

ASYMMETRIC NONLINEAR EXCHANGE RATE PASS-THROUGH IN SOUTH AFRICA: A NARDL APPROACH

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ABSTRACT

The breakdown of the Bretton Woods fixed exchange system led some economies, including South Africa, to shift from fixed to floating exchange rate systems. Under a floating exchange rate and an open trade policy, a country becomes more vulnerable to external economic shocks, with the exchange rate acting as a key transmission channel. The degree to which exchange rate changes influence import prices and consumer prices is called exchange rate pass-through. Recent research highlights that ERPT is often asymmetrical and nonlinear, especially in emerging economies. Despite the importance of these dynamics, there is limited research on nonlinear and asymmetric ERPT in South Africa. This study aims to address that gap by examining the nonlinear and asymmetric ERPT effect on consumer prices in South Africa using the nonlinear autoregressive distributed lag approach and the Wald test. The NARDL tests indicate that exchange rate fluctuations impact consumer inflation in a nonlinear and asymmetric way, with currency depreciations having a stronger effect than appreciations. However, the Wald test results show no significant long-term nonlinear and asymmetric relationship between exchange rates and consumer inflation. This suggests that long-term inflation adjustments might be influenced by other factors beyond exchange rates, such as monetary policy and inflation targeting. Overall, this finding implies that mechanisms within the South African economy may reduce the long-term impact of exchange rate movements on inflation.

Keywords: Nonlinear Asymmetric Exchange Rate Pass-Through, Consumer Prices, Nonlinear Autoregressive Distributed Lag Approach, Wald Test, South Africa.

1. INTRODUCTION

Since dismantling the Bretton Woods fixed exchange rate system, numerous advanced and emerging economies have transitioned toward more flexible exchange rate regimes. South Africa followed suit in the early 1990s, embracing a floating exchange rate regime and, subsequently, in 2002, adopting an inflation-targeting framework. These policy shifts contributed to considerable exchange rate volatility, exposing the domestic economy to external shocks. As Chiparawasha (2015, p.45) notes, "When a country adopts a floating exchange rate and an open trade policy, it loses the power to insulate its economy from external economic shocks." One critical transmission channel for these shocks is the exchange rate's influence on domestic price levels.

The degree to which exchange rate fluctuations translate into changes in domestic prices is termed exchange rate pass-through (ERPT). ERPT measures the responsiveness of import and consumer prices to changes in the nominal exchange rate (Anderl and Caporale, 2023; Aisen et al., 2021; European Central Bank, 2020). This transmission occurs through two primary channels:

- **Direct Channel:** Changes in the exchange rate directly affect the prices of imported final goods. For instance, a depreciation in the local currency makes imported consumer products more expensive, leading to immediate increases in consumer price inflation (Cao et al., 2015).
- **Indirect Channel:** Exchange rate movements impact the cost of imported intermediate goods used in domestic production. A weaker domestic currency raises the prices of these inputs, escalating production costs for domestic firms. These increased costs are often passed on to consumers, exerting upward pressure on domestic consumer prices over time (Cunningham et al., 2017; Dilla et al., 2017).

Understanding ERPT is essential for policymakers because it directly influences the transmission of exchange rate fluctuations into domestic prices. When the exchange rate depreciates or appreciates, it alters the cost of imported goods and services and affects overall consumer price inflation. A high degree of ERPT implies that changes in exchange rates will quickly and significantly impact inflation, reducing the effectiveness of monetary policy. Conversely, a low ERPT suggests that price stability can be maintained even amid exchange rate volatility. Therefore, accurate estimates of ERPT help central banks like the South African Reserve Bank tailor interest rate decisions, inflation targeting, and currency management strategies more effectively (Anderl and Caporale, 2023; Aisen et al., 2021). In emerging economies, where currencies are often more volatile, understanding the extent and asymmetry of ERPT is particularly important for designing robust monetary frameworks that promote price and financial stability.

Empirical studies have shown that ERPT is typically incomplete, particularly in emerging economies and in periods of low and stable inflation. The presence of pricing-to-market strategies by firms, along with inflation-targeting regimes, contributes to this limited transmission (Krugman, 1986; Goldberg and Knetter, 1997; Magwiro et al., 2019). In the case of South Africa, the ERPT to consumer prices has historically been low compared to import prices. Between 2002 and 2018, the ERPT to consumer prices ranged between 20 and 30 percent (Kabundi and Mlachila, 2018), despite considerable currency volatility during that period. For instance, between January and August 2018, the rand depreciated by 21.1 percent against the US dollar, while core consumer price inflation rose by only 0.4 percentage points (Magwiro et al., 2019), highlighting the phenomenon of incomplete pass-through.

Recent evidence further suggests that ERPT is both asymmetric and nonlinear. Exchange rate depreciations tend to have a larger effect on inflation than appreciations, and the magnitude of ERPT may vary depending on the size and direction of the exchange rate change (Cheikh et al., 2018; Karaoğlu and Demirel, 2021). In South Africa, studies by Kabundi and Mbelu (2018) and Magwiro et al. (2019) provide preliminary evidence of such asymmetries and nonlinearities. However, comprehensive studies exploring these dynamics within the South African context remain scarce.

Given the vital role of exchange rate dynamics in influencing inflation and guiding monetary policy, a deeper understanding of the nature of ERPT in South Africa is essential. The present study aims to empirically investigate the nonlinear and asymmetric ERPT to consumer prices using monthly data from 2015 to 2023.

In doing so, the study not only fills a gap in the existing literature but also offers critical insights for policymakers operating within an inflation-targeting framework.

The study introduces a novel approach by applying the Nonlinear Autoregressive Distributed Lag (NARDL) model (which allows for the decomposition of exchange rate movements into positive (appreciation) and negative (depreciation) changes, facilitating a nuanced analysis of their distinct impacts on inflation), coupled with Wald tests. By statistically testing asymmetries using Wald tests, the study offers robust evidence on the effects of differential currency depreciations and appreciations on consumer prices. This approach addresses a gap in the South African context, where previous research has often assumed symmetry in exchange rate pass-through or employed linear models that may not capture the complexities of the relationship.

2. LITERATURE REVIEW

Early empirical studies found varying levels of ERPT across countries and periods (Campa and Goldberg, 2005; Taylor, 2000). Taylor's hypothesis asserts that low and stable inflation environments tend to reduce ERPT, which has been confirmed in several advanced economies such as the US, Japan, and the Eurozone (Devereux and Engel, 2002).

However, in emerging markets, ERPT is typically higher due to greater macroeconomic volatility, reliance on imports, and weaker monetary policy credibility (Calvo and Reinhart, 2002; Ha et al., 2020). More

recent studies show the importance of distinguishing between first-stage pass-through (exchange rate to import prices) and second-stage pass-through (import prices to consumer prices), as each stage exhibits different dynamics (Bussière, 2013).

Several studies have also confirmed asymmetries in ERPT. For instance, Delatte and López-Villavicencio (2012) and Brun-Aguerre et al. (2016) find that ERPT is higher during depreciation than appreciation periods. Similarly, Cheikh and Rault (2016) find that pass-through is more pronounced during economic expansions than contractions, indicating business cycle asymmetries.

Research on South Africa has generally confirmed incomplete ERPT, particularly for consumer prices. Kabundi and Mbelu (2018) found that while first-stage ERPT was high and nearly complete, the second-stage ERPT was around 20–30%, suggesting substantial absorption along the supply chain. Their findings also show asymmetric behavior across the business cycle.

Magwiro et al. (2019) provide evidence of asymmetries between depreciation and appreciation episodes, though the significance varied. Gereziher and Nuru (2023) remain the only study that directly modeled asymmetric ERPT using a nonlinear approach, but their analysis ends in 2021. There is a clear gap in updated and comprehensive studies that jointly explore both asymmetry and nonlinearity in the South African context, especially using data post-2021.

3. METHODOLOGY

Research Approach

A quantitative research approach is adopted, utilizing time-series econometric modeling to analyze the South African economy's Exchange Rate Pass-Through (ERPT). This approach facilitates the rigorous statistical analysis of historical data, enabling the identification of patterns, relationships, and causality between exchange rate fluctuations and consumer prices.

Theoretical Framework

The study is grounded in the Pricing-to-Market (PTM) theory, which posits that foreign firms adjust their markups in response to exchange rate movements to maintain competitiveness in the importing country (Marston, 1990; Kassi et al., 2019). Rather than fully transmitting exchange rate changes to domestic prices, firms may absorb costs during depreciations or raise markups during appreciations, leading to asymmetric and nonlinear pass-through. This framework helps explain the varied inflationary effects of exchange rate fluctuations observed in South Africa.

The Empirical Model

The study follows Karaoğlu and Demirel (2021) by employing the nonlinear autoregressive distributed lag (NARDL) model developed by Shin et al. (2014), which is an extension of the method introduced by Pesaran et al. (2001). Unlike the linear ARDL model, which does not allow for the possibility of positive and negative shocks affecting the inflation rate differently, and thus overlooks any asymmetries in the short- and long-run transmission of uncertainty shocks, the NARDL framework accounts for hidden cointegration (i.e., between the positive and negative components of individual time series), thus allowing for possible nonlinearities (Liang et al., 2020; Anderl and Caporale, 2023).

Furthermore, it has advantages over other nonlinear frameworks. First, it distinguishes between short- and long-run asymmetries. Second, it estimates separately the impact of positive and negative shocks under non-stationarity. Third, it provides a flexible approach to establishing long-run relationships between variables with mixed integration orders. The model therefore offers an opportunity to test asymmetry in shocks, that is, whether the positive shocks of the independent variables have the same effect as their negative shocks on the dependent variables (Menegaki, 2019; Anderl and Caporale, 2023).

(equations remain unchanged — already consistent)

Data Issues

This study employs monthly data series from January 2015 to July 2023 to estimate the nonlinear and asymmetric exchange rate pass-through to consumer prices in South Africa, sourced from the South African Reserve Bank. The study used EViews software to analyze data. This period captures various exchange rate fluctuations, inflationary episodes, and monetary policy shifts, providing a rich context for analysis.

Estimation Techniques

This study utilized the nonlinear autoregressive distributed lag (NARDL) bounds cointegration technique to determine the long-run relationships and short-run dynamics between the nonlinear and asymmetric exchange rate pass-through to consumer prices. The Wald test is used to analyze short-run asymmetries in ERPT, which can aid in gaining a better understanding of how exchange rate changes influence prices and inform policy decisions (Tang and Lean, 2007). The Wald test is a statistical test used to determine the significance of individual regression model coefficients. It can also be used to test hypotheses regarding the relevant parameters. In the context of short-run asymmetry in a regression model, the Wald test can be used to determine if certain coefficients are substantially different from zero, thereby indicating the presence of short-run asymmetry. Diagnostic tests were used to check for misspecification in the model. This includes the autocorrelation test, heteroscedasticity test, and the normality test.

Ethical Considerations

The data for this study were obtained from publicly available economic databases, such as the South African Reserve Bank (SARB), Statistics South Africa (Stats SA), and international financial institutions like the International Monetary Fund (IMF) and World Bank. Using publicly available data ensures transparency, replicability, and ethical compliance. Additionally, all data is processed and analyzed following ethical guidelines in economic research, ensuring that findings are reported objectively without manipulation.

4. RESULTS

Long-run relationship between Consumer Inflation and Exchange Rate

Table 1. ARDL Bounds Test

Test statistic	Value	Signif	I(0)	I(1)
F-Statistic	8.1721	10%	2.53	3.59
	6	5%	2.87	4
		2.5%	3.19	4.38
		1%	3.6	4.9

The results for ARDL show that the F- F-statistic value (8.1721) is greater than the lower bound $I(0)$ and the upper bound $I(1)$ tabulated values; hence, the null hypothesis of no long-run relationship is rejected, and we conclude that there is a long-run relationship between the dependent and explanatory variables. The next step was to estimate the NARDL.

Nonlinear ARDL (NARDL) Test Results

Table 2. NARDL – Long Run

Variable	Coefficient	Std. Error	t-statistic	Prob
Inflation (-1)	0.7629	0.0486	15.6746	0.0000
Imports_Pos	-0.2237	0.04155	-5.3833	0.0000
Imports_Neg	-0.0905	0.0698	-1.2969	0.1978
GDP-Growth_Pos	1.1561	0.2284	5.0602	0.0000
GDP-Growth_Neg	-0.9554	0.1555	-6.1406	0.0000
Excrate_Pos	0.0072	0.3145	0.0229	0.9818
Excreate_Neg	-0.3036	0.1889	-1.6071	0.1114

Note: POS implies a positive or direct relationship between the independent and dependent variables, whilst NEG implies a negative or indirect relationship between the independent and dependent variables.

In the case of asymmetry, if the response of the dependent variable to the positive (negative) changes in the independent variable is larger than that of a negative (positive) change, we say there is an asymmetric relationship between the two variables. However, if it is the same, we conclude that the relationship is symmetric.

The positive change in imports has a significant effect, as denoted by the p-value of 0.0000, whilst its negative effect has an insignificant effect, as portrayed by the p-value of 0.1978. The negative sign of the coefficient of IMPORTS_POS (-0.2237) implies that, if there is an increase in imports by R1 million, consumer inflation will decrease by 0.2 %. On the contrary, the negative sign of IMPORTS_NEG (-0.0905) implies that, if imports decrease by R1 million, consumer inflation will increase by 0.09 (or about 0.1) %.

In the case of GDP_GROWTH, the positive sign of GDP_GROWTH_POS (1.1561) implies that, if there is an increase in GDP growth by R1 million, consumer inflation will also increase by 1.15% (or 1.6%) units. Conversely, the positive sign of GDP_GROWTH_NEG (-0.9554) implies that, if GDP growth decreases by R1 million, consumer inflation will decrease by 0.95 (or about 0.1) %.

The positive sign of EXCRATE_POS (0.0072) implies that, if the exchange rate appreciates by 1%, consumer inflation will also increase by 0.01%. On the other hand, the negative sign of EXCRATE_NEG implies that if the exchange rate depreciates by 1%, consumer inflation will increase by 0.30 units (or about 0.3%) %.

The results reveal an asymmetric nonlinear relationship between the dependent variable (consumer prices) and each independent variable.

A negative change in the dependent variable results in a response to a change in imports, as denoted by the coefficient -0.2237, which is greater than the relatively smaller change in asymmetry.

The long-run results indicate that, in the long run, inflation is affected by positive changes in imports. Results show that when imports increase, inflation goes down. However, the effect of negative changes in imports does not affect inflation.

Results show that inflation is affected by both negative and positive changes in GDP in the long run. The results show that inflation is affected positively by positive changes in GDP. This implies that when GDP increases, inflation also increases.

Results also reveal that negative changes in GDP result in a decrease in inflation. This implies that when GDP decreases, inflation also decreases.

The effect of *excrate* on inflation was seen to be insignificant. This implies both positive (0.0072) and negative changes (-0.3036) in exchange rate do not have a significant effect on inflation.

Table 3. Short-run NARDL results

Imports POS	-0.943649	0.216459	-4.359486	0.0000
Imports NEG	-0.382077	0.325516	-1.173761	0.2435
GDP Growth POS	4.876977	1.117737	4.363259	0.0000
GDP Growth NEG	4.030248	0.883975	4.559234	0.0000
EXCRATE POS	0.030426	1.328364	0.022905	0.9818
EXCRATE_NEG	-1.280761	0.802469	-1.596026	0.1139

Table 4. ECM Regression

Variable	Coefficient	Std.Error	T-statistic	Probability
C	1.072213	0.137927	7.773774	0.0000
@Trend	0.003290	0.000429	7.664575	0.0000
CoinEq(-1)*	-0.237061	0.030379	-7.803588	0.0000

The speed-of-adjustment coefficient, also referred to as the error correction term (ECT) tells us how fast the process for the dependent variable reverts to its long-run relationship when this equilibrium is distorted. If it is closer to 1, this would imply that—in the absence of any other short-run fluctuations, any deviation from the equilibrium is corrected within a short period after the distortion occurs. In contrast, if it is closer to 0, this would imply that the process returns to its equilibrium path after a long period (Kripfganz & Schneider, 2023). The error correction term has a coefficient (-0.237061) with a correct negative sign, which is less than 1 and is perfectly significant with a p-value of 0.000.

The ECT coefficient (-0.237061) implies that if there is any disturbance in this system, it takes an average speed of about 24% to adjust to the long run (Chirwa, 2017).

The positive change in imports has a significant effect, as denoted by the p-value of 0.0000, whilst its negative change has an insignificant impact, as portrayed by the p-value of 0.2435.

The negative sign of IMPORTS_POS implies that, if imports increase by R1 million, consumer inflation will decrease by 0.9 %. On the contrary, the negative sign of IMPORTS_NEG implies that, if imports decrease by R1 million, consumer inflation will increase by 0.38 (or about 0.4) %.

In the case of GDP_GROWTH, the positive sign of GDP_GROWTH_POS implies that, if imports increase by R1 million, consumer inflation will also increase by 4.87 (or 4.9) %. Conversely, the positive sign of GDP_GROWTH_NEG implies that, if imports decrease by 1 unit, consumer inflation will decrease by 0.38 (or about 0.4) %.

The positive sign of EXCRATE_POS (0.0072) implies that, if the exchange rate appreciates by 1%, consumer inflation will also increase by 0.03 %. On the other hand, the negative sign of EXCRATE-NEG (-. implies that, if the exchange rate depreciates by 1%, consumer inflation will increase by 1.28 units (or about 1.3) %.

Wald Test

Tables 5.1, 5.2, and 5.3 present the Wald tests for exchange rate-Inflation, imports-Inflation, and GDP_GROWTH-Inflation nexuses, respectively. The null hypothesis is that there is an asymmetric nonlinear long-run relationship between the dependent variable and the explanatory variable, against the alternative one that there is a symmetric nonlinear long-run relationship between the dependent variable and the explanatory variable.

Table 5.1. Wald tests

Test Statistic	Value	Df	Probability
t-statistics	-1.594704	93	0.1142
F-statistic	2.543081	(1, 93)	0.1142
Chi-square	1.594704	1	0.1108

C (2)*IMPORTS_POS + C (3)*IMPORTS_NEG

From Table 5.1, the null hypothesis is that there is an asymmetric nonlinear long-run relationship between inflation and imports. As the p-value (0.1142) is greater than 0.05 at the 5% level of significance and therefore insignificant, we fail to reject the null hypothesis and conclude that the two variables have an asymmetric nonlinear short-run relationship.

Table 5.2. Equation: NARDL

Test Statistic	Value	Df	Probability
t-statistic	1.192675	93	0.2360
F-statistic	1.422473	(1, 93)	0.2360
Chi-square	1.422473	1	0.2330

C (4)*GDP_GROWTH_POS + C (5)*GDP_GROWTH_NEG

The p-value on the relationship between inflation and GDP_GROWTH (0.2360) from Table 5.2 is insignificant as it is greater than 0,05 at the 5% level of significance. We can also conclude that inflation and GDP_GROWTH have an asymmetric, nonlinear short-run relationship.

Table 5.3. Equation: NARDL

Test Statistic	Value	Df	Probability
t-statistic	-4.397058	93	0.0000
F-statistic	19.33412	(1, 93)	0.0000
Chi-square	19.33412	1	0.0000

EXCRATE_POS + C(7)*EXCRATE_NEG + C(8)

From Table 5.3, an asymmetric correlation between inflation and exchange rate is non-existent in the case of exchange rates. This is portrayed by a significant p-value (0.0000) of less than 0.05.

Diagnostic Tests

Diagnostic tests were conducted to determine any possible violation of the classical assumptions. Since non-violation produces more efficient estimates. The following tests were used: the Breusch–Godfrey serial correlation LM test, the Breusch-Pagan Heteroscedasticity test, the normality test, and the Ramsey test.

Table 6. Serial Correlation Test

F-statistic	0.1596	Prob. F	0.8527
Obs*R-Squared	0.3565	Prob. Chi-Square	0.8367

In the serial correlation test, the null hypothesis of no serial correlation against the alternative positive or negative serial correlation hypothesis is tested. Results show that there was no serial correlation in the model. The Probability of the F-statistic turned out to be 0.852 and this was above 0.05. This shows that there was no serial correlation.

Table 7. Breusch-Pagan-Godfrey Heteroscedasticity Test

F-statistic	1.1109	Prob.F	0.3632
Obs*R-Squared	8.8971	Prob-Chi Square	0.3510
Scale Explained SS	8.9522	Prob-Chi-Square	0.3463

Heteroscedasticity tests suggest two hypotheses: H0 (null hypothesis) indicates homoscedastic data (covariance), and Ha (alternative hypothesis) suggests heteroscedastic data (no covariance). Results show that there is homoscedasticity in the model. The Probability of the F-statistic turned out to be 0.3632 and this was above 0.05. This shows that there was no heteroscedasticity.

Table 8. Jarque-Bera Normality Test

Jarque Bera	4.663720
Prob	0.097115

The null hypothesis for the Jarque-Bera normality test is that the data is normally distributed, against the alternative hypothesis that the data does not come from a normal distribution. The results show that the residuals are normally distributed. This is shown by the p-value associated with the JB statistic of above 0.05.

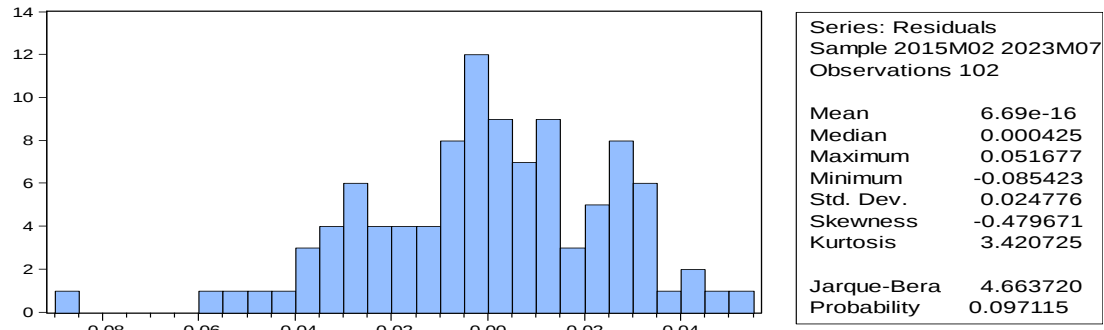


FIGURE 1
NORMALITY TEST

The Jarque-Bera test is based on the notion that the skewness should be 0 and Kurtosis has a value of 3 (Kallner, 2017). Figure results1 implies that the residuals are normally distributed, given the probability value of 0.097115. Although the skewness is not exactly zero, however, it is almost close to zero, and the kurtosis is 3.420725; the value is still accepted.

5. DISCUSSION

The findings of this study confirm that the Exchange Rate Pass-Through (ERPT) to consumer prices in South Africa is both nonlinear and asymmetric. The results indicate that currency depreciations have a stronger impact on inflation than appreciation, suggesting that firms adjust prices differently depending on the direction of exchange rate movements. However, the absence of a significant long-run nonlinear relationship, as evidenced by the Wald test results ($p\text{-value} < 0.05$), suggests that other macroeconomic factors, such as monetary policy interventions, inflation-targeting frameworks, and global economic conditions, play a role in moderating ERPT over time. These findings align with existing studies on emerging markets, where ERPT tends to be incomplete and influenced by economic structures and policy responses.

Policy Implications

The study's findings suggest several key policy implications for South Africa. The asymmetric nature of Exchange Rate Pass-Through (ERPT), with depreciations having a stronger inflationary impact than appreciations, highlights the need for proactive exchange rate risk management and monetary policy responses sensitive to currency movements. Strengthening the credibility of the inflation-targeting framework remains crucial to anchor expectations, while structural reforms aimed at reducing import dependence can help mitigate exposure to exchange rate shocks. Additionally, wage and social policies should be responsive to inflation dynamics to protect consumer purchasing power. Finally, the absence of a long-run nonlinear relationship indicates that broader macroeconomic factors, such as global economic trends and domestic policy frameworks, play a vital role in moderating ERPT over time.

REFERENCES

1. Aisen, A., Jinjark, Y., Kubo, K. and Zhou, Y., 2021. *The Transmission of Exchange Rate Fluctuations to Domestic Prices in Emerging Markets*. IMF Working Paper No. 21/55. Washington, DC: International Monetary Fund.
2. Anderl, C. and Caporale, G.M., 2023. Exchange rate pass-through, inflation and monetary policy: Evidence from emerging and advanced economies. *Economic Modelling*, 122, 106153.
3. Brun-Aguerre, R., Fuentes, A. M., & Phylaktis, K. (2012). Exchange rate pass-through into import prices revisited: What drives it?. *Journal of international Money and Finance*, 31(4), 818-844.
4. Bussiere, M. (2013). Exchange rate pass-through to trade prices: The role of nonlinearities and asymmetries. *Oxford Bulletin of Economics and Statistics*, 75(5), 731-758.
5. Calvo, G.A. and Reinhart, C.M., 2002. Fear of floating. *Quarterly Journal of Economics*, 117(2), pp.379–408.
6. Campa, J. M., & Goldberg, L. S. (2005). Exchange rate pass-through into import prices. *Review of Economics and Statistics*, 87(4), 679-690.

7. Cao, S., Dong, W. and Tomlin, B., 2015. The role of exchange rates in pass-through to U.S. import prices. *Bank of Canada Staff Working Paper* 2015-29. Ottawa: Bank of Canada.
8. Cheikh, N.B. and Rault, C., 2016. Exchange rate pass-through in the South African economy: Evidence from linear and nonlinear models. *Economic Change and Restructuring*, 49(1), pp.71–93.
9. Cheikh, N.B., Louhichi, W. and Rault, C., 2018. Nonlinear and asymmetric exchange rate pass-through in the BRICS. *Macroeconomic Dynamics*, 22(3), pp.688–717.
10. Chiparawasha, B., 2015. *An analysis of the impact of exchange rate volatility on economic growth in Zimbabwe*. Master's thesis. University of Zimbabwe.
11. Chirwa, T.G., 2017. Macroeconomic policies and economic growth: What difference do policy regimes make? *African Development Review*, 29(2), pp.153–168.
12. Cunningham, R., Li, F. and Vilmi, L., 2017. Exchange rate pass-through, import prices and inflation in Canada. *Bank of Canada Review*, 2017(Spring), pp.18–30.
13. Delatte, A. L., & López-Villavicencio, A. (2012). Asymmetric exchange rate pass-through: Evidence from major countries. *Journal of Macroeconomics*, 34(3), 833-844.
14. Devereux, M. B., & Engel, C. (2002). Exchange rate pass-through, exchange rate volatility, and exchange rate disconnect. *Journal of Monetary economics*, 49(5), 913-940.
15. Dilla, S., Lartey, E. and Mengesha, L., 2017. Exchange rate pass-through and inflation in developing countries: Evidence from Sub-Saharan Africa. *Journal of African Economies*, 26(3), pp.1–24.
16. European Central Bank (ECB), 2020. *Exchange rate pass-through in the euro area*. ECB Economic Bulletin, Issue 7/2020. Frankfurt: European Central Bank.
17. Gereziher, H. and Nuru, S., 2023. Asymmetric exchange rate pass-through to consumer prices in South Africa: Evidence from nonlinear models. *African Journal of Economic Policy*, 30(2), pp.55–72.
18. Goldberg, P. K., & Knetter, M. M. (1996). Goods prices and exchange rates: What have we learned?.
19. Ha, J., Kose, M.A. and Ohnsorge, F., 2020. *Inflation in Emerging and Developing Economies: Evolution, Drivers, and Policies*. Washington, DC: World Bank.
20. Kabundi, A. and Mbelu, A., 2018. Exchange rate pass-through to consumer prices in South Africa: Evidence from disaggregated data. *South African Reserve Bank Working Paper* WP/18/04. Pretoria: SARB.
21. Kabundi, A. and Mlachila, M., 2018. The role of exchange rate pass-through in South African inflation dynamics. *South African Reserve Bank Working Paper* WP/18/02. Pretoria: SARB.
22. Kallner, A. (2017). *Laboratory statistics: methods in chemistry and health sciences*. Elsevier.
23. Karaoğlu, N. and Demirel, O., 2021. Asymmetric and nonlinear exchange rate pass-through: Evidence from emerging economies. *Economic Systems*, 45(4), 100927.
24. Kassi, D.F., Sun, G., Yao, X. and Ding, N., 2019. Asymmetric exchange rate pass-through in emerging economies: New evidence from panel nonlinear ARDL approach. *Economic Modelling*, 81, pp.540–556.
25. Kripfganz, S., & Schneider, D. C. (2023). ardl: Estimating autoregressive distributed lag and equilibrium correction models. *The Stata Journal*, 23(4), 983-1019.
26. Krugman, P., 1986. Pricing to market when the exchange rate changes. *NBER Working Paper* No. 1926. Cambridge, MA: National Bureau of Economic Research.
27. Liang, Q., Kim, D. and Suh, S., 2020. Nonlinear ARDL models and exchange rate pass-through. *Journal of Economic Studies*, 47(5), pp.1089–1106.
28. Magwiro, S., Ngepah, N. and Nhleko, Z., 2019. Exchange rate pass-through to consumer prices in South Africa: Nonlinear and asymmetric analysis. *Economic Research Southern Africa (ERSA) Working Paper* No. 784. Cape Town: ERSA.
29. Marston, R. C. (1990). Pricing to market in Japanese manufacturing. *Journal of International Economics*, 29(3-4), 217-236.
30. Menegaki, A.N., 2019. The NARDL method in energy-growth nexus: Application to European countries. *Energy Policy*, 129, pp.236–263.
31. Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics*, 16(3), 289-326.
32. Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. In *Festschrift in honor of Peter Schmidt: Econometric methods and applications* (pp. 281-314). New York, NY: Springer New York.
33. Tang, T.C. and Lean, H.H., 2007. New evidence from the asymmetric ARDL model on the relationship between energy consumption and income in G7 countries. *Energy Policy*, 35(9), pp.4767–4773.
34. Taylor, J. B. (2000). Low inflation, pass-through, and the pricing power of firms. *European economic review*, 44(7), 1389-1408.