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## Article

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## OPERATIONS, INFORMATION & TECHNOLOGY | RESEARCH ARTICLE

# An investigation of the impact of exchange rate movements on consumer prices in the Southern African Customs Union (SACU)

Teboho Mashao<sup>1</sup> and Ireen Choga<sup>1\*</sup>

**Abstract:** External shocks disrupt the effectiveness of the central bank in stabilising prices. Therefore, this study investigates the effect of exchange rate movement on consumer prices in the SACU region for the period from 1990 to 2021 (31 observations for each nation). To achieve this, panel auto-regression distributed lags (PARDL) and pooled group mean (PGM) estimation techniques were employed in this study. Variables used in this study include consumer price index, exchange rate, import prices, gross domestic product (GDP) and money supply. The results indicate that the exchange rate has significantly influenced consumer prices negatively in the SACU region in the long run. Furthermore, the effects of exchange rate on consumer prices are low and incomplete. This undermines the PPP theory, which asserts that local prices should change in the same direction as the exchange rate. Nonetheless, the long-run findings align with some empirical evidence within the region. The short-run effects of the exchange are mixed and only significant in Botswana. Moreover, consumer prices in the SACU region are influenced by GDP, money supply and exchange rate. Granger causality results indicate that there is a unidirectional relationship between consumer prices and exchange rate. The findings in this study have implications for monetary policy in the SACU region. The exchange rate is anti-inflationary. Inflated consumer prices are likely to have been influenced by internal forces. Therefore, it is imperative to reconsider monetary policy targets and how they may be reorganised to regulate the level of consumer prices in the SACU economies.



Teboho Mashao

### ABOUT THE AUTHORS

Teboho Mashao is a student at North-West University and holds a master's degree in economics. His areas of research are in Macroeconomics, and International trade with a special focus on exchange rate movements and exchange rate pass through to consumers. Prof Ireen Choga is a full Professor of Economics at the North-West University. Her main research interest is in International trade mainly focusing exports and determinants of exports such as the exchange rate.

### PUBLIC INTEREST STATEMENT

The role of exchange rate in the local economy cannot be undervalued. The exchange rate plays an important role in the open economy and international trade. However, there has been different opinions concerning the effect of exchange rate movement on the domestic prices. As a result, this study investigates the impact of exchange rate movements on consumer prices in the Southern African Customs Union (SACU).

**Subjects:** Operations Management; Statistics for Social Sciences

**Keywords:** exchange rate; movements; SACU; consumer prices; PARDL; PMG

## 1. Introduction

No nation on the planet is entirely independent, and consequently the local economy frequently engages in international trade. All nations in the South African Customs Union (SACU) region are small open economies and highly dependent on external trade. The high dependency on external trade implies that more quantities of imports enter the local economy. This means that the exchange rate movements play a vital role in affecting a wider range of domestic factors because the exchange rate is used as a key instrument that interlinks the internal and external economy. As a result, the more open an economy is, the easier it is for external shocks to be spread to internal factors through exchange rates. Mpete (2019) states that the exchange rate changes affect the domestic prices in most nations, and therefore influence inflation. The exchange rate instabilities affect the overall objective of promoting price stability and sustainable growth. In addition, the exchange rate has implications for the design of monetary policy, and the issues of ERPT are central to developing an effective monetary policy. Given the concept that inflation results from exchange rate devaluation, it is critically important to comprehend the influence of the exchange rate on local consumer prices.

According to Kabundi and Mlachila (2018), the South African rand has been relatively unstable due to both internal and external factors given its role as a shock absorber. In addition, high rand instability has historically been associated with rand depreciation. As a result, the weak domestic currency affects import prices, which are then passed on to local prices. In addition, import price changes have an impact on domestic prices through the prices of imported intermediate and final goods. As a result, the degree to which an exchange rate change is reflected in import prices also has implications for the level of domestic prices (Mpete, 2019).

KebretTaye (2013) reported that the price pass-through, as determined by the exchange rate and prices in South Africa, plays a major part in determining the local price level in Botswana. This is because Botswana imports roughly 75% of its tradeable goods and services from South Africa; therefore, rand shocks are transmitted to Botswana inflation (Mpete, 2019). Khumalo et al. (2017) reported that the main cause of the rise in the general local prices in Eswatini is a persistent hike in food prices due to a relatively weaker rand against the U.S dollar and the nation depends on imports rather than exports. Similarly, in Namibia and Lesotho, the main determinant of local prices is the South African exchange rate. The SACU (2021) annual report reveals that the Lesotho recorded the highest consumer price index of 4.1%, followed by Eswatini, South Africa, Namibia and Botswana by 3.7, 3.3, 3.2 and 2.2%, respectively. Noteworthy, changes in the local currency had somehow affected local prices for SACU nations through import prices.

### 1.1. Research questions

Understanding the impact of the exchange rate movements on consumer prices helps in efficiently implementing the monetary strategy to sustain price stability. Therefore, this study attempts to answer the following research questions: How does the exchange rate affect the domestic consumer prices in the SACU region? Is the effect of the exchange rate on consumer prices identical across SACU nations? Is there any impact of the exchange rate on consumer prices across SACU members over the short run and long run?

### 1.2. Research objectives

The study concentrates on these objectives. The primary objective of this study is to examine the effect of exchange rate movement on consumer prices in the SACU region. In addition, the sub-objectives of this study are as follows:

- To examine the nature of the relationship between exchange rate and consumer prices across SACU members.
- To determine empirically the impact of the exchange rate on consumer prices across SACU members over the short run and long run.
- To establish whether the exchange rate determines consumer prices within SACU members.
- To test whether the effects of exchange rate on consumer prices are identical or not across SACU members in the short run.
- To provide relevant policy recommendations that are derived from empirical findings.

### 1.3. Research hypothesis

The hypotheses of this study are as follows:

$H_0$ : Exchange rate has no significant influence on consumer prices among SACU members in the short-run and long-run.

$H_1$ : Exchange rate has an influence on consumer prices across SACU members in the short-run and long-run.

### 1.4. Contribution of the study

To achieve the objectives and answer research questions, this study uses a panel data analysis method. The reason for using this method is that the existing literature points to no evidence of the application of panel data analysis methods on the impact of the exchange rate movements on consumer prices in the South African Customs Union (SACU) region. However, the existing literature reveals that prior studies applied time series data analysis methods to examine the impact of the exchange rate on consumer prices at individual prospects (Balcilar et al., 2019; Ellyne & Hearn, 2014; Mdlovu, 2021; Mushendam & Namakalu, 2016; Nkwe, 2019; Sheefeni & Ocran, 2014). As a result, these studies are constrained by the limitation of not investigating the impact of the exchange rate on consumer prices at the regional level. To the authors' best knowledge, there are no or limited panel studies that have explored the influence of the exchange rate on consumer prices collectively across SACU members. As a result, this current study has contributed to existing literature by addressing the impact of the exchange rate on consumer prices jointly across SACU members. In addition, this study employs a panel data analysis method recognised as panel auto-regression distributed lags (PARDL) with pooled means group (PMG) estimator to answer the research questions. The motivations in relation to selecting a PMG estimator are thoroughly detailed in the methodology section.

Among trading partners, achieving a stable exchange rate is crucial since it affects international trade. The exchange rate's unpredictability affects the economies of SACU members. Consequently, an informed understanding of the association between changes in exchange rates and changes in consumer prices is imperative to policymakers and the economies of SACU members. The current study intends to generate new empirical information that adds to the literature on price stability and the impact of the exchange rate on volatile markets. Therefore, the emerging findings from this study could ascertain the influence of the exchange rate on internal consumer prices across SACU members and provide insight to policymakers that could assist in stabilising local prices and sustaining a stable exchange rate. The study additionally helps potential investigators, scholars, and policymakers to identify other factors that might influence consumer prices across SACU members.

## 2. Literature review

This section elaborates on the theoretical framework that discusses the economic theories that are foundational to the exchange rate and consumer price constructs. In addition, this section also elaborates on the empirical literature conducted by various researchers to assess the validity of these economic theories in the SACU region.

## 2.1. Theoretical framework

### 2.1.1. Purchasing power parity

The term *purchasing power parity* was developed by Swedish economist Gustav Cassel in 1918 (Officer, 1976). The concept of purchasing power parity (PPP) is an extension of the law of one price (LOOP). It evolves the theoretical underpinning on which a close connection between prices and exchange rates is built. The PPP relies on numerous assumptions that include no trade barriers and transportation costs; markets are perfectly competitive; and goods and services in both nations are similar and interchangeable (Bada et al., 2016). The exchange rate must fluctuate as prices change internationally to have prices expressed in a single currency across the nations. According to the LOOP, when the value of prices is expressed in a single currency, identical goods traded in different nations must sell for the same price in the lack of trade frictions and under environments of price flexibility and free competition. This law applies to the SACU region because it is a unified market with free interchange of goods among its members. PPP would be applicable between the two nations if the LOOP holds for all goods and services between the two nations (Bada et al., 2016). Therefore, at equilibrium, the price of tradable goods in two nations is not anticipated to vary when measured in a single currency and consequently, ensuring a complete pass-through. Although the markets are in different locations, a change in a local currency in one market will result in an equivalent change in price in the other.

The PPP concept has weaknesses that have been identified by some economists. According to Krugman et al. (2011), the following are the critics for the PPP concept.

- Trade barriers: Moving goods between markets located in different nations is costly because of government trade restrictions and shipping costs, thereby undermining the law of one price mechanism that underpins PPP.
- Perfect competition: In the real-world, limited price information, market barriers and different products among firms may lead to imperfect competition. So, when imperfectly competitive market structures and trade restrictions happen at the same time, the link between national price levels is weakened more. Under imperfect competition, heterogeneous products are sold. As a result, the LOOP is violated and subsequently the PPP is nullified.

### 2.1.2. Monetarist flex-price model

In support of the PPP concept, Frenkel (1976) and Mussa (1976) presented the flex-price model. According to Mussa (1976, p. 229), this model highlights that both the exchange rate and the balance of payments are monetary phenomena. Therefore, factors influencing the exchange rates and balance of payments are the demands for and the supplies of numerous national monies. According to the flex-price model, the level of the exchange rate is closely associated with the level of the relative money supply in the long run. Furthermore, this model supports that product prices are flexible, the monetary circumstances are stable at home and in a foreign nation, the demand for money is stable, and PPP always holds (Moosa & Bhatti, 2009, p. 87). The model emphasises that the PPP does not only hold in the long run, but even in the short run. Like the PPP concept, the flex-price model also has some weaknesses. Pearce (1983) came up with empirical evidence to confirm that PPP does not hold even in the short run. Therefore, the assumption that the PPP does hold even in the short run is one of the reasons given for the low performance of this model. Notably, it has been argued that prices are sticky in the short run and do not have the required flexibility to retain the money market in equilibrium.

### 2.1.3. Mundell-Laffer (M-L) hypothesis

The Mundell-Laffer (M-L) hypothesis is credited to Prof Robert Mundell and Arthur Laffer; however, the M-L model was termed and developed in the 1970s (Wanniski, 1975). The argument is based on the supposition that global economies are closely unified, and that goods arbitrage would ensure that the LOOP always holds. The LOOP states that all goods traded in a home or foreign nation will have identical prices measured in a single currency, while the LOOP ensures that



a change in the exchange rate will not change the relative price level of domestic or foreign goods. However, it does not detail which price level, the foreign or local one, will carry a significant adjustment (Goldstein, 1977; Kreinin, 1977). Here, the M-L model shows how changes in the exchange rate affect the global price. According to the M-L hypothesis, the devaluation in currency fails to correct the balance of payment imbalance but contributes to the global general price level. Notably, the M-L hypothesis suggests that the price level in the devaluing nation will carry a significant change because a weak currency decreases export fees and inflates import prices, and therefore, the effect is inflationary (Goldstein, 1977). However, a revaluation of the currency does not have the same reserve effect as those of devaluation, and the price level in the revaluing nation will slightly decrease or not decrease at all. Consequently, the impact of the exchange rate adjustment is asymmetry and is commonly known as the ratchet effect.

This hypothesis has some weakness that have been identified by some economists. The M-L hypothesis ignores the importance of demand and supply elasticity for traded and non-traded products as well as marginal import propensities in nations with revaluing and devaluing currencies (Ahmad, 1984). These two factors are likely to play a substantial role in controlling how prices are distributed between revaluing and devaluing nations after an exchange rate alteration. Consequently, there is no reason to expect one nation to engross most or all the price alterations in relation to the exchange rate adjustment only if these parameters are roughly similar in both nations (Goldstein, 1977). However, one nation would engross most or all the price alterations in relation to the exchange rate alteration only if the extent of the elasticities is different in both nations. In addition, there is no *a priori* motive to expect the asymmetry influence in the event of exchange rate changes. In sum, the amount of the pass-through is an empirical question and should not be generalised.

## 2.2. Empirical literature

The importance of exchange rate movements in a small open economy like the SACU region members has resulted in numerous studies exploring the impact of the exchange rate pass-through (ERPT) within the SACU region states. Therefore, this section scrutinises earlier studies conducted by several researchers regarding the exchange rate and local prices within the SACU region.

Using a structural vector autoregressive model, Sheefeni and Ocran (2014) inspected the effects of the ERPT on local prices in Namibia for the period from the first quarter of 1993 to the last quarter of 2011. The study confirmed that there is a larger ERPT in internal prices and the effects are long-lasting. Adjustments in the price level are produced by adjustments in the exchange rate. In addition, the results show that the ERPT is incomplete, signifying that the PPP theory does not hold in Namibia. Similarly, Mushendam and Namakalu (2016), using the same model in Namibia, show that ERPT is low and incomplete, signifying that the PPP theory does not hold in Namibia for the period between 2000 and 2014.

In case of South Africa, Ellyne and Hearn (2014) employed an SVAR approach to evaluate the ERPT to the producer, import and consumer prices covering a quarterly period from 2000 to 2013. The study showed that 46, 24.4 and 10 percent of the exchange rate effects are spread through import, producer and consumer prices in the long run, respectively. Similarly, the pass-through is low in the short run and the overall results indicate that the PPP does not hold in South Africa.

Kabundi and Mbelu (2018) utilised the two-stage exchange rate pass-through framework instead of the direct pass-through from the exchange rate to consumer inflation to assess the variation in the ERPT for South Africa from 1994 to 2014. The study applied rolling-window estimation to examine the possibility of change in the ERPT over time. The findings showed that the ERPT is complete in the first stage, however, incomplete in the second stage. It indicates that retailers do not pass all the cost to consumers. Balcilar et al. (2019) examined the pass-through influence of the exchange rate on consumer prices for the biggest economies in Africa (Nigeria and

South Africa) using the ADRL model. The study showed that the association between the exchange rate and consumer prices is inverse and significant in the short run and long run in both economies. Overall, the outcomes reject the monetarist flex-price theory on the view that the PPP holds even in the short run.

Nkwe (2019) investigated the monetary policy conduct and the size of exchange rate pass-through in Botswana for the period ranging from 2007Q1 to 2017Q4 using the VECM. The study verifies that the effects of exchange rate on consumer and import prices are low in the short run, but greater in the long run. Overall, the effects of exchange rate are incomplete suggesting that the PPP does not hold in Botswana. In addition, the nature of the relationship between consumer price and the exchange rate is negative in the long run. The finding corroborates that of Ntsosa and Nkwe (2016) who found that the exchange rate is incomplete.

Mdlovu (2021) assessed the nature of ERPT on consumer prices for Eswatini utilising time series data from 1989 to 2018. The research employed the vector error correction model, and the results confirm that there is a presence of a long-run relationship between the exchange rate and consumer prices, which is direct in nature. However, the effects of exchange rate on consumer prices are incomplete in both the short run and long run. The author acknowledged that the study's weakness is the choice of its price indices, which could fall short of capturing price fluctuations due to the constant changes in weights.

Ejaz et al. (2021) examined the influence of the exchange rate fluctuations to inflation in Pakistan using ARDL model for the period from Q3:1992 to Q2:2017. The study discovered that the pass-through of devaluation of Pakistan currency to inflation is significant and the pass-through of revaluation is found to be insignificant. Nonetheless, the pass-through is incomplete. Lastly, the results infer that there is a significant role for the exchange rate in the determination of prices in Pakistan in the long-run. The study did not investigate the symmetry effect of exchange rate.

Karaoğlu and Demirel (2021) examined the asymmetric exchange rate Pass-Through into inflation in Turkey using a nonlinear autoregressive distributed lag model for 2004:Q1–2019:Q4. The results showed that the exchange rate pass-through into inflation is asymmetric in Turkey in the long-run. Moreover, a depreciation in the exchange rate has no statistically significant effect on inflation, but a revaluation also increases inflation in the short-run. The results further confirmed that an appreciation of the Turkish lira leads to a higher pass-through effect than depreciation in the long-run. The study did not investigate the symmetry effect of exchange rate.

The empirical evidence collected from the reviewed studies demonstrates opposing results for the theories mentioned above. Considering the empirical literature reviewed, evidence for the combined SACU region members is rare, as no investigation has been done before. Moreover, the recent studies have focused on the asymmetric effects of the exchange rate on price. Therefore, this study takes this opportunity to embark on assessing the effect of exchange rate on consumer prices collectively across SACU region members, in an attempt to fill the void that exists in the literature. In addition, some members within the region are also members of the common monetary union, so it was necessary to determine whether the use of a common currency has a similar influence on consumer prices across member nations.

### 3. Methodology

The methodology followed in this study and with model specification, estimation methods and modelling procedure employed in this study are discussed in this section. The theoretical framework in the previous section informs the analysis of this study. The core intention of this section is to detail relevant methods and tools employed to achieve the objectives of this study.



This study follows the model developed by Kassi, Rathnayake, Edjoukou et al. (2019) who assessed the association between consumer prices and the exchange rate in 40 Sub-Saharan African (SSA) nations utilising quarterly panel data through the ARDL approach. The model is specified as follows:

$$Lcpi_{i,t} = \alpha_i + \Theta_i Ler_{i,t} + \pi_i Lmon_{i,t} + \kappa_i Lgdp_{i,t} + \psi_i Loil_{i,t} + \varepsilon_{i,t} \quad (1)$$

Where  $Lcpi$ ,  $Ler$ ,  $Lmon$ ,  $Lgdp$  and  $Loil$  represent the logarithm of consumer price ( $cpi$ ), the exchange rate ( $er$ ), money supply ( $mon$ ) gross domestic products ( $gdp$ ) and oil price ( $oil$ ), respectively. Meanwhile,  $\alpha_i$ ,  $\Theta_i$ ,  $\kappa_i$  and  $\psi_i$  are the parameters of country  $i$  and  $\varepsilon$  is the error term. Therefore, we adopt and modify the model given in equation 1 to review the correlation between consumer prices and the exchange rate in the SACU region. Changes are made by removing some variables, such as oil price, and by introducing a new important variable specific to this study, i.e. import price. The reason for removing oil prices is to avoid multicollinearity that might arise from adding too many variables in the model, as this study intends to add import prices. Moreover, import prices are critical, according to the ERPT channels, as the effect of exchange rate movements is initially passed on to import prices and eventually on to overall consumer prices. Therefore, the modified model is specified as follows:

$$Lcpi_{i,t} = \alpha_i + \Theta_i Ler_{i,t} + \pi_i Lm2_{i,t} + \kappa_i Lgdp_{i,t} + \psi_i Limp_{i,t} + \varepsilon_{i,t} \quad (2)$$

Where  $i$  represents a number of countries from one to five,  $t$  is time,  $L$  is the logarithm of the variables,  $cpi$  signifies a consumer price index,  $er$  is the exchange rate,  $gdp$  signifies gross domestic product,  $m2$  is money supply and  $imp$  represent import prices. Import prices and gross domestic product are measured in as US dollar, the money supply is expressed as a ratio of GDP, and consumer prices are measured as a percentage. The exchange rate is measured by the index of official exchange rate. The independent variables of this study are selected based on the relationship with the dependent variable. For instance, according to the PPP theory, the prices are connected to the exchange rate movement. In relation to money supply, the quantity theory of money infers that money growth and price level are directly related to each other. With regards to import prices, the ERPT transmission channel shows that there is a direct influence from import prices on local consumer prices. Lastly, it can be argued that the consumer prices are also influence by the GDP but the relationship between these variables is unclear.

Data for the variables employed in the model was sourced from the World Bank and Statista. The SACU region comprises South Africa, Lesotho, Eswatini, Botswana and Namibia, which were sampled for the period of 1990 to 2021. This study depends on panel data analysis. This study investigates the effect of exchange rate movement on consumer prices utilising the panel auto-regressive distributed lag (ARDL) technique. Pesaran and Shin (1999) developed the ARDL method, which accomplishes a sole cointegrating equation and was further improved by Pesaran et al. (2001). The method is chosen because it has the dynamic capability to detect short-run and long-run coefficients with an error correction term. This method has many advantages over other symmetric methodologies; it is also suitable and applicable for estimating  $I(0)$  variables,  $I(1)$  variables, or a hybrid of the two. ARDL is also useful regardless of whether the sample observation is small or large, unlike the Engle and Granger test, Johansen and Juselius test and Johansen test, which all require variables to be integrated at  $I(1)$ . Moreover, the ARDL model yields better outcomes even with small sample size. Chudik et al. (2015) specified a PARDL method as follows:

$$y_{it} = \sum_{\ell=1}^{p_{yi}} \varphi_{i\ell} y_{i,t-\ell} + \sum_{\ell=0}^{p_{xi}} \beta_{i\ell} x_{i,t-\ell} + \mu_{it} \quad (3)$$

$$\mu_{it} = \gamma_i' f_t + e_{it} \quad (4)$$

Where  $y_{it}$  represents the predicted variable,  $x_{it}$  is a vector of  $(k * 1)$  regressor,  $it$  is the sum of cross-sectional unit ( $i = 1, \dots, 5$ ) while ( $t = 1990, 1991, 1992, \dots, 2021$ ),  $f_t$  is the unit-specified fixed effects,  $p_{yi}$  and  $p_{xi}$  are optimal lag orders, and  $e_{it}$  is the error term.

If a long-run relationship is found, the ECM is required to calculate how long it would take for the system to reach equilibrium. The error correction model (ECM) refers to the process of adjusting the short-run disequilibrium and the long-term relationship. The ECM equation can be written as:

$$\Delta y_{it} = \beta_i y_{i,t-1} - \vartheta_i y_{i,t-j} \sum_{j=1}^{p-1} \gamma_{il} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij} \Delta x_{i,t-j} + \gamma'_i f_t + \varepsilon_{it} \quad (5)$$

$\beta_i$  is the error correction term (ECT) that represents the speed of correction to long-run equilibrium,  $\Delta$  represents the first difference operator, and  $p$  and  $q$  represent optimal lags. If ECT is equal to zero, therefore, there is no cointegration of variables. For the variables to be cointegrated, ECT must consist of a sign that is negative and is statistically significant. Like any other econometric technique, the unit root analysis comes first in the ARDL analysis. The order of integration for the main variables is determined using Levin, Lin and Chu (LLC) and Im, Pesaran and Shin (IPS) unit root tests in this study. Levin et al. (2002) proposed the LLC unit root test, which assumes that the coefficient among variables is the same and independently distributed. Conversely, Im et al. (2003) presented IPS tests to assess the unit root in the heterogeneous panel.

The second step entails selecting the optimal lags based on three main information criteria using an unrestricted vector auto regression (VAR) model. To choose the best long-run model, the optimum lag length must be established using suitable model order selection criteria, like the Akaike information criterion (AIC), the Schwarz Bayesian criterion (SBC), or the Hannan-Quinn criterion (HQC). All these selection criteria should have lower statistics (Menegaki, 2019).

The third step is to cointegrate the variables. It is vital to take a cointegration test as it determines whether a model empirically displays a long-run relationship. Even though there are many cointegration tests, this study mainly focuses on panel data, and therefore the panel cointegration tests are being utilised. The panel cointegration test used is the Kao test. The Kao test assumes that cointegrating vectors are homogeneous (Kao, 1999).

The fourth step is to select the suitable PARDL estimator to estimate the efficient estimates. Pesaran et al. (1999) demonstrated the two core estimation approaches that could be employed to evaluate resourceful PARDL models, which are the pooled mean group (PMG) and mean group (MG) estimator techniques. The MG estimator is reliable for large  $N$  and  $T$  ( $N$ = number of groups and  $T$ = number of years). On the other hand, the PMG estimator is effective for small  $N$  and large  $T$ . Therefore, this study employs the PMG estimator because the panel data in this study meets the assumptions of the PMG. That is, the small  $N$  and large  $T$ , for this study we have  $N$ , which is the total of five countries and  $T$  is 30 years' time span. In addition, another assumption of the PMG estimator imposes the restriction on homogeneity in the long run. In terms of the exchange regime or monetary policy, South Africa, Eswatini, Lesotho, and Namibia formed a common monetary area, which is a hybrid of a currency board and a monetary union. The exchange rate and monetary policy of all members of the CMA are influenced by those of the host of the CMA, which is South Africa. This suggests that the influence of the exchange rate movement on the consumer prices in the four member countries of the CMA is identical. Botswana's exchange rate regime structure is the same as that of other members of the SACU region. For instance, Botswana's exchange rate regime is fixed and aligned with the rand. This suggests that the South African rand has a significant impact on the currencies of the SACU states (South Africa is the economic heart of the SACU).

The penultimate step entails testing for granger causality. Granger (1969) presented a relatively basic test that described the causality, as follows: in the Granger logic, variable  $y_t$  is the cause of variable  $x_t$ . This means  $x_t$  can be examined with greater precision by utilising the historical values of the  $y_t$ . In addition, there must be either bi-directional or unidirectional causality between  $x_t$  and  $y_t$ .

The ultimate step entails testing for normality of the residuals and cross-sectional independence. It is common practice in statistics and data analysis to determine whether a data sample is taken from a normally distributed population. Normality is one of the assumptions that is credited to the classical linear regression model (CLRM). According to the CLRM, the evaluated model's residuals are expected to be normally distributed (Gujarati & Porter, 2008). As a result, the normality test exams the null hypothesis that residuals are normally distributed. Cross-section independence is referred to as a condition in which the residuals from the evaluated panel model do not rely on another variable (Pesaran, 2021). It simply means that the cross-section residuals are not interrelated. As a result, the cross-sectional independence test examines the null hypothesis that "there is no cross-sectional dependence". In addition, a well-specified PARDL model must fulfil the assumption of the normality test and must also pass the cross-section dependence tests.

#### 4. Results

This study strove to examine the effect of exchange rate movement on consumer prices in the SACU region. Therefore, the purpose of this section is to present the key findings. The requisite pre-estimation tests for series are discussed, including the panel unit root test, lag length selection criteria and the cointegration tests, which were computed using Eviews 12. PARDL estimation results including the ECM and Granger causality test are reported, accompanied by a sustained discussion. Table 1 illustrates descriptive statistics.

Table 2 illustrates that the correlation for the regressors against each other is between  $\pm 0.80$  percent, indicating that the model to be estimated will not encounter multicollinearity.

The findings obtained in Table 3 illustrate that variables such as LCPI and LEX are stationary at the level when tested using IPS and LLC tests at 1, 5 and 10 percent levels of significance under intercept as well as intercept and trend model specifications, respectively. But LEX is only stationary when using the LLC test. Therefore, we can conclude that the LCPI and LEX are integrated to the order of zero  $I(0)$ .

**Table 1. Descriptive statistics**

	LCPI	LEX	LGDP	LIMP	LM2
Mean	1.921	1.890	7.901	22.020	3.787
Median	1.944	1.952	8.124	21.328	3.799
Maximum	3.073	2.802	9.084	25.377	4.312
Minimum	.3578	0.621	5.858	2.189	2.985
Std. Dev.	.480	0.530	.817	1.436	0.331
Skewness	-.357	-0.339	-.821	1.092	-0.431
Kurtosis	3.176	2.335	2.813	2.976	2.470
Jarque B.	3.496	5.823	17.648	3.825	6.618
P(JB)	.174	0.054	.000	.000	0.036
Sum	297.775	292.988	1224.589	3413.077	587.028
Sum Sq.Dev.	35.401	43.240	102.896	317.416	16.867
Observations	155	155	155	155	155

Source: Estimation by researcher using Eviews 12.

As shown in Table 1, the Jarque-Bera statistic illustrates that the GDP, money supply and import prices are statistically significant at a 5 percent level. As a result, it can be decided that the GDP, money supply and import prices are not normally distributed. Only the exchange rate and consumer prices are statistically insignificant and accept the null hypothesis of normal distribution. Therefore, we can conclude that the exchange rate and consumer prices are normally distributed. In addition, exchange rate and consumer prices are normally skewed while the gross domestic product and money supply are skewed to the left. Import prices are skewed to right.

**Table 2. Correlation matrix**

	LCPI	LEX	LGDP	LIMP	LM2
LCPI	1.000	−0.647	−.322	−.308	−0.352
LEX	−.647	1.000	.269	.279	0.498
LGDP	−.322	0.269	1.000	.664	0.562
LIMP	−.308	0.279	.664	1.000	0.535
LM2	−.352	0.498	.562	.535	1.000

Source: Estimation by researcher using Eviews 12.

**Table 3. Panel unit root tests at level**

Variable	Test	With Intercept		With Trend and Intercept		Order of integration
		Statistic	P-value	Statistic	P-value	
	LLC	−3.263	0.000***	−4.393	0.000***	I (0)
LCPI	IPS	−2.236	0.013**	−4.001	0.000***	I (0)
	LLC	−2.466	0.007***	−1.448	0.074*	I (0)
LEX	IPS	−.157	0.438	−1.116	0.132	Not integrated
	LLC	−.729	0.233	.390	0.652	Not integrated
LGDP	IPS	.905	0.817	−.301	0.382	Not integrated
	LLC	−1.064	0.144	.766	0.778	Not integrated
LIMP	IPS	.529	0.702	.843	0.800	Not integrated
	LLC	.336	0.632	.689	0.755	Not integrated
LM2	IPS	.659	0.745	.246	0.597	Not integrated

Notes: The symbols \*\*\*, \*\*, and \* indicate statistical significance at 1%, 5%, and 10% levels, respectively.

Source: Estimation by researcher using Eviews 12.

The findings obtained in Table 4 show that variables like LEX, LGDP, LIMP and LM2 are stationary at first difference when tested using IPS and LLC methods at 1, 5 and 10 percent levels of significance under intercept as well as intercept and trend model specifications, respectively. Therefore, we can conclude that LEX when using the IPS tests is integrated to the order one I(1). Moreover, LGDP, LIMP and LM2, when using both the IPS and LLC tests, are integrated to the order one I(1). Nonetheless, the ARDL method is applicable as there is a hybrid of I(0) and I(1) and not any of the variables are I(2).

For this study, the ideal lag length is determined using Eviews 12 software's automatic model selection. The maximum dependent variable and regressors lag of two were chosen for automatic selection using AIC, SBC, and HQC to determine selection criteria with a lower value. Table 5 illustrates that the AIC has the lowest value of all. Therefore, the best model selected is ARDL (2.2.2.2.2).

Table 6 shows that the Kao (1999) cointegration test is rejected because the probability for the examined ADF t stats is below the 1, 5 and 10 percent levels of significance. Therefore, we can

**Table 4. Panel unit root tests at difference**

Variable	Test	With intercept		With trend and intercept		Order of integration
		Statistic	P-value	Statistic	P-value	
	LLC	N/A	N/A	N/A	N/A	N/A
LEX	IPS	−6.071	0.000***	−5.115	0.000***	I (1)
	LLC	−7.867	0.000***	−6.821	0.000***	I (1)
LGDP	IPS	−6.642	0.000***	−5.116	0.000***	I (1)
	LLC	−6.005	0.000***	−5.146	0.000***	I (1)
LIMP	IPS	−5.228	0.000***	−3.963	0.000***	I (1)
	LLC	−3.427	0.000***	−1.639	0.051*	I (1)
LM2	IPS	−4.639	0.000***	−2.976	0.002***	I (1)

Notes: The symbols \*\*\*, \*\*, and \* indicate statistical significance at 1%, 5%, and 10% levels, respectively.

Source: Estimation by researcher using Eviews 12.

**Table 5. Criteria Table**

Model	LogL	AIC	SBC	HQC	Specification
4	41.536	0.241*	1.452	0.733	ARDL(2.2.2.2.2)
2	35.814	0.251	1.359	0.701	ARDL(1.2.2.2.2)
1	−2.579	0.505	1.203	0.788	ARDL(1.1.1.1.1)
2	2.231	0.507	1.308	0.833	ARDL(2.1.1.1.1)

Notes: \* signifies the ideal model.

Source: Estimation by researcher using Eviews 12.

**Table 6. Kao (1999) cointegration test findings**

Test	ADF T-statistic	Probability	Conclusion
Kao Cointegration Test	−4.048	0.000***	Cointegrated

Notes: The symbols \*\*\*, \*\*, and \* indicate statistical significance at 1%, 5%, and 10% levels, respectively.

Source: Estimation by researcher using Eviews 12.

deduce that the variables are cointegrated and a long-run relationship is present between the predicted variable and regressors.

Table 7 illustrates the findings of the PARDL model. The findings illustrate that the coefficient of LEX is significant. A 1 percent increase in LEX would significantly reduce LCPI by 0.21 percent in the long run, *ceteris paribus*. This basically implies that a 1 percent growth in the exchange rate makes consumer prices deflate by 0.21 percent in SACU nations in the long run, *ceteris paribus*. The cut in the internal consumer prices in the SACU region could suggest that most of the price variation could be absorbed by intermediate processing enterprises in order to stabilise the final consumer price. In addition, the effects of exchange rate on consumer prices are low and incomplete. This undermines the PPP theory, which asserts that local prices should change in the same direction as the exchange rate. Nonetheless, some studies in the region have confirmed similar findings. For instance, studies by Balcilar et al. (2019) for South Africa and Nkwe (2019) for Botswana, confirmed a low and incomplete pass-through and also support a negative relationship between exchange rate and consumer prices.

**Table 7. Long-run regression estimates**

**Model: ARDL (2.2.2.2.2)**

**Predicted variable: LCPI**

Regressors	Coefficient	Standard error	T-statistic	Probability
LEX	−0.212	0.076	−2.787	0.006**
LGDP	−0.572	0.161	−3.559	0.001***
LIMP	0.163	0.176	0.922	0.359
LM2	0.557	0.278	2.007	0.046**

Notes: The symbols \*\*\*, \*\*, and \* indicate statistical significance at 1%, 5%, and 10% levels, respectively.

Source: Estimation by researcher using Eviews 12.

The long-run findings also illustrate that a 1 percent increase in LGDP would significantly lead to a 0.57 percent decline in LCPI, *ceteris paribus*. This basically suggests that a 1 percent increase in the gross domestic product causes the consumer price level to deflate by 0.57 percent in the SACU nations, *ceteris paribus*. The statistical significance of the GDP variable indicates that changes in demand conditions affect consumer prices in the SACU nations. In addition, an increase in GDP means that more products for money to chase, and subsequently aggregate demand for products adjusts more slowly than supply, causing prices to decline. The significant negative relationship is supported by Mdlovu (2021), who established a similar relationship in the case of Eswatini. However, the findings are inconsistent with other studies within the region. For instance, Balcilar et al. (2019) showed that a change in GDP would insignificantly lead to a change in consumer prices in South Africa, although it supports a negative relationship in the long run.

In addition, Table 7 illustrates that a 1 percent rise in LIMP would hardly lead to a 0.16 percent increase in consumer prices, *ceteris paribus*, since the relationship between import prices and consumer prices in the SACU region is insignificant. The statistical insignificance of import prices indicates that changes in import prices are not reflected in consumer prices and could be absorbed by producers and retailers to stabilise the final consumer price. Table 7 also shows that LM2 and LCPI have a long-run positive and significant relationship. A 1 percent growth in the money supply would, in the long run, inflate consumer price by 0.56 percent in the SACU region, *ceteris paribus*. The statistical significance of money supply indicates that changes in demand conditions affect consumer prices, which is where more money in the economy leads to more jobs and higher wages, increasing household incomes and subsequently leading to an increase in consumer spending and further rising aggregate demand and consequently, the prices of goods and services rise. The findings corroborate the quantity theory of money, which highlights that money growth and price level are directly related to each other. Some studies corroborate the findings of this study. For instance, Nkwe (2019) established a positive association between money supply and consumer prices in Botswana.

For short run, Table 8 shows that the exchange rate hardly affects consumer prices in South Africa, Namibia, Lesotho and Eswatini. The effects of exchange rate are only significant in Botswana with a magnitude of 2.22%. However, the findings contradict the monetarist flex-price model view; that is, the PPP holds even in the short run. In addition, import prices only affect consumer prices in South Africa, Lesotho and Namibia. The economies of South Africa, Eswatini, Lesotho and Namibia adjust rapidly and substantially to reach the steady state since their speeds of adjustment are 83.6, 88.2, 121.3 and 61%, respectively. Conversely, the economy of Botswana adjusts slowly to reach the steady state, since the speed of adjustment is less than 50%.

Table 9 shows that there is a unidirectional association between LCPI and LEX, LGDP and LCPI, LGDP and LIMP, LGDP and LM2, LGDP and LEX as well as LIMP and LM2.



**Table 8. Short-run regression estimates**

**Model: ARDL (2.2.2.2.2)**

**Predicted Variable: D(LCPI)**

Lagged variables	SOUTH AFRICA	BOTSWANA	ESWATINI	LESOTHO	NAMIBIA
D(LCPI (-1))	-0.175 (0.003)***	-0.283 (0.003)***	0.172 (0.004)*	0.423 (0.000)***	0.020 (0.216)
D(LEX (-1))	9.218 (0.372)	2.216 (0.035)**	-1.469 (0.596)	1.739 (0.102)	1.597 (0.369)
D(LGDP (-1))	6.372 (0.572)	2.719 (0.010)**	-1.742 (0.555)	0.534 (0.585)	1.356 (0.511)
D(LIMP (-1))	0.673 (0.091)*	-0.092 (0.351)	-0.845 (0.179)	1.418 (0.079)*	-1.835 (0.011)**
D(LM2 (-1))	1.565 (0.139)	0.946 (0.001)***	-0.8278 (0.344)	0.973 (0.011)**	-0.530 (0.053)*
ECT(-1)	-0.836 (0.000)***	-0.108 (0.006)***	-0.882 (0.000)***	-1.213 (0.000)***	-0.610 (0.000)***

Notes: The symbols \*\*\*, \*\*, and \* indicate statistical significance at 1%, 5%, and 10% levels, respectively.

The value inside the parentheses is the corresponding probability value for the t statistic parenthesis.

Source: Estimation by researcher using Eviews 12.

Lastly, post-estimation diagnostic tests are used to ensure that the PARDL produces valid and reliable estimates. A well-specified PARDL model must fulfil the assumption of the normality test and must also pass the cross-section dependence tests. According to the findings presented in Table 10, for both normality and cross-section independence tests (except for Peseran cross-section dependence test), the null hypotheses fail to be rejected at all levels of significance. As a result, it can be concluded that the residuals are normally distributed, and not serially correlated using the three cross-section independence tests.

## 5. Discussion and conclusion

The primary objective of this paper was to examine the effect of the exchange rate movement on consumer prices in the SACU region for the period from 1990 to 2021, which was done utilising the panel auto regression distribution lags model. Inflation control is a top policy priority for monetary authorities in the SACU region. This is accomplished by manipulating interest rates to influence the circulation of money in the economy. However, if domestic prices are influenced by both internal and external factors, then, using the interest rate alone would be inappropriate. The estimated PARDL model findings illustrate that the exchange rate has significantly influenced consumer prices negatively by 0.21 percent in the SACU region in the long run. However, this is inconsistent with the PPP theory as previously discussed. Similarly, the gross domestic product significantly influences consumer prices negatively by 0.57 percent in the long run in the region. The estimated PARDL model findings also demonstrate that money supply has positively influenced consumer prices in the long run, supporting the quantity theory of money, which highlights that money growth and price level are directly related to each other. In short, money supply has positively influenced consumer prices by 0.56 percent in the SACU nations over the period. Moreover, import prices insignificantly influence consumer prices by 0.16 percent.

In reporting on the sub-objective of examining the nature of the relationship between exchange rate and consumer prices across SACU members, the estimated PARDL findings demonstrated that there is a significant negative relationship between the exchange rate and consumer prices in the SACU region in the long run. However, this nature of relationship undermines the PPP theory, which asserts that local prices should change in the same direction as the exchange rate. In the short run, the identity of the relationship between these variables differs across SACU members since the

**Table 9. Causality test findings**

Null Hypothesis	Obs.	F-Statistic	Prob.	Decision
LEX does not Granger Cause LCPI	150	29.577	2.E-11	No Causality
LCPI does not Granger Cause LEX		6.295	0.002***	Causality
LGDP does not Granger Cause LCPI	150	5.137	0.007***	Causality
LCPI does not Granger Cause LGDP		0.422	0.657	No Causality
LIMP does not Granger Cause LCPI	148	1.751	0.177	No Causality
LCPI does not Granger Cause LIMP		0.466	0.628	No Causality
LM2 does not Granger Cause LCPI	150	2.295	0.105	No Causality
LCPI does not Granger Cause LM2		2.232	0.111	No Causality
LGDP does not Granger Cause LEX	150	1.241	0.292	No Causality
LEX does not Granger Cause LGDP		4.172	0.017**	Causality
LIMP does not Granger Cause LEX	148	1.478	0.235	No Causality
LEX does not Granger Cause LIMP		2.260	0.108	No Causality
LM2 does not Granger Cause LEX	145	0.995	0.373	No Causality
LEX does not Granger Cause LM2		0.762	0.469	No Causality
LIMP does not Granger Cause LGDP	148	0.860	0.425	No Causality
LGDP does not Granger Cause LIMP		2.375	0.097*	Causality
LM2 does not Granger Cause LGDP	145	1.520	0.222	No Causality
LGDP does not Granger Cause LM2		2.731	0.069*	Causality
LM2 does not Granger Cause LIMP	145	0.175	0.840	No Causality
LIMP does not Granger Cause LM2		2.652	0.074*	Causality

Notes: The symbols \*\*\*, \*\*, and \* indicate statistical significance at 1%, 5%, and 10% levels, respectively.

Source: Estimation by researcher using Eviews 12.

cross-sections are assumed to be heterogeneous over the short run by the PMG estimator. The relationship between exchange rate and consumer prices is only positive in all SACU nations in the short run, except in Eswatini.

In reporting on another sub-objective of empirically determining the impact of the exchange rate on consumer prices across SACU members over the short run and long run, it emerged that in, the long run, the estimated PARDL model findings confirm that the exchange rate has significantly

**Table 10. Residuals diagnostics post-estimation findings**

Test	Type of the test	Test Stat.	Probability	Decision
Normality test	Jacque-Bera	0.298	0.862	Fail to reject $H_0$
	Breusch and Pagan LM dependence test	15.843	0.104	Fail to reject $H_0$
Cross-section independence tests	Peseran cross-section dependence test	3.401	0.000***	Reject to reject $H_0$
	Peseran scaled LM dependence test	1.306	0.191	Fail to reject $H_0$
	Bias corrected LM dependence test	1.217	0.224	Fail to reject $H_0$

Notes: The symbols \*\*\*, \*\*, and \* indicate statistical significance at 1%, 5%, and 10% levels, respectively.

Source: Estimation by researcher using Eviews 12.

influenced consumer prices negatively by 0.21% in the SACU region. However, in the short run, the impact is only significant in Botswana with the magnitude of 2.22%.

In extending to report on another sub-objective of establishing whether the exchange rate determines consumer prices within SACU members, the estimated long-run PARDL model demonstrates that exchange rate determines consumer prices in the SACU region. However, in the short run, exchange rate only determines consumer prices in Botswana. The last sub-objective was to test whether the effects of exchange rate on consumer prices are identical or not across SACU members in the short run. The short-run estimated PARDL model provides evidence that the effects of the exchange rate on consumer prices are not identical across SACU members. In addition, the effects are only significant in Botswana with an influence size of 2.22%. However, the effects of the exchange rate are not compelling in the short-run in South Africa, Namibia, Eswatini and Lesotho since the exchange rate is insignificant in influencing consumer prices.

Moreover, in terms of accepting or rejecting this study's null hypotheses, the null hypothesis states that the exchange rate has no significant influence on consumer prices among SACU members in the long run. The estimated long run PARDL model demonstrates that the influence of the exchange rate on consumer prices is significant. As a result, we reject the null hypothesis and conclude that the exchange rate has an influence on consumer prices in the SACU region in the long run.

## 6. Recommendations and implications for policy

The findings of the study have significant implications for monetary policy in the SACU region. In the long run, the estimated PARDL model results suggest that exchange rate has significantly influenced consumer prices negatively in the SACU region. This simply mean that a hike in the exchange rate cannot inflate local consumer prices in the long run, but deflates consumer prices, and therefore the exchange rate is anti-inflationary. In addition, the import prices exert little if any effect on consumer prices. Inflated consumer prices in the region during the period under review are likely to have been influenced by internal forces. Therefore, it is imperative to reconsider monetary policy targets and how they may be reorganised to regulate the level of consumer prices in the SACU economies.

The low and incomplete pass-through rate presented in this study has significant benefits for the SACU members. This suggests that the consumer prices in the SACU members are relatively immune to the monetary policy of other nations. In the event that the United States strengthen its monetary policy, this will affect the exchange rate between be the U.S and the SACU members, however, will not have exert much influence on the consumer prices in the SACU. As result, the monetary policy and

other nation-specific factors that control the sensitivity of consumer prices to exchange rate movements are the primary factors behind the low and incomplete pass-through in the SACU members.

Moreover, the influence of the exchange rate on consumer prices is low in the SACU region in the long run, which suggests that local consumer prices are less affected by external shocks and, consequently, existing monetary policies within the SACU economies are effective in containing external shocks. Therefore, we further recommend that policymakers in the SACU economies should focus on price stability and not be overly concerned with the movement of the exchange rate. In addition, the positive impact of money supply on consumer prices suggests that an increase in money supply generally leads to inflation and to control inflation, policymakers should therefore use monetary tools such as repo rates to regulate the money supply in the economy as this could mitigate the impact of the money supply on local consumer prices. Moreover, policymakers could discourage spending by increasing the repo rate and thus high repo rate stimulate savings and discourage spending.

The negative impact of gross domestic product on consumer prices demonstrates that changes in demand conditions have an impact on consumer prices in SACU nations. Furthermore, an increase in GDP means that there are more items for money to chase, and aggregate demand for products adjusts more slowly than supply, causing prices to fall. As a result, policymakers should monitor the forces of demand and supply in the economy as this could aid in regulating the level of consumer prices.

## 7. Limitations and recommendations for further studies

This study made every effort to guarantee that the findings are accurate and dependable. Nevertheless, the key limitation may be that the chosen study period (1990–2021) had a global financial crisis event in 2008 and a global pandemic in COVID-19 event that began in 2019, both of which may have caused a structural break that was not captured in the model. As a result, the researchers admit that the model could be sensitive to such weakness. Additional studies could assess further to overcome this limitation by including dummy variables to represent such structural breaks in the model.

Furthermore, because of the limitation of Eviews 12 software, we have not explored the Hausman test for pooled group mean and mean group, which is an imperative step when applying the PARDL model. However, this limitation does not discredit the findings, contribution, or significance of this study. It only points to an area for additional research and thus we recommend that future studies could examine further to eliminate this weakness by using different econometrics software programs.

Lastly, the study does not report on the question of potential asymmetry of the effect of the exchange rate in the revaluation and devaluation periods. Therefore, this question could be taken up in further and additional research in this niche.

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