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An Empirical Assessment of the Exchange Rate Pass-through in Mozambique

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Abstract

Determining the magnitude and speed of the exchange rate passthrough (ERPT) to inflation has been of paramount importance for policy-makers in developed and emerging economies. This paper estimates the exchange rate passthrough in Mozambique using econometric techniques on a sample spanning from 2001 to 2019. Results suggest that the ERPT is assymetric, sizable and fast, with 50 percent of the exchange rate variations passing through to prices in less than six months. Policy-makers should continue to pursue low and stable inflation and develop a strong track record of prudent macroeconomic policies for the ERPT to decline.

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I. INTRODUCTION

The exchange rate is an important determinant of economic activity and prices in open economies. Depreciation (appreciation) of domestic currency increases (reduces) the cost of imports expressed in domestic currency which is transmitted to domestic prices. Moreover, depreciation (appreciation) may stimulate (depress) net exports by lowering (increasing) the cost of domestic products for foreign consumers, stimulating (depressing) the demand for domestically produced goods and hence their domestic prices.

Due to its potential effects on inflation in particular, and given the clear-cut implications for macroeconomic stability in general, quantifying the magnitude by which exchange rate variations are transmitted to domestic prices (exchange rate pass-through-ERPT) has been a paramount concern for researchers and policy makers. Moreover, the magnitude and speed of the ERPT is critical in the design and conduct of monetary policy aimed at stabilizing inflation. While modern central banks account for the ERPT given the primacy of price stability frequently embedded within their mandate, estimating the size of the ERPT remains an empirical matter.

In this paper, we revisit the empirical estimation of the ERPT using time series data from Mozambique, a country with a relevant history of sudden depreciations and monetary policy regime shifts. On the one hand, the country's episodes of pronounced depreciations generally coincide with episodes of high inflation. This was the case, for instance, during the 2015-2017 high inflation and depreciation period triggered by the country's major external debt crisis. This high correlation between the exchange rate and inflation provides an opportunity to quantify the magnitude of the ERPT.[2]

On the other hand, since 2017 Mozambique is undergoing a gradual transition from a monetary-based to an interest rate-based monetary policy framework. The transition is an opportunity to assess whether the regime shift has changed the magnitude of the ERPT. However, as ERPT estimates mask potential endogeneity between the exchange rate and prices, establishing causality requires the use of appropriate econometric techniques and model specification. There are often omitted variables, such as external volatility and climate shocks, which might drive the correlation between the two variables. Also, the correlation may reflect causality from domestic prices to exchange rates as shown in Hassan and Simione (2013) who study exchange rate determinants in Mozambique.

[2] The level correlation is about 0.91, 0.89 and 0.62 against the nominal effective exchange rate (NEER), the United States' Dollar (USDMZN) and the South Africa's Rand (ZARMZN), respectively, for the period 2001-2019.

This paper estimates the ERPT in Mozambique, focusing on its evolution over time and accounting for the role of the inflationary environment, financial crisis and the monetary policy regime. It employs the Autoregressive Distributed Lag Approach (ARDL) covering monthly data from 2001 to 2019. In addition to the advantage of addressing small sample issues, this approach does not require same-order integration and reduces concerns over reverse causality by exploring lagged interactions among the variables.

The results suggest that exchange rate variations have an asymmetric effect on domestic prices, and that a 10 percent depreciation of the domestic currency against the nominal effective exchange rate (NEER), USD and ZAR increase domestic prices by 4.2, 5.3 and 3 percent, respectively. The ERPT was broadly stable in the sample period but tended to be relatively high in periods of high volatility of the exchange rate and inflation, especially during the 2008 global financial crisis and the 2016 debt crisis in Mozambique.

Although previous research estimated the ERPT for Mozambique (e.g. Ubide, 1997, Omar, 2003; Cirera and Nhate, 2006; Vicent, 2007), the novelty of this paper lies in the use of an alternative methodology (the ARDL), model specification and longer time series. In addition, the paper analyzes the impact on ERPT of the inflation environment and change of monetary policy regime, as well as the asymmetric effects of the ERPT, both not addressed in previous research in Mozambique. Also, compared to previous studies which focus on the exchange rate vis-à-vis the South Africa Rand, the paper also considers the exchange rate vis-à-vis the United States Dollar (USD) and the nominal effective exchange rate (NEER) in recognition of Mozambique's increased integration into the global economy. The remainder of the paper is structured as follows. Section 2 summarizes the relevant empirical literature. Section 3 describes the data and methodology used in the empirical analysis. Section 4 presents the main empirical results, and Section 5 concludes the paper.

II. A SURVEY OF THE LITERATURE

Economists' interest in ERPT is long dated. At the micro level, several frameworks have been proposed to model the ERPT under different assumptions on whether the Law of One Price (LOOP) holds.[3] In such frameworks, ERPT can result from domestic producers' incentives to protect profits by fully reflecting exchange rate changes into sales prices. However, the magnitude of the ERPT depends, among other things, on whether the domestic economy is close to a monopoly or imperfect competition structure, and whether consumers maximize their utility by consuming locally produced goods rather than imported ones (Krugman 1987; Obstfeld and Rogoff 1995). So, when the domestic economy is competitive

[3] The LOOP is a well-known concept in economics. It states that, in the absence of trade frictions, and under free competition and price flexibility, identical goods sold in different countries must sell for the same price when prices are expressed in a common currency.

enough, in which case producers may aim at keeping their market share unchanged, they may have incentives to bear a part of the exchange rate change, and thus attenuating the ERPT. The same attenuating effect would hold when the share of domestically produced goods is higher in the domestic consumption basket.

At the macro level, it has been argued that the degree of ERPT also depends on the inflation environment and monetary policy. As suggested in Taylor (2000), countries with lower inflation environment will tend to experience lower ERPT. Accordingly, firms set prices in advance based on their expectations of future costs which ultimately relates to expected inflation. To the extent that low inflation expectations can result from more credible monetary policy, the latter can play a role in shaping the ERPT (Gagnon and Ihrig, 2004; McCarthy, 2007; Özyurt, 2016). However, a low ERPT can open room for more independent monetary policy by reducing the "fear of floating". From this perspective, a low ERPT may make it easier for monetary policy to stabilize inflation and output (Mishkin 2008), although the exchange rate channel of monetary policy could be reduced under low ERPT (Jašová et al. 2016). This exchange rate channel is captured in most modern new Keynesian models of monetary policy which include the exchange rate gap, in addition to output gap, in the central bank reaction function to inflation.

The magnitude of the ERPT is ultimately an empirical matter. Whether the ERPT is full or incomplete depends on whether the LOOP holds, which in turn depends on macro-structural and administrative factors. As noted in Frankel et al. (2005), any theory of incomplete ERPT must start with the reasons why the LOOP fails due to barriers to arbitrage. According to these authors, these barriers include transport costs (proxied by bilateral distance between the exporting and importing country), trade barriers (proxied by commodity-specific tariffs) and the costs of distribution and retail (proxied by the country's wage rate).

Several studies have analyzed the ERPT mainly in developed countries (Taylor, 2000; Gagnon and Ihrig, 2004; McCarthy, 2007; Özyurt, 2016) and to a lesser extent in developing countries (Choudhri and Hakura, 2006; Akofio-Sowah, 2009; Razafimahefa, 2012; Lariau et al., 2016; Helmy et al., 2018). Several of these studies suggest that exchange rate variations are only partially transmitted to domestic prices mainly through import prices and profit markups. Additionally, some studies have identified a weak and declining ERPT in both developed countries (Taylor, 2000; Özyurt, 2016) and developing countries (Razafimahefa, 2012; Lariau et al., 2016). The estimation methodologies adopted in these studies can be grouped in two, namely, the vector autoregressive and the single equation method, in most cases resulting in ERPT estimates that are not directly comparable. [4]

[4]Detailed review of econometric methods to estimate the exchange rate pass-through can be found on Bache (2006).

It has been argued that the weak and declining pass-through in developed and emerging countries is a result of low inflation environment from more sophisticated, stable and credible monetary policies which better anchor inflation expectations (Taylor, 2000; Gagnon and Ihrig, 2004; McCarthy, 2007; Özyurt, 2016). [5]

Based on a combination of macro and microeconomic models, Taylor (2000) investigates the ERPT and its evolution in the United States. His results suggest that the pass-through declines due to lower expectation of depreciation persistence. According to Taylor, firms set prices in advance based on their expectations of future costs, so they are more likely to increase prices if they expect a persistent depreciation of the domestic currency.

Gagnon and Ihrig (2004) estimate the ERPT for 20 industrialized countries. They find evidence that countries with lower and stable inflation experienced lower ERPT than those with high and volatile inflation. They also find that monetary policy played a role in the declining ERPT, particularly due to greater focus on inflation stabilization by central banks operating inflation targeting frameworks. As they further suggest, when the central bank has credibility in fighting inflation and its intentions are understood, agents are less likely to pass-through cost increases, including from exchange rate depreciations.

McCarthy (2007) also estimates the ERPT on a sample of industrialized countries and concludes that, while the ERPT is modest, the magnitude is higher for countries with a higher share of imported goods. Özyurt (2016), investigates the magnitude and speed of ERPT to import prices in the Euro Zone. The results suggest a partial and falling ERPT reflecting mainly the slow nominal price adjustments and the pricing-to-market behavior of firms.

In developing countries[6], researchers suggest that the weak and declining pass-through is mainly due to price rigidity and lower competition which lead to lower responsiveness of prices at least in the short run (Choudhri and Hakura, 2006; Akofio-Sowah, 2009; Razafimahefa, 2012; Lariau et al., 2016; Helmy et al., 2018).

To test Taylor (2000)'s hypothesis that the ERPT is relatively lower in low inflationary environment, Choudhri and Hakura (2006) carried out a cross country analysis comprising 71 countries. They find a strong incomplete pass-through, and that low inflation reduces ERPT as the later reflects the expected effect of monetary shocks on current and future costs. Similar results are found by Akofio-Sowah (2009), who investigate the impact of monetary regime on the magnitude of ERPT in Sub-Saharan Africa and Latin American countries. However, in contrast to other studies, their results show that the monetary policy regime has no significant impact on the ERPT on grounds that the newly adopted regimes did not

[5] Detailed review of literature for developed countries can be found in Burstein and Gopinath (2014)
[6] Detailed literature review for developing and emerging markets can be found in Tunç, (2017).

increase monetary policy credibility. However, they find that the pass-through is lower for countries with lower inflation.

To understand the ERPT to domestic prices and its determinants, Razafimahefa (2012) carries out a cross-country study for Sub-Saharan Africa countries and find that the passthrough is incomplete, asymmetric, and larger after domestic currency depreciations than after appreciations. He also finds that the passthrough declined in Sub-Saharan Africa countries since the mid-1990s due to improvements in macroeconomic and political environments. He further notes that the ERPT is lower for countries with lower inflation environment, flexible exchange rate, prudent monetary policy, and sustainable fiscal policy. A recent study by Kassi et al. (2019) finds a short-run asymmetric effect of ERPT. Accordingly, a 10 percent exchange rate depreciation leads to 6 percent increase in prices, and appreciations do not have a significant effect on prices at 5 percent significance level.

Lariau et al. (2016) investigate the magnitude of ERPT in Angola and Nigeria. For Angola, the authors find that the long run ERPT is high but declining in recent years due to de-dollarization, although insignificant in the short run due to price distortions resulting from administrative price setting schemes. For Nigeria, they find the ERPT to be insignificant in the long run. The short-run estimate is significant for nonfood prices arguably because most food items are locally produced.

Helmy et al. (2018) analyze the ERPT in Egypt. They conclude that the pass-through is high but incomplete, and slow on the three categories of prices (consumer price index, producer price index and import prices). According to the authors these results are explained by the composition of Egypt's consumer basket heavily influenced by subsidized commodities and goods with administered prices.

In Mozambique, research on the ERPT has focused mainly on the bilateral exchange rate of the Mozambican Metical (MZN) vis-à-vis the neighbor South Africa's Rand (ZAR). In general, as documented in Appendix C, the studies find a pass-through between 10 and 74 percent. The range of the estimates includes 20 percent for the period 1989-1996 (Ubide,1997), 74 percent for the period 1993-2001 (Omar, 2003), 50 to 70 percent for the period 2000-2005 (Cirera and Nhate, 2006), 15 percent for the period 2001-2006 (Vicente, 2007). These different results reflect mainly differences in methodologies, time span, model specification and the level of aggregation of the domestic price variable.

III. Data and Methodology

A. Data

The empirical analysis covers monthly data from January 2001 to December 2019[7][8]. The key variables included in the analysis are the Mozambique Consumer Price Index (CPI) and exchange rates. The CPI was obtained from Mozambique's National Institute of Statistics. The bilateral exchange rates of the Mozambican Metical (MZN) vis-à-vis the neighbor South Africa's Rand (ZAR) and the United States' Dollar (USD) were obtained from the Bank of Mozambique. The nominal effective exchange rate (NEER) was obtained from the International Monetary Fund. The bilateral exchange rates are defined as units of domestic currency per unit of foreign currency, so an increase of the exchange rate represents a depreciation of the domestic currency. The NEER is calculated as a trade-weighted average of bilateral exchange rates of the Mozambican Metical vis-à-vis Mozambique's main trading partners[9]. An increase of NEER indicates a depreciation of the local currency against the weighted average exchange rates of currencies of its main trading partners. In addition to the above variables, and in line with most empirical applications, we include three control variables, namely the import price index, money supply and a rain fall index:

1. Import price indices (MPIs): measure changes in the prices of goods and services provided by nonresidents (rest of the world) and purchased by residents of Mozambique. The MPIs were obtained from the International Monetary Fund and are calculated as a weighted average of the price indices for the elementary aggregates, using as weights the relative values of the trade for each elementary aggregate.[10]

2. Money supply: real money supply (M3), obtained from the Bank of Mozambique, intends to capture the demand conditions**.** Most studies proxy the demand conditions with the Gross Domestic Product (GDP) gap. Since monthly GDP data is not available, we proxied the demand conditions with broad money supply gap. The real money supply was calculated by dividing the broad money supply by the CPI. The gap was computed as the deviation of actual real broad money supply from the trend derived through the Bandpass filter. As a

[7] Extending the sample to earlier periods would arguably not be recommended anyway because of the potential war and the post-war effects on the estimates. Inflation was very volatile during the war and post-war periods.

[8] All the data series were seasonally adjusted through the X-13 ARIMA-SEATS seasonal adjustment method.

[9] In 2019 the Mozambique's 10 major trading partners were South Africa (47%), India (23%), China (18%), Singapore (10%), United Arab Emirates (10%), Italy (8%), Netherlands (7%), United Kingdom (6%), Japan (5%) and Belgium (5%).

[10] For each elementary aggregate, the relative value of the trade is computed as the share of the related product in the total value of imports. The detailed methodology can be found on the IMF's Manual of Export and Import Index (https://www.imf.org/~/media/Websites/IMF/imported-full-text-pdf/external/np/sta/xipim/pdf/_xipim.ashx)

robustness check for the model specification, we alternatively use the gaps of narrower money supply (M2 and M1), and the economic activity index obtained from the National Institute of Statistics.

3. Rainfall index: the rainfall index was obtained from the National Institute of Statistics and intends to capture supply conditions and food scarcity. The rationale for including this variable is that the agriculture sector, which in Mozambique accounts for around a quarter of GDP, is heavily dependent on rainfall. Scarce rainfall tends to reduce the supply of domestically produced food with adverse impacts on inflation. As a robustness check for the model specification, we also alternatively control for a measure of supply gap, computed as the deviation of actual rainfall index from the trend derived through the Bandpass filter.

Table 1 in appendix A summarizes the descriptive statistics for key variables. All variables entail substantial variation as suggested by the relatively large standard deviations and the gap between the minimum and the maximum values. Except for the USD/MZM, the distributions of all series included in the baseline regression model are approximately symmetric, as suggested by the skewness values, reducing potential concerns over extreme observations. Figure 1 in appendix B depicts the levels of the variables over time. The CPI, the exchange rates and import prices exhibit overall a positive trend, while the money supply and rainfall index gaps fluctuate around the mean. The ZAR/MZN, import price, and to a lower extent the USD/MZN and NEER series, reveal apparent structural breaks coinciding with the global financial crisis in 2007-2009. This could lead to a change in the magnitude of the ERPT in later years, an issue which we also investigate. Overall, the charts suggest that there is a positive correlation between the levels of CPI, exchange rates and import prices.

Prior to deciding on the appropriate econometric methodology, the time-series properties of the individual variables were tested for stationarity based on the Augmented Dickey-Fuller (ADF) and Phillips-Peron (PP) tests, and the results are reported on Table 2 of Appendix A. The results reveal that, except for real money supply and rainfall gaps[11], all variables are nonstationary in level but become stationary in first differences[12]. Since not all the variables have the same order of integration, the Johansen cointegration approach cannot be applied, so we adopted the Autoregressive Distributed Lag (ARDL) developed by Pesaran et al (2001).

B. Empirical Model Specification

As noted earlier, since not all the variables have the same order of integration, the paper adopts the Autoregressive Distributed Lag (ARDL) model developed by Pesaran et al

[11] These was expected as both the real money supply gap and rainfall index gap were computed as the deviation from their actual trend through the Bandpass filter

[12] We also tested for unit root hypothesis in the presence of structural break. The results remain broadly the same.

(2001).The ARDL, unlike Johansen's approach, does not require that the series are integrated to the same order for a long-run relationship to hold among variables, although none of the series should be integrated of order two or more. Moreover, the ARDL model is more reliable and has better statistical properties in small samples and it is able to account for asymmetric effects in the short-run and long-run (Nkoro and Uko, 2016:64; Narayan, 2005:1980; Pesaran et. al, 2001:289). Furthermore, the lagged features of the model help limit concerns over endogeneity from reverse causality.

Based on the literature, our model specification of the ERPT is based on the Purchasing Power Parity hypothesis. The long-run regression in *logs* is expressed by Equation 1.

$$lnCPI_t = \varphi_0 + \varphi_1 lnE_t + \varphi_2 lnMPI_t + \varphi_3 T + \in_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .1$$

Where *CPI* is the domestic consumer price index, *E* is the exchange rate (nominal effective exchange rate, USD/MZN rate, ZAR/MZN), *MPI* is the import price index controlling for non-exchange rate related changes in the price of imported goods (e.g., production and import costs), φ_1 to φ_3 are the elasticities of their respective independent variables. φ_0 is the constant, *T* is the trend, *ln* is the natural logarithm, *t* is the time subscript and ϵ is the error term; $\varphi_1$is the ERPT coefficient which captures the overall exchange rate impact on the CPI through exchange rate-induced changes in the domestic price of final imported goods and domestically produced tradable goods, the latter affected by changes in the price of imported inputs.

Following Pesaran et al (2001), the ARDL model error correction representation of Equation 1 is given by Equation 2.

$$\Delta LnCPI_t = \beta_0 + \sum_{i=1}^{p} \beta_i \, \Delta LnCPI_{t-i} + \sum_{i=0}^{q} \gamma_i \, \Delta LnE_{t-i} + \sum_{i=0}^{k} \theta_i \, \Delta LnMPI_{t-i} + \alpha_1 LnCPI_{t-1} + \alpha_2 LnE_{t-1} + \alpha_3 LnMPI_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots .2$$

Where Δ is a difference operator, β_0 is an intercept term, $\beta_i, \gamma_i, \theta_i$ are the short-run elasticities and α_1 to α_3 are the long-run elasticities of their respective independent variables and *p*, *q* and *k* are the respective lag lengths, and ε_t is the error term.

Before estimating long-run elasticities, the existence of the long-run relation among the variables is tested through the bounds test for cointegration based on the Wald Statistics (F-statistics) expressed on the following null and alternative hypothesis:

H_0: $\alpha_1 = \alpha_2 = \alpha_3 = 0$ (Null, i.e. the long run relationship does not exist)
H_A: $\alpha_1 \neq \alpha_2 \neq \alpha_3 \neq 0$ (Alternative, i.e. the long run relationship exists)

Provided that a stable long-run relationship is supported by the Wald Statistic, the next step is estimating the *ARDL (p, q, r)* model representation of Equation 1 given by Equation 3 below, from which the long-run elasticities will be estimated.

$$LnCPI_t = b_0 + \sum_{i=1}^{p} b_{1i}\, LnCPI_{t-i} + \sum_{i=0}^{q} b_{2i}\, LnE_{t-i} + \sum_{i=0}^{r} b_{3i}\, LnMPI_{t-i} + b_i T + \mu_t \dots\dots\dots\dots\dots\dots \quad 3$$

The long-run elasticities of domestic prices in relation to the exchange rate and the import price can be estimated from Equation 4.

$$\hat{\varphi}_i = \frac{\sum_0^q \hat{b}_{ti}}{1 - \sum_1^p \hat{b}_{1i}} \dots\dots\dots\dots\dots\dots \quad 4$$

Similarly, the long-run coefficients associated to the deterministic coefficients with fixed lags (trend and constant) are estimated from Equation 5.

$$\hat{\emptyset}_i = \frac{\hat{b}_i}{1 - \sum_1^p \hat{b}_{1i}} \dots\dots\dots\dots\dots\dots \quad 5$$

Hereafter, in the third and final step, we obtain short-run dynamic parameters by estimating an error correction version of the *ARDL (p, q, r)* model represented by Equation 6.

$$\Delta LnCPI_t = c_0 + \sum_{i=1}^{p} c_i\, \Delta LnCPI_{t-i} + \sum_{i=0}^{q} c_i\, \Delta LnE_{t-i} + \sum_{i=0}^{r} c_i\, MPI_{t-1} + \vartheta ECT_{t-1} + \epsilon_t \dots\dots\dots\dots \quad 6$$

where ECT is the error correction term and ϑ represents the error correction coefficient which measures the speed of adjustment to the steady state. A negative and significant error correction coefficient is an indication of cointegration, that is, ensures convergence of the short-run disequilibrium on CPI to the steady state. The *ECT* is derived as the error term obtained from the long-run model represented by Equation 1.

C. Accounting for asymmetric effects

The asymmetry analysis of ERPT aims to assess whether domestic prices react differently from positive (depreciation) or negative (appreciation) exchange rate variations. To test for asymmetry, we apply the extended form of Pesaran et al. (2001)'s ARDL modeling framework developed by Shin et al. (2014) represented by Equation 7.[13]

[13] The literature is irresolute on whether the time trend should be included, with arguments on both sides. We include the time trend in the asymmetric model in order to accommodate the strong upward trending behavior of the CPI. Additionally, we include the time trend to account for the possibility of time varying Harrod-

(continued…)

$$\Delta LnCPI_t = \beta_0 + \sum_{i=1}^{p} \beta_i \, \Delta LnCPI_{t-i} + \sum_{i=0}^{q^+} \gamma_i^+ \, \Delta LnE_{t-1}^+ + \sum_{i=0}^{q^-} \gamma_i^- \, \Delta LnE_{t-1}^- + \sum_{i=0}^{r} \delta_i \, MPI_{t-i} + \varphi_1 LnCPI_{t-1} + \varphi_2^+ LnE_{t-1}^+ + \varphi_2^- LnE_{t-1}^- + \varphi_3 MPI_{t-i} + \varphi_4 T + \varepsilon_t \; \ldots\ldots\ldots\ldots\ldots.\ldots.7$$

LnE^+ and LnE^- are respectively the partial sums of domestic currency depreciations and appreciations and can be computed as follows:

$$LnE_t^+ = \sum_{i=1}^{t} \Delta LnE_i^+ = \sum_{i=1}^{t} Max(\Delta LnE_i \, , 0)$$

$$LnE_t^- = \sum_{i=1}^{t} \Delta LnE_i^- = \sum_{i=1}^{t} Min(\Delta LnE_i \, , 0)$$

The error correction form of Equation 7 can be represented by Equation 8.

$$\Delta LnCPI_t = \beta_0 + \sum_{i=1}^{p} \beta_i \, \Delta LnCPI_{t-i} + \sum_{i=0}^{q^+} \gamma_i^+ \, \Delta LnE_{t-1}^+ + \sum_{i=0}^{q^-} \gamma_i^- \, \Delta LnE_{t-1}^- + \sum_{i=0}^{r} \delta_i \, P_{t-i}^* + \sum_{i=0}^{k} \theta_i \, \Delta LnDPI_{t-i} + \varphi_1 ECT + \varepsilon_t \; \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.8$$

From the Equation 7 the long-run elasticities of ERPT are represented by $-\frac{\varphi_2^+}{\varphi_1}$ and $-\frac{\varphi_2^-}{\varphi_1}$ for domestic currency depreciation and appreciation, respectively. The short-run elasticities of ERPT are obtained from Equation 8 and are represented by $\sum_{i=0}^{q^+} \gamma_i^+$ and $\sum_{i=0}^{q^-} \gamma_i^-$ for domestic currency depreciation and appreciation, respectively.

Equation 7 provides a relationship that may exhibit either short-run or long-run asymmetry, both or none of them. So, to test the existence of short-run and long-run asymmetric effects, that is, whether domestic prices react in the same magnitude to appreciation and depreciation of domestic currency, we perform the Wald test under the null hypothesis that "depreciation and appreciation of domestic currency have symmetric effects on domestic currency" and are represented as follows:

$$H_0 \colon -\frac{\varphi_2^+}{\varphi_1} = -\frac{\varphi_2^-}{\varphi_1} \text{ (for long-run) and } \; H_0 \colon \sum_{i=0}^{q^+} \gamma_i^+ = \sum_{i=0}^{q^-} \gamma_i^- \text{ (for short-run)}$$

Samuelson effects as suggested by Taylor and Taylor (2004) and for potential differences in trends among variables.

D. Accounting for inflation environment, financial crisis and monetary policy regime

Mozambique has witnessed a decline in inflation over time, so we test the Taylor (2000)'s hypothesis that countries with relatively lower and stable inflation tend to have lower ERPT to domestic prices relative to those with high inflation environment. To assess the impact the inflationary environment effect on the ERPT, we follow Lopez-Villavicencio and Mignon (2016) and estimate the ARDL models represented by Equation 9.

$$\Delta LnCPI_t = \beta_0 + \sum_{i=1}^{p} \beta_i \, \Delta LnCPI_{t-i} + \sum_{i=0}^{q} \gamma_i \, \Delta LnE_{t-i} + \sum_{i=0}^{r} \alpha_i \, \Delta LnE_{t-i} * D_{t-1} + \sum_{i=0}^{l} \theta_i \, \Delta LnMPI_{t-i} + \varphi_1 LnCPI_{t-1} + \varphi_2 LnE_{t-1} + \varphi_3 LnE_{t-i} * D_{t-1} + \varphi_4 LnMPI_{t-1} + \varepsilon_t \; \ldots\ldots\ldots\ldots\ldots\ldots 9$$

Where *D* represent, in two separate regressions, the 12 months moving average (MAINF) and standard deviation (SDINF) of inflation rate. The *MAINF* captures the level (high or low) of inflation environment while *SDINF* captures inflation stability. The total long-run elasticities of ERPT are obtained by $-\frac{\varphi_2}{\varphi_1} - \frac{\varphi_3}{\varphi_1}$ for both regressions. Positive and significant value of $-\frac{\varphi_3}{\varphi_1}$ suggest that high inflation increase the ERPT for the *MAINF* model and that more unstable inflation increases the ERPT for the *SDINF* model.

We also assess the effect of global financial crisis on the ERPT to domestic prices. According to Leigh et al. (2016), the global financial crisis and its aftermath were characterized by large movements in the relative prices of major currencies with impact on prices of imported goods. In Mozambique, a trend analysis of the NEER, ZAR/MZN and USD/MZN series reveals apparent structural breaks during the period of global financial crisis in 2007-2009, which might have potentially affected the magnitude and direction of ERPT.

We similarly assess the impact of monetary policy regime on the ERPT. As Taylor (2000) argues, credible and rule-based monetary policy anchors well inflation expectations which reduces the propensity of firms to react to cost shocks from exchange rate variations as, at least in the long run, they believe that prices will follow the path and speed announced by the central bank. In April 2017, the central bank of Mozambique moved from a monetary targeting to an interest rate-based monetary policy regime, with the latter better anchoring inflation expectations (Aisen and Simione, 2019). We assess whether the regime shift impacted the direction and magnitude of the ERPT.

To evaluate the impact of the global financial crisis and the monetary policy regime shift on ERPT, we follow Lopez-Villavicencio and Mignon (2016) and we adjust Equations 2 and 3 to Equation 10.

$$LnCPI_t = d_0 + \sum_{i=1}^{p} d_{1i}\, LnCPI_{t-i} + \sum_{i=0}^{q} d_{2i}\, LnE_{t-i} + \sum_{i=0}^{k} d_{3i}\, LnE_{t-i} * D_{t-1} + \sum_{i=0}^{l} d_{4i}\, LnMPI_{t-i} + \varphi_1 LnCPI_{t-1} + \varphi_2 LnE_{t-1} + \varphi_3 LnE_{t-i} * D_{t-1} + \varphi_4 LnMPI_{t-1} + \varphi_{4i} D_{t-1} + \in_t \quad ..10$$

Where D_{t-1} is a dummy variable capturing changes in inflation environments, monetary policy regime and the financial crisis. The dummy variable takes the value 1 for the period after the global financial crisis (from September 2009) and for the period of new monetary policy regime (from April 2017). The dummy variable is interacted with exchange rate to capture any change in ERPT that occurs because of a transition to a new monetary regime and to capture the contribution of financial crisis on the change of ERPT.

IV. Empirical Results

A. Bounds F-test for Cointegration

To perform the ARDL Bounds F-test for cointegration, an optimal lag length for each variable was automatically selected through the Akaike Information Criterion (AIC) for all ARDL models. A linear trend term was added to the cointegration test due to the trending behavior observed in all series. Table IV-1 reports the results of cointegration test between the consumer price index, exchange rates and foreign prices in the five regression models considered. The null hypothesis of “no cointegration” can be rejected at 5 percent significance level for all the 3 ARDL models (NEER, USD/MZN, ZAR/MZN) under the five regressions (the computed F-statistics are greater than the upper bound critical value of 5.85 at 5 percent significance level). So, we conclude that there is a stable long run cointegration between the CPI, the three exchange rates and other explanatory variables.

Table IV-1: Cointegration Test - ARDL Bounds Test

ARDL Model - Exchange Rate	F-Statistics		
	NEER	USDMZN	ZARMZN
Baseline Model	18.22	11.71	10.73
Assymetric Effects Model	21.65	10.55	7.62
Inflationary Environmental Effects Model	12.91	9.68	9.13
Monetary Policy Regime Model	11.48	7.60	7.23
Financial Crisis Effect Model	11.86	9.48	7.49
Cointegration	Yes	Yes	Yes
Model	ECM	ECM	ECM
	Significance Level	Lower Bound - I(0)	Upper Bound - I(1)
Critical Values	5%	4.87	5.85

Notes: All variables are in logs and a constant and trend were included in all Models

Null Hypothesis: No long-run relationship

Critical Values obtained from Pesaran et al. (2001)

Source: Researchers' computation based on Eviews 11

B. Long-run and short-run estimates of ERPT and Asymmetric Effects

Estimates of the baseline ERPT for the three models are reported in Table IV-2[14]. The long-run elasticities of domestic prices to exchange rates and import prices are all significant and have the expected sign. This suggests that both the depreciation of the domestic currency and increases in import prices lead to higher domestic prices as measured by the CPI.

Specifically, the results suggest that a 10 percent depreciation of the domestic currency relative to NEER, USD and ZAR increase domestic prices by, respectively, 4.2, 5.3 and 3 percent, all else equal. The impulse response analysis from Table 5 and Figure 2 in Appendix A and B, respectively, suggest that about 50 percent of the ERPT from NEER and ZAR/MZN to the CPI occur in about 4 months, while occurring in about 5 months for the USD/MZM. The variance decomposition, in Table 5 of appendix A, suggests that variations of the NEER and USD/MZN explain most of the variations of CPI contributing, respectively, with up to 80 percent of the total variation in 20 months and 59 percent of the total variation in 40 months, while the ZAR/MZN variations explain up to 27 percent in 50 months.

Table IV-2: Estimated Long Run Elasticities using the ARDL Approach

Dependent Variable: Consumer Price Index

ARDL Models - Exchange Rate	**NEER (2, 2, 2)**	**USDMZN (2,2, 1)**	**ZARMZN (2, 2, 1)**
Variables	Coeficient (p-value)	Coeficient (p-value)	Coeficient (p-value)
Exchange Rate	0.418 (0.000)	0.531 (0.000)	0.296 (0.000)
Import Prices	0.133 (0.000)	0.331 (0.000)	0.069 (0.026)
Trend	0.004 (0.000)	0.003 (0.002)	0.006 (0.000)
Constant	5.507 (0.262)	0.471 (0.439)	2.352 (0.000)

Notes: All variables are in logs and a constant and trend were included in all Models
Source: Researchers' computation based on Eviews 11

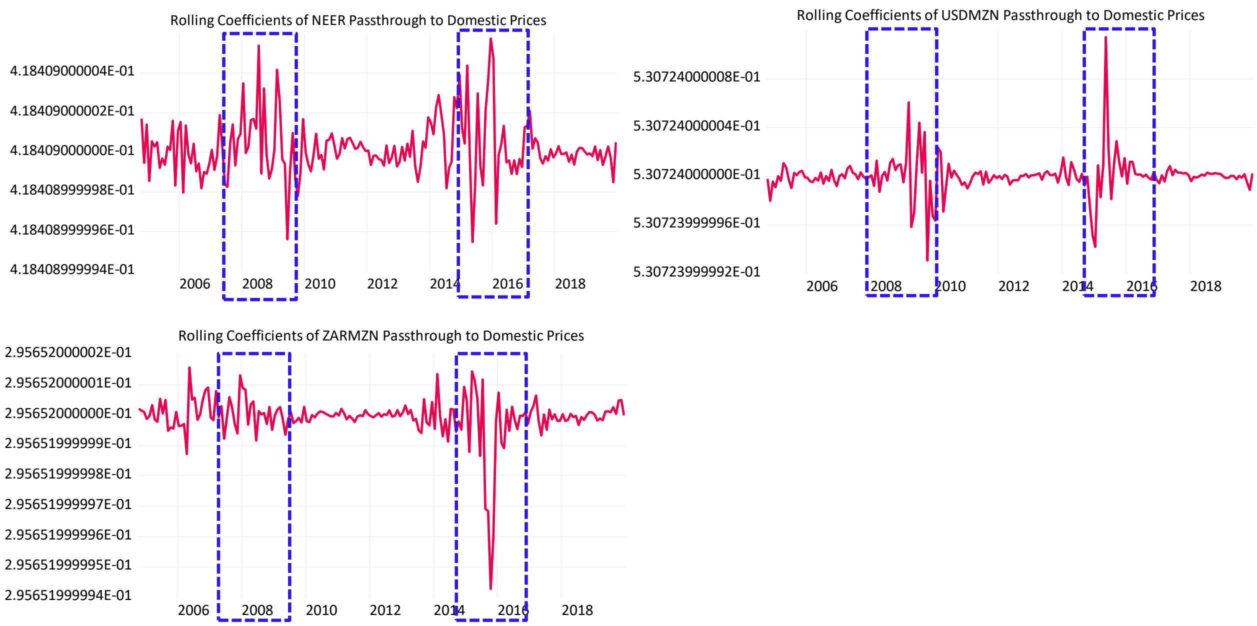
The above results suggest that the ERPT is higher for the US Dollar (USD/MZN) relative to the South Africa's Rand (ZAR/MZN). This is a plausible finding given that, although South Africa is Mozambique's major trading partner (28% of total Mozambique's imports in 2019),

[14] The variables are not trend-adjusted for the reasons discussed in footnote 12.

the US Dollar is the main currency used in foreign transactions.[15] The ERPT results for the ZAR/MZN are in-between those found in previous studies for Mozambique. The differences likely reflect differences in methodologies, time span and model specification.

Figure IV-1 suggests that the long-run ERPT is volatile and tends to be higher in periods of higher exchange rate and inflation volatility, especially during the 2007/9 global financial crisis and 2015/17 debt crisis in Mozambique.

Figure IV.1: Rolling Coefficients of Exchange Rate Passthrough to Domestic Prices[16]



The short-run elasticities are reported in Table 3 of Appendix A. The results suggest that exchange rate variations have significant impact on domestic prices only with one-month lag. A 10 percent depreciation of the Metical against the NEER, USD and ZAR increase domestic prices by, respectively, 0.46, 0.71 and 0.42 percent in the following month. The lower and lagging ERPT may reflect price setting schemes (administered prices) that were in place for several years in Mozambique thus preventing prices to adjust quickly. The error correction

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[15] Also, some imports from South Africa, although quoted in South Africa's Rand, are indexed to the US Dollar. We caution, however, that the relative importance of the ERPT under the ZAR/MZM and USD/MZM could potentially change when considering different regional samples. This is because the ZAR/MZM exchange rate is more important than the USD/MZM rate in southern Mozambique which is more integrated with the neighbor South Africa.

[16] Figure IV.1 shows the evolution of the Passthrough coefficients over time for the three exchanges rates (NEER, USDMZN, ZARMZN)

term coefficient is negative and significant, suggesting that the short-run disequilibrium of the CPI is adjusted towards the steady state. Specifically, the results suggest that 9.5, 4.9 and 6.6 percent of the short run disequilibrium of the CPI are corrected toward the long run equilibrium in one month for, respectively, the NEER, USD and ZAR models. It takes, respectively, about 11, 20 and 17 months to completely converge to the steady state long run equilibrium.

Table 06 on Appendix A reports the asymmetric elasticities and the asymmetric Wald test results. The Wald Test results suggests that, overall, exchange rate appreciations and depreciations have symmetric effects on domestic prices in the long run, and asymmetric effects in the short run. However, the elasticities suggest that in the long run the magnitude of depreciations pass-through to inflation is higher than the appreciations pass-through, particularly for the USD/MZM exchange rate. Furthermore, the variations of the USD/MZN exchange rate have the highest contribution to inflation relative to the ZAR/MZN and NEER exchange rates. The short-run asymmetric effect possibly reflects retail market structure and competition issues that go beyond the scope of the analysis in this paper.

C. Exchange Rate Passthrough, Inflation Environment, Monetary Policy Regime and Financial Crisis

This section assesses whether the ERPT has changed over time because of changes in the inflationary environment and monetary policy regime, as well as with the advent of the 2007-2009 global financial crisis.

Table IV-4 reports the long-run ERPT accounting for the inflation environment. The impact of inflation environment on the ERPT is captured by the interaction between the exchange rate and the 12-month moving average of inflation rate, as well as with the 12-month moving average of the standard deviation of inflation rate. The moving average of inflation captures the level of (high or low) inflation environment while the moving average of the standard deviation of inflation captures its volatility.

Table IV-3: Long-Run ERPT Elasticities - Accounting for Inflation Environment

Dependent Variable: Consumer Price Index

ARDL Models - Exchange Rate	**NEER**		**USDMZN**		**ZARMZN**	
	(2, 2, 0, 2)	**(2, 2, 1, 2)**	**(2, 2, 0, 1)**	**(4, 2, 1, 1)**	**(2, 3, 0, 1)**	**(2, 2, 1, 1)**
Variables	Coeficient (p-value)	Coeficient (p-value)	Coeficient (p-value)	Coeficient (p-value)	Coeficient (p-value)	Coeficient (p-value)
Exchange Rate	0.423 (0.000)	0.430 (0.000)	0.618 (0.002)	0.491 (0.000)	0.248 (0.000)	0.266 (0.000)
Exchange Rate*Moving average Inflation	0.133 (0.672)		-0.732 (0.403)		0.760 (0.087)	
Exchange Rate*Standard deviation of Inflation		0.670 (0.049)		0.936 (0.206)		1.466 (0.012)
Import Prices	0.132 (0.018)	0.147 (0.000)	0.351 (0.000)	0.331 (0.000)	0.097 (0.001)	0.104 (0.000)
Trend	0.004 (0.000)	0.004 (0.000)	0.002 (0.0112)	0.003 (0.000)	0.006 (0.000)	0.006 (0.000)
Constant	5.542 (0.000)	5.480 (0.000)	0.085 (0.932)	0.595 (0.290)	2.403 (0.000)	2.287 (0.000)

Notes: All variables are in logs and a constant and trend were included in all Models
Source: Researchers' computation based on Eviews 11

Table IV-4 shows that the effect of inflation environment on the ERPT is mixed. When defined as periods of high versus low inflation as captured by the 12-month moving average inflation, the inflation environment does not have a significant effect on the ERPT, that is, there is no evidence supporting that the ERPT is different in a low and high inflation environment. An alternative approach was also employed by interacting the exchange rate with a dummy variable set to 1 when inflation is higher than one digit levels for at least six months, and zero otherwise. Under this specification, the inflation environment does not have a significant effect on the ERPT (results not shown).

However, when measured by volatility of inflation[17], we find a positive and significant impact on the ERPT for the NEER and ZAR/MZN models. That is, the ERPT is higher in more volatile inflation periods. These results are consistent with Figure IV-1 which suggests that the ERPT was higher in periods of macroeconomic instability, including during the global financial crisis (2007-2009) and Mozambique’s debt crisis (2015-2017) when instability prevailed. The results potentially mask several factors including expectations of further depreciations in times of pronounced macroeconomic instability, coping strategies of passing through cost changes quickly during stressed periods, and the degree of dollarization in the economy. Understanding the role of these factors would benefit from a separate follow up research.

[17] Measured by the coefficient of the interaction term between the standard deviation of inflation and the exchange rate.

Table 7 in Appendix A suggests that the global financial crisis changed the magnitude of the ERPT only temporarily. Although the ERPT increased during the financial crisis, it reverted to its long-run equilibrium in later years as suggested by Figure 4.1. On the other hand, Table 8 in Appendix A suggests that the recent change in the monetary policy framework, from monetary to interest rate targeting, did not affect the magnitude of the ERPT. A possible explanation for this finding is that, although the new framework seems to have anchored relatively well inflation expectations (Aisen and Simione, 2020), the time since the regime shift in April 2017 is not long enough to have significantly changed the behavioral parameters governing the ERPT. While the finding could also imply that the monetary policy regime shift is not able to influence the long-run ERPT (as compared to the short-run ERPT which is less subject to structural factors such as the share of traded goods), this interpretation does not corroborate several studies which find a declining ERPT over time from transition to more credible monetary policy frameworks (Taylor, 2000; Gagnon and Ihrig, 2004; McCarthy, 2007; Özyurt, 2016).

D. Robustness check

Two arguably key regressors missing in our specifications are the demand and rainfall conditions which could, respectively, upward and downward bias our estimate of the ERPT. Arguably, demand and supply conditions tend to be, respectively, positively and negatively correlated with the CPI and the exchange rate. We have therefore attempted to control for demand and supply conditions by adding money supply[18] and rainfall index[19] as additional controls. Table 09 in Appendix A suggests that the results are robust as both money supply and rainfall do not have a significant effect on domestic prices, and the ERPT estimates remain significant and broadly unchanged. The results remain broadly unchanged also when testing the unit root hypothesis in presence of structural break, with different break dates considered. The results are also robust to replacing the money supply with the economic activity index as a proxy for demand conditions.

[18] An equilibrium is assumed between the supply and demand for money. Most research proxy the demand conditions as Real GDP. However, in Mozambique the real GDP data is only available quarterly. The money supply aggregate presented on Table 09 are for M3 but we also checked M2 and M1 and results remain statistically the same. We also proxied the demand conditions by Economic Activity Index and the results suggested that demand was not significant. Results not reported on Table 09 are available upon request.

[19] As argued before, the rationale for including this variable is that the agriculture sector, which accounts for around 25 percent of GDP, is heavily dependent on rainfall. Scarce rainfall tends to reduce the supply of domestically produced food with adverse impacts on inflation.

V. CONCLUSIONS

The exchange rate is an important determinant of domestic prices in open economies. Mozambique, where a significant part of household's consumption basket is sourced through imports, is not an exception. This paper assessed the extent to which changes in the exchange rate are passed on to domestic prices (the exchange rate pass-through). We find significant pass-through effects for the two main bilateral exchange rates in Mozambique with respect to the US Dollar (USD/MZM) and South Africa's Rand (ZAR/MZM), as well as for the nominal effective exchange rate (NEER). In the long-run, each 10 percent depreciation of the Mozambican Metical vis-à-vis the US Dollar, the Rand and the NEER leads, respectively, to 5.3 percent, 2.96 percent and 4.2 percent increase in domestic prices, all else equal. Based on these results, we find that about 50 percent of the pass-through for the ZAR/MZM and USD/MZM occur in 4 to 5 months, respectively. In each case, the exchange rate accounts for 27 percent and 59 percent of the variation in domestic prices in 50 months and 40 months, respectively.

We further examine the pass-through accounting for the inflation environment, the 2007-09 global financial crisis, assymetric price effects and the monetary policy regime shift. We find significant and higher pass-through during the high-volatility inflationary period, in line with Taylor's 2000 hypothesis and most empirical studies. As for the 2007-09 global financial crisis, we find that it has led to a temporary increase in the pass-through coefficient before it converged back to its long-term trend. We also find evidence of assymetric effects in the short-run pass-through, suggesting that depreciations are transmitted by a larger magnitude to domestic prices than appreciations. Thus far, we found no evidence that the pass-through has changed with the transition to the new interest rate-based monetary policy regime in April 2017.

These findings are relevant for macroeconomic policies in Mozambique. The overall high magnitude of the ERPT and speed of adjustment represent a significant policy challenge that is difficult to tackle in the short term. Trying to limit the ERPT to inflation by targeting the exchange rate level or its variation could be a risky strategy and bound to be unsustainable for a given stock of international reserves. This is particularly true when fiscal discipline is not warranted. Rather, a floating exchange rate regime consistent with a credible interest rate-based forward looking monetary policy regime could prove effective in anchoring inflation expectations. In this context, the recent transition to an interest rate-based monetary policy regime in Mozambique holds the potential to reduce the ERPT over time. While results do not yet show a decline in the ERPT with the introduction of the new regime , this is likely to be a matter of time since the new regime, introduced in April 2017, is still being consolidated. As widely documented in the literature, the ERPT should eventually start to decline if monetary policy objectives are pursued consistently, accompanied by a low and stable inflation outcomes and a strong track record of prudent macroeconomic policies.

As the implementation of the new monetary policy regime advances in Mozambique, further questions surrounding the dynamics of the ERPT would benefit from clarification: (i) what explains the higher ERPT in periods of high macroeconomic volatility? (ii) does the assymetric ERPT observed in the short run also hold in periods of high macroeconomic volatility? Will the new monetary policy regime lead to lower ERPT as expected? Future research is warranted to shed light on these questions.

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APPENDIX A: TABLES

Table 0-1: Descriptive Statistics

Statistic	CPI	NEER	USDMZN	ZARMZN	Foreign Prices	Rainfall (mm)	M3 (Million MT)
Mean	96.15	130.11	34.30	3.60	70.55	60.65	162,706.70
Median	95.10	128.55	27.50	3.49	67.34	37.15	120,701.30
Maximum	171.77	245.05	77.58	5.60	121.86	329.50	474,714.00
Minimum	34.58	59.10	17.12	2.17	36.04	-	17,318.53
Std. Dev.	39.96	40.88	15.42	0.78	20.69	68.61	138,265.10
Skewness	0.42	0.46	1.28	0.46	0.27	1.73	0.72
Kurtosis	2.16	2.99	3.18	2.62	2.18	5.93	2.09
Observations	228.00	228.00	228.00	228.00	228.00	228.00	228.00

Source: Researchers' calculation based on Eviews11

Table 0-2: Augmented Dickey-Fuller and Philips-Perron Unit Root Tests

Variable	Deterministic Trend	Augmented Dickey-Fuller			Phillips-Perron			Order of Integration
		Lags	Test Statistics	Critical Value**	Lags	Test Statistics	Critical Value**	
lnCPI	c,t	1	-3.191	-3.430	7	-2.776	-3.430	I(1)
D(lnCPI)	c	0	-8.686	-2.874	4	-8.743	-2.874	
lnP*	c,t	1	-1.924	-3.430	6	-1.851	-3.430	I(1)
D(lnP*)	c	0	-10.493	-2.874	4	-10.567	-2.874	
lnUSDMZN	c,t	1	-1.749	-3.430	9	-1.981	-3.430	I(1)
D(lnUSDMZN)	c	0	-10.080	-2.874	7	-10.624	-2.874	
lnZARMZN	c,t	1	-2.547	-3.430	7	-2.535	-3.430	I(1)
D(lnZARMZN)	c	0	-10.685	-2.874	3	-10.736	-2.874	
lnNEER	c,t	2	-2.878	-3.430	8	-2.608	-3.430	I(1)
D(lnNEER)	c	1	-7.022	-2.874	5	-10.631	-2.874	
lnM3	c,t	0	-3.538	-3.430	1	-3.340	-3.430	I(0)
D(lnM3)	c	0	-13.760	-2.874	5	-13.741	-2.874	
lnRainfall)	c,t	6	-9.840	-3.430	8	-10.072	-3.430	I(0)
D(lnRainfall)	c	12	-10.750	-2.875	19	-40.506	-2.874	

**Obtained from MacKinnon(1996). The null hypothesis for ADF and PP is of Unit Root

Source: Researchers' computation based on Eviews 11

Table 0-3: Short-Run ARDL-ECM Results

Dependent Variable: D(LnConsumer Price Index)						
Variable|ARDL Model	**NEER (2,2,2)**		**USDMZN (2,2,1)**		**ZARMZN (2, 2, 1)**	
	Coefficient	**Std. Error**	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**
ECM(-1)	-0.095*	0.014	-0.049*	0.009	-0.066*	0.013
D(CPI(-1))	0.257*	0.063	0.266*	0.077	0.307*	0.070
D(CPI(-2))	0.016	0.060	0.026	0.078	0.079	0.070
D(ER)	0.017	0.017	0.026	0.016	-0.015	0.012
D(ER(-1))	0.046**	0.018	0.071**	0.031	0.042**	0.016
D(ER(-2))	0.014	0.018	0.018	0.030	0.019	0.014
D(P)	-0.014	0.010	-0.004	0.011	-0.012	0.011
D(P(-1))	-0.016	0.011	-0.005	0.011	-0.010	0.011
D(P(-2))	-0.003	0.011				
Trend	0.000	0.000	0.000	0.000	0.000	0.000
C	0.001	0.001	0.000	0.001	0.000	0.002
R-squared	0.493		0.464		0.453	
S.E. of regression	0.007		0.007		0.007	
Prob(F-statistic)	0.000		0.000		0.000	
Durbin-Watson Stat	2.013		1.999		1.993	
LM Test: F. Prob(χ² Prob)	0.2911(0.272)		0.3956(0.3771)		0.959(0.957)	
Ramesey TestF. Prob(χ² Prob)	0.0819(0.0734)		0.1785(0.1673)		0.1841(0.1345)	
BPG Test: F. Prob(χ² Prob)	0.2151(0.2138)		0.0004(0.0006)		0.001(0.002)	
JB Test: Prob	0.000		0.000		0.000	

Notes: All variables are in logs and a constant and trend were included in all Models
* ,** represent significance level at 1% and 5% respectively.
Source: Researchers' computation based on Eviews 11

Table 0-4: CPI Response to One Percent Shock of Exchange Rate and Import Prices

Period	**NEER Model**		**USDMZN Model**		**ZARMZN Model**	
	NEER	**Import Prices**	**USDMZN**	**Import Prices**	**ZARMZN**	**Import Prices**
1	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
2	0.077	-0.007	0.107	0.010	0.062	-0.008
	(0.017)	(0.011)	(0.017)	(0.010)	(0.012)	(0.011)
3	0.158	0.000	0.189	0.031	0.117	-0.002
	(0.025)	(0.016)	(0.028)	(0.017)	(0.019)	(0.017)
4	0.234	0.016	0.236	0.054	0.156	0.008
	(0.032)	(0.020)	(0.035)	(0.022)	(0.023)	(0.021)
5	0.297	0.033	0.262	0.072	0.182	0.016
	(0.038)	(0.022)	(0.039)	(0.026)	(0.026)	(0.023)
10	0.429	0.041	0.291	0.093	0.223	0.010
	(0.068)	(0.038)	(0.052)	(0.040)	(0.037)	(0.032)
20	0.302	-0.039	0.260	0.040	0.199	-0.054
	(0.091)	(0.049)	(0.073)	(0.044)	(0.051)	(0.043)
30	0.157	-0.061	0.183	-0.010	0.136	-0.084
	(0.087)	(0.049)	(0.075)	(0.041)	(0.055)	(0.047)
40	0.048	-0.056	0.096	-0.037	0.068	-0.082
	(0.072)	(0.042)	(0.064)	(0.037)	(0.051)	(0.044)
50	-0.017	-0.039	0.022	-0.045	0.012	-0.062
	(0.060)	(0.030)	(0.054)	(0.031)	(0.045)	(0.036)

() -Standar Errors
Source: Researchers' computation based on Eviews 11

Table 0-5: Variance Decomposition of CPI (in Percent)

Period	NEER Model				USDMZN Model				ZARMZN Model			
	S.E.	CPI	NEER	Import Prices	S.E.	CPI	USDMZN	Import Prices	S.E.	CPI	ZARMZN	Import Prices
1	0	100	0	0	0	100	0	0	0	100	0	0
2	0	96	4	0	0	94	6	0	0	96	4	0
3	0	88	12	0	0	86	13	1	0	92	8	0
4	0	76	24	0	0	78	20	2	0	88	11	0
5	0	63	36	1	0	72	25	4	0	85	14	1
10	0	29	69	2	0	53	38	9	0	78	20	2
20	0	19	80	2	0	40	51	10	0	70	21	9
30	0	17	80	4	0	35	57	8	0	66	17	17
40	0	16	78	6	0	33	59	8	0	64	13	23
50	0	16	77	7	0	32	58	10	0	63	10	27

Source: Researchers' computation based on Eviews 11

Table 0-6: Short-Run Exchange Rate Asymmetric Effects

Dependent Variable: D(LnConsumer Price Index)							
Variable|ARDL Model		NEER (2,3,3,2)		USDMZN (2,3,3,1)		ZARMZN (2,3,1, 1)	
		Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
ECM(-1)		-0.105*	0.016	-0.069*	0.010	-0.083*	0.014
D(CPI(-1))		0.243*	0.064	0.179*	0.067	0.272*	0.066
D(CPI(-2))		0.000	0.060	-0.027	0.063	0.063	0.061
D(ER-Depreciation)		0.024	0.025	0.060*	0.021	0.000	0.021
D(ER-Depreciation(-1))		-0.034	0.027	0.085*	0.022	0.058*	0.021
D(ER-Depreciation(-2))		-0.082*	0.027	0.062*	0.023	0.050**	0.021
D(ER-Depreciation(-3))		-0.006	0.027	-0.011	0.024	-0.009	0.020
D(ER-Apreciation)		0.026	0.033	-0.033*	0.042	-0.042***	0.022
D(ER-Aepreciation(-1))		-0.053	0.034	0.014	0.043	0.012	0.023
D(ER-Apreciation(-2))		0.089*	0.034	-0.098	0.042		
D(ER-Apreciation(-3))		-0.002	0.033	0.003	0.039		
D(PF)		-0.011	0.010	0.000*	0.010	-0.007	0.011
D(PF(-1))		-0.019***	0.011	-0.014	0.011	-0.011	0.011
D(PF(-2))		0.000	0.010				
Trend		0.001	0.001	0.000	0.001	0.000*	0.001
C		0.000	0.000	0.000	0.000	0.000	0.000
Assymetry Test - F stat(p-value) Ho=No assymetry	Long-run	9.082(0.003)		1.834(0.177)		1.691(0.195)	
	Short-run	4.758(0.0303)		24.911(0.000)		8.346(0.004)	
R-squared		0.529		0.529		0.477	
S.E. of regression		0.006		0.006		0.007	
Prob(F-statistic)		0.000		0.000		0.000	
Durbin-Watson Stat		1.989		1.998		1.976	

Notes: All variables are in logs and a constant and trend were included in all Models
* ,** and *** represent significance level at 1%, 5% and 10% respectively.
Source: Researchers' computation based on Eviews 11

Table 0-7: Estimated Long Run Elasticities - Accounting for Financial Crisis Effects

Dependent Variable: Consumer Price Index			
ARDL Models - Exchange Rate	**NEER (2, 2, 0, 0, 2)**	**USDMZN (2, 2, 0, 0, 1)**	**ZARMZN (2, 2, 0, 0, 1)**
Variables	Coeficient (p-value)	Coeficient (p-value)	Coeficient (p-value)
Exchange Rate	0.488 (0.000)	0.661 (0.004)	0.226 (0.001)
Exchange Rate*Financial Crisis2008	-0.092 (0.210)	-0.110 (0.618)	0.092 (0.268)
Financial Crisis2008	-0.444 (0.212)	0.510 (0.590)	-0.404 (0.248)
Import Prices	0.108 (0.000)	0.319 (0.000)	0.088 (0.005)
Trend	0.004 (0.000)	0.002 (0.002)	0.006 (0.000)
Constant	5.960 (0.000)	-0.004 (0.937)	2.556 (0.000)

Notes: All variables are in logs and a constant and trend were included in all Models
Financial Crisis2008 is a shift dummy variable capturing the global financial crisis 2008/9. It takes the value one from September 2009 and zero before it.
Source: Researchers' computation based on Eviews 11

Table 0-8: Estimated Long Run Elasticities - Accounting for Monetary Policy Regime

Dependent Variable: Consumer Price Index			
ARDL Models - Exchange Rate	**NEER (2, 2, 2)**	**USDMZN (2,2, 1)**	**ZARMZN (2, 2, 1)**
Variables	Coeficient (p-value)	Coeficient (p-value)	Coeficient (p-value)
Exchange Rate	0.439 (0.000)	0.588 (0.000)	0.324 (0.000)
Exchange Rate*MPReforms17	0.151 (0.657)	-0.38 (0.706)	0.279 (0.287)
MPReforms17	0.619 (0.673)	1.865 (0.718)	-1.307 (0.265)
Import Prices	0.116 (0.000)	0.316 (0.000)	0.037 (0.344)
Trend	0.004 (0.000)	0.003 (0.002)	0.006 (0.000)
Constant	5.685 (0.000)	0.297 (0.649)	2.357 (0.000)

Notes: All variables are in logs and a constant and trend were included in all Models
Reforms17 is a shift dummy variable capturing a central bank's change of Monetary Policy Regime. It that takes the value one from April 2017 and zero before it.
Source: Researchers' computation based on Eviews 11

Table 0-9: Estimated Long Run Elasticities using the ARDL Approach (including Money Supply and Rainfall Index)

Dependent Variable: Consumer Price Index

ARDL Models - Exchange Rate	**NEER (2, 2, 2, 0)**	**NEER (2, 2, 1, 1)**	**NEER (2, 2, 2, 3, 3)**	**USDMZN (2, 2, 1, 3)**	**USDMZN (2, 2, 1, 3)**	**USDMZN (4, 2, 2, 3, 3)**	**ZARMZN (2, 2, 1, 3)**	**ZARMZN (2, 1, 0, 1)**	**ZARMZN (2, 1, 0, 1, 0)**
Variables	Coeficient (p-value)	Coeficient (p-value)	Coeficient (p-value)	Coeficient (p-value)	Coeficient (p-value)	Coeficient (p-value)	Coeficient (p-value)	Coeficient (p-value)	Coeficient (p-value)
Exchange Rate	0.392	0.385	0.325	0.279	0.413	0.316	0.194	0.271	0.281
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Import Prices	0.141	0.128	0.128	0.231	0.272	0.233	0.092	0.063	0.068
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015	0.014
Money Supply	0.053		-0.163	-0.107		-0.023	0.003		0.157
	0.686		0.206	0.573		0.206	0.983		0.356
Rainfall Index		-0.009	-0.010		-0.037	-0.186		-0.017	-0.011
		0.308	0.407		0.063	0.276		0.090	0.386
Trend	0.004	0.004	0.005	0.004	0.003	0.004	0.006	0.006	0.006
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Constant	5.323	5.344	5.023	2.116	1.582	2.018	3.240	3.270	3.245
	0.000	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000

Notes: All variables are in logs and a constant and trend were included in all Models
Source: Researchers' computation based on Eviews 11

Appendix B: Figures

Figure 0.1: Research Variables Plots (in logs)

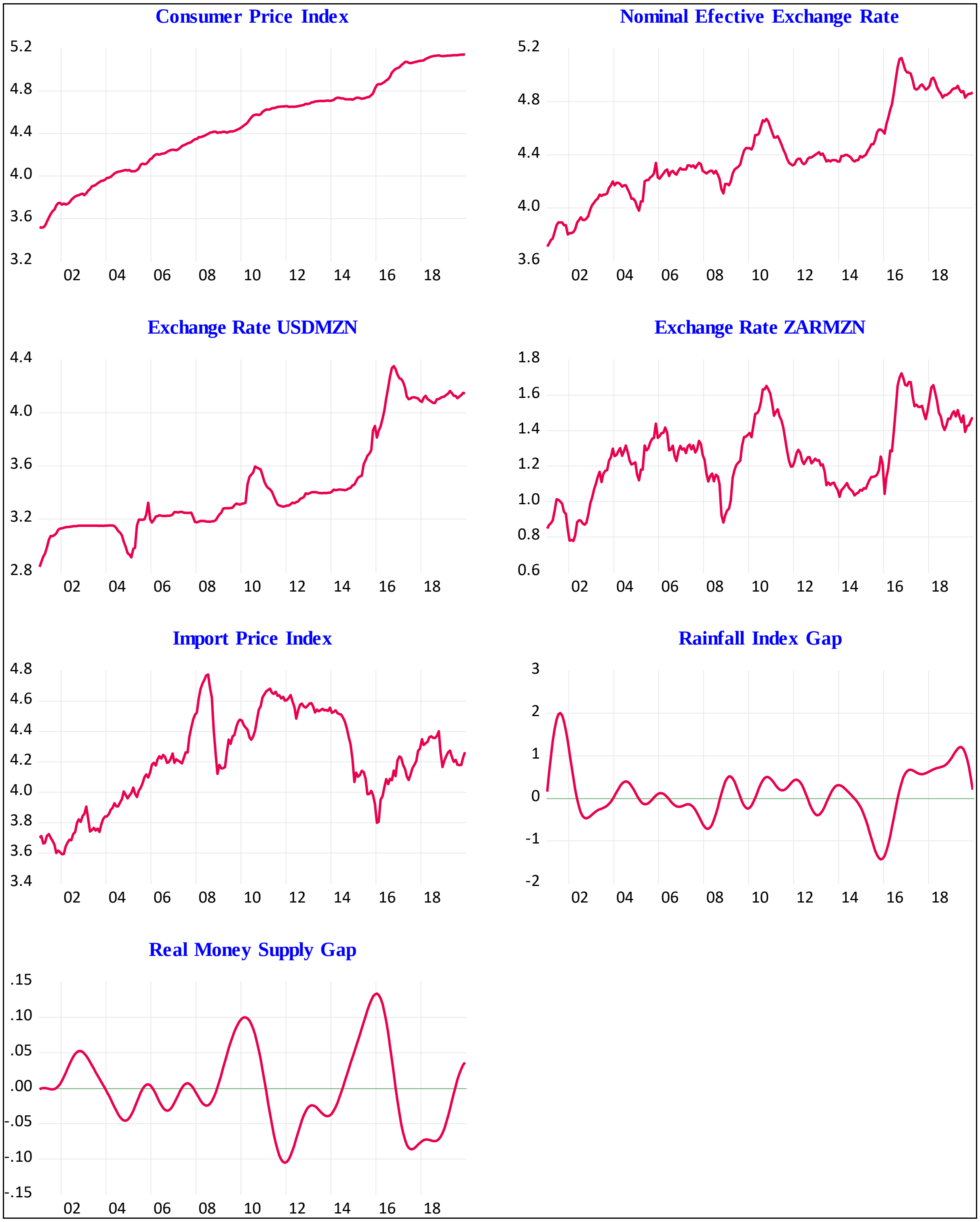
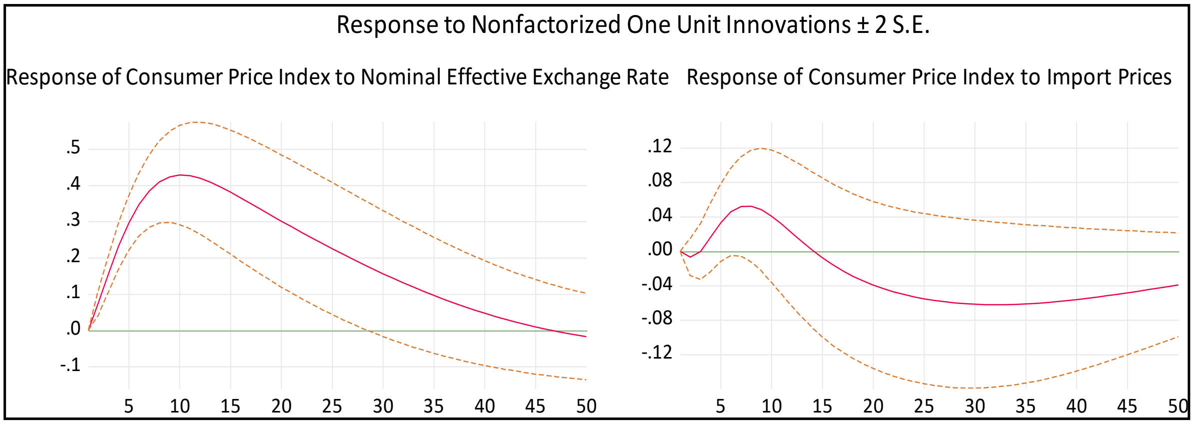


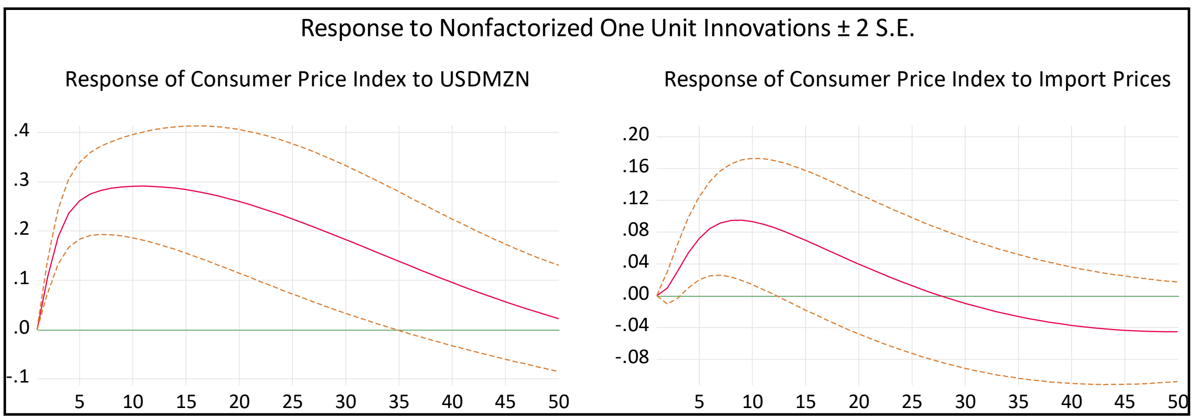
Figure 0.2: Research Variables Plots (in first log-difference)

Figure 0.3: CPI Responses to NEER, USDMZN, ZARMZN and Import Price Chocks

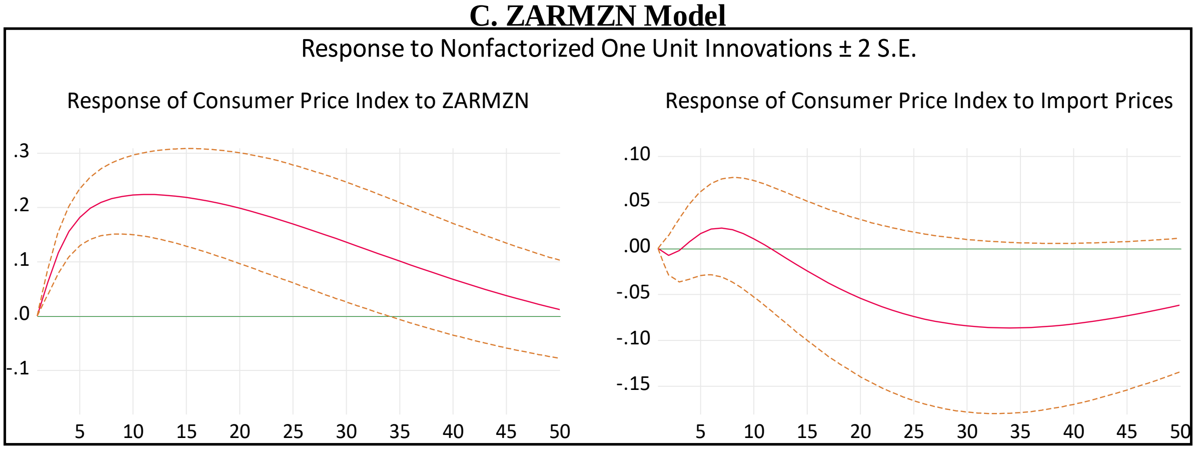
A. NEER Model



B. USDMZN Model



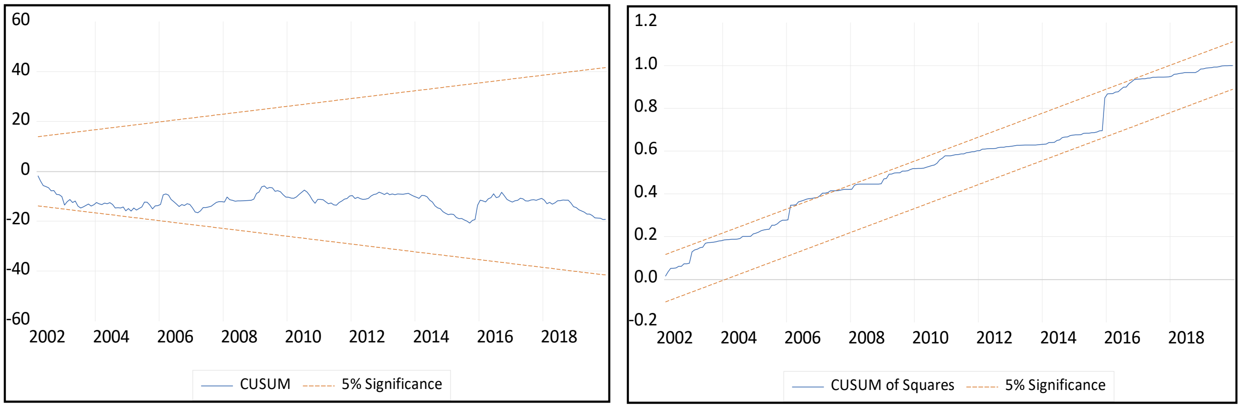
C. ZARMZN Model



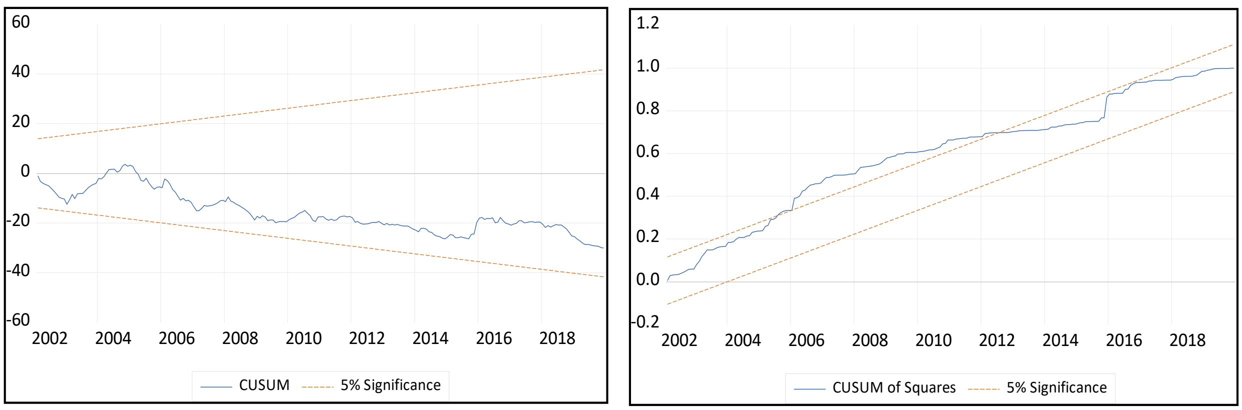
Source: Researchers' computation based on Eviews 11

Figure 0.4: Plots of CUSUM and CUSUM Squares

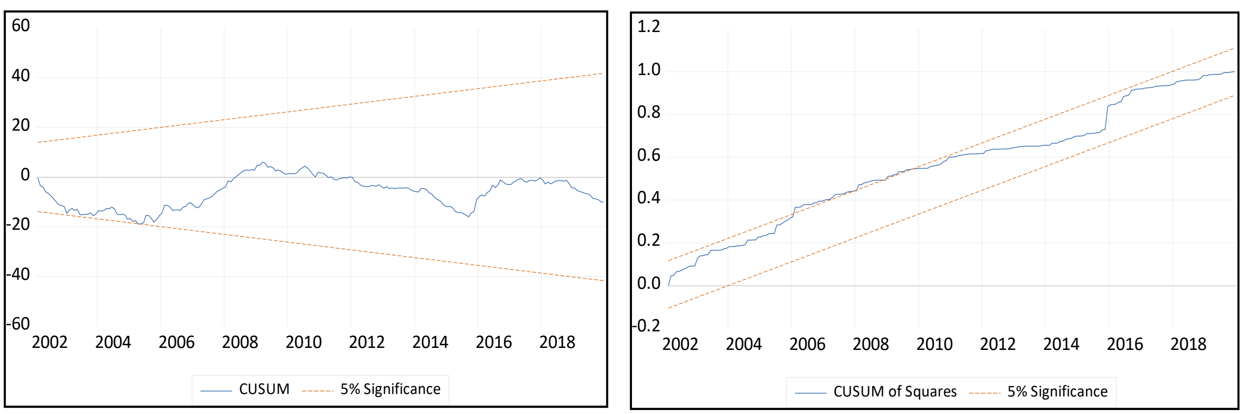
A. NEER ARDL Model



A. USD ARDL Model



C. ZAR ARDL Model



Source: Researchers' computation based on Eviews 11

Appendix C: Previous Studies on Exchange rate Pass-through in Mozambique

Study	Methodology	Sample	Exchange rate variable	Price variable	Findings
Ubide (1997)	Error-correction model	1989M1-1996M12	ZAR/MZM	CPI	One percent depreciation of the exchange rate is associated with 0.2 percent increase in inflation. The effect lasts about 10 months and dies after 20 months.
Omar (2003)	Error-correction model	1993M1-2001M12	ZAR/MZM	CPI	One percent depreciation of the exchange rate is associated with 0.74 percent increase in inflation.
Cirera and Nhate (2006)	OLS controlling for product-specific heterogeneity	2000M1-2005M12 (provinces panel)	ZAR/MZM	Selected import products	The degree of ERPT is high (50 to 75 percent depending on the specification). ERPT tends to be symmetric.
Vicente (2007)	Co-integrated VAR	2001M1-2006M12	ZAR/MZM	CPI	One percent exchange rate depreciation is associated with 0.15 percent increase in the price level.