Journal of Economics and Financial Analysis
Type: Double Blind Peer Reviewed Scientific Journal
Printed ISSN: 2521-6627 | Online ISSN: 2521-6619
Publisher: Tripal Publishing House | DOI:10.1991/jefa.v9i1.a75
Received: 12.03.2024 | Accepted: 19.04.2025 | Published: 27.08.2025
Journal homepage: ojs.tripaledu.com/jefa

The Exchange Rate Pass-Through: Evidence of South Africa

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Abstract

Understanding the role of the exchange rate behaviour in domestic prices is crucial for monetary authorities in anticipating inflation. Over the last 28 years (1994 – 2022), the inflation rate in South Africa has increased, averaging at 5.7% per year. It is believed that some of the increase in the inflation rate is a result of trade, hence this study aims at identifying how much of the changes in the exchange rate is passed on to domestic inflation. This idea is of interest in a country like South Africa that had implemented inflation targeting. The study identifies two channels of the exchange rate pass-through (ERPT); direct and indirect. the direct involves the change in import prices that is associated with the change in the exchange rate. The indirect channel involves the change in consumer price index (CPI) and the producer price index (PPI) that is associated with a change in import prices. The study uses monthly data from 1994 – 2022 to identify the speed and the magnitude of the exchange rate pass-through to domestic prices in the short-run and the long-run. Using the vector autoregressive model (VAR) and the vector error correction model the results shows that the magnitude of the exchange rate pass-through to import prices is relatively higher than the exchange pass-through to the CPI and PPI and that import prices; CPI and PPI increases immediately after an increase in the exchange rate.

Keywords: *Exchange Rate; Pass-through; Import; Exports; Prices; Depreciation.*

JEL Classification: *E31; E52; F31; C32.*

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1. Introduction

South Africa's growing trade openness has made its domestic inflation dynamics increasingly sensitive to external shocks. Exchange rate fluctuations, reflecting both global disturbances and domestic vulnerabilities, have played a central role in shaping import and consumer prices. As Van der Merwe (2004) notes, there is broad consensus that the primary objective of monetary policy should be to ensure price stability. In 2000, South Africa formally adopted an inflation-targeting framework, with a band of 3–6 percent, entrusting the South African Reserve Bank (SARB) with managing the inflationary consequences of exchange rate volatility.

Exchange rate pass-through (ERPT) refers to the degree to which exchange rate changes translate into domestic prices. Ihrig et al. (2006) describe it as the transmission of foreign currency movements into inflation, while Kim et al. (2021) emphasize the mechanism whereby a depreciation raises import prices, which in turn feed into the consumer price index (CPI). South Africa's currency crises have illustrated this vividly: the 2001 rand collapse, which saw a depreciation of 26 percent, drove inflation to 10.5 percent in October 2002 (Pierdzioch et al., 2016). Even under inflation targeting, inflation has exceeded the SARB's band in episodes such as 2002 and 2007, highlighting the persistent challenge of ERPT.

The literature remains divided on the magnitude of ERPT in South Africa. Ca'Zorzi et al. (2007) argue that inflation and ERPT are positively correlated, suggesting relatively high pass-through in emerging markets. By contrast, Kabundi and Mbelu (2018) find that recent rand depreciations have had weaker inflationary effects, consistent with declining pass-through. This reflects a broader debate in international economics: while some studies identify declining ERPT globally due to stronger monetary policy credibility (Choudhri & Hakura, 2006; Goldberg & Campa, 2010), others emphasize its persistence in open, commodity-dependent economies. For the SARB, this uncertainty complicates policy, as exchange rate shocks remain a recurrent source of inflationary risk.

This study therefore investigates the magnitude, channels, and evolution of ERPT in South Africa over 1994–2022. By analyzing both direct effects on import prices and indirect effects on consumer and producer prices, it provides new evidence on the extent to which exchange rate volatility continues to shape inflation outcomes in an emerging market with a formal inflation-targeting regime.

2. Exchange Rates Fundamentals

Exchange rate pass-through can be defined as the percentage change in domestic prices associated with a one-percent change in the exchange rate (Ghosh & Rajan, 2009). Empirical work typically distinguishes between two stages: a direct channel, where exchange rate changes alter import prices, and an indirect channel, where these effects cascade into broader indices such as the CPI and PPI (Hüfner & Schröder, 2002; Hyder & Shah, 2004). Evidence consistently shows that the first stage tends to be stronger, while the second is dampened by distribution costs, pricing-to-market, and incomplete pass-through (Cheikh & Rault, 2017).

The magnitude of ERPT depends on structural conditions. Greater trade openness is often associated with higher pass-through (Ca'Zorzi et al., 2007), but openness also increases competitive pressures that may reduce firms' ability to adjust prices (Romer, 1993; Gust et al., 2010; Auer, 2015). Inflation regimes matter as well: Taylor (2000) and Choudhri & Hakura (2006) show that low-inflation environments exhibit significantly lower ERPT, as firms perceive less scope to adjust prices. Goldberg and Campa (2010) confirm this across OECD countries, linking declining ERPT to stronger monetary frameworks.

Another important dimension is asymmetry. Depreciations typically trigger stronger pass-through than appreciations, as firms are quicker to raise prices when costs rise than to reduce them when costs fall (Caselli & Roitman, 2019). In South Africa, Aron et al. (2014) and Karoro et al. (2009) confirm such asymmetries, estimating ERPT of 72 percent for depreciations versus 64 percent for appreciations. Yet Pollard and Coughlin (2004) argue that asymmetries often reflect menu costs and strategic pricing rather than depreciation per se.

Global structural shifts have also altered ERPT. Jasova et al. (2016) document declining pass-through in emerging markets after the 2008 global financial crisis, while Gopinath (2015) attributes this to increased use of foreign currency invoicing, global value chains, and pricing-to-market strategies. For South Africa, with its reliance on imported intermediate goods and exposure to commodity cycles, these global mechanisms interact with domestic vulnerabilities to shape ERPT outcomes.

Taken together, the literature suggests three testable hypotheses for South Africa. First, ERPT is likely incomplete, with stronger transmission at the import price stage than at the CPI or PPI stage. Second, pass-through is asymmetric, with depreciations exerting larger effects than appreciations. Third, ERPT may have declined in the post-2008 era as inflation targeting matured and global structural

changes reduced sensitivity of domestic prices to exchange rate shocks. These hypotheses guide the empirical analysis that follows.

3. Methodology and Analysis

3.1. Economic Framework

The exchange rate pass-through (ERPT) is central to understanding how external shocks transmit into domestic inflation. In South Africa, trade openness amplifies this channel, as import prices adjust to exchange rate movements and are then transmitted into producer and consumer prices. Bahmani-Oskooee and Xi (2012) emphasize that exchange rate volatility depresses consumption through its effect on inflation, while Patel et al. (2019) highlight the role of imported intermediate goods in linking exchange rate changes to the producer price index (PPI) and ultimately the consumer price index (CPI).

From a theoretical standpoint, two distinct channels of ERPT can be identified (Goldberg & Campa, 2010; Choudhri & Hakura, 2006). The first stage is the direct pass-through, in which exchange rate changes alter the domestic currency cost of imports. The second stage is the indirect pass-through, where changes in import prices cascade into producer and consumer prices. In emerging markets such as South Africa, ERPT is often higher because of commodity dependence, thinner financial markets, and higher inflation persistence (Aron et al., 2014). However, credible inflation targeting frameworks may reduce ERPT by anchoring expectations (Taylor, 2000; Ca'Zorzi et al., 2007).

This study therefore evaluates both the direct and indirect channels of ERPT, while also testing for asymmetry (differential effects of depreciations vs appreciations; see Caselli & Roitman, 2019), and structural change in the post-2008 era, when financial globalization and inflation targeting matured.

3.2. Econometric Strategy

This study involves different estimations of time series data. Given the nature of time series data – complexity, seasonality, non-stationarity, trends, cointegration - it is therefore essential to run some statistical tests that ensures reliability. These tests serves as a guide to which statistical models and techniques are appropriate for our estimation and analysis. The empirical analysis proceeds in three steps.

A) Baseline Models

In determining the magnitude of the exchange rate pass through, and the impulse responses given a disturbance in the exchange rate, the study will use the vector autoregressive (VAR) model. Sims (1980) established VAR to assist in analysing time series data or econometrics. He presents the model as a system where the present value of a variable depends on its own previous values and previous values of other variables. One of the advantages of the VAR model is that it captures bi-directional cointegration. All variables are endogenous. Rebucci (2010) agrees with this idea as he states that VARs are helpful and widely used models to summarize and analyse the dynamic relationship of variables of interest, especially in macroeconomics. The impulse response and variance decomposition which traces out how a variable responds if there is a shock in an error term, a relative variable, or its own shock assists in interpreting the VAR model.

Given a VAR model of order p, where p is the number of lags, including k variables, it a be presented as:

$$Y_t = \beta_0 + \sum_{p=1}^{k} \Phi_p Y_{t-p} + \varepsilon_t$$

where Y_t is the vector of endogenous variables (NEER, import prices, CPI, PPI, exporter production costs), Φ_p are lagged parameter matrices, and ε_t is the error term. Impulse response functions (IRFs) and forecast error variance decompositions (FEVDs) are employed to trace the dynamic effects of exchange rate shocks (Rebucci, 2010).

Because non-stationarity is common in macroeconomic time series, we test for unit roots using Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and KPSS tests. Where variables are integrated of order one, we test for cointegration using the Johansen (1991) method.

B) Long-run and Short-run Dynamics

If cointegration is established, we estimate a **Vector Error Correction Model (VECM)** to distinguish between short-run adjustments and long-run equilibrium relationships (Brooks, 2019). The VECM can be expressed as:

$$\Delta Y_t = \alpha + \Pi Y_{t-1} + \sum_{p=1}^{k-1} \Gamma_p \Delta Y_{t-p} + \varepsilon_t$$

where *Π* captures the long-run cointegrating relationships, Γ_p represents short-run dynamics, and the error correction term reflects the speed of adjustment back to equilibrium.

C) Extended Models: Asymmetry and Structural Breaks

To test asymmetric ERPT, we augment the VECM with interaction dummies that distinguish between depreciations and appreciations of the rand (Aron et al., 2014; Caselli & Roitman, 2019).

$$\Delta P_t = \alpha + \beta_1 \Delta ER_t^{Dep} + \beta_2 \Delta ER_t^{App} + \gamma X_t + \varepsilon_t$$

where ΔER_t^{Dep} and ΔER_t^{App} denote depreciations and appreciations, respectively.

To assess **structural change**, subsample regressions are estimated for the pre-2008 and post-2008 periods. This design tests whether ERPT declined as South Africa integrated more deeply into global financial markets and as inflation targeting matured (Jasova et al., 2016; Gopinath, 2015).

3.3. Stationarity

Many authors including Gujarati (2004) defined stationarity as a time series data with constant mean, constant variance, and autocorrelation. Different tests are used to test for stationarity as mentioned above, these tests include the Kwaitowski, Phillips, Schmidt, and Shin (KPSS) test. The null hypothesis of stationarity is not rejected given that test statistic is less than the critical values. Alternatively, the unit root test uses the Augmented Dickey-Fuller test (ADF) and Phillips Perron (PP) where the null hypothesis of unit root is rejected when the test statistics are less than the critical values therefore it is then concluded that the series is stationary. Given that the series is not stationary it is then differenced. Some authors are against differencing data to make it stationary as they believe that it may cause loss of any long run relationship in the variables of interest (Chinn et al., 2014). According to Ca'Zorzi et al. (2007), the use of a first differenced VAR model is expected to result to incorrectly specified results if there

are cointegrating relationship among variables, hence the use of the vector error correction model (VECM) is preferred.

3.4. Model Specification

To examine how exchange rate movements affect domestic prices in South Africa, this study distinguishes between the two standard channels of ERPT identified in the literature. The **direct channel** captures the immediate effect of exchange rate changes on import prices, while the **indirect channel** reflects the subsequent transmission of import price movements to domestic consumer (CPI) and producer (PPI) prices. Since import prices are influenced not only by exchange rate fluctuations but also by the production costs of South Africa's major trading partners, this study incorporates exporter production costs as an additional determinant. Rising production costs abroad are expected to raise the rand-denominated prices of imported goods, which in turn feed into domestic producer costs and ultimately consumer prices. Accordingly, the first-stage estimation links import prices to the nominal effective exchange rate (NEER) and exporter production costs, while the second-stage equations evaluate the transmission from import prices to CPI and PPI. Following the literature, three equations are estimated:

A) First stage (direct ERPT):

$$\ln M_t = \beta_{11} + \beta_{12} \ln NEER_t + \beta_{13} \ln EPC_t + \varepsilon_t$$

where M_t is import prices, $NEER_t$ is the nominal effective exchange rate, and EPC_t proxies exporter production costs.

B) Second stage (indirect ERPT to consumer prices):

$$\ln CPI_t = \beta_{21} + \beta_{22} \ln M_t + \varepsilon_t$$

C) Second stage (indirect ERPT to producer prices):

$$\ln PPI_t = \beta_{31} + \beta_{32} \ln M_t + \varepsilon_t$$

In these specifications, lnM_t, $lnCPI_t$, and $lnPPI_t$ denote import prices, the consumer price index, and the producer price index at time *t*, respectively. EPC_t represents exporters' production costs, serving as a proxy for foreign cost conditions. In equation (A), β_{11} is the constant term, while β_{12} captures the elasticity of import prices with respect to the nominal effective exchange rate

(NEER). A value of $\beta_{12}=0$ would imply no exchange rate pass-through to import prices, whereas $\beta_{12}=1$ indicates complete pass-through; in practice, $0<\beta_{12}<1$ is expected (Edwards & Cabezas, 2022). The parameter β_{13} measures the effect of exporters' production costs on import prices. The error term ε_t captures idiosyncratic shocks. Since the model is estimated in logarithmic form, all coefficients can be interpreted as elasticities, making it easier to assess both short- and long-run relationships. In equations (B) and (C), β_{21} and β_{31} denote constant terms, while β_{22} and β_{32} represent the elasticities of CPI and PPI with respect to import prices, respectively.

3.4. Data and Variables

The empirical analysis relies on monthly data spanning January 1994 to December 2022, obtained from the Federal Reserve Bank of St. Louis (FRED) and the World Bank's *Global Economic Monitor*. The use of high-frequency, non-seasonally adjusted data is appropriate for capturing the dynamic nature of inflationary processes in South Africa, while avoiding distortions that may arise from seasonal adjustment techniques. The starting point, 1994, coincides with South Africa's democratic transition and the subsequent liberalization of trade flows. This period also marks a structural shift in the economy, as greater openness increased exposure to exchange rate fluctuations. Importantly, the adoption of inflation targeting in the early 2000s further altered the degree of exchange rate pass-through (ERPT), underscoring the need for a long-horizon dataset to capture both pre- and post-regime dynamics. The key variables included in the analysis are defined as follows.

The **Nominal Effective Exchange Rate (NEER)** measures the value of the South African rand relative to a trade-weighted basket of foreign currencies. As emphasized by Bahmani-Oskooee and Gelan (2011), the NEER provides a comprehensive indicator of currency movements in the context of international trade, reflecting changes in competitiveness across multiple trading partners. In this study, NEER is expressed in indirect form (rand per unit of foreign currency), such that a decrease indicates depreciation and an increase indicates appreciation. Figure 1 illustrates the downward trend of the rand since 1994, punctuated by episodes of sharp depreciation during crises, alongside periods of moderate appreciation.

Figure 1. Nominal Effective Exchange Rate USD to one Rand (Log)

Import Prices (M) capture the cost of goods purchased from abroad and serve as the direct channel of ERPT. Persistent depreciation of the rand has generally translated into higher import prices, though cyclical fluctuations—such as the decline during the 2008–2009 global trade collapse—are also evident (Figure 2).

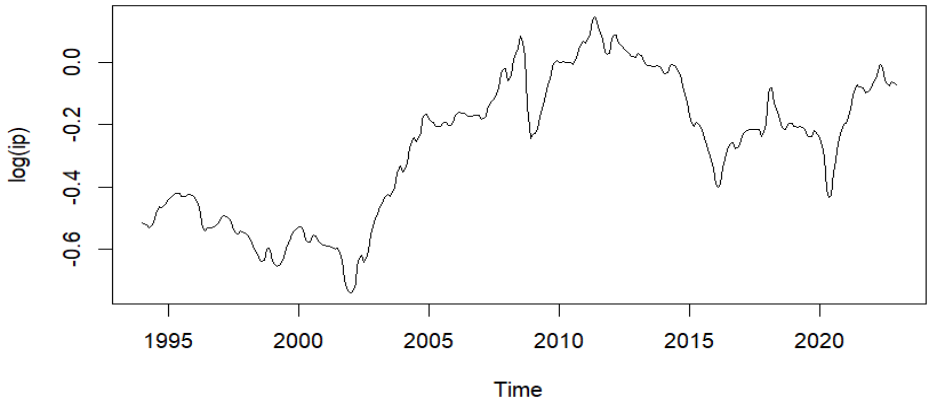

Figure 2. South African Import Prices (log)

The **Consumer Price Index (CPI)**, obtained from Statistics South Africa and FRED, represents the broad measure of consumer inflation. It aggregates twelve major expenditure categories, including food, beverages, housing, health, transport, and education, with 2015 as the base year (2015=100). Figure 3 demonstrates the steady upward trajectory of consumer prices since 1994,

consistent with rising fuel and food costs as well as structural inflationary pressures.

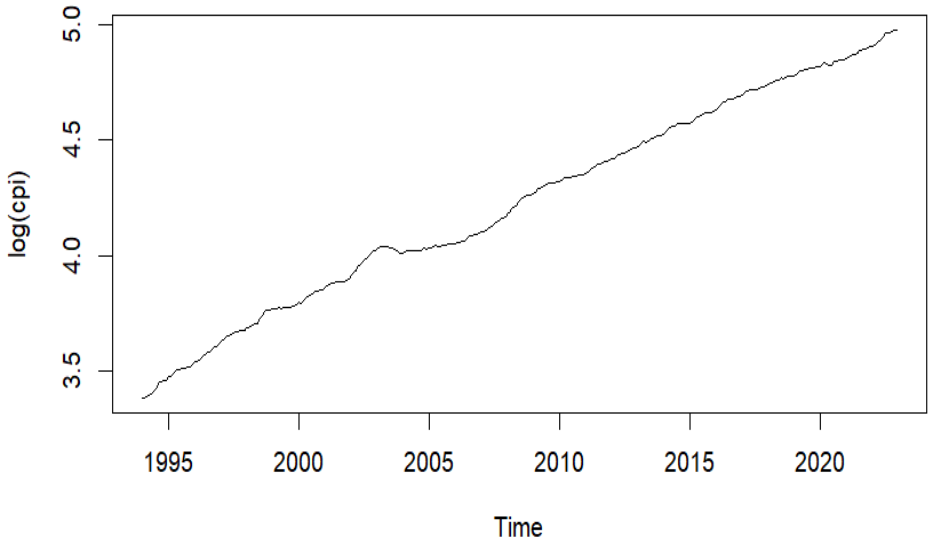

Figure 3. South African Consumer Price Index (Log)

The **Producer Price Index (PPI)**, sourced from the U.S. Bureau of Labor Statistics and domestic databases, tracks changes in the prices received by South African producers. The co-movement of CPI and PPI, as depicted in Figures 3 and 4, confirms the transmission of cost pressures from producers to consumers, underscoring the indirect channel of ERPT.

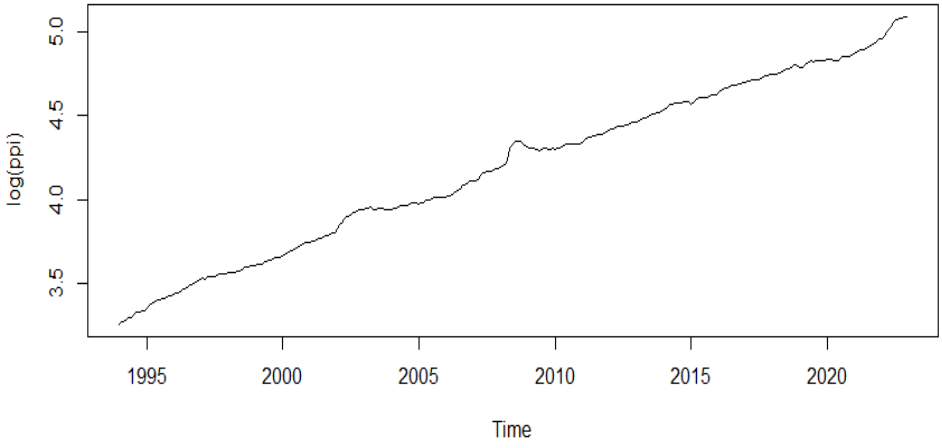

Figure 4. South African Producer Price Index (Log)

Finally, **Exporters' Production Costs (EPC)** are included to capture the foreign cost conditions of South Africa's major trading partners. As highlighted by Karoro et al. (2009), changes in exporters' costs influence the prices of imported intermediate and final goods. In this study, EPC is proxied by the weighted average of export prices from South Africa's five largest trading partners—China, the United States, Germany, Japan, and the United Kingdom. Figure 5 shows that production costs among these partners fluctuate significantly across time, with notable declines during 2020–2021 in the wake of the COVID-19 shock.

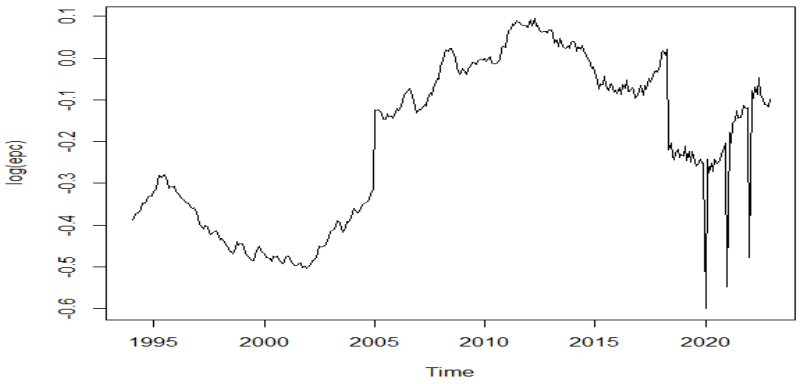

Figure 5. Major trading partners production costs

Collectively, these variables allow the analysis to disentangle the direct effect of exchange rate movements on import prices and the indirect transmission through consumer and producer price indices. The inclusion of exporters' costs as a proxy for external supply-side conditions ensures that the ERPT estimates capture not only exchange rate dynamics but also underlying shifts in global cost structures.

4. Analyses

The primary objective of this study is to estimate the extent of exchange rate pass-through (ERPT) to domestic prices in South Africa. Building on the econometric framework outlined earlier, we employ both the VAR and VECM models to analyze the dynamic relationships among the exchange rate, import prices, producer prices, and consumer prices. The analysis proceeds in stages. First, stationarity and cointegration properties of the series are examined to ensure model reliability. Second, the VAR and VECM models are applied to estimate short- and long-run ERPT effects through both the direct channel

(exchange rate → import prices) and the indirect channel (exchange rate → import prices → CPI and PPI). Finally, diagnostic tests, impulse response functions (IRFs), and variance decomposition provide additional insights into the speed and magnitude of the pass-through.

4.1. Unit Root Test

Stationarity is a prerequisite for reliable time-series estimation. While graphical inspection (Figures 1–5) suggests non-stationarity, formal tests are required. Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests were conducted to determine the order of integration. Table 1 reports the ADF results, which are consistent across both tests. At levels, the null hypothesis of a unit root cannot be rejected for all variables. However, at first differences the null is rejected at the 5% level, confirming that all series are integrated of order one, I(1). This validates the use of cointegration techniques such as the Johansen test and the VECM.

Table 1. Unit Root Tests

Variables	Augmented Dickey-Fuller (ADF)		Integration Order
	Levels	First Difference	
lnIP	-2.0819	-5.6227**	I(1)
lnNEER	-3.3048	-6.962**	I(1)
lnEPC	-1.253	-7.3082**	I(1)
lnCPI	-2.8439	-5.6594**	I(1)
lnPPI	-3.0908	-6.3587**	I(1)

Note: Critical Value for the ADF test at 5% level of significance is -3.43. ** indicate significance at 5% level.

4.2. Lag Length Selection

Lag length selection is essential to avoid omitted variable bias or loss of degrees of freedom (Ajilore & Ikhide, 2013). Table 2 presents the criteria for lag order determination. While the Schwarz (SC) and Hannan–Quinn (HQ) criteria suggest one lag, both the Akaike Information Criterion (AIC) and Final Prediction Error (FPE) point to 12 lags. Following the AIC and FPE, and given the high frequency of the data, 12 lags are adopted for subsequent estimations.

Table 2. Lag Length Criteria

Lag	AIC	HQ	SIC	FPE
1	-4.20E+01	-4.19E+01*	-4.17E+01*	5.68E-19
2	-4.20E+01	-4.18E+01	-4.14E+01	5.70E-19
3	-4.22E+01	-4.18E+01	-4.12E+01	4.95E-19
4	-4.22E+01	-4.17E+01	-4.10E+01	4.73E-19
5	-4.22E+01	-4.17E+01	-4.08E+01	4.52E-19
6	-4.24E+01	-4.17E+01	-4.06E+01	4.01E-19
7	-4.25E+01	-4.17E+01	-4.04E+01	3.61E-19
8	-4.24E+01	-4.15E+01	-4.01E+01	3.75E-19
9	-4.24E+01	-4.14E+01	-3.98E+01	3.72E-19
10	-4.25E+01	-4.13E+01	-3.96E+01	3.52E-19
11	-4.27E+01	-4.14E+01	-3.95E+01	2.87E-19
12	-4.32E+01*	-4.18E+01	-3.97E+01	1.86E-19*

Note: AIC: Akaike Information criterion; HQ: Hanna-Quinn Information criterion; SIC: Schwarz Information criterion. * indicates lag selected by the criterion

4.3. First-Stage ERPT: Cointegration Tests

The first stage assesses whether the exchange rate (NEER), import prices (IP), and exporters' production costs (EPC) share a long-run equilibrium. Using Johansen's trace and maximum eigenvalue tests, we reject the null of no cointegration at the 10% significance level (Table 3). Both tests confirm at least one cointegrating relationship, justifying the use of a VECM.

Table 3. Johansen Trace and Maximal Eigenvalue Cointegration Test

Hypothesised no. of CE's	Trace test	Critical values	Max-eigen test	Critical values
$r \leq 0$	34.47*	32.00	17.50*	16.77
$r \leq 1$	16.98	17.85	15.62	13.75
$r = 2$	1.36	7.52	1.36	7.52

Note: The "r" denote cointegration equation. * imply significance at 10% level.

The estimated cointegration vector (Table 4) reveals a **positive** long-run relationship between the NEER and import prices: a 1% appreciation of the rand increases import prices by 0.12%. This counterintuitive result may reflect high import duties or market rigidities that offset the expected negative relationship. By contrast, the negative coefficient on EPC suggests that higher foreign production costs reduce import prices, also unexpected. Such anomalies may arise from structural factors such as tariff adjustments or compositional changes in South Africa's import basket.

Table 4. Cointegration Vector(estimated by ML)

	Differenced (lnIP)	**Differenced (lnNEER)**	**Differenced (lnEPC)**
r1	1	0.1236	-1.2192

Note: The "r" denote cointegration equation. * imply significance at 10% level.

4.4. First-Stage VECM

The VECM results (Table 5) indicate a significant error correction term (–0.38), confirming adjustment toward long-run equilibrium. Importantly, the magnitude lies within the theoretically expected range of –1 and 0, which ensures both model stability and the absence of spurious dynamics. As emphasized by Sovbetov (2018), an ECT coefficient in this interval indicates that deviations from the long-run relationship are corrected over time, while positive or excessively large negative estimates would imply either serial correlation or structural instability. In this case, the coefficient of –0.38 suggests that approximately 38% of disequilibrium is corrected each period, providing further evidence of convergence toward equilibrium.

Short-run dynamics show that shocks to the NEER initially exert a relatively strong effect on import prices, which then decays over subsequent lags. This pattern is consistent with the **J-curve phenomenon**, where a depreciation initially raises import values before consumer substitution effects reduce demand for foreign goods. Overall, results confirm that the first-stage ERPT is incomplete, with only a fraction of exchange rate shocks transmitted to import prices.

Table 5. Vector Error Correction Estimates

Variable	Coefficients	Variable	Coefficients
ΔlnNEER(-1)	0.0640 (0.0258)*	*Intercept*	-0.0001 (0.0007)***
ΔlnEPC(-1)	-0.4265 (0.1057)***	*ΔlnIP(-1)*	0.2754 (0.0924)**
ΔlnEPC(-2)	-0.3744 (0.0997)***	*ΔlnIP(-2)*	0.4848 (0.0931)***
ΔlnEPC(-3)	-0.3213 (0.0944)***	*ΔlnIP(-3)*	-0.6794 (0.0964)***
ΔlnEPC(-4)	-0.2809 (0.0890)**	*ΔlnIP(-4)*	0.3095 (0.0956)***
ΔlnEPC(-5)	-0.2448 (0.0836)**	*ΔlnIP(-5)*	0.4809 (0.0968)***
ΔlnEPC(-6)	-0.2111 (0.0782)**	*ΔlnIP(-6)*	-0.6863 (0.0995)***
ΔlnEPC(-7)	-0.1874 (0.0723)*	*ΔlnIP(-7)*	0.1865 (0.0868)*
ΔlnEPC(-8)	-0.1669 (0.0656)*	*ΔlnIP(-8)*	0.2866 (0.0866)**
ΔlnEPC(-9)	-0.1427 (0.0577)*	*ΔlnIP(-9)*	-0.4170 (0.0872)***
ΔlnEPC(-10)	-0.1105 (0.0485)*	*ΔlnIP(-12)*	-0.1967 (0.0597)**
ECT	-0.3803 (0.0885)***		

Note: Dependent variable is ΔlnIP. *, **, *** indicate 10%, 5%, 1% significance.

4.5. Diagnostic Tests

Ensuring model stability requires that the residuals satisfy standard econometric assumptions, namely constant variance (homoscedasticity), absence of autocorrelation, and approximate normality. The diagnostic tests applied to the VECM residuals reveal several departures from these assumptions.

First, the Breusch–Godfrey test for serial correlation rejects the null hypothesis of no autocorrelation at conventional significance levels (p-value = 2.2e-16). This result suggests the presence of residual autocorrelation, a common feature in high-frequency macroeconomic time series. Second, the ARCH test indicates significant autoregressive conditional heteroscedasticity (p-value = 6.66e-08), confirming that residual variance is not constant over time. Such volatility clustering is not unexpected in exchange-rate and price data, reflecting the tendency of shocks to propagate in clusters. Third, the Jarque–Bera normality test also rejects the null of normally distributed residuals (p-value = 2.2e-16), consistent with the fat-tailed distributions typical in financial and macroeconomic series.

While these diagnostic violations may raise concerns for forecasting applications, they do not undermine the study's primary objective of estimating long-run and short-run exchange rate pass-through dynamics. As Brooks (2019)

note, VECM estimation remains valid under heteroscedastic and non-normal disturbances provided that robust standard errors are employed. Accordingly, this study reports HAC-robust standard errors throughout, ensuring the reliability of inference despite non-ideal residual properties.

4.6. First Stage Impulse Response

Impulse response functions (IRFs) are employed to trace the dynamic effects of exchange rate shocks on import prices within the first stage of the ERPT process. Figure 6 illustrates the response of South African import prices to a one percent appreciation of the rand. In the immediate period (month one), the response is negligible, suggesting that pass-through is not instantaneous. From the second month onward, import prices begin to decline, reaching their lowest point around the sixth month. This trajectory is consistent with the J-curve hypothesis, whereby currency appreciation initially reduces import values as price adjustments filter through contracts and supply chains.

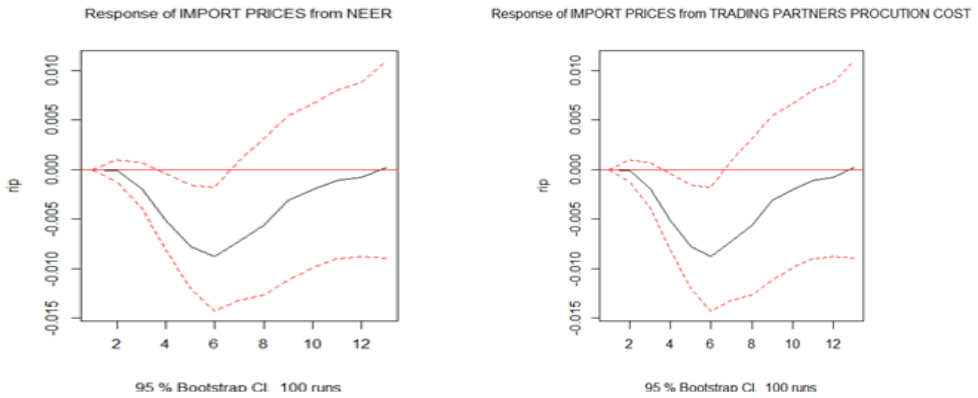

Figure 6. Impulse Response

Beyond the sixth month, import prices begin to rise again, reflecting consumer substitution and adjustment effects. As imports become cheaper in the wake of appreciation, demand for foreign goods increases, gradually exerting upward pressure on import prices. This delayed rebound underscores the non-linear and time-varying nature of the ERPT.

The IRFs also reveal that import prices respond in a broadly similar manner to changes in the production costs of South Africa's major trading partners (proxied by export prices). Specifically, higher foreign production costs translate into a delayed but persistent rise in South African import prices, following a pattern analogous to the exchange rate shock. The similarity of these responses highlights

the interconnectedness of external cost pressures and exchange rate movements in shaping South Africa's import price dynamics.

4.6. Indirect Channel of ERPT

Having established the direct pass-through from exchange rates to import prices, the analysis now turns to the indirect channel, which operates through consumer and producer prices. Table 6 presents the Johansen cointegration test results for the second stage of the ERPT process.

Table 6. Johansen Trace and Maximal Eigenvalue Cointegration Test

Hypothesised no. of CE's	Trace test	Critical values	Max-eigen test	Critical values
r = 0	39.42*	32.00	24.53*	19.77
r ≤ 1	14.88	17.85	11.38	13.75
r ≤ 2	3.50	7.52	3.50	7.52

Note: The "r" denote cointegration equation. * imply significance at 10% level.

The results indicate that the null hypothesis of no cointegration is rejected at the 10% level, confirming the existence of at least one cointegrating relationship among import prices, CPI, and PPI. This suggests that exchange rate shocks exert a long-run influence on domestic inflation through the indirect transmission channel. Consistent with Brooks (2019), the presence of cointegration justifies the use of a Vector Error Correction Model (VECM) to estimate both short- and long-run dynamics.

Table 7 reports the estimated long-run relationship. Import prices exert the expected positive effect on consumer prices, with a one percent increase in import prices raising CPI by 0.13%. In contrast, the negative coefficient on PPI is counterintuitive, as theory suggests that higher producer costs are typically passed on to consumers. This anomaly may reflect structural frictions, incomplete cost pass-through, or data limitations in capturing sectoral heterogeneity.

Table 7. Cointegration Vector(estimated by ML)

	Differenced (lnCPI)	Differenced (lnIP)	Differenced (lnPPI)
r1	1	0.1379	-0.7152

Note: The "r" denote cointegration equation. * imply significance at 10% level.

4.7. Indirect Channel VECM

Table 8 presents the short-run VECM estimates for the indirect ERPT channel. The error correction term (–0.539) is highly significant, confirming that deviations from the long-run equilibrium are gradually corrected over time.

Table 8. Vector Error Correction Estimates

Variable	Coefficients	Variable	Coefficients
ΔlnIP(-1)	0.0882(0.0219)***	*ΔlnPPI(-1)*	-0.2084(0.0865)*
ΔlnIP(-2)	0.0674(0.0224)**	*ΔlnPPI(-2)*	-0.1735(0.0827)*
ΔlnIP(-3)	0.0540(0.0228)*	*ΔlnPPI(-3)*	-0.1646(0.0783)*
ΔlnIP(-4)	0.0692(0.0251)**	*ΔlnPPI(-4)*	-0.1833(0.0734)*
ΔlnIP(-5)	0.0572(0.0259)*	*ΔlnPPI(-5)*	-0.1326(0.0704)
ΔlnIP(-6)	0.0337(0.0262)	*ΔlnPPI(-6)*	-0.1237(0.0672)
ΔlnIP(-7)	0.0672(0.0235)**	*ΔlnPPI(-7)*	-0.1958(0.0649)**
ΔlnIP(-8)	0.0511(0.0237)*	*ΔlnPPI(-8)*	-0.1615(0.0620)**
ΔlnCPI(-1)	-0.2216 (0.1162)	*Intercept*	0.0005 (0.0002)*
ΔlnCPI(-2)	-0.2305 (0.1082)*	*ECT*	-0.5390 (0.1204)***

Note: Dependent variable is ΔlnCPI. *, **, *** indicate 10%, 5%, 1% significance.

The short-run coefficients reveal that shocks to import prices have an immediate and positive effect on consumer prices, particularly in the first three to five months, after which the magnitude declines. Specifically, CPI rises by 0.088% following a one percent increase in import prices in the first month, but the effect weakens to 0.027% by the tenth month and becomes negligible thereafter. This finding highlights a rapid but incomplete adjustment of consumer prices to exchange rate fluctuations.

Unexpectedly, the results suggest that higher producer prices are associated with lower consumer prices in the short run. This negative relationship runs counter to the cost-push inflation mechanism discussed in the literature (Hyder & Shah, 2004; Cheikh & Rault, 2017). One possible explanation is that higher input costs may suppress consumer demand, prompting producers to absorb part of the cost increase rather than fully passing it on. Alternatively, structural breaks or aggregation bias in the data may drive this outcome.

The corresponding VECM equation can be expressed as:

$$\Delta lnCPI_t = -0.54 \times ECT_{t-1} - 0.22 \times \Delta lnCPI_{t-1} + 0.09 \times \Delta lnIP_{t-1} - 0.21 \times \Delta lnPPI_{t-1}$$

4.8. Indirect Channel Impulse Response

Impulse response functions (IRFs) provide additional insight into the transmission of import price shocks to CPI and PPI. As shown in Figure 7, consumer prices increase modestly in response to an import price shock, peaking at less than 0.001% before gradually declining into negative territory after the tenth month. This decay pattern suggests that consumer adjustment dampens the persistence of ERPT, consistent with evidence of incomplete pass-through in emerging economies (Jasova et al., 2016).

Producer prices also rise initially but decline after the fourth month, followed by a partial rebound at a slower rate. The asymmetry between the responses of consumer and producer prices underscores the complexity of pass-through dynamics, where firms may adjust margins or alter sourcing strategies to mitigate cost shocks.

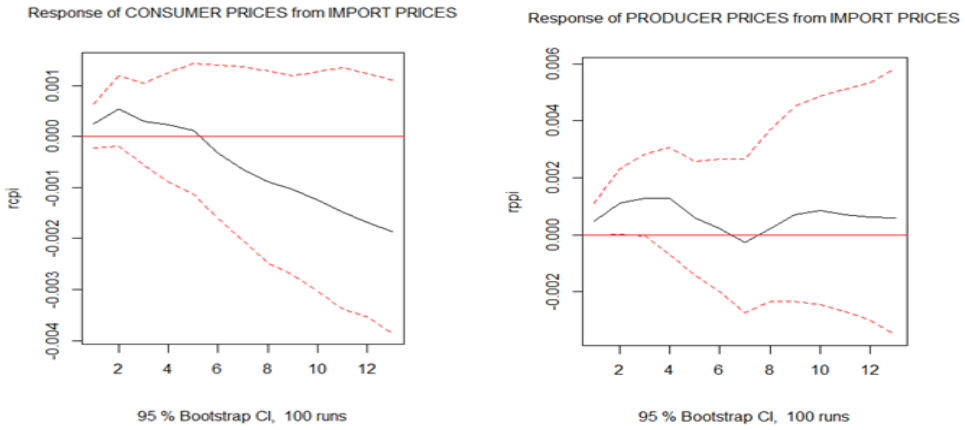

Figure 7. Consumer and Producer Prices Impulse Response

4.9. Forecast Error Variance Decomposition

Forecast error variance decomposition (FEVD) complements the cointegration and IRF analyses by quantifying the proportion of variation in each variable explained by exchange rate shocks. Figure 8 shows that, while import prices are largely self-determined in the short run, the contribution of exchange rate innovations increases over time. For consumer prices, the share of variance explained by import prices and exchange rate shocks rises steadily, highlighting the indirect transmission mechanism.

Producer prices display even greater sensitivity to exchange rate variation, with effects visible as early as the first month. This finding suggests that producers are more exposed to external cost shocks than consumers, likely reflecting South Africa's reliance on imported intermediate inputs.

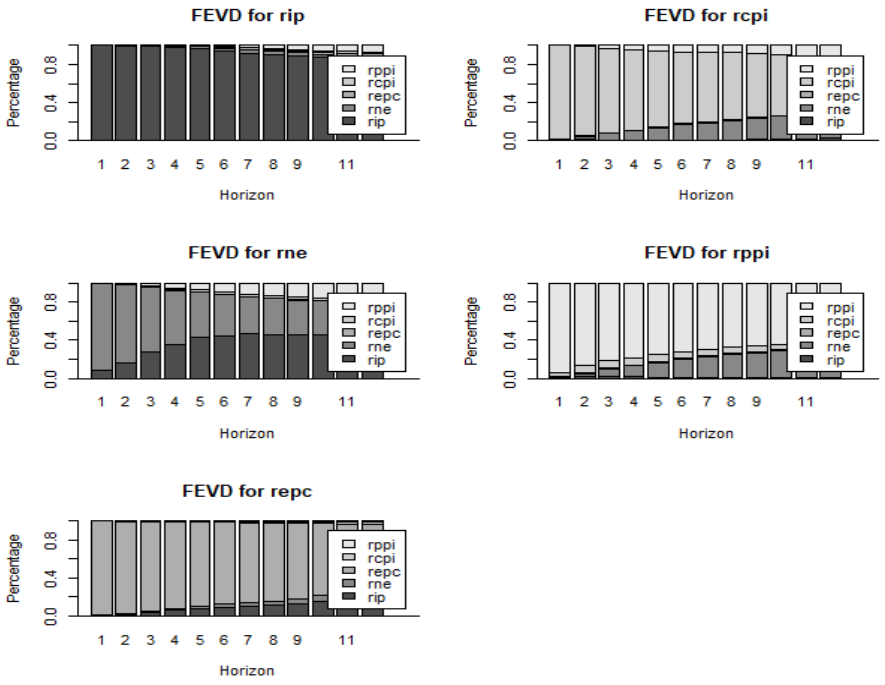

Figure 8. Forecast Error Variance Decomposition

Overall, the FEVD results confirm that the ERPT process is gradual and incomplete. The estimated pass-through rate of approximately 16% for South Africa in recent years represents a marked decline from the 49% reported before 1995. This decline aligns with international evidence of reduced ERPT in inflation-targeting economies, where credible monetary policy regimes and greater market competition limit the persistence of exchange rate shocks (Taylor, 2000; Goldberg & Campa, 2010).

5. Conclusion and Recommendations

5.1. Summary of Findings

This study has investigated the extent and dynamics of exchange rate pass-through (ERPT) to domestic prices in South Africa using monthly data from 1994 to 2022. Employing vector autoregressive (VAR) and vector error correction (VECM) frameworks, the analysis disentangled the direct pass-through to import prices and the indirect pass-through to consumer and producer prices.

The results confirm that ERPT in South Africa is incomplete in both channels, aligning with earlier evidence from Karoro et al. (2009) and subsequent studies on emerging markets. In the long run, a one percent depreciation of the rand raises import prices by approximately 0.12% and consumer prices by 0.14%, whereas the effect on producer prices is unexpectedly negative. Short-run dynamics, revealed through impulse response functions, indicate that shocks to the nominal effective exchange rate (NEER) initially exert a strong influence on import prices, which then dissipates over time as consumers and producers gradually adjust their behavior. The forecast error variance decomposition further demonstrates that consumer prices are progressively explained by import price movements, while producer prices remain more directly sensitive to exchange rate shocks.

These findings underscore three key insights. First, the indirect channel of ERPT—operating from import prices to consumer prices—appears stronger than the direct channel. Second, the adjustment is sluggish, consistent with the J-curve mechanism, whereby import values initially rise after depreciation before substitution effects set in. Third, South Africa's ERPT has declined over time, consistent with global evidence that inflation targeting and improved monetary policy credibility reduce the persistence of exchange rate shocks (Taylor, 2000; Goldberg & Campa, 2010).

5.2. Limitations and Directions for Future Research

While the study provides novel evidence on ERPT in South Africa, several limitations merit attention. First, the presence of heteroscedasticity and autocorrelation in the residuals may affect inference, particularly in explaining the counterintuitive negative relationship between producer prices and import prices. Although heteroscedasticity is common in macro-financial time series and less concerning when the objective is structural estimation rather than forecasting, future work should employ heteroscedasticity-robust or GARCH-type specifications to better capture volatility dynamics.

Second, the reliance on proxies—such as aggregate export prices to capture foreign production costs—may obscure country-specific heterogeneity. Given that South Africa's main trading partners (China, the United States, Germany, Japan, and the United Kingdom) differ in cost structures and trade elasticities, future research should disaggregate ERPT by partner country to identify asymmetries in transmission.

Third, the analysis does not explicitly consider the role of exchange rate regimes and trade barriers in shaping pass-through. South Africa's free-floating exchange rate regime, combined with tariff and non-tariff barriers, may explain part of the incompleteness of ERPT. Further research could extend the model to include regime-switching dynamics or tariff-adjusted import price indices.

Finally, the decline in ERPT magnitude since the 1990s suggests that structural changes—such as globalization, supply chain diversification, and stronger monetary policy credibility—may have dampened exchange rate transmission to inflation. A fruitful avenue for future research is to investigate how these structural shifts interact with financial integration and capital flows in shaping ERPT in emerging markets.

5.3. Policy Implications

From a policy perspective, the results highlight that while exchange rate shocks do influence domestic prices, the effect is muted and delayed, suggesting that South Africa's inflation-targeting framework has been effective in anchoring expectations and limiting second-round effects. Nevertheless, policymakers must remain vigilant during episodes of sharp depreciation, as pass-through—though incomplete—can still impose significant inflationary pressure in the short run. Moreover, the stronger indirect channel underscores the importance of monitoring import-intensive consumer goods, as they serve as the primary transmission mechanism of exchange rate shocks to household welfare..

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