pass-through they are in line with what Choudhri & Hukura (2001) and Goldfajn & Werlang (2000) was argued. They backed their finding with empirics of 122 countries data. Devereux & Yetman (2010, 2008) also develop a theoretical model counts for determinant of ERPT to consumer prices. They found that price stickiness (slow price adjustment) is a key determinant of ERPT. They also noted that ERPT and inflation have positive relationship but in a non linear fashion. This generally focused on taking account of the endogeneity of exchange rate pass-through in designing monetary policy for a small open economy.

Using a sample of 34 countries which was a blend of both developed (18) countries and emerging (16) countries by utilizing 52 quarter data for each since 1979,Choudhri&Hukura, (2015) studied ERPT to import and export prices with the inclusion of the role of nominal rigidities and choice of currency. By applying DSGE, both the regression-and VAR estimate, they found that ERPT to import prices is incomplete and higher than the pass-through export prices. They also suggested that the hybrid model with both PCP and LCP is helpful to explain ERPT to various prices, despite the debate on the choice among them.

A study by Carrière-Swallow *et al*., (2016) using a data from 62 countries (both developed and emerging) find evidence of a strong link between exchange rate pass-through to consumer prices and the monetary policy regime's performance in delivering price stability and price stability and central bank credibility have reduced ERPT. When sample is divided based on income group pass-through is lower for advanced economies than for emerging markets, with the cumulative impact after two years reaching 0.13 for the former, and 0.39 for the latter. Again when sample is spilt based on region among emerging markets, the pass-through is lower for Asia (0.2), than for Latin America (0.28), and Europe (0.5). There are also differences in the speed of adjustment of consumer prices. For advanced economies outside the euro area, the process is relatively fast and quite smooth, with the bulk of the price response taking place within 12 months. Among emerging economies, the speed of pass-through varies by region. While it is quite fast among Latin American economies, where the effect peaks after 9 months, the response of prices is much more gradual in emerging Europe and Asia. The decline in pass-through is faster for emerging and slower to developed countries.

2.2.2 Review of Studies on Developed Countries

Using partial equilibrium analysis and disaggregated industry data with a sample of six developed and 3 three developing countries Hopper & Mann (1989) conduct a study on ERPT in 1980's focusing US import of manufacturers(manufacturers imported goods). This study shows us, due to dollar depreciation profit margin shits to other countries' exporting firm in the short-run while not in the long-run. They generally argued that pass-through is different across data.

Dixit (1989) also conduct a study based on an entry and exit decision of firms on industry, using partial equilibrium[11] analysis (treating real exchange rate as exogenous and depreciation of entry cost neglect), level in US to examine hysteresis, import penetration and ERPT. He argued that entry requires the operating profit to exceed the interest on the entry cost, and similarly for exit. The middle band of rates without entry or exit yields hysteresis; it is found to be very wide for plausible parameter values. The exchange rate pass-through to domestic prices is found to be close to one in the phases where foreign firms enter or exit, and near zero otherwise.

Knetter(1993) conducted a study on the effect of exchange rate on PTM behavior of firms. He argued that the type of industry (industry) is the main source of variation in PTM and hence ERPT using price discrimination models. He uses an industry level data from US, UK, Germany and Japan for his analysis. Moreover, Goldberg & Knetter (1997) noted that ERPT is incomplete (partial) due to third degree price discrimination (or imperfect competition). They found that, on average around 60 %of change in exchange rate are passed on to import prices while the figure is even higher for Japanese but less than 100 %.

A research department in Canada, Lafleche (1996), carried out a study on the impact of exchange rate movement on consumer prices and identify the two channel through which fluctuation in exchange rate pass on to consumer prices that is direct channel(through imported inputs) and direct channel (through demand for substitute goods and export goods-expenditure switching effect). According to this department the degree ERPT is mainly depends on monetary policy credibility (commitment to low inflation), demand condition, the relative share of import in CPI, cost of adjusting price and expectation.

Taylor (2000) had made a remarkable study to explain the reason for low pass-through in 1990's using US quarterly data based on model of staggered price setting in line with monetary policy, GDP(Gross Domestic Product), money supply and aggregate price. He evidenced that low pass-

[11] See Dixit(1989:258) for details of major and minor assumption of the model

through is due to low inflation and proved his hypothesis of ERPT and inflation has positive relationship. Furthermore McCarthy (2000) provides more comprehensive evidence using industrialized countries sample data. McCarthy's objective was to examine the impact of exchange rates and import prices on the domestic PPI and CPI in selected industrialized economies. McCarthy's time series estimates show a decline in exchange rate pass-through for all nine of the OECD countries examined in the period 1983 through 1998 compared with the period 1976 through 1982.According to those estimates the pass-through declined by 50 %or more in the United States, the United Kingdom, France, and Japan, and by a smaller amount in Germany, Belgium, Netherlands, Sweden, and Switzerland.

With the objective to examine the monetary policy implications of allowing an incomplete pass-through in an inflation targeting framework a study done by Adolfson (2001)[12] in Sweden present: the relationship between monetary policy response to both domestic and foreign shock depend on ERPT-the exchange rate channel has less impact when pass-through is low, incomplete pass-through implies less conflict between inflation and output variability, and volatility of the nominal exchange rate increases as pass-through decreases. He used aggregate supply–aggregate demand model, adjusted for incomplete pass-through, and central bank's loss function.

Hüfner & Schröder (2002)[13] carried out study on five countries of euro area (EA) viz., France, Germany, Italy, Spain and the Netherlands; examine the effects of the change in the exchange rate on consumer price level for euro area. Their study covers 20 years from January 1982 to January 2001. The study was on the basis of the data from IMF International Financial Statistics (IFS) and Bank of England. They used the weighted harmonized index of consumer prices to measure the elasticity of consumer prices to the change in the nominal exchange rate. For realizing the objective, they have used the vector error correction model. At the aggregate level, (using the relative weights of each country's inflation rate in the harmonized index of consumer price) the study found that on an average, a 10 %depreciation of effective euro nominal exchange rate leads to an increase of 0.4 %inflation rate in the euro area after one year. The total effect

[12] He also elaborate his study in 2007 by taking in to account the indirect exchange rate response-and conclude that a monetary policy that response to CPI is welfare improving.

[13]Campa & Goldberg (2002) found and average pass-through of 0.61 for 25 OECD- partial in short-run while full in the long-run.

converges to 0.8 percentage point after about three years. The study suggested that monetary authorities should acknowledge exchange rate have an effect on inflation.

Other study on euro area (EA) by Burlon *et al.* (2018) evaluated the (ERPT) into euro area (EA) inflation by estimating an open economy New Keynesian model using Bayesian methods. In the model, the ERPT is incomplete because of local currency pricing and distribution services, with the latter allowing us to distinguish between ERPT at the border and ERPT at the consumer level. The results are: the ERPT into EA prices is, in general, high-particularly at times of exchange rate and monetary policy shocks and the EA monetary stance is relevant for ERPT, which is higher if the stance is accommodative when there are expansionary demand shocks.

In addition, using a panel annual -data set of 11 industrialized countries over the period from 1977 to 2001 Bailiu & Fujii (2004)[14] found evidence to support the hypothesis that ERPT declines with a shift to a low inflation environment brought about by a change in the monetary policy regime[15]. They suggest that pass-through to all three price indexes (IPI, PPI and CPI) declined following the inflation stabilization period that occurred in many industrialized countries in the early 1990s, but not following a similar episode that occurred in the 1980s.For example, their results indicate that pass-through to import prices in industrialized countries is high in the short-run and complete (or near complete) in the long-run –pass through to import is higher than CPI[16,17]. Indeed, the point estimates of 0.75 and 0.91 reported for short- and long-run pass-through respectively, suggest that a 1 per cent increase in the annual rate of depreciation of the trade-weighted nominal exchange rate in industrialized countries leads to, on average, a 0.75 per cent increase in the annual rate of inflation of import prices in that same year, and a 0.91 per cent increase in the long-run.

Adding to the above study, research by Yazdani (2017) with objective examine pass-through effects on domestic prices among the four selected Asian countries, Japan and S. Korea, Iran

[14]See similar study ,with slight difference , by Bailiu & Bouakez(2004)- the study was done using larger sample (20 industrialized countries)

[15]Gagnon &Ihrig(2004),using 20 industrial countries between 1971 and 2003, found significant link between pass-through and inflation.

[16]Stulz (2007) also find the same result using VAR –impulse response estimation approach based on monthly data covering data from 1976.01 through 2004.12 that is pass-through to import was .54 and 1.02 percentage point while it was 0.08 and 0.34 percentage point to CPI for the first month and after two year respectively.

[17]Bouakez & Rebie(2008) for Canada and Hajek (2014) for Czech republic

and Turkey with special emphasis on an interaction between prices, monetary policies and exchange rate changes. He applied Structural vector auto-regression (SVAR) method, by which the responses of such shocked variables are evaluated during 1970- 2015. Also, the results have shown that the pass-through shocks in the short-run are more effective in the countries which benefit from a managed floating exchange rate regime and inflation targeting policy.

Other study by Berner (2010), using a Germany micro data over 20 years, finds an incomplete pass-through with an average rate of 42 %over three months period to import. However the result varies –nearly zero statistically and very high when he consider European[18] and non European countries respectively. He also come-up with new discovery that good's quality and pass-through to imports are negatively correlated.

Other areas of literature regarding ERPT in developed countries are asymmetric and non[19] linearity's in pass-through (e.g Dellate & Lopez-Villavcencio, 2010; and Bejaoui, 2013). Dellate & Lopez-Villavcencio(2010) analysis the asymmetric response of prices(CPI) to exchange rate variation using ARDL model and a data from G-7 countries during 1920 to 2009. They evidenced that prices react differently depending on the direction of exchange rate movement to appreciation and depreciation in the long-run. Particularly, they found low pass-through in USA and Germany (0.9 and 1.6 %respectively) but the opposite to Canada (10%), France(80%), UK(10 %) and Japan-which might be due to string entry barriers. Similarly Bejoaui(2013), with a sample of 4 advance countries(USA, Germany, Japan and France) , investigate the possible asymmetry in reaction of export and import prices to the change in exchange rate between 1981 and 2011using quarterly data and asymmetric co-integrating ARDL model. The result shows export and import prices respond differently depending on the direction of exchange rate variation- specifically appreciations are more pass-through to export and import price than depreciations.

A more recent study on the non linearity of ERPT in EA was conducted by Cheikh *et al.*, (2018).The paper was aimed at providing empirical evidence on the nonlinearities in ERPT. Specifically, we explored the existence of nonlinearities with respect to the business cycle. Using quarterly data over the period of January 1980 to April 2015, their finding provide strong evidence of presence of nonlinearity in 7 out of 10 Euro-zone countries. They also showed that

[18] This might be, explained, due to trade restrictions such as tariff and non tariff barriers.
[19]Donayre and Panoska(2016) examined state dependent nonlinear ERPT in Brazil and Canada

the exchange rate transmission to inflation respond nonlinearly to the economic activity in the sense that ERPT is higher during expansion than recession periods. For instance, the pass-through coefficient in Germany is 0.02%, which is not significantly different from zero when GDP growth is below 1%, i.e., during an economic slowdown. However, when the German economy is growing faster, ERPT elasticity increases to about 0.13%.

Cheihk & Louhichi; and Bandt & Razafindrabe(2014, 2014) both investigate the impact of exchange rate movement (and hence ERPT) on euro area countries. Cheihk & Louhichi (2010) measure the pass-through of exchange rate changes into domestic inflation within a cointegrated VAR (CVAR) framework. Using quarterly data for 12 EA covering 1980:1to 2010:4, they found a large degree of heterogeneity in the rates of pass-through across our sample. For instance, prices rise by 84% in Portugal following 1%depreciation of exchange rate, while for the German economy the extent of pass-through is not exceeding 0.20%. This outcome would have important implications for the general risk perceived by foreign firms and investors regarding the inflationary environment within each EA country.

At the same period Bandt, & Razafindrabe (2014) analyze the impact of currency-invoicing decision of exporting firms on the extent of exchange rate pass through (ERPT) for several Euro-area countries during the period of June 2005 to July 2013. Mainly, they use a multi-currency approach to distinguish between invoicing strategies across the most important currencies for Euro-area imports and make a distinction between bilateral and multilateral (or effective) ERPT. Their result shows ERPT is incomplete in the short-run while complete in the long-run and most importantly they estimate time varying ERPT disclose the 2008 global crises contribute for the rise of ERPT.

New evidences have still been emerging to disclose the impact, role and interaction of ERPT to various economic variables. For example; Savoie-Chabot & Khan (2015) suggested that ERPT played an important role in inflation dynamics in Canada; Ali and Anwar (2016) provide evidence that ERPT can explain price puzzle, and Cao *et al*.,(2015);and Auer & Schoenle(2016) revealed, using the market structure, that ERPT can be determined by PTM when firms are setting export price with home currency and how firm's level of market share and price complementarities affect the pass-through decisions.

Furthermore, studies on Exchange rate (ERPT) became more complex and highly sophisticated (Pennings, 2017; Devereux *et al*., 2017). Pennings(2017) wants to know the pass-through of competitor's exchange rate to US import and producers prices which was neglect by other prior models. He used the BLS(Bureau of Labor Statistics) micro data and tried to show the prices of imported goods respond to the exchange rate of the producer's foreign competitors. The result advocates that pass-through will be larger for exchange rate movements shared by greater fraction of foreign competitors. For instance quantitatively the univariate- bilateral pass-through to import price is 0.23 as compared to pass-through of competitors RERs to import prices of around 0.35 the pass-through to producers' price is 0.11and 0.16 pass-through to us producers prices. But the model failed to match "elasticity puzzle".

Devereux et al.,(2017) explore the role of product market structure on ERPT and currency invoicing in international trade using very detailed transaction level data on Canadian import over six years period using monthly record of 70 months. At the start of the sample period, pass-through is just over 50%. By around 2004, pass-through has increased to just fewer than 80%. Pass-through then declines and hovers around 50% from 2006 onwards. The share of imports accounted for by larger importers increased from about 16% at the start of the sample to almost 21% by 2005, before decreasing slightly at the end of the sample to 19%. And they suggest that the larger the import market share of large importers, the lower is overall pass-through.

And they argued that, the share of imports accounted for by larger exporters (in terms of import market share) increased slightly in about the first year of the sample—from roughly 10 to 12%—but then stayed relatively flat. The increase at the start of the sample could be associated with the initial increase in overall pass-through if import market share is shifting toward larger exporters that are located on the upward-sloping section of the U-shaped relationship between pass-through and market share. On the other hand Kim &Lin (2018) by employing VAR models for US macroeconomic data, in contrast to Devereux et al. (2017), under floating exchange regime examine the role of energy price on ERPT. They found that effect of exchange rate shocks on domestic energy prices results in a higher response in CPI.

2.2.3 Review of Studies on Emerging Economies

Although studies on ERPT had long been started prominent literatures were done, on emerging economies, beginning from early 1990s due to Asian financial crises in 1990s and the interest to know that low(decline) ERPT in those economies is as the result of low inflationary environment or else other.

García & Restrepo(2001) using a price equation based on a model of imperfect competition and employing quarterly data for Chile from 1986 Q1 to 2001 Q1 elucidate the relationship between price inflation and ERPT. Their result show that a 100% rise in the exchange rate produces an accumulated impact on prices of around 33% in the first two years (8 quarters) and pass-through increases approximating to 100% in the very long-run. This means that a nominal devaluation will not be proportionally translated into prices in the short-run, affecting the real exchange rate.

Additionally, using VAR model, Gueorguiev (2003) quantified ERPT in Romania and concluded that pass-through is fast and large (from exchange rate against US dollar) and seems to be moderate, at a time, to producer prices. That is ERPT reaches maximum as 59-72 %of Exchange rate change for producer prices and 27-43 %for consumer prices.

COZMÂNCĂ &MANEA (2010) also performs a very deep analysis on ERPT and various price indices(producers, import , consumer and others) and concludes the following: i) very high pass-through but declining in short-run and high in long-run to import prices(86%in the short-run-3 months,74% after 1 year and 81% after 5 years) ii) incomplete pass-through into producer and declining in short-run and high in five years(17%,11% and 35% respectively) iii) incomplete and non declining to consumer prices in short-run , a year after and five years later(13% ,20%, 41% respectively). The two studies are consistent each other.

Rowland (2004), by using 20 years monthly data from January 1983 to October 2002 and applying unrestricted (VAR) framework in Colombia[20] examine ERPT to domestic prices. The result shows ERPT to import is 80% but 28 % to producer prices within 12 months.

Other study was conducted by Ghosh & Rejan(2006) on Hong Kong & Singapore to examine ERPT for the period 1980 to 2005. They found that ERPT is higher for Honk Kong than Singapore and it changes over time. ERPT in India is found to significant but incomplete (Bhattacharya et al., 2008)[21]

Most importantly, Ito &Sato (2006) analyses the pass-through effects of exchange rate changes on the domestic prices in the East Asian countries (post crises) VAR approach including several price indices and domestic macroeconomic variables as well as the exchange rate. Their result

[20]Rincón-Castro & Rodríguez-Niño(2018) (in Colombia)examine the nonlinear state and shock dependence of exchange rate pass-through on prices using VAR and monthly data. They found that ERPT is non linear and endogenous.

[21] Using VAR model and the data from 1997 to 2007 on nominal exchange rate and Consumer price index

shows that the degree of exchange rate pass-through to import prices was quite high in the crisis-hit countries; the pass-through to CPI was generally low, with a notable exception of Indonesia: and monetary policy variables to exchange rate shocks and that of CPI to monetary policy shocks are positive, large and statistically significant.

Ca‘ Zorzi*et al*. (2007) examine exchange rate pass-through to prices for 12 emerging markets in Asia, Latin America and Central and Eastern Europe by applying vector auto regressive (VAR) models. The result verified that exchange rate pass-through is higher in import prices than consumer prices because of variation across the pricing chain. They also found that ERPT to developed and emerging economies are not far more, the relationship between ERPT and inflation rate lies within Taylors’s hypothesis. For example, for set of countries with average inflation rate of 10% or less, the exchange rate pass-though was generally less than 10%, however, the exchange rate pass-through was around 40% for countries that included in average inflation rate between 10% and 20%.

Recent literature on ERPT of emerging economies explores its asymmetries, non linearity, imperfect pass-through, inflation targeting and relation to monetary policy as studies do for developed countries (Baharumshah*et al.*, 2017;López-Villavicencio & Mignon,2017;Soon & Baharumshah ,2017; and Liu and Chen,2017).

López-Villavicencio & Mignon (2017) the exchange rate pass-through (ERPT) to import and consumer prices for a sample of 14 emerging countries over the 1994q1-2015q3 period. They expand the traditional bi-variate relationship between the nominal effective exchange rate and inflation by accounting for monetary stability proxied by the inflation environment, monetary policy regime and central bank behavior. They show that both the level and volatility of inflation and credible monetary policy (inflation targeting) reduce ERPT to consumer prices. These factors leads to cross country difference in ERPT to import and consumer prices. However, uncertainty about domestic monetary policy seems less relevant in explaining the pass-through to the price of imports.

Baharumshah *et al.*, (2017)[22] examines the ERPT to consumer price changes in Mexico using monthly data from 1990 to 2015 with nonlinear ARDL model. They affirm that ignoring asymmetry (sign) of ERPT will lead to invalid policy conclusion; ERPT is higher during

[22]A study by Guerra(2017), provides a more dynamic and detail discussion of ERPT by taking in to account the four exogenous shocks: productivity, cost-push, risk-premium and monetary shocks and reveal that ERPT to consumer prices are very low in Mexico with the model of small open economy.

depreciation than appreciation; inflation targeting reduces ERPT and oil price shock passes-through to domestic inflation during post inflation targeting period[23].

Similar study by Odria *et al*.,(2012) analyzes whether the exchange rate pass-through into prices changed when the inflation targeting scheme was adopted in Peru. They use DSGE and monthly data from April 1994 to December 2007 for their investigation. They found statistically significant decline in ERPT to import, producer and consumer prices for up to 3 years after the shock. They also noted that inflation targeting shrinks ERPT.

A study in China by Liu & Chen (2017) indicates that ERPT has had a limited but growing effect on domestic prices and will continue to do so. The research considers the effect of exchange rate (ER) level on China's domestic prices during the period of 2003–2012. They examine China's consumer price index (CPI), import price index (IPI) and producer price index (PPI) by using time series VEC analysis. They found that find that a shock on NEER has negative effect on CPI which depicts that real money balance (RMB) appreciation will cause CPI decrease. For example they show a shock on NEER has negative effect on CPI. The impact from exchange rate to the CPI added up gradually and reached the highest point of 0.36% around the seventh month. A shock on PPI has positive effect on CPI. The effect is quick (reaches the highest point in the first months at about 0.36%) and then faded out to 0.1% after 12 months. A shock from imported price also has positive effect on CPI. It reaches the highest point after 3 month to 0.18% and slowly fades out. The results show a short-term pass-through channel from exchange rate to the CPI through imported price and PPI.

2.2.4 Review of Studies on Developing (and SSA) Countries

Using a sample of 24 developing countries over the period from 1980 to 2003, BARHOUMI (2005) examine ERPT to import prices with variable such as nominal exchange rate (NER), price of competitor's product, exporter's cost and demand condition. His result indicates that there is no long-run homogeneity in the pass-though across countries due to exchange rate regimes, trade barriers and inflation regimes. Similarly, he also conducted a study on 2008 to examine whether ERPT to imports in developing countries were declining. The result matches the hypothesis.

[23]For detail empirical explanation see Baharumshah *et al.*, (2017)

Fankel *et al*., (2012) conducted a research to verify or disprove the previous thinking that ERPT is high for developing data. Using a new data set-price of eight narrowly defined brand commodities, observed in 76 countries -- they found empirical support for some of the factors that have been hypothesized in the literature, but not for others. Significant determinants of the pass-through coefficient include per capita incomes, bilateral distance, tariffs, country size, wages, long-term inflation, and long-term exchange rate variability. Some of these factors changed during the 1990s. Part (and only part) of the downward trend in pass-through to imported goods prices, and in turn to competitors' prices and the CPI, can be explained by changes in the monetary environment – including a fall in long-term inflation

A study on Latin America by Ghosh (2013)[24], has estimated exchange rate pass-through (ERPT) into CPI and import prices from 1970 to 2010 for 9 Latin American nations. ERPT is further estimated for each decade documenting declining pass-through after the turn of the millennium. The paper also examines the impact of macro fundamentals on ERPT, and found monetary policy stability, inflation rate and trade openness to have a positive impact on pass-through. Finally, de facto exchange rate inflation indices are constructed and ERPT rates are found to negatively affect them.

Akofio-Sowah (2009) examined the relationship between ERPT and monetary regime in 15 SSA countries during the period 1980–2005. He concluded that the pass-through was lower in countries under a low inflationary environment.

The International Monetary Fund's (IMF) working paper of Razafimahefa (IMF, 2012) extended the ERPT analysis to 34 SSA countries on a quarterly time series from 1980 to 2005 using a vector auto regression (VAR) framework. The author suggested that there was a declining pass-through in the 1990s due to macroeconomic reforms. It also noted that ERPT was incomplete which higher following depreciation than after appreciation and also ERPT lower in flexible exchange rate regime and could be reduced with low inflation, prudent monetary policy and sustainable fiscal policy.

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[24]Moldasheva (2013), using cointegraion method, estimated the degree of exchange rate pass-through (ERPT) into import prices for Central Asia countries over period 1995q11-2012q11 using production price indices (PPI) of three major trading partners of Central Asia countries: PPI of Russia, PPI of Turkey and PPI of China which results in varying outcome across trading partner and countries under consideration.

Most of these studies neglect the asymmetry and nonlinearity assumption between exchange rate changes and domestic prices in the SSA countries, as well as cross-sectional dependence across countries, which may lead to biased results as explained by Kassi *et al* (2019). They have investigated the relationship between the exchange rate movements and the consumer price index in 40 sub-Saharan African (SSA) countries using quarterly data from 1990 to 2018 by employing the nonlinear autoregressive distributed lag (NARDL) approach which accounts cross-sectional dependence; Feasible General Lest Square (FGLS) and POLS. Their results were: i) there was an asymmetrical exchange rate pass-through (ERPT) in most of the SSA countries generally in the short-term, except for the CFA franc sub region (WAEMU and CEMAC sub regions), where asymmetry occurred in both the short and long-term. ii) The hypothesis of zero pass-through did not hold in many SSA countries, nor did the hypothesis of complete ERPT in the short and long-term. Thus, consumer prices reacted more strongly to local currency depreciations than appreciations in the short-term. iii) Exchange rate pass-through into prices has not declined after the 1990s, especially over the long-term in the CFA franc zone. It was higher in the CFA franc zone (fixed exchange rate regime) with low price levels (1.04%) compared with the other SSA countries (floating exchange rate regime) associated with a high average inflation level (3.13%) when the analysis allowed for cross-sectional dependence between panel units. The ERPT coefficients differed between the SSA countries and the developing and emerging Asian countries. The ERPT in the SSA countries was lower than that in emerging Asian countries in the long-term.

2.2.4.1 Country Specific Studies in Developing Countries

Country specific studies which most importantly used to explain the relationship between exchange rate and inflation are briefly reviewed here under.

A study by Faryan (2016) revealed that ERPT was higher during depreciation than appreciation using disaggregated consumer price data and NARDL approach. It adds food prices are sensitive to appreciation and the consumer prices responsiveness was nonlinear to the direction and size f exchange rate change. In Turkey, the outcome of Karamelikli1, Korkmaz (2016) study using similar approach of Faryan suggests asymmetrical effect of ERPT consumer price with respect change in exchange rate.

Four empirical studies in relation to South Africa were conducted (Parsley & Oladipo, 2010; Kabundi & Mlachila, 2018; Majana, 2018 and Oladipo, 2017). The result of Parsley & Oladipo suggests ERPT was incomplete in the short-run but it become complete in the long-run. Mjanja found that ERPT to import is comparable[25] to the ERPT of developed and emerging countries. On the other hand, Kabundi & Mlachila (2018) examine the relationship between monetary policy credibility and ERPT (inflation targeting). The study confirms the remarkable achievement that, despite the many shocks that the economy has witnessed the declining pass-through is indeed explained by the improving monetary policy credibility.

Wimalasuriya (2009) has examined ERPT to various prices in Sri Lanka and ERPT was found to 50% with long linear model and 30% using VAR despite it was complete for wholesale prices. Further he argued that exchange rate affects trade balance. In addition, Bangura *et al* (2012) have explored EPRT to consumer prices in SEIRRA-LEONE and suggested that exchange rate fluctuation is the potential sources of inflation.

Further, Mushendami (2016), in Namibia, has studied degree ERPT to different prices using SVAR for the 2000to 2014. ERPT was found to be very low and incomplete with 0.04 and 0.01 to import and consumer prices respectively in the first quarter and 0.02 in the eighth quarter.

Ntsosa & Nkwe (2016) have surveyed impact of exchange rate fluctuation and other macroeconomic variable on inflation in Botswana using quarterly data from 1998 to 2013. Having VECM employed, ERPT was found to be incomplete with coefficient of 0.02. Usman and Musa (2018), applying cointegrated autoregressive model for annual data 1960 to 2015, examined ERPT to consumer price inflation in Nigeria[26] and found that there was positive relationship between exchange rate and consumer price inflation both in short-run and long-run while in Egypt it was substantial but incomplete (Helmy, Fayed & Hussien,2018).

Mwse (2006)[27] using SVAR model quantified ERPT for the period 1990q1-2005q1 in Tanzania and found ERPT declined after depreciation with pass-through elasticity of 0.087 before depreciation- years before 1995 and 0.023 after depreciation-years after 1995. But for afull sample it was 0.028.

[25]Belaisch(2003) argued that ERPT of Brazil is comparable to G-7 countries although the effects on prices expected to faster

[26]For other studies in Nigeria see also Aliyu et al(2009), and Fatai & Akinbobola(2015)

[27]Dehem and Guemazi (2016) have examined ERPT and monetary policy in Tunisia with disaggregated VAR analysis for the period 2000 to 2015 showed that the total exchange rate pass-through is about 20% after 2011.

The strong significant link between exchange movement and inflation was found by Bwire *et al.*,(2013) using quarterly data for the period 1999 to 2012 in Uganda. In this study, a well specified SVAR and VEC approach yields the dynamic ERPT elasticity of 0.48. Hence, it can be argued that exchange rate is the important source of inflation in Uganda.

Similarly, Arabi (2015) has investigated ERPT in relation to import and consumer prices in Sudan using error correction model for the period 1960 to 2011and found ERPT to consumer price was 47%. The ERPT to consumer price was higher than that import price –while consumer price adjusts in two lag import price adjusts in one lag. Thus, exchange rate has important role in determining inflation in Sudan. In addition, his comparative study of ERPT to consumer price in Cameroon and Kenya for the period between 1991 and 2012, Revelli (2020) stated ERPT varies between .18 and .58 in the short-run but 0.3125 in the long-run.

Using the monthly data (from 2001 to 2006), Vicente (2007) applied cointegration analysis with the associated error correction method to examine the effect of money , exchange rate and South African prices on consumer price in Mozambique. The result revealed that among the other things exchange rate was important determinant of inflation. As per this study, a 1% decrease in exchange rate leads to 0.15 % rise in price level.

Zgambo & Chileshe(2012), in their study of effectiveness of monetary policy in Zambia -using ARDL for money demand function(considering exchange rate as one determinant) and VAR for monetary transmission mechanism (MTM) , showed that exchange rate was an important channel for the transmission of monetary policy.

In Ethiopia early study has been done by Helen (2012)[28] to examine the exchange rate pass-through in Ethiopia. The study was conducted based on quarterly 1992-2010. The study applied Conditional Vector Autoregressive (CVAR) and SVAR models and found that ERPT in Ethiopia during the study period has been significant and moderate, and persistent in the case of import prices with 0.29 magnitudes. However, the ERPT was low and short lived in the case of consumer prices. However, Mohammadnur (2012) found a 1% change in exchange rate increase the CPI by 4.75 % in the first year using different sampling period.

[28] See for example Mohammadnur (2012), Mekasha & Molla (2015), Fetene(2015) and Andualem et al., (2017) for similar studies.

The latest study by Gudina Goda Korsa *et al.*, (2018) has examined effect of devaluation on domestic price using quarterly data from 1995 to 2017 and found a 1 % devaluation of nominal exchange rate results in an increase of inflation by 3.92 % after one year and the shock falls to 1 % after three years. The study concludes that the exchange rate pass-through in Ethiopia for the period under consideration is incomplete (less 100 %).

Using a monthly data from January 2001 to December 2009, Khemiri & Ali (2012) examined ERPT and inflation using Markov Switching. They found that ERPT was low in low inflation environment and high in high inflation environment. Further study by Soon & Baharumshah (2017) using Markov Switching Intercept Autoregressive Heteroskedasticity (MSIAH) model, have examined inflation dynamics and ERPT in Malaysia in nonlinear perspective. They found two regimes for sample period 1990Q1 to 2015Q4 they confirmed that ERPT was partial and asymmetry on which exchange rate depreciation has stronger effect on inflation than appreciation.

In general in the above studies application of NARDL models are scarce and are becoming superior to other models in capturing nonlinearity with respect to asymmetries of ERPT to consumer price inflation.

Table 2.1 Summary of the Major Empirical Literatures

Author	Title	Methodology	Conclusion
Goldfajn & Werlang(2000)	*The pass-through from depreciation to inflation : a panel study*	✓ Monthly data from 1980 to 1998 of 71 countries ✓ Apply fixed effect and Generalized Least square	✓ Output gap, RER and degree of openness are significant determinant of ERPT ✓ Higher depreciation may cause higher inflation
Choudhri & Hakura (2001)	*The exchange rate pass-through to domestic price: Does Inflationary Environment Matter?*	✓ Using NOEM it tests Taylor (2000) hypothesis ✓ Used 71 countries' data from 1979-2000	✓ Taylor Hypothesis validated
Choudhri & Hakura (2015)	*The exchange rate pass-through to import and export prices: The role of nominal rigidities and currency choice*	✓ Using Regression and VAR model quarterly data from 1979-2010 of 16 advanced and 18 emerging countries	✓ ERPT is incomplete ✓ Both producer and local currency pricing can explain the pass-through evidence even with a constant markup.
Devereux & Yetman(2002)	*Price Setting and Exchange Rate Pass-through: Theory and Evidence*	✓ Using quarterly data of 122 countries ✓ Apply model of New Keynesian small open economy	✓ 'looser' monetary policy end up with higher pass-through ✓ Low ERPT due to short-run price rigidities
Devereux &Yetman(2010, 2008)	*Price Adjustment and Exchange Rate Pass-through*	✓ Using a yearly data from 1970-2007 of 119 countries ✓ Apply model of New Keynesian small open economy	✓ Price stickiness (slow price adjustment) is a key determinant of ERPT and should be endoginize in designing monetary policy
Carrière-Swallow et al., (2016)	*Monetary Policy Credibility and Exchange Rate Pass-Through*	✓ Monthly data from January 2000-December 2005 of 31 advanced and 31 emerging economies ✓ Fixed effect model exercised of estimation	✓ Price stability and central bank credibility reduce ERPT
Knetter(1994)	*International Comparisons of Pricing-to-Market Behavior*	✓ Using the four advanced countries industry level data ✓ Covariance constrained model	✓ Type of industry as a source of PTM and PTM is the cause of ERPT
Taylor (2000)	*Low Inflation, Pass-Through, and the Pricing Power of Firms*	✓ Using monthly data from 1960M2 to 1979M1 and 1982M1 to 1999M3 of U.S. data ✓ VAR	✓ Low pass-through is due to low inflation ✓ ERPT and inflation has positive relationship

McCarthy (2000)	*Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies*	✓ Using nine of the OECD from 1976 to 1982 and 1983 to 1998 ✓ VAR come in to place for estimation	✓ Pass-through is larger in countries with a larger import share and more persistent exchange rates and import prices
Hufner & Schroder (2002)	*Exchange Rate Pass-Through to Consumer Prices: A European Perspective*	✓ Five Euro area countries' data 1982 to 2001 ✓ VEC	✓ ERPT is incomplete and should be acknowledged in designing monetary policy
Burlon et al., (2018)	*Exchange rate pass-through into euro area inflation. An estimated structural model*	✓ Open economy New Keynesian model using Bayesian methods ✓ Quarterly data from 1999Q1-2017Q2 used	✓ ERPT is incomplete because of local currency pricing and distribution services
Bailliu & Fujii (2004)	*Exchange Rate Pass-Through and the Inflation Environment in Industrialized Countries: An Empirical Investigation*	✓ Using 11 industrialized countries yearly data from 1977 to 2001 ✓ GMM	✓ ERPT declines with a shift to a low inflation environment brought about by a change in the monetary policy regime
Yazdani (2017)		✓ Using a yearly data from 1970- 2015 of four Asian countries ✓ SVAR approach	✓ ERPT effective over short-term under floating exchange rate regime and inflation targeting
Dellate & Lopez-Villavcencio (2010)	*Asymmetric responses of prices to exchange rate variations.Evidence from the G7 countries*	✓ Yearly data from 1920 to 2009 using asymmetric cointegrated ARDL	✓ Prices react differently to appreciations and depreciations inthe long-run
Cheikh et al., (2018)	*Nonlinear Exchange Rate Pass-Through: Does Business Cycle Matter?*	✓ Monthly data from January 1980 to April 2015 of 10 countries ✓ Logistic smooth transition models	✓ ERPT is higher during expansion than recession periods
Bandt, & Razafindrabe (2014)	*Exchange rate pass-through to import prices in the Euro-area: A multi-currency investigation*	✓ Using monthly data fromJune 2005 to July 2013 ✓ LSDV	✓ Short run ERPT is incomplete, while long run effective ERPT is complete
Kim and Lin(2018),	*Exchange Rate Pass-Through to Consumer Prices and the Role of Energy Prices*	✓ Monthly data of U.S from 1973M1 to 2017M4 was used ✓ VARtechniques to estimate the coefficients	✓ Weak evidence of ERPT pre-1990 but strong significant ERPT post-1990
Ito & Sato(2006)	*Exchange Rate Changes and Inflation in Post-Crisis Asian Economies*	✓ Using VAR approach ✓ Data from 1993M1 to 2005M8	✓ Degree of ERPT to import priceswas quite high in the crisis-hit countries, ✓ The pass-through to CPI was generally low

López-Villavicencio & Mignon (2017)	*Exchange rate pass-through in emerging countries: Do the inflation environment, monetary policy regime and central bank behavior matter?*	✓ 14 emerging countries over the 1994Q1-2015Q3 ✓ GMM and fixed effect as estimation technique	✓ Level and volatility of inflation ,and inflation targeting reduce ERPT
Baharumshah*et al.*, (2017)	*Asymmetric exchange rate pass-through in an emerging market economy: The case of Mexico*	✓ Uses monthly Mexican data from data from 1990 to 2015 ✓ NARDL	✓ Exchange rate fluctuation is transferred to prices level more during currency depreciation than appreciation. ✓ ERPT low after inflation targeting
Faryan(2016)	*Nonlinear Exchange Rate Pass-Through to Domestic Prices in Ukraine*	✓ Used monthly data from January 2007 to April 2016 ✓ NARDL	ERPT was higher during depreciation than appreciation
Karamelikli1&Korkmaz(2016)	*The Dynamics Of Exchange Rate Pass-Through to Domestic Prices In Turkey*	✓ Used monthly data from January 2003 to November 2015 ✓ NARDL	Asymmetrical effect of ERPT consumer price with respect change in exchange rate.
Brun-Aguerre et al., (2012,2016)	*Heads I win; tails you lose: Asymmetry in exchange rate pass-through into import prices*.	✓ Quarterly data from 1980 to 2010 for 33 emerging countries ✓ NARDL	✓ ERPT asymmetry in both short-run and long-run during depreciation (higher) and appreciation(lower) ✓ Import-dependent economy benefit from trade liberalization.
BARHOUMI (2005)	*Differences in Long Run Exchange Rate Pass-Through Into Import Prices In Developing Countries: An Empirical Investigation*	✓ Using a period from 1980 to 2003 of 24 developing countries ✓ Non-stationarypanel estimation techniques(FMOLS and DOLS)	✓ No long-run homogeneity in the pass-though across countries due to exchange rate regimes, trade barriers and inflation regimes ✓ ERPT declines after 2008
Fankel*et al.*, (2012)	*Slow Pass-through Around the World: A New Import for Developing Countries?*	✓ Using VEC model and 76 countries yearly data from 1990 to 2001 of 8 commodities data	ERPT determined by per capita incomes, bilateral distance, tariffs, country size, wages, long-term inflation, and long-term exchange rate variability
Akofio-Sowah (2009)	*Is There a Link Between Exchange Rate Pass-Through and the Monetary Regime: Evidence from Sub-Saharan Africa and Latin America*	✓ Using 15 SSA and 12 Latin American countries during the period 1980–2005 ✓ Dynamic panel: Fixed and Random effect model	✓ Pass-through was lower in countries under a low inflationary environment, and ✓ ERPT was low in extremely fixed exchange rate regime with doubt evidence of the link to regimes changes
Razafimahefa (IMF, 2012)	*Exchange Rate Pass-Through in Sub-Saharan African Economies and its Determinants*	✓ Using 34 SSA countries with quarterly data from 1980 to 2005 ✓ VAR	✓ ERPT was incomplete which was higher following depreciation than after appreciation ✓ ERPT lower in flexible exchange rate regime and could be reduced

			with low inflation, prudent monetary policy and sustainable fiscal policy.
Kassi et al., (2019).	*Asymmetry in Exchange Rate Pass-Through to Consumer Prices: New Perspective from Sub-Saharan African Countries*	✓ Using a quarterly data from 1990 to 2018 of 40 SSA countries ✓ NARDL, POLS and FGLS	✓ ERPT was asymmetrical, incomplete, non-zero, higher during depreciation and in higher change than after appreciation and small change ✓ ERPT low in fixed regime with low inflation environment than flexible with higher inflation environment.

2.3 Summary and evaluation of the literatures

Although, large amount of literature on ERPT are available, most of them mainly done on US followed by advanced countries. Giving the next weight to emerging economies, studies on developing countries are relatively lower and it worsens in Africa especially to Sub-Saharan African (SSA) countries especially in panel data method.

The vast body of literature concerning ERPT can be broadly classified as those done at micro level and those which are conducted at macro level. Studies conducted at micro-level focused in examining ERPT into disaggregated import prices of specific domestic industries-based on pricing strategies like PCP and LCP. On the other hand, those conducted at macro level examined ERPT into aggregate price indices: examines the degree of pass-through into aggregate import and consumer prices (taking in to account factors such as price stickiness).

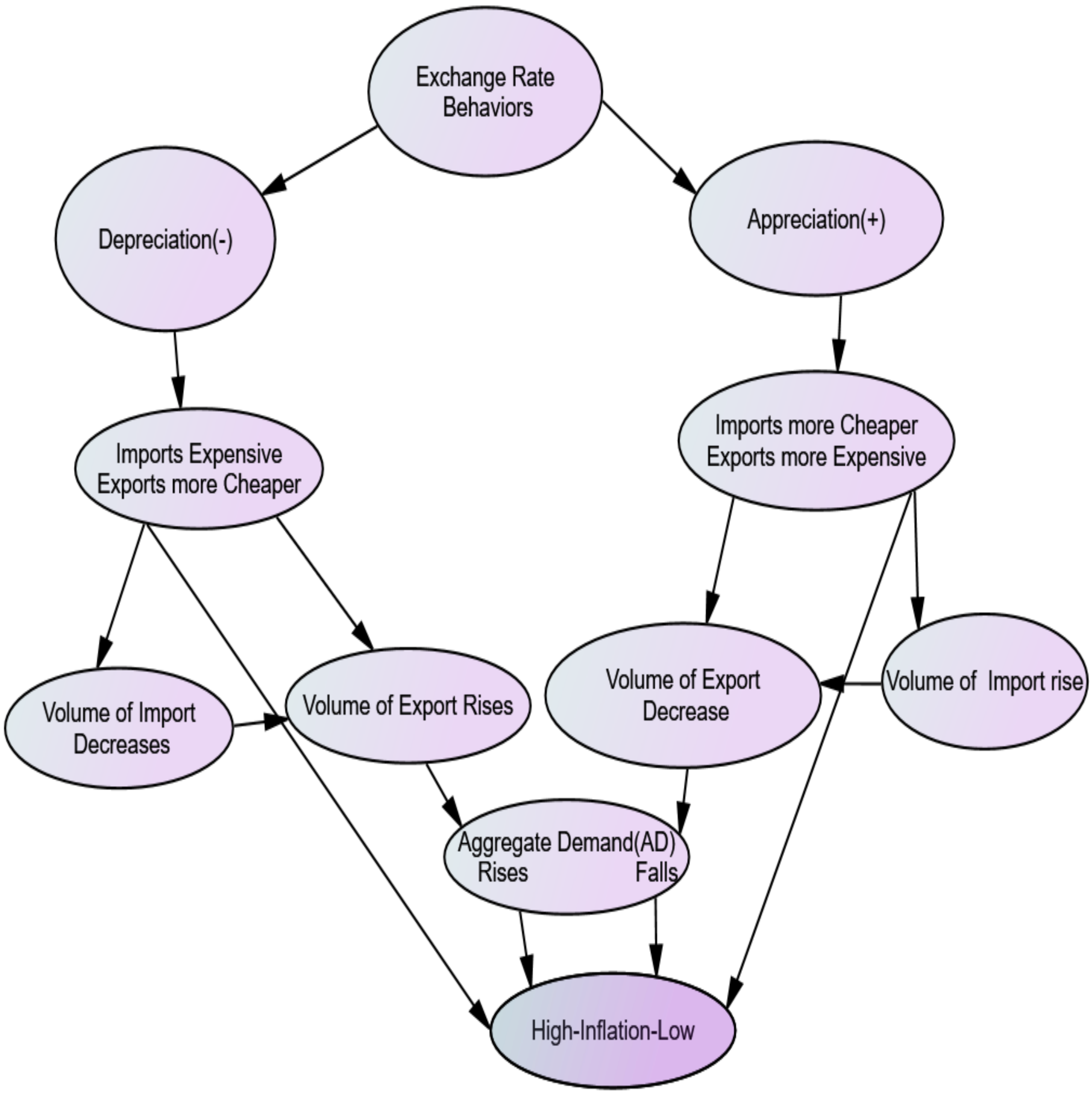
Among these, some are conducted on country level while some others are at cross country comparisons and at industry and individual level. In general previous studies try to analyze the following basic issues concerning ERPT: i) estimate the degree of pass-through to various price indices ii) try to explain complete-incomplete pass-through and why it is declining iii) whether it is a macro or micro phenomenon iv) why pass-though is lower for domestic prices than import prices and v) whether pass-through is symmetric or asymmetric vi) what factors contribute to non linearity in ERPT vii) test Taylor's hypothesis with data and viii) Why depart from PPP in the short-run but may not be in the long-run.

In sum most studies argued that(see Table 2.1); i) ERPT is incomplete in the short-run but complete in the long-run ii) credible monetary reduces ERPT iii) the gap between developed and developing countries in terms of degree of ERPT get minimized iv) endoginity of exchange rate and inflation to the analysis, except earlier studies based PPP v) ERPT to import is higher than to consumer prices but modest to producers prices iv) micro versus macro debate continue v) controversial conclusion still alive.

These studies relate to different periods, based on different data sets, considered different variables and have used different models and hence have reached contradictory results. Beyond these limitations studies are very limited in using NARDL(which is becoming superior to others) models and even very few of these studies have examined ERPT using NARDL using panel data set in SSA. But as this region has experienced repeated currency devaluation (with further downward pressure of real exchange rate) and work toward flexible exchange rate and inflation targeting studies on ERPT are found to be very interesting and important.

Bases on the above theoretical and empirical evidences this study design the following general form of conceptual framework of the pass-through due to the change in exchange rates.

Figure 1 : Conceptual Framework: Pass-through from Change in Exchange rate to consumer prices



Source: Own design Based on the reviewed literatures and www.economichelp.org

The behavior of exchange rate, citrus paribus, has implication on the behavior of prices. A decrease in exchange rate (negative change) which is depreciation of local currency could make import expensive which directly increase price but export cheaper. When import expensive and export become cheap, the volume of import decline while the volume of export rises. An increase in export would then improve current account and increases aggregated demand. The rise in aggregate demand results in higher price.

An increase in exchange rate (positive change) which is appreciation of local currency is expected to make import cheaper and export expensive resulting in lower competitiveness in international market. This also leads to lower price directly. The decline in the volume of export could worsen current account and the rise in import also cost the importing country to pay for imports in foreign currency. All these lead to decline in aggregate demand which still yield lower in general price level.

CHAPTER THREE

RESEARCH METHODOLOGY

This chapter deals with the sources, nature and description of the data followed by analytical and econometrical approach. Under the umbrella of the later methodology this chapter presents the process from theoretical model formulation to practical model estimation techniques. Some relevant econometric issues are also addressed.

3.1 Sources of the Data and Variable Description

The main interest of this study is to examine inflation dynamics along with the changes in Money Supply (MS) as % of GDP, APSP crude oil($/bbl) in USD(OIL), nominal effective exchange rate (NEER) and the output gap (YGAP). The study covered a period from 1992Q1 to 2018Q4 for 14 selected Eastern and Southern Africa of SSA countries namely; under which countries are classified by exchange rate regime based on IMF(2020) defacto classification of exchange rate regime and arrangements ; Burundi, Ethiopia, Kenya, Rwanda, Tanzania, Uganda, Botswana, Lesotho, Madagascar, Malawi, Mozambique, Namibia, South Africa, and Zambia. The employed quarterly secondary data available from different sources is presented in Table 4.1).This study conducted using a Panel NARDL analysis.

The inclusion of money supply (MS) in to analysis is to control effect of monetary policy (GudinaGodaKorsa et al., 2018)which significantly helpful in estimating ERPT (McCarthy, 2000)while the output gap (Baharumshah, Soon & Wohar, 2017) is vital to capture demand shock (Baillu & Fujii, 2004: and Helen, 2012). World crude oil price is employed to track the impact of international supply shocks which might affect exchange rate and inflation.

Nominal effective exchange rate is applied instead of the bilateral exchange rate vis-à-vis the US dollar due to i)bilateral exchange rate in not allow for a enough variation to estimate its effect on consumer prices and other variables of interest ii)Nominal effective exchange rate could capture better the change in the cost of import that would affect the domestic price iii)almost all countries in the world engage in trade with more than one country i.e. multilateral trade rather than bilateral trade which bilateral exchange rate consider only small effects(Ito & Sato,2006).

This study uses the natural logarithm of all variables for the purpose of consistency. Further countries are grouped in to two regimes (Fixed and Flexible) for a better comparative analysis and the description of the variables, their sources and countries are summarized in the following table.

Table 3.1Data Description

No.	Name	Description	Source	[29][30]Country Grouping Flexible Regimes	Fixed Regimes
1	LCPI	Log of Consumer Price Index	IMF, IFS(2020) base year 2010	Kenya	Botswana
2	LNEER	Log of Nominal Effective Exchange Rate	BRUEGEL	Madagascar	Burundi Ethiopia
3	LMS	Log of Broad Money Supply(M2)%GDP	WBDIDB[a]	Mozambique	Lesotho
4	LOIL	Log of World Oil price(APSP[b] US $/bbl)	IMF, IFS(2020)	South Africa	Malawi
5	LYGAP	Log of Output Gap(from GDP constant US$, base year =2010)	"	Uganda	Namibia
6	LNEERPOS	Log of increase in NEER(Appreciation)		Zambia	Rwanda
7	LNEERNEG	Log of decrease in NEER(Depreciation)			Tanzania

Note: "a'-refers to World Bank Development Indicators Data Base (WBDIDB); 'b' indicates APSP which stands for average petroleum spot price

3.2 Analytical and Econometric Approach

Modeling economic time series in non linear fashion is not uncommon in several empirical studies. Exchange rate and inflation are variables which exhibit number of up and down in their pattern. Thus, the linear model might not be appropriate to explain the nature of these data. To model inflation dynamics this study develops ARDL. The concept of ARDL has been used in econometrics for decades and employed as tools of investigation cointegration relationship among variables (Tansuchat & Yamaka, 2015).

The merit of ARDL approach is that it can deal with short-run spurious regression problem without transforming the data (but depending on the theoretical relationship) in order to achieve

[29]This paper uses the de facto classification of exchange rate regimes (IMF, 2020) on which countries are aggregated in to two groups by naming soft pegs(Conventional peg ,stabilized arrangement , Crawling peg and Crawl-like arrangement) as Fixed regimes but free floating, floating and others managed are categorized under Flexible regimes

[30] Result based on simple classification of countries by region i.e., Eastern and Southern Africa countries yields no significant outcome- being in East or South doesn't significant effect on ERPT. The result make available upon request.

stationary. To resolve this spurious problem, the error correction term, which is used as the estimation of the long-run and the speed of adjustment to equilibrium, is incorporated in the ARDL model and thereby having both long-run and short-run analysis in the model.

In other words ARDL is applicable on stationary, integrated and mutually cointegrated variables meaning it doesn't require the same order series to find possible cointegrating relationship between variables (Bejaoui.2013). This study applies a non linear ARDL model by using the partial sums for nominal exchange rate to capture asymmetric effect (Shin et al., 2014)

3.2.1 Panel ARDL Model

Before presenting the ARDL model this study look at the theoretical foundation of exchange rate. The purchasing power parity (PPP) theory is the theoretical foundation of the effect of change in exchange rate on domestic price. Following the works of Kassi *et al.*, (2019), the symmetric (linear) functional form of the model is:

CPI=F ($NEER^+$, MS^+, OIL^+, $YGAP^+$)……………………………………………………….(1)

Taking the log both of side of equation Eq. (1) becomes;

$$LCPI_{it} = a_{i0} + \beta_{i1}LNEER_{it} + \beta_{i2}LMS_{it} + \beta_{i3}LOIL_{it} + \beta_{i4}YGAP_{it} + e_{it} \text{…..……..…..…...} \quad (2)$$

Where i=1,2,…N indicating number of countries whereas t=1,2,…T number of periods(in our case number of quarters), a_{i0} *is an intercept* , $\beta_1, \dots \beta_4$ are elasticity parameters (coefficients) to be estimated for each independent variables.

The above empirical model can be transformed in to the following linear ARDL (p, q_1, q_2, q_3, q_4)model. where p is the lag order of the dependent variable LCPI and q_1, q_2, q_3, q_4 are the lag orders of the independent variables.

$$LCPI_{it} = \mathcal{W}_{i0} + \sum_{k=1}^{p-1} \phi_{ij} LCPI_{it-j} + \sum_{j=0}^{q-1} (\mathcal{W}_{1ij} LNEER_{it-j} + \mathcal{W}_{2ij} LMS_{it-j} + \varphi_{ij} LCPI_{it-j} + \mathcal{W}_{3ij} LOIL_{it-j} + \mathcal{W}_{4ij} YGAP_{it-j}) + e_{it} \text{……………………………………………………….} \quad (3)$$

Where $\mathcal{W}_{1ij}, \dots, \mathcal{W}_{4ij}$ are kx1 coefficient vectors ϕ_{ij} *and* φ_{ij} *are vector of scalars* , e_{it} is the error term assumed to have normal distribution with mean zero and variance σ^2 *and* $j = 0, \dots, q-1$

Re-parameterizing Eq.(3) yields an ARDL model with error correction. The error correction term is the estimation of long-run relationship or speed of adjustment (Pesaran at al., 2001).

Thus, Eq. (3) can be rewritten in the error correction form as:

$$\Delta LCPI_{it} = \mathcal{W}_{i0} + \phi_{ij}LCPI_{it-1} + \mathcal{W}_{1i}LNEER_i + \mathcal{W}_{2i}LMS_{it} + \mathcal{W}_{3i}LOIL_{it} + \mathcal{W}_{4\,i}YGAP_{it} + \sum_{k=1}^{p-1}\varphi_{ij}\Delta LCPI_{it-j} + \sum_{j=0}^{q-1}\Delta(\psi_{2ij}LNEER_{it-j} + \psi_{3ij}LMS_{it-j} + \psi_{4ij}LOIL_{it-j} + \psi_{5ij}YGAP_{it-j}) + \mathcal{E}_{it} \ldots\ldots\ldots\ldots\ldots (4)$$

Once the Equation (4) is estimated, the effects of each variable on the exchange rate in the short-run are inferred by the coefficient estimates attached to each of the first-differenced variables.
By re –estimating and reordering Eq.(4) we get the following short-run relationship with error correction.

$$\Delta LCPI_{it} = \mathcal{W}_{i0} + \sum_{k=1}^{p-1}\varphi_{ij}\Delta LCPI_{it-j} + \sum_{j=0}^{q-1}(\psi_{1ij}\Delta LNEER_{it-j} + \psi_{2ij}\Delta LMS_{it-j} + \psi_{3ij}\Delta LOIL_{it-j} + \psi_{4ij}\Delta YGAP_{it-j}) + \rho_{ij}ECT_{it-1} + \mathcal{E}_{it} \ldots\ldots\ldots\ldots\ldots (5)$$

Wherep and q are the lags of dependent and independent variables respectively as usual..The sign and value ofρ_{ij}(coefficient of EC_{ti}) represents a different adjustment. A positive value indicates a divergence, while a negative value indicates convergence. If the estimate of ρ_{ij} equals to 1, 0.5, and 0 then it indicates 100%, 50%, and no adjustment (nolong-run relationship exist)takes place within the period *t*, respectively.

So far, this study looked in to the linear (symmetric) form of ARDL. To capture the asymmetric effect of exchange rate on CPI, the partial sum of nominal effective exchange rate and included in ARDL. If both partial sums are the same sign and size, the nominal effective exchange rate effects are symmetric. Otherwise, they are asymmetric. The partial sum of NEER (Shen et al., 2014) is given by:

$$LNEERPOS_t = \sum_{k=1}^{T}\Delta LNEERPOS_t = \sum_{k=1}^{T}\max(\Delta LNEERPOS_t, 0)\ and$$

$$LNEERNEG_t = \sum_{t=1}^{T}\Delta LNEERNEG_t = \sum_{j=1}^{T}min(\Delta LNEERNEG_t, 0)$$

Thus, the NARDL($p, q_1, q_2, q_3, q_{4,}, q_{5}$)model is constructed as follows:

$$\Delta CPI_{it} = \mathcal{W}_{i0} + \phi_{ij}LCPI_{it-1} + \mathcal{W}_{1i}^{+}LNEERPOS_{it} + \mathcal{W}_{2i}^{-}LNEERPNEG_{it} + \mathcal{W}_{3i}LMS_{it} + \mathcal{W}_{4i}LOIL_{it} + \mathcal{W}_{5i}YGAP_{it} + \sum_{k=1}^{p-1}\varphi_{ij}\Delta LCPI_{it-j} + \sum_{j=0}^{q-1}\left(\psi_{1ij}^{+}\Delta LNEERPOS_{it-j} + \psi_{2ij}^{-}LNEERNEG_{it} + \psi_{3ij}\Delta LMS_{it-j} + \psi_{4ij}\Delta LOIL_{it-j} + \psi_{5ij}\Delta YGAP_{it-j}\right) + \mathcal{E}_{it} \ldots\ldots (6)$$

The parameters $\Gamma^{+} = -\frac{\mathcal{W}_{2i}^{+}}{\boldsymbol{\phi_{ij}}}, and, \Gamma^{-} - \frac{\mathcal{W}_{2i}^{-}}{\boldsymbol{\phi_{ij}}}$measures the long-run effect of a positive (appreciation) and a negative (depreciation) change of nominal exchange rate on domestic consumer prices respectively.

Following Brun-Aguerre et al (2016), the asymmetric model formulation may take four structures: i) Short-run and long-run asymmetry as specified in equation (6) ii)short-run asymmetry and long-run symmetry iii)short-run symmetry and long-run asymmetry. Hence, based on this modeling Eq.(6) has reduced in to two more equations. That is;

$$\Delta CPI_{it} = \mathcal{W}_{i0} + \phi_{1i} LCPI_{it-1} + \mathcal{W}_{2i} NERR_{it} + \mathcal{W}_{4i} LOIL_{it} + \mathcal{W}_{5i} YGAP_{it} + \sum_{k=1}^{p-1} \varphi_{ij} \Delta LCPI_{it-j} + \sum_{j=0}^{q-1} (\psi_{1ij}^{+} \Delta LNEERPOS_{it-j} + \psi_{2ij}^{-} LNEERNEG_{it} + \psi_{3ij} \Delta LMS_{it-j} + \psi_{4ij} \Delta LOIL_{it-j} + \psi_{5ij} \Delta YGAP_{it-j}) + \varepsilon_{it} \dots \dots \quad \dots \dots \dots \dots \dots \dots \dots for\ case(ii) \dots \dots \dots \dots \dots (7)$$

And

$$\Delta CPI_{it} = \mathcal{W}_{i0} + \phi_{1i} LCPI_{it-1} + \mathcal{W}_{1i}^{+} LNEERPOS_{it} + \mathcal{W}_{2i}^{-} LNEERPNEG_{it} + \mathcal{W}_{3i} LMS_{it} + \mathcal{W}_{4i} LOIL_{it} + \mathcal{W}_{5i} YGAP_{it} + \sum_{k=1}^{p-1} \varphi_{ij} \Delta LCPI_{it-j} + \sum_{j=0}^{q-1} (\psi_{it-j} \Delta LNEER_{it-j} + \ + \psi_{3ij} \Delta LMS_{it-j} + \psi_{4ij} \Delta LOIL_{it-j} + \psi_{5ij} \Delta YGAP_{it-j}) + \mathcal{E}_{it} \dots \dots \dots \dots forcase(iii) \dots \dots (8)$$

3.2.2 Model Estimation Techniques

The main objective of this study is to apply panel NARDL, to explain the different scenarios of asymmetry. These equations are estimated using mean group(MG), pooled mean group (PMG) and Dynamic fixed effect (DFE) based on two groups of countries. For long panel data (T>N) these techniques were applied (Siok Kun Sek, 2017).

MG imposes no restriction on cross-country and homogeneity of all parameters. Due to this it is less restrictive approach. Its estimator model derives long-run estimates by averaging the individual country-specific coefficients from ARDL but it might be sensitive to outliers in case of small sample size (Siok Kun Sek, 2017).

On the other hand PMG assumes homogeneous long-run parameters across countries but imposes no restriction on the intercepts, short-run coefficients and error variances to be different across countries (Pesaran et al,1999)-short-run heterogeneous dynamics but share common long-run equilibrium(Asongu et al, 2016). In this study analysis, among the other thing, sampled countries are developing characterized by higher inflation with fluctuated exchange rate.

Some assumption are dealt to PMG: (i) there is no correlation in the error terms; (ii) there exist a long-run relationship between dependent and independent variables; and (iii)all long-run parameters are restricted to be same across countries. The PMG estimator is consistent and asymptotically normal distributed- more efficient when the restriction on homogeneous long-run coefficient is valid.

Regarding the DFE, it constraints the long-run and short-run coefficients to be same but allows the intercepts to differ across countries (Asongu *et a*l, 2016). DFE also restricts the error variances and speed of adjustment coefficient to be identical across countries and the simultaneous equation bias at the time of small sample size is it'd drawback.

To determine the most appropriate estimator, Hausman(1978) test was performed between MG and PMG estimators based on the null hypothesis of homogeneity in the long-run slope (PMG restriction is valid). If it's failed to reject the null hypothesis, PMG estimator is chosen. However, if data don't support the null hypothesis, it should be conduct the second test between MG and DFE- with the null hypothesis DFE is valid. In this case the rejection of the null hypothesis tells MG is more efficient than DFE.

However, the Hausman test result makes the study prefer DFE to other models. Further, the existence of cross sectional dependence accompanied by failure of the classical linear regression post estimation specification test demands the uses of fixed effect model with robust and Driscroll-Kraay(1998) standard errors. Thus, Eq. (4) converted in to fixed effect model (Eq.9) by replacing $\mathcal{E}_{it}$ with $\theta_i + \mu_{it}$.

$$\Delta LCPI_{it} = \mathcal{W}_{i0} + \phi_{ij} LCPI_{it-1} + \mathcal{W}_{1i} LNEER_i + \mathcal{W}_{2i} LMS_{it} + \mathcal{W}_{3i} LOIL_{it} + \mathcal{W}_{4\,i} YGAP_{it} + \sum_{k=1}^{p-1} \varphi_{ij} \Delta LCPI_{it-j} + \sum_{j=0}^{q-1} \Delta(\psi_{2ij} LNEER_{it-j} + \psi_{3ij} LMS_{it-j} + \psi_{4ij} LOIL_{it-j} + \psi_{5ij} YGAP_{it-j}) + \theta_i + \mu_{it} \quad \ldots (9)$$

Where θ_i is entity-specific intercepts that capture heterogeneities across entities and μ_{it} is an idiosyncratic error term which is observation-specific zero-mean random error which varies across entities and time.

Similarly the base lone model Eq.(6) can also be adjusted to fixed effect model as follows;

$$\Delta CPI_{it} = \mathcal{W}_{i0} + \phi_{ij}LCPI_{it-1} + \mathcal{W}_{1i}^{+}LNEERPOS_{it} + \mathcal{W}_{2i}^{-}LNEERPNEG_{it} + \mathcal{W}_{3i}LMS_{it} + \mathcal{W}_{4i}LOIL_{it} + \mathcal{W}_{5i}YGAP_{it} + \sum_{k=1}^{p-1}\varphi_{ij}\Delta LCPI_{it-j} + \sum_{j=0}^{q-1}(\psi_{1ij}^{+}\Delta LNEERPOS_{it-j} + \psi_{2ij}^{-}LNEERNEG_{it} + \psi_{3ij}\Delta LMS_{it-j} + \psi_{4ij}\Delta LOIL_{it-j} + \psi_{5ij}\Delta YGAP_{it-j}) + \theta_i + \mu_{it} \dots\dots\dots(10)$$

3.2.2.1 Formulation of Hypotheses

Following Brun-Aguerre et al. (2016) and Kassi et al. (2019), by using Eq. (10) this study develop the following hypotheses:

- **Hypothesis 1**. Assume symmetric Long-run ERPT, i.e.,H_0^1:$\mathcal{W}_{1i}^{-} = \mathcal{W}_{2i}^{+}$vs. H_A^1: $\mathcal{W}_{1i}^{+} \neq \mathcal{W}_{2i}^{-}$
- **Hypothesis 2**. Assume symmetric short-run ERPT , i.e., H_0^2:$\sum_{j=0}^{q-1}\psi_{1i,j}^{-} = \sum_{j=0}^{q-1}\psi_{1i,j}^{+}$vs.$vs.H_A^2$:$\sum_{j=0}^{q-1}\psi_{1i,j}^{+} \neq \sum_{j=0}^{q-1}\psi_{1i,j}^{-}$
- **Hypothesis 3.** Assumes zero ERPT for depreciations ($\mathcal{W}_{1i}^{-}$) and appreciation ($\mathcal{W}_{1i}^{+}$) in the long-run, i.e.,H_0^3: $\mathcal{W}_{1i}^{-} = 0, and\ \mathcal{W}_{2i}^{+} = 0$ vs. H_A^3: : $\mathcal{W}_{1i}^{-} \neq 0, and\ \mathcal{W}_{2i}^{+} \neq 0$ respectively.
- **Hypothesis 4.** Assumes zero ERPT for depreciations and appreciation in short-run, i.e., H_0^4:$\sum_{j=0}^{q-1}\psi_{1i,j}^{-} = 0\ and\ \sum_{j=0}^{q-1}\psi_{1i,j}^{+} = 0$vs.$H_A^4$:$\sum_{j=0}^{q-1}\psi_{1i,j}^{-} \neq 0\ and\ \sum_{j=0}^{q-1}\psi_{1i,j}^{+} \neq 0$ respectively
- **Hypothesis 5.** Assume complete ERPT for depreciations ($\mathcal{W}_{1i}^{-}$) and appreciation ($\mathcal{W}_{1i}^{+}$) in the long-run, i.e.,H_0^5: $\mathcal{W}_{1i}^{-} \geq 1, and\ \mathcal{W}_{2i}^{+} \geq 1$ vs. H_A^5: $\mathcal{W}_{1i}^{+} < 1, and\ \mathcal{W}_{2i}^{-} < 1$ respectively.
- **Hypothesis 6.** Assumes complete ERPT for depreciations and appreciation in short-run, i.e., H_0^6:$\sum_{j=0}^{q-1}\psi_{1i,j}^{-} \geq 1\ and\ \sum_{j=0}^{q-1}\psi_{1i,j}^{+} \geq 1$vs.$H_A^6$:$\sum_{j=0}^{q-1}\psi_{1i,j}^{+} < 1\ and\ \sum_{j=0}^{q-1}\psi_{1i,j}^{-} < 1$ respectively.

3.2.3 Modeling Asymmetries of ERPT

The asymmetries of ERPT, as it was indicated and validated in the previous empirical studies, can be analyzed in three forms; with respect to direction, size of change in exchange rates and the level of inflation.

3.2.3.1 Asymmetry with respect to direction of change in exchange rate

In this study the type of asymmetry with regard to the direction of the change in exchange rate was investigated according to Shen et al (2014) modeling which decomposes the partial sum of exchange rate variable in to positive change (appreciation) and negative change (depreciation). The computation looks;

$LNEERPOS_t = \sum_{K=1}^{T} \Delta LNEERPOS_t = \sum_{t=1}^{T} \max(\Delta LNEERPOS_t, 0)$ *and*

$LNEERNEG_t = \sum_{t=1}^{T} \Delta LNEERNEG_t = \sum_{j=1}^{T} min(\Delta LNEERNEG_t, 0)$ This asymmetry is incorporated in and can be tested using Eq. (10) above.

3.2.3.2 Asymmetry with respect to direction and size of change in exchange rate

In order to examine the asymmetry of ERPT with respect to direction and size of exchange in exchange rate (the important of menu costs), this study adopt the Pollard & Coughlin (2004) approach. In this approach dummy variables are included to capture the range of change in exchange rate with the direction and size. Thus, four dummy variable are generated for; large and small change in appreciation, and depreciation of exchange rate. The size of exchange rate change necessary to determine a large or small change is 3%. Given this figure, study presents the dummy variables for the direction and size of change in exchange rate as follows;

L_t=1, $if\ |\Delta LNEER_t| \geq 3\%$, L_t=0 otherwise and S_t=1, if $|\Delta LNEER_t| < 3\%$, S_t=0 otherwise

This distinguishes large changes from small change in exchange rate specific to direction. These variables are used to create the large change in exchange rate ($L_t \Delta LNEER_t$) and small change in exchange rate ($S_t \Delta LNEER_t$). Again by using these variables it can be constructed the dummy variables for the combined effect of direction and size of change in exchange rate as follows;

$L_t \Delta LNEERNEG_t$=1 when $L_t \Delta LNEER_t = 1$and $LNEERNEG_t = 1$, 0 otherwise

$L_t \Delta LNEERPOS_t$=1 when $L_t \Delta LNEER_t = 1$and $LNEERPOS_t = 1$, 0 otherwise

$S_t \Delta LNEERNEG_t$=1 when $S_t \Delta LNEER_t = 1$and $LNEERNEG_t = 1$, 0 otherwise

$S_t \Delta LNEERPOS_t$=1 when $S_t \Delta LNEER_t = 1$and $LNEERPOS_t = 1$, 0 otherwise

Where;

$L_t \Delta LNEERNEG_t$ = large change in exchange rate during local currency depreciation (LD)

$L_t \Delta LNEERPOS_t$= large change in exchange rate during local currency appreciation (LA)

$S_t \Delta LNEERNEG_t$ =small change in exchange rate during local currency depreciation (SD)

$S_t \Delta LNEERPOS_t$ = large change in exchange rate during local currency appreciation (SA)

Interacting these dummy in to exchange rate terms and included in Eq.(10) yields;

$\Delta CPI_{it} = \quad \mathcal{W}_{i0} + \phi_{ij} LCPI_{it-1} + \mathcal{W}_{3i} LMS_{it} + \mathcal{W}_{4i} LOIL_{it} + \mathcal{W}_{5i} YGAP_{it} \psi^{+}_{1ij} +$
$\mathrm{L_t} \Delta LNEER_{it-j} + \psi^{-}_{2ij} \mathrm{S_t} \Delta LNEER_{it} + \sum_{k=1}^{p-1} \varphi_{ij} \Delta LCPI_{it-j} + \quad \sum_{j=0}^{q-1} (\psi_{3ij} \Delta LMS_{it-j} +$
$\psi_{4ij} \Delta LOIL_{it-j} + \psi_{5ij} \Delta YGAP_{it-j}) + \theta_i +$
$\mu_{it} \ldots \ldots \ldots \ldots for\ overall\ size\ \ change \ldots \ldots \ldots \ldots .(11)$

And

$\Delta CPI_{it} = \mathcal{W}_{i0} + \phi_{ij} LCPI_{it-1} + \mathrm{L_t} \Delta LNEERNEG_{t_{it}} + \mathrm{L_t} \Delta LNEERPOS_t + \mathrm{S_t} \Delta LNEERNEG_t +$
$\mathrm{S_t} \Delta LNEERPOS_t + \mathcal{W}_{3i} LMS_{it} + \mathcal{W}_{4i} LOIL_{it} + \mathcal{W}_{5i} YGAP_{it} + \sum_{k=1}^{p-1} \varphi_{ij} \Delta LCPI_{it-j} +$
$\sum_{j=0}^{q-1} (\psi_{3ij} \Delta LMS_{it-j} + \psi_{4ij} \Delta LOIL_{it-j} + \psi_{5ij} \Delta YGAP_{it-j}) + \theta_i + \mu_{it} \ldots \ldots \ldots \ldots \ldots \ldots \ldots . \ldots .(12)$

3.2.3.3 Asymmetry with Respect to the Size of Inflation

The relationship between ERPT asymmetry and the level (size) of inflation has been first investigated by Taylor (2000). He argued that the level of inflation (inflationary environment) has positively correlated to the pass-through of ERPT. The responsiveness of domestic prices to exchange rate fluctuation positively relies on inflation. More specifically, low inflationary environment causes a decline in ERPT. In this study, the effect of inflation environment on EPRT to consumer price inflation was investigated using the approaches of Kassi et al., (2019) which classifies countries in to low and high inflation countries based on the mean of the entire countries treated as single group. Accordingly, countries with the mean inflation of below 4.11% were regarded as low-inflation countries while those above 4.11% were high-inflation countries. The combined classification with exchange rate regime and inflation levels was also presented (see appendix A Table 1). Estimation technique was similar to Eq. (10) except considering inflation levels.

3.2.4 Notes on Some Econometric Issues: Cross Sectional Dependence, Stationarity, Cointegration and Lag Length Selection Criteria

3.2.4.1 Cross Sectional Dependence

The experience of an ever-increasing economic and financial integration of countries and financial entities implies strong interdependencies between cross-sectional units. As the result the rise in the numbers of panel data literatures which conclude the existence of substantial cross-sectional dependence in the errors is not an odd. The reason behind may be the presence of common shocks and unobserved components that ultimately become part of the error term, spatial dependence, and idiosyncratic pair-wise dependence in the disturbances with no particular pattern of common components or spatial dependence (Hoys & Sarafidis, 2006). The detection of cross sectional dependence in the panel data analysis is thus important.

When units forming the panel are related to the error term in panel data the econometric analysis of cross-sectional dependency could be explained by considering a situation that units forming panel are affected by a shock, then the other units of panel are affected as well. The equational representation of the model is;

$$y_{it} = \theta_i + \beta_i x_{it} + \varepsilon_{it} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (13)$$

$$Cov(\varepsilon_{it}, \varepsilon_{ij}) \neq 0$$

Although there are various tests to analyze cross sectional dependence in the panel data, this study uses the Breusch & Pagan (1980) CD_{LM1} and (Pesaran, 2004) CD_{LM} for pre and post estimation of the analysis. These two tests are selected based the suitability for large T and small N of panel data.

CDLM1 tests which are developed by Breusch and Pagan (1980) are calculated as below.

$$CD_{LM1} = T \sum_{i=1}^{N-1} \sum_{j=i-1}^{N} \tau^{\wedge 2}_{ij} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots. (2)$$

This tests uses the OLS based sum of correlation coefficient squares among cross section residuals and has N (N-1)/2 degree of freedom. The null and alternative hypotheses of the test are;

H_0: No relations between cross sections.

H_1 : Relations exist between cross sections.

CD_{LM} test is the second test to examine cross-sectional dependency in panel data and is calculated with the following formula.

$$CD_{LM} = \sqrt{\frac{2T}{N(N-1)}} \left[\sum_{j=1}^{N-1} \sum_{j=i+1}^{N} \tau_{\hat{ij}} \right], N(0,1) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (14)$$

This test is based on asymptotically standard normal distribution with similar other features and hypotheses to the above test. Note that $\hat{\tau}_{ij}$ is the sample estimate of the pairwise correlation of the residuals.

3.2.4.2 Stationarity Test

In dealing with time series analysis knowing the stationarity (non-statonarity) of the data is a prerequisite. Proper estimation of a time series model requires a stationary data otherwise conducting time series analysis on non-stationary data results what is called “spurious” or “nonsense” regression, i.e., a situation where the estimated regression has a high R^2 and significant t values without any economic relationship between the variables. The simplest way of observing the pattern of the variables is visual display. The plots of variables in the level and first difference are depicted (see appendix A). In a panel data to check whether the data exhibit stationarity or not –the so called unit root test is applied. The presence of unit root implies non stationary of data.

The objective of performing panel unit-root tests was checking the stationarity and level of integration of each variable. Both ARDL and NARDL models require no variable is integrated larger than 1 but allows a combination of I(0) and I(1) of variables in the model. Among the others, in the presence of cross-sectional dependence the widely used panel unit root test are Pesaran (2003) test-PESCADF(Cross-sectionally Augmented Dickey Fuller) and Pesaran(2007) test-CIPS(Cross-sectionally Augmented IPS) test in the presence of cross-sectional dependence (Barbieri, 2006).He argued that *CIPS* test has better power properties than the individual *CADF* tests and should therefore be preferred. The very brief and short notes of the two tests are presented as below.

Pesaran(2003) test

This is a new and simple procedure of dynamic panel unit root test used in the presence of cross sectional dependence and serially correlated error terms. Suppose the following dynamic linear heterogeneous panel data model;

$$y_{it} = (1-\gamma_i)\mu_i + \delta_i y_{it-1} + \mu_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (15)$$

Where μ_i is a deterministic component, the initial values $y_{i0}$are given and the disturbancesfollow a one-factor structure:

$$\mu_{it} = \lambda_i \mathrm{f}_i + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (16)$$

$where\ \varepsilon_{it}$are the idiosyncratic shocks $ID(0, \sigma_i^2)$ both across *i*and *t* and finite forth-order moments.$f_i$is unobserved common factor is serially uncorrelated with zero mean, constant variance(σ_f^2) and finite forth-order moment. Suppose (σ_f^2) is set equal to one and the variable $\varepsilon_{it}, \lambda_i$ *and* f_i are assumed to be mutually independent for all i Eq.(15 and 16) yields:

$$\Delta y_{it} = \alpha_i - (1-\gamma_i)\mu_i + \delta_i y_{it-1} + \lambda_i f_i + \varepsilon_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (17)$$

Thus, the unit root hypothesis is given by;

$$H_0: \gamma_i = 1 \; for \; \forall i \; and \; H_1: \begin{cases} \gamma_i < 1 \; for \; i = 1, \ldots N_1 \\ \gamma_i = 1 \; for \; i = N_1, \ldots, N \end{cases}$$

$$N/_{N_1} \rightarrow k \; as \; N \rightarrow \infty \; and \; 0 < k < 1$$

Pesaran (2007) test

Since the above test based on the unit root tests on deviations from the estimated common factors, this test is based on standard unit root statistics in a *Cross-sectionallyAugmented DF* (*CADF*) regression - that is it applies the cross section averages of lagged levels and first-differences of the individual series which is given by:

$$\Delta y_{it} = \alpha_i + \emptyset_i y_{it-1} + \varphi_i \bar{y}_{t-1} + d_t \Delta \bar{y}_t + e_{it} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (18)$$

Where $\bar{y}_t = N^{-1}\sum_{j=1}^{N} y_{jt}$, $\Delta\bar{y}_t = N^{-1}\sum_{j=1}^{N}\Delta y_{jt}$ and e_{it} is the error term. When the $\bar{y}_t$ *and* $\bar{y}_{t-1}$ are used for as proxy of f_i and assume $CADF_i$be the *ADF* statistic for the *i*-th cross-sectional unit given by the *t*-ratio of the *OLS* estimate $\hat{\emptyset}_{i_i}$ of $\emptyset_i$in the *CADF* regression then;

$$\text{CIPS} = \frac{1}{\text{N}}\sum_{\text{i}=1}^{\text{N}} \text{CADF}_\text{i} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (19)$$

The null hypothesis of CIPS unit root test is the series is I(1). If the calculated value CIPS is greater than the tabulated statistic (Zt-bar) , the null hypothesis is rejected meaning that the series is stationary.

3.2.4.3 Panel Cointegrationtest

A time series $y_t$is said to cointegrated if the series taken individually is integrated of order one, I(1), meaning that it is non-stationary with unit root while some linear combination of the series $\alpha' y_t$is stationary or I(0). Cointegration means although many developments can cause permanent change in individual element of series $y_t$there is some long-run equilibrium connecting the individual components together (Hamilton, 1994). Thus, testing the presence of this long-run relationship is the most important elements of time series analysis.

The most widely used panel cointegraion test the under the presence of cross sectional dependence is Westerlund (2007) panel error correction cointegration tests. This test provides the error term based cointegration test along with strong result for small sample. Further, the test uses the bootstrap cointegration test in the presence of cross sectional dependence. It has four error [31]correction panel conintegration test statistics of which two are for panel (P_t and P_a)and the other two are for group statistics($G_t and$ G_a).

Based on the short-run error correction model indicated in Eq. (5) and the error correction parameter ρ_{ij} the panel and group hypotheses are;

P_t& P_a: H_0: $\rho_{ij} = 0$ Cointegration does not exist for $\forall ij$

H_1: $\rho_{ij} < 0$ Cointegration exist for $\forall ij$

G_t & G_a: H_0: $\rho_{ij} = 0$ Cointegration does not exist for $\forall ij$

H_1: $\rho_{ij} <$ 0 Cointegration exists for some units, but for some it does not exist.

3.2.4.4 Lag Length Selection Criteria

Testing serial correlation in time series data requires knowing the number of terms back down the autoregressive process (AR)-called lag length. Determining the maximum lag length in time series data involves choosing the number of parameters that minimize information criteria. The most known information criteria(IC) are; the Akaike Information Criteria (AIC), Schwarz Information Criteria (SC)/ Bayesian information criteria (BIC) and Hannan-Quin Information Criteria (HQ). Usually the model with the smallest AIC or BIC value is preferred, but when the number of independents variable tend to high the BIC could be appropriate and provide simple model that is not too big or too small(Acquah,2010). Thus, in this study the BIC was used to determine appropriate lag length of the model.

[31] Interested reader may see Westerlund(2007) for mathematical details

CHAPTER FOUR

EMPERICAL RESULT AND ANALYSIS

The analysis involves several steps as descriptive statistics, unit root test to ensure that the variables are not with an integrated order higher than 1. The second step is NARDL model specification test to select the optimal lag length through followed by model estimation of mean group (MG), pooled mean group (PMG) and dynamic fixed effect (DFE) estimators. The estimation result of MG and PMG presented for simple contrast not the purpose of interpretation. Then test of cointegration took the next place. If no cointegration exists ARDL is no more valid. Further steps in analysis include performing Hausman test to decide the best estimator, cross-sectional dependence test, panel estimation under cross-sectional dependence nd followed by a discussion of the asymmetric effect of exchange rate on consumer prices.

4.1 Descriptive Statistics

The primary result starts with some descriptive statistics on the variables for each subgroups of and individual countries (Table 4.1) .The panel as whole has experienced a 58.93% depreciation(the negative change in exchange rate) which indicates that the sampled counties as whole share currency depreciation trend. Looking the subgroup of the countries; the fixed exchanges regimes experience more exchange rate volatilities (60.65%) than the flexible exchange rates regimes(56.64%) indicating that countries with fixed exchange rate regime are more frequently depreciate (negative change in exchange rate) their currency than the flexible exchange rate regime countries.

The result of Table 4.1 also shows that countries from fixed exchange rate category experience the highest volatility (Tanzania 73.15% followed by Ethiopia 62.98%) while the least volatile country was Namibia with 53.70%. Among countries in flexible regime Madagascar followed by Mozambique took the highest volatility with 62.98 % and 60.19% respectively on the other hand Kenya experienced the lowest volatility (50.93%). The fact that some countries follows different trend of exchange rate volatility is due to different monetary policy they adopt.

Table 4.1 Descriptive Statistics

		LNEER(%)				LCPI(%)		LMS(%)		LOIL(%)		LYGAP(%)	
Country /Group	Period	Mean	SD	APP(+)	Dep(-)	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Full Sample	1992Q1-2018Q4	4.7804	0.581	41.0700	58.9300	4.1067	0.8571	3.2896	0.4526	3.6893	0.7099	8.17E-13	0.0951
Regime- FIXED(n=8)	1992Q1-2018Q4	4.8059	0.625	39.3500	60.6500	4.1711	0.7082	3.2652	0.4131	3.6893	0.7099	8.63E-13	0.1020
Regime -FLEXI(n=6)	1992Q1-2018Q4	4.7464	0.514	43.3600	56.6400	4.0210	1.0169	3.3223	0.4988	3.6893	0.7099	7.55E-13	0.0852
Indvidual Countries													
Burundi	1992Q1-2018Q4	4.9814	0.6957	42.59	57.41	4.0141	0.9889	3.0913	0.3906	3.6893	0.7099	1.4E-12	0.0496
Botswana	1992Q1-2018Q4	4.7671	0.1920	45.37	54.63	4.1541	0.6004	3.5842	0.3227	3.6893	0.7099	3.9E-13	0.0695
Ethiopia	1992Q1-2018Q4	4.5716	0.4531	37.04	62.98	4.2184	0.7702	3.4590	0.2426	3.6893	0.7099	1.0E-12	0.0761
Kenya	1992Q1-2018Q4	4.5338	0.1333	49.07	50.93	4.0893	0.7384	3.6418	0.0653	3.6893	0.7099	1.6E-13	0.0905
Lesotho	1992Q1-2018Q4	4.5985	0.4099	37.96	62.04	4.4115	0.3432	3.4441	0.1192	3.6893	0.7099	5.4E-13	0.0907
Madagascar	1992Q1-2018Q4	4.8921	0.5511	37.04	62.98	3.9088	1.3604	3.0826	0.0876	3.6893	0.7099	9.5E-13	0.0888
Mozambique	1992Q1-2018Q4	4.8884	0.5855	39.81	60.19	3.8461	1.0754	3.2802	0.3962	3.6893	0.7099	1.1E-12	0.0923
Malawi	1992Q1-2018Q4	5.1439	1.2662	37.96	62.04	4.0300	0.8037	2.8941	0.2778	3.6893	0.7099	1.3E-12	0.1678
Namibia	1992Q1-2018Q4	4.6608	0.2470	46.30	53.70	4.1834	0.5943	3.7883	0.2161	3.6893	0.7099	9.3E-13	0.0825
Rwanda	1992Q1-2018Q4	4.9054	0.3997	41.67	58.33	4.1540	0.6248	2.8528	0.1570	3.6893	0.7099	5.7E-13	0.1508
Tanzania	1992Q1-2018Q4	4.8186	0.3954	26.85	73.15	4.2033	0.7065	3.0077	0.2025	3.6893	0.7099	7.8E-13	0.0713
Uganda	1992Q1-2018Q4	4.6180	0.2851	45.37	54.63	4.3060	0.5132	2.8780	0.2607	3.6893	0.7099	7.5E-13	0.0596
South Africa	1992Q1-2018Q4	4.3297	0.4352	47.22	52.78	4.6529	0.3361	4.1429	0.1805	3.6893	0.7099	6.7E-13	0.0873
Zambia	1992Q1-2018Q4	4.8936	0.7758	41.67	58.33	3.6463	1.3710	2.9086	0.1451	3.6893	0.7099	9.5E-13	0.0899

Note: SD is the standard deviation of the variable; Dep(-) and App (+) respectively represent the depreciation and the appreciation of the currency i.e., the percentage of the quarter in which there are positive (App (+)) and negative (Dep (-)) exchange rate changes and n is the number of the panel units. Own computation using STATA 14.

Another way of preliminary analysis is the graph of panels the time series variables under study. Such a plot gives a first insight about the likely nature of the data. The plots of the variables included in the study model are provided in appendix A. From these graphs it is noted that at level the time series variables exhibit some trends-either upward or downward. LCPI, M2 and LOIL plots shows upward trend, while that of NEER show a downward trend. This suggests that the mean of all the above variables might be changing which perhaps implies they are not stationary at level. Such an intuitive idea is important starting point for more formal tests of stationarity.

4.2 Preliminary test

This section deals with the first round tests on the data to check the kind of properties variables would exhibit. The Variance Inflation Factor (VIF) test, the cross sectional dependence (CSD) test and a simple pair-wise correlation(r) test were applied to check the presence of multicollinearity, existence of cross sectional dependence and the occurrence of some association between variables respectively. The result of the three tests can be seen in Table 4.2.

Table 4.2 VIF, CSD and r tests

Variable	Multicollinearity test		Cross sectional dependence test				Pairwise Correlation(r)				
	VIF	1/VIF	CD-test	p-value	corr	abs(corr)	LCPI	LMS	LNEER	LOIL	LYGAP
LCPI	N.A		92.460	0.000	0.933	0.933	1				
LMS	1.110	0.904	25.020	0.000	0.252	0.352	0.3068***	1			
LNEER	1.600	0.624	78.840	0.000	0.795	0.795	-0.7644***	-0.2567***	1		
LOIL	1.630	0.614	97.780	0.000	0.986	0.986	0.7353***	0.2669***	-0.5923***	1	
LYGAP	1.050	0.955	18.410	0.000	0.186	0.251	0.0019	-0.0939***	0.0841***	0.0843***	1
Mean VIF	**1.35**										
Variable	VIF	1/VIF									
DLCPI	N.A		18.480	0.000	0.187	0.261	DLCPI	DLMS	DLNEER	DLOIL	DLYGAP
DLMS	3.6200	0.2765	3.320	0.001	0.034	0.146	1				
DLNEER	3.3300	0.3001	1.480	0.139	0.015	0.151	0.7865***	1			
DLOIL	1.4100	0.7094	90.560	0.000	0.918	0.918	0.779***	0.7985***	1		
DLYGAP	1.2700	0.7852	11.830	0.000	0.120	0.207	0.5175***	0.4955***	0.4937***	1	
Mean VIF	**2.41**						0.0158***	-0.1979	0.0792***	0.0882***	1

Note: N.A denotes not available and *** shows 1% significance unless otherwise the p-values are clearly indicated as CSD-test above. Own computation using STATA 14

The result of VIF-test clearly indicates the presence of low multicollinearity where the "Mean VIF" is 1.35 and 2.41 in the level and first difference of the variables respectively on which in either forms the VIF is below the standard level of 5%. The CSD- test confirms the existence of cross sectional dependence in all variables both on the level and first difference (except DLNEER which supports absence of cross sections, p-value =0.139). Indeed, the occurrence of cross sectional dependence indicates countries share some common characteristics-which necessitates the examinations of the stationary of the variables. Table 4.3 shows the outcomes of Pesaran's CADF test and CIPS -2nd generation unit root test.

The pair-wise correlation of variables both in the level and first difference presents there is no severe correlation problem since in either case r is below the standard level 80%. LMS and LOIL have positive significant association with LCPI. Despite its insignificant LYGAP also have positive association with LCPI but LNEER shows negative association in level. On the other hand in first difference all variables have positive and significant association with LCPI.

Table 4.3 Unit Root Test Results

Variables	First Generation unit root test Pesaran's CADF test PESCADF :Z(t-bar)		2nd Generation Unit Root test CIPS :Z(t-bar)	
	Intercept	Intercept +Trend	Intercept	Intercept +Trend
LCPI	-4.154***	-1.168*	-2.513	-2.566
LMS	0.315	1.085	-1.714	-2.119
LOIL	18.293	18.303	2.610***	1.7
LYGAP	-3.473***	-1.174	-3.473***	-1.174
LNEERPOS	-18.293***	-18.303***	-18.293***	-18.303***
LNEERNEG	-17.715***	-17.639***	-17.715***	-17.639***
DLCPI	-10.106***	-9.208***	-5.324***	-5.513***
DLNEER	-17.752***	-17.653***	-14.412***	-13.424***
DLMS	-17.318***	-16.713***	-5.956***	-6.067***
DLOIL	18.293	18.303	2.610***	1.7
DLYGAP	-16.383***	-15.219***	-16.383***	-15.219***

Notes :***,* indicates statistical significance at 1% and 10% level, the prefix 'D' to each variables denotes the variables are in the first difference. Both PESCADF and CIPS tests have Ho: series are I (1).Own computation Using STATA 14

The result of PESCADF-test indicates that variables LMS and LOIL are non stationary at level both with and without trend but LMS is stationary at first difference 'I (1)' but not LOIL. Further LCPI is weakly stationary at level with trend. The PESCADF-test, therefore, shows all variables are stationary at the first difference- I (1) except LOIL.

The outcomes of second generation unit root test (CIPS-test) show the dependent variable(LCPI) and LMS are not stationary with and without trend at level but at first difference –ensuring that LCPI is I(1). It also shows that variables are stationary both at level and first difference except LYGAP (which not stationary with trend at level but at first difference) and LOIL (which is not stationary with trend both at level and first difference).

Thus, since, the data employed in this study suffer from cross sectional dependence and the analysis is mainly with the majority test, the unit root test outcomeconcludes all variables are not integrated order higher than I(1). The unit root test result claims the use of NARDL.

4.3 Panel Cointegrationt test

This study further conducted the panel cointegration test under cross sectional dependence to examine whether long-run relationship between dependent variables and explanatory variables. The most widely used panel cointegration test in literature is Westerlund(2007). It is flexible and can be applied in both cross section dependence and independence. In this study bootstrap distribution is used as cross-sectional dependency exists.

Table 4 4 Error -Correction Panel Cointegration Test Results

Test	**t-statistics**			**P-value**[a]	**P-value**[b]
	Full Sample	**Fixed regime**	**Flexible regime**		
Gt	-4.385	-4.310	-4.486	0.000	0.000
Ga	-58.142	-39.378	-83.16	0.000	0.000
Pt	-15.126	-12.307	-9.664	0.000	0.000
Pa	-47.823	-41.96	-52.234	0.000	0.000

Note: All tests are applied constant and with trend. *a* indicates the tests where p-values are asymptotic normal distribution. *b*indicates the tests that has a p-value based on bootstrap method. In this study, 400 bootstrap repeats are used. Own computation using STATA 14

The Gt and Ga are group statistics while Pt and Pa are panel statistics. The Ho: of panel and group statistics is no cointegration but the alternative is cointegration exists for the first one and some units are cointegrated and some are not for the second statistics. In this study with the maximum of lag length 4, the null hypothesis of no cointegration is rejected. Therefore, panel cointegration test indicates the existence of long-run relationship between variables in all types of sampled countries classification. In other words consumer price index has long-run relationship with nominal effect exchange rate, broad money as percents of GDP, oil price and output gap in which all variables are in log forms.

4.4 Lag Length Selection criteria

BIC was used to search for optimal lag length for the NARDL models.The search was made by allowing the STATA 14(default BIC) to choose the maximum lags. And it searches to the maximum of 3 lags for the dependent variable (LCPI) and 4 lags for few independent variables. BIC suggested different lag lengths (the optimal lag was selected for the model with the smallest BIC). For each panel the STATA software provides different lag length based on the smallest value of the BIC’s lag specification. The last decision was made based on the most common lags from all panels to both full sample and regime dependent categories. Table 4.5 summarizes results.

Table 4.5 Lag Length Selection Result

Country	BIC	Full Sample	Fixed Regime	Flexible Regime
Burundi	-5.015189	ARDL(2, 1, 2, 2, 0, 0)	ARDL(2, 1, 2, 2, 0, 0)	
Botswana	-6.925572	ARDL(4, 1, 0, 0, 2, 0)	ARDL(4, 1, 0, 0, 2, 0)	
Ethiopia	-4.139358	ARDL(2, 0, 0, 1, 3, 0)	ARDL(2, 0, 0, 1, 3, 0)	
Kenya	-5.261029	ARDL(3, 1, 0, 0, 3, 1)		ARDL(3, 1, 0, 0, 3, 1)
Lesotho	-3.004019	ARDL(2, 0, 0, 0, 2,1)	ARDL(2, 0, 0, 0, 2,1)	
Madagascar	-4.522299	ARDL(3, 1, 0, 0, 4, 0)		ARDL(3, 1, 0, 0, 4, 0)
Mozambique	-3.013243	ARDL(2, 0, 0, 0, 0, 0)		ARDL(2, 0, 0, 0, 0, 0)
Malawi	-5.190349	ARDL(2, 0, 0, 2, 2, 0)	ARDL(2, 0, 0, 2, 2, 0)	
Namibia	-6.328335	ARDL(2, 0, 1, 2, 1, 0)	ARDL(2, 0, 1, 2, 1, 0)	
Rwanda	-6.011685	ARDL(2, 0, 1, 4, 4, 4)	ARDL(2, 0, 1, 4, 4, 4)	
Tanzania	-6.479807	ARDL(3, 1, 0, 1, 1, 0)	ARDL(3, 1, 0, 1, 1, 0)	
Uganda	-5.850665	ARDL(3, 1, 0, 1, 0, 1)		ARDL(3, 1, 0, 1, 0, 1)
South Africa	-7.500499	ARDL(2, 0, 0, 0, 0, 4)		ARDL(2, 0, 0, 0, 0, 4)
Zambia	-5.945073	ARDL(3, 1, 2, 2, 1, 0)		ARDL(3, 1, 2, 2, 1, 0)
Decision		**ARDL(2, 1, 0, 0, 0, 0)**	**ARDL(2, 0, 0, 2, 2 ,0)**	**ARDL(3,1, 0, 0, 0, 0)**

Note: Order of variables in ARDL: LCPI, LMS, LOIL, LYGAP, LNEERNEG, LNEERPOS; Source: Own computation using STATA 14

4.5 Poolability Test

If there is significant cross sectional or temporal effect, it can't be assumed constant intercept for all companies and times. Thus, one-way or two-way error component model should be considered. The NARDL mode (10) has the following two assumptions (1) heterogeneous intercepts and homogeneous slope, and (2) heterogeneous intercepts and slopes (Vijayamohanan, 2017).

In general, this study considers the following possible assumption of the fixed effects panel data models:

i. Slope coefficients constant but intercept varies over companies.
ii. Slope coefficients constant but intercept varies over time.
iii. Slope coefficients constant but intercept varies over companies and time.
iv. All coefficients (intercept and slope) vary over companies.
v. All coefficients (intercept and slope) vary over time.
vi. All coefficients (intercept and slope) vary over companies and time.

Note , however, that the result of assumption v and vi can't be displayed for analysis due to STATA couldn't display large matrices result(matsize too small error) but the remaining assumptions are sufficient to conclude whether there is poolability or not in the panel data. The test results of these assumptions are displayed in Table 4.5.

Table 4 6 Poolability Test Result

Cases	Description	F-value	P-value
i	Slope coefficients constant but intercept varies over countries	F(13, 1493)=11.66	0.0000
ii	Slope coefficients constant but intercept varies over time	F(107, 1399)=15.72	0.0000
iii	Slope coefficients constant but intercept varies over countries and time		
	Over companies and time	F(120, 1386)=21.88	0.0000
	Over time	F(107, 1386)=21.08	0.0000
	Over countries	F(13, 1386)=33.50	0.0000
iv	All coefficients (intercept and slope) vary over countries	F(13, 1428)=24.88	0.0000
	Slopes only	F(5, 1428)=51.42	0.0000
	Slopes, Intercepts & Countries: LMS	F(13, 1428)=20.80	0.0000
	Slopes, Intercepts & Countries: LOIL	F(13, 1428)= 22.93	0.0000
	Slopes, Intercepts & Countries: LYGAP	F(13, 1428)= 3.46	0.0000
	Slopes, Intercepts & Countries: LNEERNEG	F(13, 1428)= 3.14	0.0001
	Slopes, Intercepts & Countries: LNEERPOS	F(13, 1428)= 1.96	0.0263

The test result of all assumptions of the fixed effect model was rejected at least at 5 % significance level implying that the possibility of pooling the cross sections. Thus, in this study, it is logical to pool the cross sections and consider them as panel in the analysis.

4.6 Determining the Best Estimator

Determining the best estimator for the model in this study pass-through comparison of various estimators's using different test statistics. As indicated in panel unit root test and panel cointegration test this study claimed the application of panel ARDL. To estimate panel NARDL model the study applied the Mean Group (MG), Pool Mean Group (PMG) and Dynamic Fixed Effect (DFE) estimators. Selecting the most efficient estimator involves the use of Hausman test. Study estimates the model using MG followed by PMG – in this case the null hypothesis of Hausman test states that PMG is the best estimator. The test rejects the null hypothesis (significant at 1% level)-thus it is opted for MG for full sample and fixed regime categories. But the PMG was selected as most efficient estimator under flexible regime sub sample (see Table 4.7).

Once the most efficient estimator from MG and PMG was decided, it is necessary to further investigate the best estimator from PMG and DFE. This process takes the DFE regression estimates first and PMG second with null hypothesis of PMG is the best estimator. Based on the Hausman test, the null hypothesis was rejected hence DFE is the most efficient estimator across all sample categories (see Table 4.7). Since the study experience mixed results the next task is to compare the MG and DFE estimators. Here the null hypothesis proposed DFE is the best estimator. The consecutive Estimation of MG and DFE with the help of Hausman test prove DFE is the most efficient estimator for all samples. Thus, from the three estimators (MG, PMG and DFE), the Hausman test result shows DFE is final best estimator in all cases.

However, given that the data of this study suffer from cross sectional dependence and as the result heteroskedasticity problem the paper further applied the Hausman test to select the most efficient estimator from random effect (RE)and fixed effect (FE) models. Under the null hypothesis of RE is the most efficient, Hausman test rejects the hypothesis and took fixed effect model as the best model for full panels and flexible regime cases while for fixed regime the most efficient estimator was random effect as the null hypothesis was not rejected (at 1% significance level).

Furthermore, the result of Hausman test is not enough by itself so that to perform analysis, other test called Breusch-Pagan Lagrangian Multiplier (B-P LM-test) need to be applied to decide the best model from Pooled OLS (POLS) and random effect. Under this test the null hypothesis is POLS is the most efficient estimator. But the B-P Lm-test rejects the null hypothesis at 1% in all cases and hence opts for RE model. At the last F-joint test was applied to determine the best model between POLS and FE. To perform the F-joint test this study used the Least Square Dummy Variable (generating regimes, time and country dummies and included in FE model, and then test the joint significance of the dummies). The null hypothesis of the F-test holds that the dummies are jointly insignificant and equal to zero. But in all cases the null hypothesis was rejected meaning that FE model is preferred. Table 4.7 presents the detailed result of all the above discussed tests.

To windup, the Hausmant test result of Panel NARDL chooses DFE from MG and PMG estimators while FE was selected as best estimator for full sample and flexible regime against RE. This suggests mixed result. But it is logical to choose DFE as best estimator in the presence of cross sectional dependency where residuals are heteroskedastic. Intuitively, DFE is efficient, beta coefficients are adjusted with fixed effects but slightly higher standard errors than RE which allows controlling cross sections and hetro problems through cluster and robust standard errors.

Table 4.7 B-P LM test, F-joint test and Hausman Tests Results

Type of tests	Estimators and Test Statistics		Sample Categories		
			Full Sample	**Fixed Regime**	**Flexible Regime**
B-P LM-test	RE vs. POLS	Chi-2	536.75	94.15	156.75
		P-value	.000	.000	.000
		Decision	RE	RE	RE
Joint F-test	LSDV(FE) vs. POLS	F	26.190	11.400	25.83
		P-value	.0000	.000	.0000
		Decision	FE	FE	FE
Hausman test	FE vs. RE	Chi-Square	32.01	6.62	37.23
		p-value	.0000	.4695	.0000
		Decision	FE	RE	FE
	MG vs. PMG	Chi-Square	40073.42	13.81	.0100
		p-value	.0000	.0169	1.000
		Decision	MG	MG	MG
	PMG vs. DFE	Chi-Square	-74.90	-91.14	-8.74
		p-value	-	-	-
		Decision	DFE	DFE	DFE
	MG vs. DFE	Chi-Square	.0100	.0300	.0000
		p-value	1.000	1.000	1.000
		Decision	DFE	DFE	DFE
Final Decision			**DFE**	**DFE**	**DFE**

To compute the Hausman test the "*constant*" was used. Own calculation using STATA 14

4.7 Estimation Result of Panel NARDL

Having the required test mentioned above, the results of the estimation for NARDL model (Eq.10) were summarized in Table 4.8. As Hausman test suggested DFE as the best estimator in all cases, the interpretation was relied on DFE. The comparison of the coefficients across the three estimators (DFE, MG and PMG) shows that the values of the coefficient are quite different across estimators. Further as can be seen from Table 4.8, the speed of adjustment in all cases of the sample categories with the given estimators is negative and above 1% implying that there is the convergence to the long-run equilibrium if there happen an external short-shock to economy.

Table 4.8 NARDL Estimation Result, DLCPI Dependent Variable

Coefficient	Full sample			Fixed Regime			Flexible Regime		
	DFE	PMG	MG	FE	PMG	MG	FE	PMG	MG
Long-run									
LMS	.0962	1.1143	.8614*	-.1358	.3506***	.5842***	.2033	.4288***	.6537
LOIL	.3353***	.2319**	8314*	.3341***	.4589***	.7105**	.4807***	.4187***	33833**
LYGAP	-2.1056***	-1.3601**	-3.6690**	-1.3269**	-.4251	1.9426	-1.0923**	-1.8802***	-1.5430***
LNEERNEG	-1.3799	-2.5365*	9.5388*	3.0745**	.9432	.3911	4.3436*	.6748	4.7820*
LNEERPOS	-5.2154***	.9931	1.8274	-4.6638**	-1.7258	3.6431	-2.3261	-1.4430	-8.0567
Short-run									
ϕ_i	-.0173***	-.0108***	-.0143***	-.0220***	-.0145***	-.0140***	-.0172***	-.0134***	-.0130***
DLCPI(-1)	.4759***	.4181***	.3808***	.4565***	.4696***	.4060***	.4954***	.4340***	.3939**
DLCPI(-2)	.0503***	.1470***	.0922***	.1163**	.09993***	.0714**	.1339***	.1010***	.1443**
DLCPI(-3)	-	-	-	-	-	-	-.0665**	.0082	.0113
DLMS	-.0770***	-.1408**	-.0784**	-.0335*	-.0208	-.0331**	-.1219***	-.0864**	-.1394**
DLMS(-1)	.0524***	.0680*	.0451***	-	-	-	.0670**	.0554***	.0559*
DLOIL	-.0002	.0091*	.0056***	-.0007	.0056	.0050	.0048	.0065	.0081***
DLYGAP	.0548	.0748***	.0057	.1395	.0556	.0583	-.0385	-.0145	-.0726**
DLYGAP(-1)	-		-	-.0850***	-.0610	-.0583	-	-	-
DLYGAP(-2)	-		-	-.0424**	-.0401	.0395	-	-	-
DLNEERNEG	.0380***	.2181	.0234	-.0406	-.0313	-.0650	.0278	.0113	.0184
DLNEERNEG(-1)	-	-	-	.0835***	-.0474*	-.0693	-	-	-
DLNEERNEG(-2)	-	-	-	.0392**	-.0250	-.0347	-	-	-
DLNEERPOS	.0234	-.0036	.0097	.0252	.0189	.0005	.0286	.0107	.0227
C	.0350***	.0065**	.0198	.0454***	.0292***	.0197	.3131**	.0272***	.0098

Notes: *** significance at 1% level; ** significance at 5% level; and * significance at 10% level. DLCPI: The natural logarithm of CPI at first difference. The MG estimators are the un-weighted mean of the individual regression coefficients. Own computation using STATA 14

Referring to Table 4.8 oil price (LOIL) was the main determinant contributing to higher consumer price index (LCPI) for both fixed exchange rate regime and flexible exchange rate countries in the long-run. That is, change in world oil price is external to countries and they couldn't control it most of which are oil importing counties. As opposed to the long-run result, the impact of world oil price in the short was not significant in all cases. This could be due to government subsidies on oil price in majority of oil importing counties.

On the other hand output gap (LYGAP) and positive change in exchange rate (LNEERPOS-appreciation) were the most important factors in reducing consumer price in the long-run across all sample divisions. In the long-run it is expected that the gap between actual and potential output get narrowed (decrease in negative output gap) implying that expansionary economy-higher aggregate supply and aggregate demand however prudent monetary policy resulting in lower price. However, in short a higher output gap (increase in negative output gap) leads to decline in economic activities. And in such situation aggregated demand decline which in turn results lower prices. The result is in support of theoretical arguments.

Likewise the outcome also revealed that the positive change in exchange rate was large under fixed exchange regime countries and influential has impact on CPI inflation. This could be through direct channel. Meaning appreciation of currency could lead to a lower imported input's price so that it pushes the production cost down and CPI inflation decline as the result.
However under flexible exchange rate regimes appreciation has no both long-run and short-run impact on CPI inflation. In spite of this, the effect of a negative change in exchange rate (LNEERNEG- depreciation) on CPI inflation was significant under the short-run-ERPT to consumer price for full sample and fixed exchange rate regime countries. Its effect under flexible exchange rate regime sub samples was insignificant. On the other hand the long-run effect was not significant. This implies that there is no significant ERPT in the long-run for the all samples.

Therefore, change in exchange rate in any direction adversely affects CPI inflation in countries under fixed exchange rate regime than under flexible exchange rates. For example, a 10% increase (appreciation) or decrease (depreciation) of exchange rate lead a 52.2 % decrease in CPI inflation in the long-run and a 47.6 % rise in CPI inflation in the short-run in the first period and it went down to 5% in next quarter.

Monetary growth (broad money as % GDP-LMS) has no long-run effect on CPI inflation for all samples. However, in the short-run an increase its lagged difference value leads to a higher inflation in CPI under flexible exchange rate regime. In examining the short-run effect of moneys supply on CPI inflation it was found money supply was wrongly signed but significant coefficient.

From short-run result in Table 4.8 the error correction term (ϕ_i) - measures how much of the disequilibrium is being adjusted- coefficients were all significant and negative which suggest that the speed of adjustment of CPI to its long-run equilibrium is very slow. For example, for full sample it was .0173-meaning that if CPI inflation deviates from its long run equilibrium by one percentage point only 1.73 % the disequilibrium is being adjusted every period, so it takes about 58 quarters (almost 14 years) for inflation to adjust to its long-run equilibrium. The speed of adjustment is relatively quick for fixed exchange rate regime (nearly 45 quarters).

4.8 Panel Fixed Effect Model under Cross-Sectional Dependence

Although the above estimation yields a sensible analysis of ERPT to consumer price inflation subject to different macro-economic determinants of inflation and regime specific examination under long-run and short-run time span, the dynamic fixed effect (DFE) couldn't provide sufficiently enough elucidation. Because, the cross sectional dependence effect yet to accounts.

As noted from Table 4.8, in support of Housman test (FE is the appropriate model) some specification test were implemented i)Pesaran (2003) test to check the existence of contemporaneous correlation between cross-section; ii) Breusch and Pagan(1980) Langragian Multiplier test of independence to verify whether the variances across individuals are correlated; iii) Wooldridge(2010) test to check the existence of serial correlation; iv) Modified test to identified the existence of group-wise heteroscedasticity in the residuals of a fixed effect regression model; v) Durbin-Watson statistic test, to verify the presence of the first-order autocorrelation in the disturbance when all the regressors are strictly exogenous; vi) Baltagi-Wu LBI-test(2008), to test serial correlation in the disturbance. This procedure closely follows the work of Koengkan(2018). Table 4.9 shows the results of specification tests.

Table 4.9 Post Estimation Specification Tests

Tests	Null Hypotheses	Statistics	Decision
Pesaran Test	Cross Sections are Independent	65.419***	Rejected
Breusch and Pagan LM test	Residuals are not Correlated	Chi2(91) 4840.537***	Rejected
Modified Wald test	Residuals are Homoscedastic Ho: $\sigma_i^2 = \sigma^2$ for all i	Chi2(14) 937.03***	Rejected
Wooldridge's test	No first order autocorrelation	F(1,13) 430.31***	Rejected
Durbin-Watson test	No first order autocorrelation in the disturbance term-when strict exoginity in regressors	0.0948***	Rejected
Baltagi-Wu LBI-test	No Serial Correlation in the disturbance term	0.1950***	Rejected

Note: *** denotes significance level at 1%; Own computation using STATA 14

The specification tests (Table 4.9) points to the presence of cross-section dependence, the presence, correlated residuals, the presence of the first-order autocorrelation, the presence of heteroscedasticity in the residuals and first-order correlation and serial correlation in the disturbance. Thus, in the presence of correlated residuals, heteroskedasticity, first-order autocorrelation, contemporaneous correlation, and cross-section dependence in the context of a long-time span, the Driscoll and Kraay estimator needs to be used (Koengkan, 2017).The Driscoll and Kraay estimator generates robust standard errors for several phenomena found in the sample errors. The FE estimator, FE robust (to control for the heteroskedasticity) and FE Driscoll and Kraay (FE D.-K.) are presented in Table 4.10. The result of FE estimation is similar to DFE except to robustness with the inclusion of various standard errors.

Table 4.10 NARDL Fixed Effect Estimation Result: DLCPI Dependent Variable

Coefficient	Full sample			Fixed Regime			Flexible Regime		
	FE	FE-Robust	FE-D.-K.	FE	FE-Robust	FE-D.-K.	FE	FE-Robust	FE-D.-K.
Long-run									
LMS	.0962			-.1358			.2033		
LOIL	.3353***	***	***	.3341***	***	***	.4807***	***	***
LYGAP	-2.1056***	***	***	-1.3269**	***	**	-1.0923**	**	**
LNEERNEG	-1.3799			3.0745**			4.3436*	*	*
LNEERPOS	-5.2154***	**	*	-4.6638**	***	***	-2.3261		
Short-run									
ϕ_i	-.0173***	***	***	-.0220***	***	***	-.0172***	***	***
DLCPI(-1)	.4759***	***	**	.4565***	***	***	.4954***	***	***
DLCPI(-2)	.0503***	***	**	.1163**	***	**	.1339***	***	***
DLCPI(-3)	-	-		-			-.0665**	**	**
DLMS	-.0770***	***	*	-.0335*	*		-.1219***	**	**
DLMS(-1)	.0524***	***		-			.0670**		
DLOIL	-.0002			-.0007			.0048		
DLYGAP	.0548			.1395			-.0385		
DLYGAP(-1)	-	-		-.0850***	**	**	-		
DLYGAP(-2)	-	-		-.0424**	*	**	-		
DLNEERNEG	.0380***	***	**	-.0406		***	.0278		
DLNEERNEG(-1)	-	-		.0835***	***	***	-		
DLNEERNEG(-2)	-	-		.0392**	**	**	-		
DLNEERPOS	.0234			.0252			.0286		
trend	.0002***	**	**	.0002	**	*	.0003***	***	***
C	.0350***	***	***	.0454***	**	**	.3131**		
N		1470			840			630	
n		14			8			6	
R^2		.5076			.4234			.6122	
R-^2		.5028			.4194			.6064	
F	106.18	-	62.84	42.90	-	12.48	64.08		69.41

Note:***,**,* denotes significance level of 1%, 5% and 10% respectively; N: total number of observation(n*T), n: number of panel unit in the model, R^2:R-square within, R-^2: adjusted R-square within, ϕ_i: error correction term(speed of adjustment) which is the coefficient of LCPI lagged once. The long-run elasticities (coefficients) were calculated by dividing the FE regression coefficient to ϕ_i multiply by -1.

The outcome of Table 4.10 is similar to the DFE model except difference in the magnitude of both long-run and short-run elasticities- slightly lower in these cases. Like the DFE model, the models the economy converges toward long-run equilibrium but a little bit faster. The longest time that takes disequilibrium to get back to the original was almost about 58 quarter which is as in DFE. Similarly, world oil price (LOIL) and output gap were still the major determinants of CPI inflation in the long-run for the entire samples and fixed exchange regime countries. The effect of output gap in the long-run was lower under fixed exchange rate regime than the full (entire) sample but not in the short-run.

ERPT due to appreciation or depreciation was higher under fixed exchange rate regime in all models across different sub samples. Particularly, the impact of appreciation was significant and higher in the long-run on CPI inflation but the impact of depreciation has significant effect on CPI inflation in the short-run. In general, the net effect of ERPT was higher during episodes of appreciation than depreciation under fixed exchange rate regime but the outcome was insignificant under flexible exchange rate regime. The result is in line with Knetter(1994) and Akofio-Sowah(2009) but on the contrary to Kassi et al(2019).

The impact of inflation inertia in all cases was significant. Meaning that past inflation affects current inflation situation significantly. This is in fact due to adaptive expectation-people tends to expect about the future inflation based past and current information. Generally, the most important implication of the result was any change in exchange rate has strong effect on countries with fixed exchange rate regimes than others.

4.9 ERPT Asymmetries

Exchange rate pass-through asymmetry could be analyzed in three ways; with the direction in change in exchange rate, the size and direction of exchange rate change and with the size of inflation. In the following three consecutive section; 4.9.1, 4.9.2 and 4.9.3 this study looked in to them thoroughly.

4.9.1 ERPT Asymmetries-Direction of Exchange Rate Change

In this section ERPT asymmetry with respect to direction of exchange rate change; depreciation negative change in exchange rate and appreciation positive change in exchange rate was analyzed. The result of ERPT asymmetry with respect to direction change in exchange rate is depicted in Table 4.11. The hypothesis(H_0^1) of symmetrical ERPT in the long-run was rejected under fixed exchange rate regime sub group using all model estimation and the hypothesis (H_0^2)of short-run symmetry was failed to be rejected in all cases of models and for all sub groups. Thus, result suggests long-run asymmetrical ERPT to CPI inflation under fixed exchange rate regime and short –run symmetrical pass-though for all sub groups which is in contrast to the result of Kassi et al.(2019) on which in most cases asymmetrical short-run ERPT was observed.

On the other hand the hypothesis (H_0^3)of zero pass-though for depreciation was rejected over long-run using fixed effect model with robust standard error for flexible exchange rate regime but not the case for other sub samples. Besides, the hypothesis was rejected for appreciation over the long-term-implying that non-zero pass-through of appreciation of exchange rate to CPI inflation in the longer time span. The result, however, showed mixed result to the hypothesis (H_0^4) of zero pass-through for depreciation and appreciation over short-term. The non-zero pass-through of depreciation was consistently obtained for the entire sampled countries (rejection of H_0^4). But the hypothesis was failed to reject for appreciation under all samples and models. Hence, the outcome yields non-zero pass-through of depreciation and zero pass-through appreciation over short-term, and non-zero pass-through of appreciation and zero pass-through of depreciation over the long-term. Similar result has been presented in works of Baharumshah, (2017);López-Villavicencio& Mignon (2017); and Choudhri & Hakura,(2015).

This study also presented the existence of complete pass-through of appreciation over the long-term regardless of the significance level and magnitude of the ERPT coefficients (failed to reject hypothesis H_0^5). The null hypothesis of complete pass-through of depreciation over the short-term was also rejected (rejection of H_0^6). Meaning that, ERPT is complete in the long-run but incomplete in the short-run for all sample categories and under all model estimation results. In other words consumer price more strongly react to local currency depreciation over the short-term and local currency appreciation over the long-term.

Table 4.11 Exchange Rate Asymmetries with respect to Direction Wald-test

A. Dynamic Fixed Effect: Error correction mechanism

Sub Groups	Long-run relationship _ERPT					Short-run relationship_ ERPT				
	Dep(-)= App(+)	Dep(-)	App(+)	Dep(-)	App(+)	Dep(-)= App(+)	Dep(-)	App(+)	Dep(-)	App(+)
	$\Gamma^- = \Gamma^+$	$\Gamma^- = 0$	$\Gamma^+ = 0$	$\Gamma^- \geq 1$	$\Gamma^+ \geq 1$	$\Omega^- = \Omega^+$	$\Omega^- = 0$	$\Omega^+ = 0$	$\Omega^- \geq 1$	$\Omega^+ \geq 1$
Full	3.43*	1.63	9.55***	3.98	12.3	0.14	7.38***	1.06	5011.46***	1571.44
Fixed	4.4**	0.1	7.89***	0.94	9.91	0.23	4.4***	0.26	2717.81***	789.73
Flexible	0.03	1.96	0.53	3.1	0.94	0	2.1	0.64	2271.97***	780.19

B. Fixed effect: Robust standard errors

Sub Groups	Long-run relationship _ERPT					Short-run relationship _ERPT				
	Dep(-)= App(+)	Dep(-)	App(+)	Dep(-)	App(+)	Dep(-)= App(+)	Dep(-)	App(+)	Dep(-)	App(+)
	$\Gamma^- = \Gamma^+$	$\Gamma^- = 0$	$\Gamma^+ = 0$	$\Gamma^- \geq 1$	$\Gamma^+ \geq 1$	$\Omega^- = \Omega^+$	$\Omega^- = 0$	$\Omega^+ = 0$	$\Omega^- \geq 1$	$\Omega^+ \geq 1$
Full	1.87	0.95	6.03***	2238.13	769.09	0.09	7.73***	1.09	5688.40***	1455.75
Fixed	2.00*	0.04	4.49*	737.53	304.56	0.07	2.84	1.26	1815***	412.91
Flexible	0.27	5.81*	0.47	4195.05	1040.03	0.01	4.67*	1.05	5678.25***	1622.84

C. Fixed effect: Driscoll-Kraay standard errors

Sub Groups	Long-run relationship _ERPT					Short-run relationship _ERPT				
	Dep(-)= App(+)	Dep(-)	App(+)	Dep(-)	App(+)	Dep(-)= App(+)	Dep(-)	App(+)	Dep(-)	App(+)
	$\Gamma^- = \Gamma^+$	$\Gamma^- = 0$	$\Gamma^+ = 0$	$\Gamma^- \geq 1$	$\Gamma^+ \geq 1$	$\Omega^- = \Omega^+$	$\Omega^- = 0$	$\Omega^+ = 0$	$\Omega^- \geq 1$	$\Omega^+ \geq 1$
Full	1.6	0.73	5.04**	1954.45	565.66	0.53	4.12**	0.05	3427.28***	762.8
Fixed	2.90*	0.05	5.89**	1007.54	399.21	0.04	2.56	0.26	1631.56***	403.61
Flexible	0	1.41	0.85	1366.85	897.41	0.01	1.33	0.91	2007.99***	1028.87

Note: ***, **,* denotes significance level at 1%, 5% and 10% respectively; Γ is long-run elasticity (ERPT) directly obtained from DFE error correction equation but in Table 'B' and 'C' $\Gamma^- -\left(\frac{w_i^-}{\phi_i}\right)$, $\Gamma^+ = -(\frac{w_i^+}{\phi_i})$; Ω is short-run(cumulative) ERPT which is $\Omega^- = \sum_k^t \mathcal{W}_{i,k}^-$ and $\Omega^+ = \sum_k^s \mathcal{W}_{i,k}^+$.; the Wald- test in Table A are chi-square values but it is F- values in Table B and C. The full, fixed and flexible contains 14, 8& 6 panel units respectively. Table design borrowed from Kassi et al (2019). Own computation using STATA14

4.9.2 ERPT Asymmetry with Respect to Direction and Size of Exchange Rate Change

In this section exchange rate movements were decomposed in to large and small to examine their impact on CPI inflation. In other words it was investigated that whether the size of pass-through was positively related to the size of exchange rate that is, to know whether menu costs are important in selected samples. The approach closely follows the work of Pollard & Coughlin (2004). This approach constructs the large and small changes of exchange rate as the follows:

L_t=1, $if\ |\Delta LNEER_t| \geq 3\%$, L_t=0 otherwise and S_t=1, if $|\Delta LNEER_t| < 3\%$, S_t=0 otherwise

These dummy variables are used to construct the large change in exchange rate $(\mathrm{L_t}\Delta LNEER_t)$ and small change in exchange rate$(\mathrm{S_t}\Delta LNEER_t)$. This construction was further applies in to non linear ARDL model;

$\mathrm{L_t}\Delta LNEERNEG_t$ = large change in exchange rate during local currency depreciation

$\mathrm{L_t}\Delta LNEERPOS_t$=large change in exchange rate during local currency appreciation

$\mathrm{S_t}\Delta LNEERNEG_t$=small change in exchange rate during local currency depreciation

$\mathrm{S_t}\Delta LNEERPOS_t$ =small change in exchange rate during local currency appreciation

Thus, using these four variables the non linear equation (Eq.10) was estimated. Table 4.12 shows the size of exchange rate change during depreciation and appreciation across sub regions.

Table 4.12 Behavior of Exchange Rate

Behavior of the Exchange Rate: 1992Q1–2018Q4 (Percent of Total Change)						
Sub-groups	Overall		Appreciation		Depreciation	
	Large Change	Small Change	Large Change	Small Change	Large Change	Small Change
Full Sample(n=14)	15.28	84.72	14.35	85.65	27.78	72.22
Fixed Regime(n=8)	12.85	87.15	11.92	88.08	25.93	74.07
Flexible Regime(n=6)	18.52	81.48	17.59	82.41	30.25	69.75

Note: n is the number of panel units in each group. Table design borrowed from Kassi et al(2019) Own computation using STATA 14

The large change in exchange rate was higher under flexible exchange rate regime (18.52 %) than other sub-groups in overall change in exchange rate. However, a small change was higher under fixed exchange rate regime (87.15%). Again the percent of quarters of large appreciation were higher (17.59%) under flexible regime than fixed regime. Thus, small change in the exchange rate for both appreciation and depreciation was higher in countries with fixed exchange rate regimes than flexible exchange rate regimes but the percent of small change was higher during appreciation than depreciation. The implied outcomes of the above statistics are presented in Table 4.13.

Table 4.13 ERPT Asymmetry with Respect to the Size and Direction of Exchange Rates

A. Dynamic Fixed Effect-Error correction mechanism

Sub-Groups	ϕ_1	Overall			Depreciation			Appreciation			Asymmetry Tests	
		Large	Small	Ho:	Large	Small	Ho:	Large	Small	Ho:	Ho:	Ho:
		L	S	L=S	LD	SD	LD=SD	LA	SA	LA=SA	LA=LD	SD=SA
Full	-.0131***	-3.3420**	-9.6095***	6.48**	3.7532***	7.1943	.47	.6100	-8.5392***	12.63***	2.7*	4.66**
Fixed	-.0154***	-2.5418**	-9.4448**	4.5**	2.4982**	1.3609	0	-2.3187	-12.6502**	6.56**	2.92*	1.71
Flexible	-.0159***	-5.4407**	-7.6989	.07	4.0034**	9.6001	.55	4.8486	-8.2789	1.65	.06	1.61

B. Fixed effect: Robust standard errors

Sub-Groups	ϕ_1	Overall			Depreciation			Appreciation			Asymmetry Tests	
		Large	Small	Ho:	Large	Small	Ho:	Large	Small	Ho:	Ho:	Ho:
		L	S	L=S	LD	SD	LD=SD	LA	SA	LA=SA	LA=LD	SD=SA
Full	-.0131***	-3.1701**	-.9.4961*	3.61*	6.292***	4.9008	.62	-2.3664	-.12.809**	9.34***	1.86	4.85**
Fixed	-.0154***	-2.4444*	-11.6870**	4.81*	1.5902**	1.03846	.01	-1.4188	-7.9701**	9.39**	3.06*	2.70*
Flexible	-.0159**	1.9685	-4.6352	.19	1.6100	7.0251	.69	2.1132	-5.9182	2.28	.23	1.17

C. Fixed effect: Driscoll-Kraay standard errors

Sub-Groups	ϕ_1	Overall			Depreciation			Appreciation			Asymmetry Tests	
		Large	Small	Ho:	Large	Small	Ho:	Large	Small	Ho:	Ho:	Ho:
		L	S	L=S	LD	SD	LD=SD	LA	SA	LA=SA	LA=LD	SD=SA
Full	-.0131***	-3.3053***	-9.4427	5.80*	3.7100***	7.1145**	1.38	.6031	-8.9695*	8.84*	2.13*	6.95***
Fixed	-.0234***	-1.7393*	-5.9615	3.9*	3.0769***	2.8077	.02	-.5684	-5.4102*	5.35*	2.63*	2.53*
Flexible	-.0159***	1.9685	-4.6352	.13	1.6100	7.0251	1.12	2.1132	-5.9182	2.28	.07	2.02

Note: ***, **,* denotes significance level at 1%, 5% and 10% respectively. L,S, LD, SD, LA and SA represents large change, small change, large change depreciation, small change depreciation, large change appreciation and small change appreciation respectively. The Wald- test in Table A is chi-square values but it is the F- values in Table B and C. Ho denotes the null hypothesis for each cases. Table design borrowed from Kassi et al(2019). Own computation Using STATA 14

The result in Table 4.13 showed that , considering the overall change in exchange rate, ERPT was higher during small change in exchange rate than large change in Table 4.13 A and B . However, ERPT was higher during large depreciation and small appreciation for the full sample and fixed exchange rate sub-group. Furthermore, the result presented the insignificant effect of the size and direction exchange rate on CPI inflation under flexible exchange rate regime sub-group except for large depreciation case under DFE error correction model.

The other important result derived from the estimation is with respect to asymmetry. In most cases, the asymmetrical ERPT was obtained between large depreciation and appreciation; and small depreciation and appreciation. Thus, there is no positive relationship between ERPT and the size of change in exchange rate which is in contrast to the outcome of Pollard & Coughlin (2003).

Given the significant result, an increase in CPI inflation during depreciation was lower than a decrease in CPI inflation during appreciation. For example, a 1% decline in exchange rate (during large depreciation of local currency) leads to a 6.3% rise in CPI inflation but a 12.8% decline in CPI inflation at about 1% increase in change rate (during small appreciation of local currency) (see Table 4.13 B full sample case).

4.9.3 ERPT Asymmetry with Respect to Size of Inflation

Under this section the relationship between ERPT and size of inflation was analyzed under different inflationary environment; Low and High inflation. This study categorized the sampled countries in to four taking in to account regime types. Because, the argument that countries under fixed exchange rate regime have had low inflation than countries under flexible exchange rate regime is inconclusive in this study. Meaning, as it can be seen from Table 4.1, there were countries with higher inflation under fixed exchange rate regime (e.g. Lesotho 4.11%) and countries with flexible exchange rate regime but low inflation (e.g. Zambia 3.65%).Thus, it is logical to classify countries based on the combination of exchange rate regime and inflation level.

Therefore, depending on the above premises countries were grouped under; countries under fixed exchange rate regime with low(fixed-low) and high(fixed-high) inflation; and countries under flexible exchange rate regime with low(flexible-low) and high(flexible-high) inflation. The respective number of countries for the first two groups was 2 and 6 but for the second groups the number of countries included was 4 and 2. The criterion to classify the countries was average inflation rate of the full sample. Hence, countries with average inflation below 4.11% were regarded as low inflation while those with more than 4.11% of inflation were labeled under high inflation category (see appendix A Table 1). Table 4.14 presents the result of ERPT coefficients and the Wald test result of symmetry test.

Due to small size the result in fixed effect with Driscoll-Kraay standard errors was insignificant in almost all cases and ignored. Hence the interpretation was mainly based on DFE error correction and fixed effect with robust standard errors.

The result suggests the speed of adjustment was significant and converges to the equilibrium slowly. But it was quick under low CPI inflation than high CPI inflation irrespective of exchange rate regime in all three models. For instance it takes about 22 quarters to back to equilibrium under low inflation but about 43 quarters in high inflation of fixed exchange rate regime countries'. This is against the result gained from general classification of Low and High inflation-in which adjustment speed was higher with high inflation (2.23%- approximately 45 quarters) than low inflation (2.01%- approximately 50 quarters)(see appendix C Table 1).

Further, it is evident that the coefficients of ERPT were significant; during depreciation than appreciation over the long-term (though not in expected sign) and during appreciation than depreciation over the short-term under fixed- low scenario. And another significant result was obtained under fixed-high cases over the long-term. Unexpected outcome was observed under flexible- high case on which depreciation had significant long-term effect on CPI inflation. But no significant result exists for flexible-low situation which might be due to prudent monetary policy measures. In general, ERPT was higher during appreciation over the long-term and during depreciation over the short-term with overall higher coefficients during appreciation than depreciation; and ERPT was low with low inflation and high with high inflation under fixed exchange rate regime. The result was mixed for flexible exchange rate regime.

The result fail to reject the hypothesis (H_0^1) of long run symmetry irrespective of inflation size, exchange rate regime and the model applied with exception to fixed- high scenario(reject the null hypothesis of long run symmetry) where as the hypothesis (H_0^2) short run symmetry was rejected under fixed-low option. However, the data don't support the rejection of short run symmetry in all model and scenarios. Considering the general Low and High classification, only in fixed effect with robust standard errors model and under low inflation the long run symmetry was rejected but asymmetrical short run

Similarly, the hypothesis of (H_0^3) zero pass-through of appreciation was rejected under fixed-low alternative at 1% significance level in the long-run in all models whereas significant result (rejection of zero pass-through of depreciation) at 5% and 10% level was gained under fixed-high case in DFE error correction and fixed effect with robust standard models errors respectively over the long-term as opposed to non inflation size estimation(the zero pass-through of depreciation over the long-term).

On the other hand, non-zero pass-through of depreciation (rejection of hypothesisH_0^4) was revealed under fixed-low at 1% and 10% significance level in DFE error correction and fixed effect model respectively in the short-run. The hypothesis was also rejected under flexible-low DFE error correction model in the short-run. But it was evident that failure to reject the null hypothesis under all other scenarios and models. The test result of the hypothesis of complete pass-through in the long-run and short-run (H_0^5 and H_0^6 respectively) make available on demand when deemed necessary.

Table 4 14 ERPT Asymmetry with respect to Size of Inflation and the Wald test

			Long-run relationship _ERPT					Short-run relationship _ERPT				
A. Dynamic Fixed Effect: Error correction mechanism												
Regimes	Inflation Type	ϕ_i	Dep(-)	App(+)	Dep(-)= App(+)	Dep(-)	App(+)	Dep(-)	App(+)	Dep(-)= App(+)	Dep(-)	App(+)
			Γ^-	Γ^+	$\Gamma^-=\Gamma^+$	$\Gamma^-=0$	$\Gamma^+=0$	Ω^-	Ω^+	$\Omega^-=\Omega^+$	$\Omega^-=0$	$\Omega^+=0$
Fixed	Low(n=2)	-.0447***	1.1178**	-.4683***	2.36	5.25**	52.16***	.0416***	-.0155*	23.29***	131.53***	3.53*
	High(n=6)	-.0232***	.7089	-9.5414**	7.94**	.09	4.92**	.0541	0.0552	.00	1.38	.31
Flexible	Low(n=4)	-.0214**	-1.6508	-1.8352	.03	1.10	2.02	.0297**	.0368	.09	4.05**	2.06
	High(n=2)	-.0150***	1.7549**	2.5317	.27	5.06**	.38	0.0028	-0.0193	.27	.72	.17
B. Fixed effect: Robust standard errors												
Regimes	Inflation Type	ϕ_i	Dep(-)	App(+)	Dep(-)= App(+)	Dep(-)	App(+)	Dep(-)	App(+)	Dep(-)= App(+)	Dep(-)	App(+)
			Γ^-	Γ^+	$\Gamma^-=\Gamma^+$	$\Gamma^-=0$	$\Gamma^+=0$	Ω^-	Ω^+	$\Omega^-=\Omega^+$	$\Omega^-=0$	$\Omega^+=0$
Fixed	Low(n=2)	-.0447***	-1.1186	-.4676***	4.000	12.27	7299***	.0416*	-.0155	23.41***	132.20*	3.59
	High(n=6)	-.0232***	.7112	-9.5431*	5.30*	0.08	6.31*	.0541	.0551	.0000	1.4	0.31
Flexible	Low(n=4)	-.0212*	-1.7453	-2.8443*	1.46	2.44	5.63*	.0300	.0490	.65	4.44	3.62
	High(n=2)	-.0150**	2.5333	-1.7533	2.00	3.74	.41	.0028	-.0193	.27	.73	.18
C. Fixed effect: Driscoll-Kraay standard errors												
Regimes	Inflation Type	ϕ_i	Dep(-)	App(+)	Dep(-)= App(+)	Dep(-)	App(+)	Dep(-)	App(+)	Dep(-)= App(+)	Dep(-)	App(+)
			Γ^-	Γ^+	$\Gamma^-=\Gamma^+$	$\Gamma^-=0$	$\Gamma^+=0$	Ω^-	Ω^+	$\Omega^-=\Omega^+$	$\Omega^-=0$	$\Omega^+=0$
Fixed	Low(n=2)	-.0447***	-1.0401	-.5307	.07	1.93	0.15	.0388	-.015	.59	1.78	.08
	High(n=6)	-.0232**	.7112	-9.5431***	2.63	.04	6.88***	.0541	.0551	.0000	1.09	.49
Flexible	Low(n=4)	-.0212***	-1.7453	-2.8443	0.15	1.15	2.06	.0300	.0490	.12	1.25	1.39
	High(n=2)	-.0150**	-1.7533**	2.5333	1.99	2.88*	1.14	.0028	-.0193	.73	.05	1.000

Note: ***, **,* denotes significance level at 1%, 5% and 10% respectively; $\boldsymbol{\phi_i}$ is speed of adjustment; Γ is long-run elasticity (ERPT) directly obtained from DFE error correction equation but in Table 'B' and 'C' $\Gamma^- -\left(\frac{w_i^-}{\phi_i}\right)$, $\Gamma^+=-(\frac{w_i^+}{\phi_i})$; Ω is short-run(cumulative) ERPT which is $\Omega^- =\sum_k^t \mathcal{W}_{i,k}^-$ and $\Omega^+=\sum_k^s \mathcal{W}_{i,k}^+$.; the Wald- test in Table A are chi-square values but it is F- values in Table B and C; n is the number of panel units; Low indicates low inflation with average inflation below 4.11% and High indicates High inflation with average inflation above 4.11%. Own computation using STATA14

4.10. Time Series Analysis

4.10.1 Unit Root

This study applies the three most common unit root test for each individual country namely; augmented Dickey–Fuller (ADF, Dickey and Fuller 1981), Phillips–Perron (PP, Phillips and Perron 1988) and Kwiatkowski–Phillips–Schmidt–Shin (KPSS, Kwiatkowski et al. 1992). The null hypothesis of ADF and PP is non-stationary of a series while the null hypothesis of KPSS states that the series is stationary. The results of unit root test presented in Table 4.15 below. From table 4.15 it's evident that in most cases the ADF and PP shows consumer price and money supply is stationary at first difference while the output gap, negative and positive change in exchange rate are stationary at level. With respect to oil price, it's stationary at first difference according to ADF but it was stationary at level according to PP and KPSS.

4.10.2 Cointegration and Symmetry Test

The existence of long-run relationship between the dependent variable and the covariates can be analyzed using Banerjee et al. (1998) t-test and Pesaran et al. (2001) F-test. The former (t_{BDM}) tests the null hypothesis of the speed of adjustment is equal to zero against the one-sided alternative hypothesis which is less than zero , while the latter F_{PSS}tests the null hypothesis of no co-integration, i.e., all coefficients are equal to zero , against the alternative of evidence of a long-term relationship, all coefficients jointly different from zero. The result of cointegration and symmetry test is displayed in Table 4.16.

According to Table 4.16 the outcome of the test result varies across countries. Among fixed exchange rate regimes countries; in Botswana, Burundi, Malawi, Rwanda and Tanzania there exists long-run relationship between the dependent variable and the explanatory variables while the other not. Likewise, from flexible exchange rate regime countries Kenya, Uganda, South Africa and Zambia the existence of cointegration was evidenced.

The asymmetrical effect of ERPT to consumer prices was also tested for each individual countries and shows different results meaning that , although the countries can be grouped as a panel as poolability test suggests , each country has its own individual specific characteristics such as the monetary policy, different political-economy situation, stages of growth, development of financial market and institutions.

The hypothesis of symmetry of ERPT to CPI inflation was also investigated to each country. In Table 4.16 it's observed that 50% of countries experience long-run asymmetrical effect of ERPT to consumer prices in both fixed and flexible regimes countries. However, except Zambia which was exceptional on which both long-run and short-run asymmetrical effect of ERPT to consumer prices was looked at. Furthermore, Tanzania was the only country with short-run asymmetrical but long-run symmetrical effect of ERPT.

Thus, the hypothesis of long-run symmetry (H_0^1)was rejected in Botswana , Burundi, Lesotho and Rwanda from fixed exchange rate regime countries ; and in Madagascar , Mozambique and Zambia among flexible exchange rate regimes. On the other hand, in other countries from both groups it's failed to reject the hypothesis of long-run symmetry. In spite of mixed result for (H_0^1) , the hypothesis of short-run symmetry (H_0^2) was failed to reject in all countries except Zambia.

Generally, the result was consistent-in most cases- to the panel fixed NARDL estimation i.e. the outcome from this model yields short-run symmetry like the time series analysis and long-run symmetry result as in country specific result. The asymmetrical effect of exchange changes was visualized through cumulative dynamic multiplier graph as depicted in appendix E(Table 1)

4.10.2 Time Series NARDL Estimation and ERPT

The long-run effect of money supply on CPI inflation was significant and positive in Rwanda and Zambia at 10% and 1% respectively. On average a 1% rise in money supply increase inflation by about 1% in Rwanda and 0.6% in Zambia, citreous paribus. Similarly, the strong world oil price effect on inflation was observed in Burundi, Botswana, Ethiopia and Rwanda over the long-term with an average rate of 0.4%, .02%, 10% and 0.2% respectively when oil price goes up by 1%. From this result, it was observed that oil price has significant long-run effect in fixed exchange rate countries than flexible exchange rate countries. Furthermore, Malawi and Namibia experienced significant positive long-run effect of output gap on CPI inflation.

Table 4 15 Time Series Unit Root test result

Sub-Groups	Countries		LCPI			LMS			LYGAP			LNEERNEG			LNEERPOS		
			ADF: Ho=I(1)	PP: Ho=I(1)	KPSS: Ho=I(0)	ADF: Ho=I(1)	PP: Ho=I(1)	KPSS: Ho=I(0)	ADF: Ho=I(1)	PP: Ho=I(1)	KPSS: Ho=I(0)	ADF: Ho=I(1)	PP: Ho=I(1)	KPSS: Ho=I(0)	ADF: Ho=I(1)	PP: Ho=I(1)	KPSS: Ho=I(0)
Fixed Regimes	Burundi	At level	-2.3894	-2.4379	1.1608***	0.1615	-12.2859***	1.0515***	-3.6283***	-3.7599***	0.0353	-7.189***	-7.1514***	0.2935	-10.3072***	-10.3081***	0.3776*
		At 1st difference	-4.2882***	-4.3914***	0.4336*	-5.9875***	-50.9098***	0.3177	-3.8724***	-5.1983***	0.0431	-8.7193***	-48.914***	0.1756	-60.7846***	-25.0044***	0.3874*
	Botswana	At level	-3.8138***	-4.7672***	1.1839***	-1.8905	-1.1967	0.7823***	-4.4069***	-3.0666**	0.0301	-7.1781***	-7.1333***	0.2125	-8.7364**	-8.8009***	0.1096
		At 1st difference	-5.8243	-5.8195***	0.9067***	-2.9575**	-5.0357***	0.1156	-3.2365**	-4.8273***	0.0300	-9.4904***	-32.6667***	0.1779	-9.4205***	-48.5675***	0.5000***
	Ethiopia	At level	0.7510	1.0306	1.0906***	-0.0593	-1.2306	0.4921**	-3.3992**	-3.4775**	0.0346	-6.7526***	-6.7395***	0.1118	-8.3425***	-8.1935***	0.2410
		At 1st difference	-5.7463***	-5.7020***	0.4462*	-2.5636	-4.1868***	0.1748	-4.7951***	-5.0374***	0.0479	-9.4940***	-27.0698***	0.2012	-9.2293***	-67.6193***	0.5000**
	Malawi	At level	-3.0088**	-2.3422	1.1620***	-2.1069	-1.5864	0.2968	-4.7129***	-3.4207**	0.0259	-8.1308***	-8.1558***	0.1508	-7.1573***	-7.0963***	0.0534
		At 1st difference	-4.3885***	-4.4579***	0.3221	-2.5955*	-5.2088***	0.1256	-5.5037***	-5.3370***	0.0236	-10.9534***	-40.4454***	0.3187	-12.1184***	-26.4418***	0.1088
	Nambia	At level	-2.2162	-2.8662*	1.1720***	-1.4007	-2.0959	0.9685***	-3.6329***	-3.0917**	0.0357	-8.5554***	-8.4092***	0.0698	-8.9576***	-9.0313***	0.0481
		At 1st difference	-3.0810**	-5.1394***	0.5700**	-2.7387*	-5.2201***	0.2733	-3.5898***	-5.3472***	0.0297	-11.7198***	-57.5370***	0.5000**	-12.3092***	-47.5821***	0.1721
	Rwanda	At level	-2.4312	-2.8676*	1.1399***	-2.1996	-2.1584	0.4956**	-3.9246***	-2.6373*	0.0337	-8.6609***	-8.6502***	0.3231	-8.5101***	-8.4907***	0.6171**
		At 1st difference	-3.1992**	-5.2328***	0.3572*	-1.0649	-4.5453***	0.1883	-4.7463***	-8.0590***	0.1134	-6.0187***	-35.6504***	0.1272	-9.4806***	-49.4331***	0.5000**
	Tanzania	At level	-1.7566	-4.0792***	1.1478***	-2.6371*	-1.5873	0.2360	-3.7744***	-3.3408**	0.0394	-3.7068***	-3.9686***	0.2600	-8.3614***	-8.3614***	0.0561
		At 1st difference	-2.4323	-2.4980	0.5877***	-2.6486*	-4.8156***	0.1079	-3.8229***	-5.2371***	0.1954	-12.8874***	-12.9411***	0.0491	-11.2464***	-56.1473***	0.5000***
Flexible Regimes	Kenya	At level	-1.3845	-2.7086*	1.1950***	-2.8978**	-2.4374	0.3657*	-5.1049***	-3.9271***	0.0381	-5.8916***	-7.6878***	0.5686**	-8.7266***	-8.8151***	0.4695**
		At 1st difference	-5.3602***	-5.3742***	0.3675*	-2.5964*	-6.2240***	0.0682	-4.9228***	-4.5294***	0.1025	-10.4932***	-37.6929***	0.0259	-8.8759***	-82.2222***	0.2559
	Lesotho	At level	-0.9585	-0.9825	0.9422***	-2.1492	-1.7389	0.2253	-4.1204	-2.9366	0.0335	-9.1017***	-9.0286***	0.0456	-7.7246***	-7.8709***	0.1763
		At 1st difference	-3.2318**	-5.3964***	0.0657	-3.7780***	-5.0434***	0.1116	-3.9668***	-5.0592***	0.0318	-11.8708***	-64.7322***	0.5000**	-11.6660***	-65.8442***	0.2056
	Madagascar	At level	-1.0663	-2.6012*	1.1386***	-2.5761	-2.3478	0.2871	-4.3852***	-3.3751**	0.0297	-7.4586***	-7.4971***	0.1431	-8.1345***	-8.1345***	0.4665**
		At 1st difference	-2.0675	-3.8090**	0.4519*	-3.1203**	-5.4015***	0.0507	-5.9713***	-7.2358***	0.0323	-11.5495***	-29.1433***	0.1258	-10.5296***	-24.2691***	0.0969
	Mozambique	At level	-2.9723**	-1.9608	1.1206***	-0.5916	-0.2196	0.9774***	-4.4984***	-3.4250**	0.0324	-7.0764***	-7.0505***	0.1940	-8.5745***	-8.5394***	0.2783
		At 1st difference	-3.7573***	-5.2680***	0.2336	-2.2951	-5.2357***	0.1974	-3.4909**	-5.5988***	0.0891	-11.7908***	-33.9992***	0.2256	-11.3370***	-81.7151***	0.2281
	Uganda	At level	-0.7717	-1.7952	1.1782***	-2.3588	-3.5564***	1.0988***	-3.2498**	-3.3638**	0.0523	-9.3802***	-9.3797***	0.1847	-5.4146***	-7.5866***	0.2781
		At 1st difference	-5.9724***	-5.9009***	0.2286	-3.8819***	-5.6115***	0.4101*	-4.5116***	-7.1187***	0.0383	-9.9311***	-69.8956***	0.3966*	-7.5049***	-18.5060***	0.0247
	South Africa	At level	-1.6871	-2.1710	1.1805***	-2.1782	-0.9871	1.0024***	-4.7293***	-3.0397**	0.0359	-8.6224***	-8.4887***	0.0841	-8.1802***	-8.3133***	0.0810
		At 1st difference	-4.6097***	-4.5655***	0.3481*	-3.3865**	-4.6145***	0.1737	-3.6416***	-5.1395***	0.0298	-11.7876***	-65.7959***	0.5000**	-12.3061***	-42.3933***	0.1337
	Zambia	At level	-10.0474***	-5.8899***	1.1343***	-1.7147	-1.8444	0.9374***	-3.9895***	-3.3143**	0.0398	-7.8205***	-8.1502***	0.5845**	-6.8448***	-6.3356***	0.0450
		At 1st difference	-7.0439***	-19.7652***	0.7082**	-3.3703**	-7.3166***	0.1216	-4.5785***	-6.5741***	0.0340	-11.1657***	-26.6318***	0.0150	-11.1009***	-41.7096***	0.3209
			ADF:	**PP:**	**KPSS:**												
	Oil Price	At level	-1.1148	-5.9045***	1.114***												
	LOIL	At 1st difference	-26.8091***	-24.6833***	0.2814												

Note:***, **, * indicates the level of significance at 1%, 5% & 10% respectively. Probability based on Mackinnon (1986) one-sided p-values. The output was obtained using E-views 9 all unit root test Add-ins developed by Dr. Imadeddin AIMosabbeh Qassim University –KSA. Further result was based on with constant and no trend

Table 4 16 Cointegration and Symmetry test of time series

	Country	F-Bound test	L_{Asy} & S_{Asy}		L_{sy} & S_{Asy}		L_{Asy} & S_{sy}		L_{sy} & S_{sy}		Symmetry Test	
											Long-run	Short-run
		F-value	t_{BDM}	F_{PSS}	t_{BDM}	F_{PSS}	t_{BDM}	F_{PSS}	t_{BDM}	F_{PSS}	$\Gamma = \Gamma$	$\Omega = \Omega$
Fixed Regimes	Botswana	8.3273***	-4.4051**	6.1685***	-3.3953*	6.4504***	-4.3626**	6.8211***	-4.2544**	6.6364***	91.42***	0.1178
	Burundi	4.0569**	-2.6383	4.1628**	-1.5661	3.9954*	-2.1232	3.8709*	-2.7489	0.3885*	34.711***	0.0354
	Ethiopia	2.2388	-1.1531	1.7373	0.1831	0.9618	-1.8271	2.7935	-0.8566	1.7405	0.003	0.2385
	Lesotho	1.5431	-2.1634	1.5608	-2.9292	1.1961	-2.6565	1.8237	-2.5737	2.1666	3.494*	0.4643
	Malawi	7.4925***	-1.7693	2.2811	-3.4053*	3.9852	-2.2168	3.2782*	-2.2648	2.6012	2.301	0.9213
	Namibia	5.0865***	-1.0091	2.2849	-0.7314	2.669	-1.5181	2.0553	-0.5534	2.3013	0.002	0.2425
	Rwanda	2.6211	-2.5743	3.0328	-2.0821	2.5659	1.9282	8.5519***	-1.9071	4.5391	7.061***	0.1955
	Tanzania	2.9594	-3.6520*	5.6126***	-4.6059***	8.4863***	-3.4817*	5.3084***	-3.2645*	5.4796***	0.0865	4.594**
Flexible Regimes	Kenya	4.9796***	0.8814	5.1672***	-2.12	3.1042*	-1.8809	4.1650**	-2.3611	3.7501*	1.845	1.926
	Madagascar	3.5917**	-0.3676	1.201	-1.0872	1.1658	-0.6940	1.8933	-0.2402	2.0104	6.407**	0.01
	Mozambique	3.5710**	-3.6866*	2.7559	-3.2973*	3.7085*	-3.9166*	2.2862	-3.6497*	2.5958	5.959**	0.0376
	Uganda	6.1982***	-1.0163	2.4342	-1.4795	2.2478	-.9373	2.7589	-1.3347	3.1230	0.3146	0.1135
	South Africa	3.5109**	-3.4163*	2.4928	-3.4096*	3.1479*	-3.5608*	2.5299	-3.0596	2.0887	0.0448	0.6634
	Zambia	9.7528***	.0290	15.0016	-2.3836	15.9916***	-2.3836	24.3256	.1341	16.0065***	4.145**	5.936**

Note: ***, **, * denotes the 1%. 5% & 10% level of significance; the result of F-bound test was obtained from E-views 9 while the output of t_{BMD} & F_{PSS} were obtained from NARDL estimation using STATA 14. Further result was based on with constant and no trend. The critical values of t_{BMD} & F_{PSS} were obtained from Narayan(2004) critical values for I(0) and *I(1) see Appendix D(Table 1)*

Table 4 17 Times Series NARDL estimation and ERPT

	Fixed Exchange rate Regimes Countries								Flexible Exchange rate Regimes Countries					
Countries	**Burundi**	**Botswana**	**Ethiopia**	**Malawi**	**Lesotho**	**Namibia**	**Rwanda**	**Tanzania**	**Kenya**	**Madagascar**	**Mozambique**	**Uganda**	**South Africa**	**Zambia**
Long-Run														
LMS	-0.6413*	-	0.00986	0.0371	1.18150	-	-	-	-	-	-.1959	-	-	-
LMS(-1)	-	-	-	-		0.1421	0.9574*	0.0925	3.52915	-0.0621	-	2.58972	-0.2180	0.6035***
LOIL	0.4062***	-	10.1163*	-0.2556	0.1791	-	-	-	-1.3134***	-0.4324*	-.1588	-2.71***	-	-
LOIL(-1)	-	0.0171***	-	-	-	-0.8004	0.2124*	0.0351	-	-	-	-	0.0736	0.0976
LYGAP	-		-28.48260	-	-2.07740	-	-	-	-1.03376	-0.8126	.1566	-	-	-
LYGAP(-1)	-0.52411157	.0551	-	2.5260***	-	32.4079***	0.4116	-0.0475	-	-	-	4.27167	-0.7786	-0.4841
LNEER_POS	-		1.17500	-	2.03590	-	-	-	7.0697**	2.5441	.3722	9.8102*	-	-
LNEER_NEG				-0.6483	0.52680	-	-	-	1.9766	-0.6724	.8884	3.68833	-	-
LNEER_POS(-1)	1.51886**	1.6241**	-	-	-	-0.1207	0.0750	2.3418	-	-	-	-	0.1567	-0.0990
LNEER_NEG(-1)	-0.055805785	-0.9262***	2.99420	-	-	-1.6134	-0.3469	-0.7374	-	-	-	-	-0.3559	-0.6479
Short-run														
ϕ_1	-0.0484*	-0.0665***	-0.00172	-0.0218*	-0.0773	-0.0169	-0.0266**	-0.0354**	0.015**	-0.0306**	-0.0615**	-0.0036*	-0.0256*	-0.0334**
D(LCPI(-1))	0.5644***	-0.0023	0.3837***	0.5244***	0.4847***	0.2360**	0.8274***	0.3710***	0.4048***	0.6237***	.5795***	0.3251***	0.4629***	0.3348***
D(LCPI(-2))	-	-0.1133**	-	-	-	-	-	0.2181**	-	-	-	-	-	0.0701**
D(LMS)	-	-0.0323**	-	-		0.004298	0.0093	-0.0755**	-0.2411***	-0.3541***	-	-0.1239***	-0.0313	-0.0778***
D(LMS(-1))	-	-0.0073	-	-	-	0.003464	0.0058	-	-	0.2153**	-	-	0.0397	0.037722
D(LOIL)	-	0.0059	-	-	-	0.0151**	-0.0034	0.0002	-	-	-	-	0.0047	0.009242
D(LOIL(-1))	-	0.0002	-	-	-	-0.000841	-0.0019	-	-	-	-	-	0.0004	0.0115
D(LYGAP)	0.3183***	0.0199	-	0.02528	-	-0.1440***	0.3000***	-0.0673	-	-	-	-0.1932	-0.0163	-0.1296***
D(LYGAP(-1))	-0.2384***	-0.0396	-		-	0.0760*	-0.3151***	-	-	-	-	-	-0.0004	0.038535
D(LNEER_POS)	-	0.0582	-	-0.0514	-	-0.0830*	-0.1327***	0.2896***	-	-	-	-	-0.0065	0.046183
D(LNEER_POS(-1))	-	-0.0712	-		-	-0.0035	0.1219***	-	-	-	-	-	-0.0370	0.019228
D(LNEER_NEG)	-	0.0208	0.145232*		-	-0.0632	0.0057	-0.1633**	-	-	-	-	-0.0349**	-0.025899
D(LNEER_NEG(-1))	-	0.0417	-0.2743***		-	-0.0652	0.0086	-	-	-	-	-	0.0019	-0.0264*
C	-0.2023*	0.1895***	-0.07606	0.0664	0.185625	0.0608	0.0038	0.1035	0.0566	0.093567	0.0769	0.0404	0.1198*	0.00215

Note: see table 4.14

In short-run, inflation inertia was a common manifest of all countries, past inflation behavior affect the current inflation situation through adaptive expectation. The short-run impact of money supply was significant but incorrectly signed but its lagged value positively and significantly affects Madagascar's current inflation. In addition, with exception to other countries, in Namibia there was significant short-run effect of oil price on inflation. With respect to output gap, the study found a mixed result on which its impact depends on the countries specific economic performance.

When the economy hits by shocks of exchange rate, it lost it equilibrium but converges and back to original level slowly in all countries- the speed of adjustment was significant and negative to all countries except to Ethiopia, Lesotho and Namibia. The length of time it takes to get to equilibrium was shorter to (0.0665) Botswana (about 15 quarters) and get longer to Ethiopia 0.00172(non-significant) (about 581 quarters) which is unrealistic- the economy diverges.

ERPT during appreciation was higher and significant for such countries as Burundi, Botswana, Kenya and Uganda over the long-term and for countries like Namibia, Rwanda and Tanzania over the short-term. Likewise, depreciation of local currency against foreign currency has no long-run effect on CPI inflation but it has short-run effect for few countries like Ethiopia. Therefore, ERPT was higher during appreciation than depreciation in the long-run but the result was mixed during depreciation but no significant ERPT of appreciation was observed in short-term.

CHAPTER FIVE

CONCLUSION AND POLICY IMPLICATIONS

5.1 Conclusion

In modern era-where international finance get more interest in the global economy, exchange rate (the price one currency in terms of another) play a decisive role in international financial stability. Movement in exchange rates affects consumer prices. This study examines the relationship between exchange rate movements and CPI in 14 selected SSA countries covering the period from 1992Q1 to 2018Q4 using non linear Autoregressive Distributed Lag model (NARDL) under DFE error correction method and fixed effect model with robust and Driscoll-Kraay standard errors due to the presence of cross sectional dependence.

The result of preliminary test indicates the existence of low multicollinearity and cross sectional dependence where countries share some characteristics. The unit root test result leads to the use of NARDL and the panel cointegration test of Westerlund (2007) showed the long-run relationship between consumer price index and other covariates on which appropriate lag length was determined by BIC. In addition, specification test indicates the existence of contemporaneous correlation between cross-sections, the presence correlated variance, the existence of serial correlation and group-wise heteroscedasticity in the residuals of a fixed effect regression model plus the presence of the first-order autocorrelation in the disturbance when all the regressors are strictly exogenous and the presence of serial correlation in the disturbance term. Thus, the result of these specification tests appeal to use fixed effect model with robust and Driscoll-Kraay standard errors with comparison to DFE error correction model.

In DFE error correction, fixed effect model with robust and Driscoll-Kraay standard errors models consistent result was obtained. The finding shows word oil price (LOIL), output gap (LYGAP) and positive change in exchange rate (LNEERPOS-appreciation) were the most significant determinant of CPI inflation in long-run with expected sign while change in money supply and depreciation were the important factors in determining CPI inflation in the short-run. The degree of ERPT was higher during depreciation over the short-term and during appreciation over the long-term. In general, the net effect of ERPT was higher during episodes of appreciation than depreciation under fixed exchange rate regime but the outcome was insignificant under flexible exchange rate regime.

The result suggests long-run asymmetrical ERPT to CPI inflation under fixed exchange rate regime and short –run symmetrical pass-though for all sub groups. Moreover, for the entire sample and fixed exchange rate sub groups, the outcome yields non-zero pass-through of depreciation and zero pass-through appreciation over short-term, and non-zero pass-through of appreciation and zero pass-through of depreciation over the long-term except to the non-zero pass-through of depreciation over the long-term for flexible exchange rate regime in fixed effect model with robust standard errors. The result also uncovered complete pass-through appreciation in the long-run and incomplete pass-through of depreciation in the short-run. Thus, the responsiveness of consumer price was strong to local currency depreciation and appreciation in the short-run and long-run respectively.

Furthermore, ERPT was higher during large depreciation and small appreciation for the full sample and fixed exchange rate sub-group and the asymmetrical ERPT was obtained between large depreciation and appreciation; and small depreciation and appreciation. ERPT was higher during large depreciation than appreciation and lower during small depreciation than appreciation. In a nutshell, ERPT was higher during small appreciation than large depreciation which is in support of menu cost theory when invoices are denominated with exporter's currency. Given the significant result, an increase in CPI inflation during depreciation was lower than a decrease in CPI inflation during appreciation. Thus, there is no positive relationship between ERPT and the size of change in exchange rate.

In addition, the combined classification of countries using inflation size and exchange rate regime provides important remarks. ERPT was significant; during depreciation than appreciation over the long-term and during appreciation than depreciation over the short-term under fixed exchange rate regime with low inflation (fixed- low scenario). Higher coefficients during appreciation than depreciation were obtained in general; and ERPT was low with low inflation and high with high inflation under fixed exchange rate regime- the result supports Taylor hypothesis. The result was mixed for flexible exchange rate regime.

In sum, the effect of change in exchange rate has significant effect and more pronounced for the entire SSA countries as a group and under fixed exchange rate regime characterized by higher average inflation than countries under flexible exchange rate regime.

5.2 Policy Implications

It is evident that ERPT has an important implication for international macroeconomic shock transmission, adjustment in current account and monetary policy intervention. That is, the degree and speed of pass-through is important for predicting inflation and formulating monetary policy. Thus, based on the findings of this study, the following policy implications are forwarded.

The strong long-run effect of world oil price on CPI inflation has important energy consumption policy. The shocks in world oil price transmitted to small open economies of SSA African countries. Since most SSA countries import oil from abroad the rise in oil price transmitted through distribution channels (such transportation) to consumer prices. Thus, non-oil dependent and renewable energy consumption policy may cure inflation in SSA countries.

The result of negative output gap (the economy is below the long-run equilibrium) in SSA countries push government to take measures that boosts the economy (rise in government expenditure). This increase the economic activities and hence aggregate demand in the long-run. Given that there is a treatment to structural problem on aggregate supply, and prudent monetary policy inflation could be kept to reasonable rate. Thus, keeping an eye on the possible deviation of output from its long-run level is important in designing monetary policy with caution to increase in money supply to finance government expenditure.

Moreover, the degree of ERPT was found to be higher during depreciation over the short-term and during appreciation over the long-term. ERPT was higher during episodes of appreciation than depreciation under fixed exchange rate regime but the outcome was insignificant under flexible exchange rate regime. The result documents appreciation of local currency as effective exchange rate measure to lower inflation. However, appreciation makes import cheaper (high import volume) while it make export expensive (low export volume). The cheaper import put the price down and but low volume of exports deteriorate of current account in parallel with fallen in aggregate demand ends with economic slowdown. The lower price is obtained at the larger cost. Thus, policy maker should balance the dilemma and take in to account the direction of ERPT to CPI inflation and exchange rate regimes when they decide to improve current account.

The asymmetrical ERPT with respect to direction and size of exchange rate change implies lack of monetary policy credibility. In designing monetary policy SSA countries not anchor inflation expectation in a target-little transparency which possibly makes ERPT non-declining. Thus, policy maker should give appropriate concern to the size of exchange rate change in the process of formulation of monetary policy to keep consumer price stable.

Finally, the result of higher and significant ERPT under fixed exchange than flexible exchange rate regime generally, and higher ERPT for countries under fixed exchange rate with higher inflation and lower ERPT with low level of inflation particularly implies improved inflationary environment helps to predict low degree of ERPT and low degree of ERPT helps to have greater freedom in pursuing independent monetary policy which makes easy to implement inflation targeting. Further, experience of higher ERPT under fixed exchange rate advocates the move to flexible exchange rate given the preconditions of deep-liquid foreign exchange market, sound policy governing central bank's intervention, an appropriate nominal anchor together with effective system to protect exchange rate risk.

Therefore, the above policy implications in a nutshell states that it important to take in to account the effect different macroeconomic determinants of inflation together with various asymmetries of exchange rate on consumer prices when formulating exchange rate and the monetary policy rules, to encourage trade liberalization and improve macroeconomic policies for more competitive market structures in Sub-Saharan African countries. However caution must be taken in policy implications and formulation with respect to specific (individual) countries since a doctor couldn't vaccinated all patient suffered from different diseases with the same drug and equal dosage- meaning country specific monetary policy, economic situation, political-economy ideology, exchange rate regime they adopt, the strength and efficiency of financial market and institutions etc should be taken in to account. In short each individual country need to design and/or formulate or adopt its own policy based on its own circumstances and realities.

5.3 Direction for Future Research

This study examine ERPT and inflation dynamics with respect to money supply, world oil price , output gap with special focus on exchange rate movements under different exchange rate regimes by using a panels of 14 SSA countries. Due to none fulfillment of post estimation specification tests which emanates from the presence of cross sectional dependence, this study employ models that accounts this problem and addresses its objectives.

However, there are others areas of research to be exploited. Among others this study focuses on macro level and general inflation. Thus, further study could be done using micro data and under various prices (such as producer prices, import prices, food and non food inflation depending on data availability). By doing so, it can be identified which sector and types of price more affected by ERPT.

In addition, in the presence cross sectional dependence models other than DFE errors correction with cluster of panels, fixed effect model with robust and Driscoll-Kraay standard errors might also produce better outcome of asymmetrical ERPT. Such models include Markov -Switching NARDL, cross sectional non linear distributed lag model (CS-NDL), cross sectional non linear Autoregressive distributed lag model (CS-NARDL).

Lastly, the debate on ERPT and contradiction results are loading which even reflects in this study -makes exchange rate economies most interesting research area of international macro economics. Thus, further investigations are also needed to prove or disproof the result presented in this study and others.

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Appendices

Appendix A. Classification of Countries

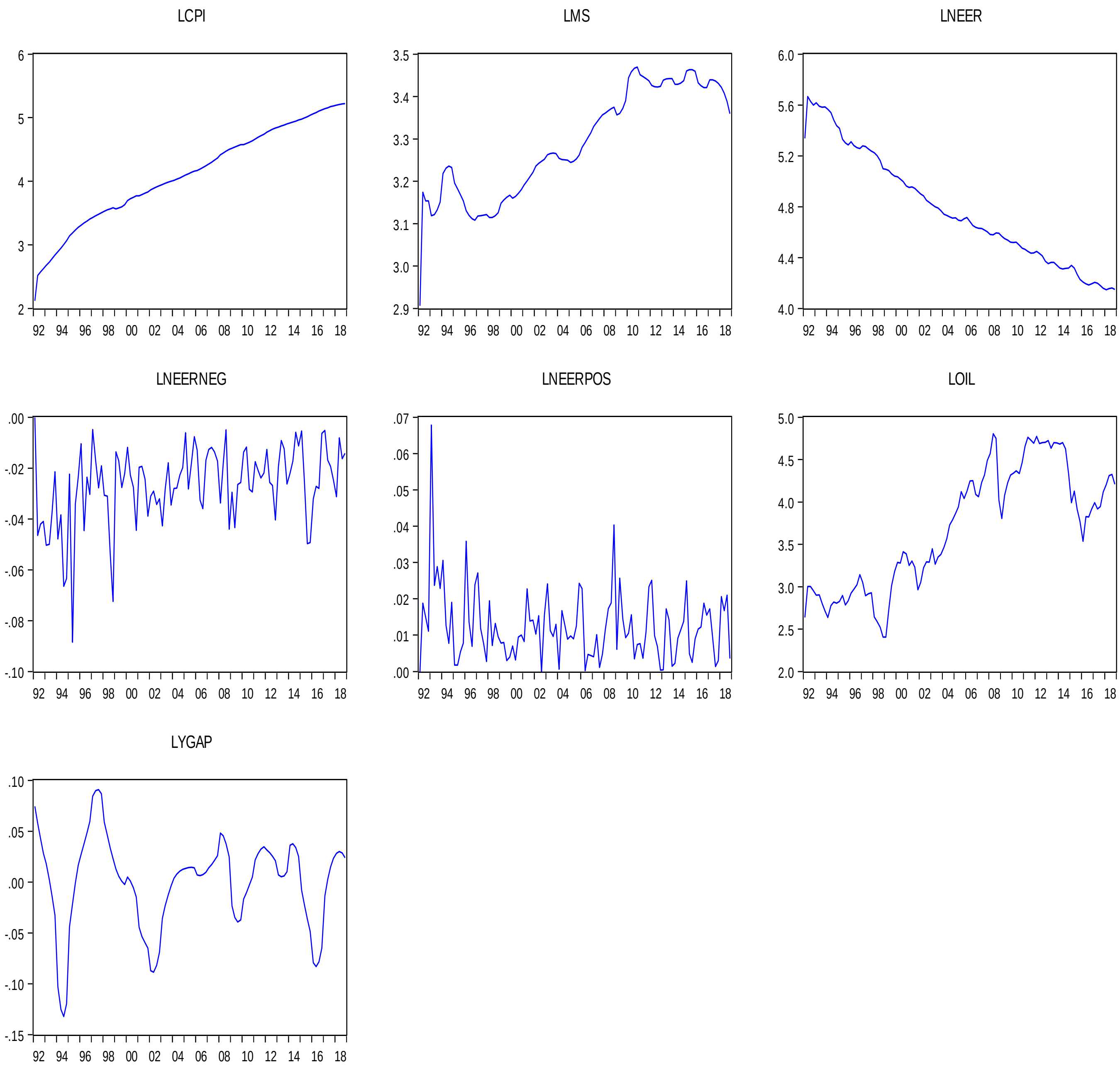
Table 1. Classification of countries based on inflation level and exchange rate regimes

Countries	c_SR_name (Country Short Name)	Inflation Size		Regime Types			
				Fixed Regime		Flexible Regime	
				Inflation Size			
		Low	High	Low	High	Low	High
Botswana	BWA		X		x		
Burundi	BDI	X		x			
Ethiopia	ETH		X		x		
Kenya	KEN	X				x	
Lesotho	LSO		X		x		
Madagascar	MDG	X				x	
Mozambique	MOZ	X				x	
Malawi	MWI	X		x			
Namibia	NAM		X		x		
Rwanda	RWA		X		x		
Tanzania	TZA		X		x		
Uganda	UGA		X				x
South Africa	ZAF		X				x
Zambia	ZMB	X				x	
Number of Countries		**6**	**8**	**2**	**6**	**4**	**2**

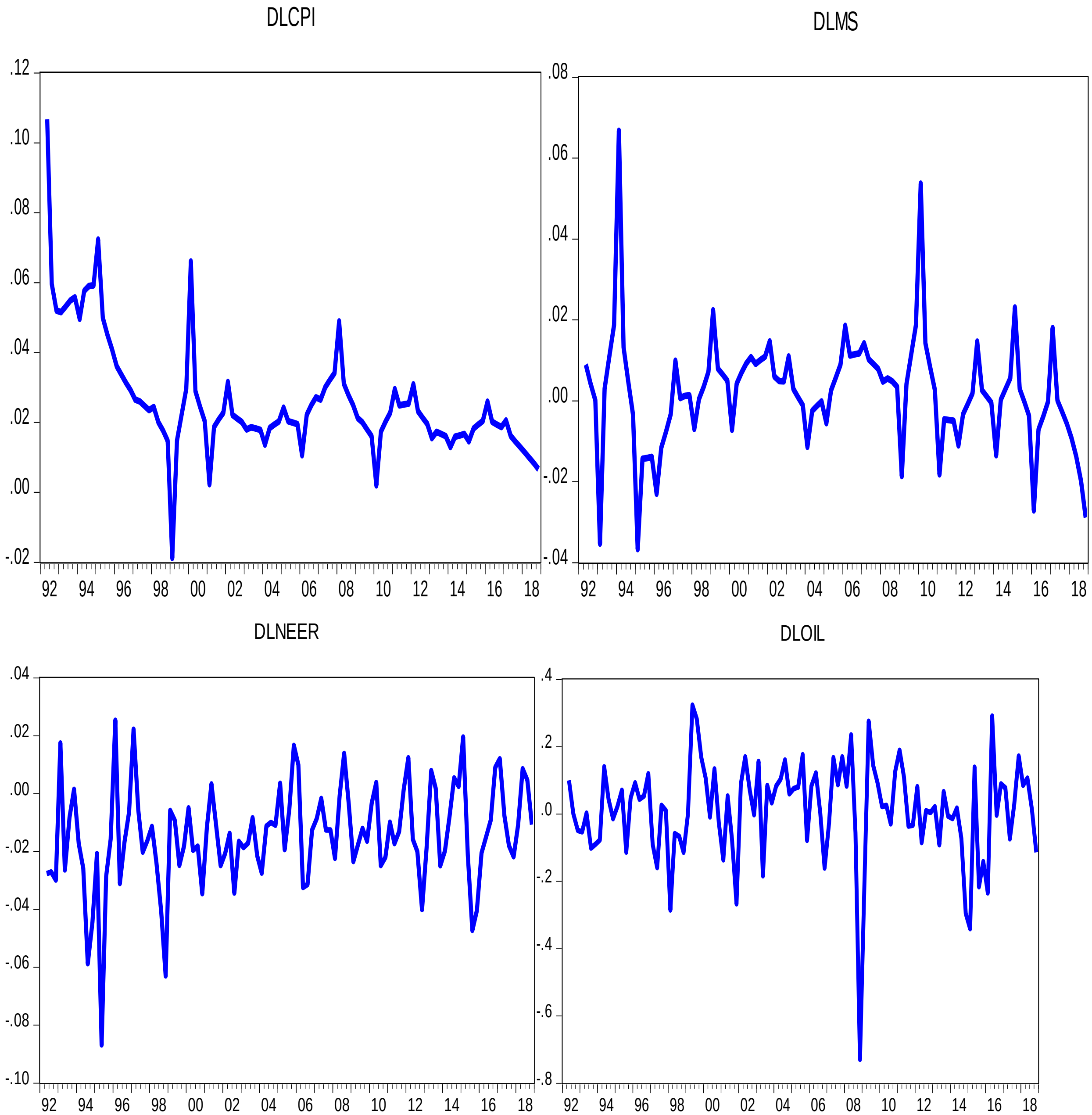
Source: Own design

Appendix B. Plots of Variables

i) Variables Used in the Empirical Analysis at Level



ii) Variables Used in Empirical Analysis at First Differences



Appendix C. Estimation Result of NARDL with the Level of Inflation

Table 1

A. Dynamic Fixed Effect-Error correction method

Inflation Type	ϕ_1	Long-run relationship_ERPT					Short-run relationship_ERPT				
		Dep(-)	App(+)	Dep(-)= App(+)	Dep(-)	App(+)	Dep(-)	App(+)	Dep(-)= App(+)	Dep(-)	App(+)
		Γ^-	Γ^+	$\Gamma^- = \Gamma^+$	$\Gamma^- = 0$	$\Gamma^+ = 0$	Ω^-	Ω^+	$\Omega^- = \Omega^+$	$\Omega^- = 0$	$\Omega^+ = 0$
Low	-.0201***	-1.6722	-.2.3248*	2.31	3.76*	0.54	.0320***	.021	13.13***	0.8	0.2
High	-.0203**	.5462	-8.1188**	.05	5.48**	6.18**	0.0416	.0397	1.53	0.55	.00

B. Fixed Effect-Robust

Inflation Type	ϕ_1	Long-run relationship_ERPT					Short-run relationship_ERPT				
		Dep(-)	App(+)	Dep(-)= App(+)	Dep(-)	App(+)	Dep(-)	App(+)	Dep(-)= App(+)	Dep(-)	App(+)
		Γ^-	Γ^+	$\Gamma^- = \Gamma^+$	$\Gamma^- = 0$	$\Gamma^+ = 0$	Ω^-	Ω^+	$\Omega^- = \Omega^+$	$\Omega^- = 0$	$\Omega^+ = 0$
Low	-.0201***	-1.6716**	-2.3234*	6.78**	6.37*	.46	.0320**	.021	13.24**	.82	.20
High	-.0223***	.0762	-7.6054**	.0000	6.75**	3.33	.0462	.0433	1.94	.56	.0000

C. Fixed effect: Driscoll-Kraay

Inflation Type	ϕ_1	Long-run relationship_ERPT					Short-run relationship_ERPT				
		Dep(-)	App(+)	Dep(-)= App(+)	Dep(-)	App(+)	Dep(-)	App(+)	Dep(-)= App(+)	Dep(-)	App(+)
		Γ^-	Γ^+	$\Gamma^- = \Gamma^+$	$\Gamma^- = 0$	$\Gamma^+ = 0$	Ω^-	Ω^+	$\Omega^- = \Omega^+$	$\Omega^- = 0$	$\Omega^+ = 0$
Low	-.0201***	1.6716	-2.3234**	1.97	3.99**	.10	.032*	.0210	3.51*	.75	.10
High	-.0223**	.0762	-7.6054**	.01	6.31**	2.17	.0462	.0433	1.15	.63	.0000

Note: see table 4.13

Appendix D: Narayan Critical Values

Table 1: Critical values for the F-test

Critical values for /(0) series					**Critical values for /(1) series**			
k	**10%**	**5%**	**2.50%**	**1%**	**10%**	**5%**	**2.50%**	**1%**
0	4.0200	5.0650	6.1050	7.4850	6.8100	8.7800	10.7200	13.3600
1	1.6900	2.2267	2.8133	3.6267	5.0900	6.3100	7.5400	9.1400
2	1.7350	2.2300	2.7400	3.4150	4.4633	5.4333	6.4000	7.8433
3	1.7520	2.2040	2.6620	3.2980	4.1350	4.9600	5.8625	7.0075
4	1.7517	2.1650	2.6000	3.1900	3.9220	4.7300	5.5140	6.5600
5	1.5014	1.8557	2.2286	2.7343	3.8283	4.5600	5.3100	6.3200
6	1.5213	1.8763	2.2438	2.7400	3.7571	4.4371	5.1314	6.1171
7	1.7400	2.1144	2.5000	3.0411	3.6850	4.3788	5.0663	6.1375
8	1.7480	2.1110	2.4920	2.9980	3.6644	4.3167	5.0589	5.9833
9	1.7545	2.1282	2.4936	3.0627	3.6570	4.3340	5.0060	5.9980
10	1.7650	2.1383	2.4983	3.0025	3.6364	4.3264	5.0382	6.0509

Note: k is the number of independent variables. I(0) and I(1) represent the order of integration. This study uses k=5 and the number of observation greater than 80 to test cointegration in Table 4.16 of chapter four.

Appendix E. The cumulative Dynamic Multiplier graph of ERPT Asymmetry