Has the Exchange Rate Pass-Through changed in South Africa?*

Alain Kabundi† Asi Mbelu‡

August 4, 2017

Abstract

This paper uses the two-stage exchange rate pass-through (ERPT) framework instead of the direct pass-through (PT) from the exchange rate to consumer inflation to assess the variation in the ERPT for South Africa from 1994 to 2014. The paper uses rolling-window estimation to examine the possibility of change in the ERPT over time. In addition, it investigates the asymmetric behaviour of the ERPT over the business cycle. The results indicate that the ERPT for South Africa is complete in the first stage but incomplete in the second stage. It implies that retailers do not pass all the cost to consumers. The first-stage ERPT has declined slightly since the Global Financial Crisis. Weak domestic demand and possibly the concentration of firms in the manufacturing sector are the main forces behind this low PT. Moreover, there is evidence of asymmetry in the first-stage ERPT in that it tends to rise in the upturn phase of the economy compared to the downturn. The second-stage ERPT shows a considerable decline since the adoption of the inflation-targeting regime. Similar to the first-stage case, the PT is muted in the downturn but rises in the expansionary phase by about 10 per cent.

JEL Classification Numbers: C51, E52, E58.

Keywords: Exchange rate pass-through, rolling-window regression, asymmetric exchange rate pass-through.

*The views expressed in this paper are those of the authors and do not necessarily represent those of the South African Reserve Bank, South African Reserve Bank policy, or World Bank policy. We are grateful to Shaun de Jager, Theo Janse van Rensburg, Chris Loewald, Laura Papi, Rowan Walter, and Yi Wu for constructive comments and suggestions.

†South African Reserve Bank, University of Johannesburg, Economic Research Southern Africa, Alain.Kabundi@resbank.co.za

‡Kiel Institute of the World Economy, asi.t.mbelu@gmail.com

1 Introduction

Since the adoption of the inflation-targeting (IT) framework, the South African Reserve Bank (SARB) has largely left the domestic currency floating freely. The rand has been responsive to both domestic and external shocks and in some regards also acts as a shock absorber. Like in most emerging market economies (EMEs), the exchange rate is one of the key drivers of inflation in South Africa. The transmission mechanism operates through import prices. Hence, the magnitude and the speed of the transmission depends largely on first-stage and second-stage pass-through (PT). First-stage PT refers to the impact of exchange rate movement on import prices, while second-stage PT points subsequently to the effects of the latter prices on overall consumer prices.

Recently, the exchange rate pass-through (ERPT) in South Africa has been less reactive to exchange rate movement. Massive depreciation of the rand has not translated into higher inflation. The question arises on how to explain this conundrum. This paper attempts to answer this puzzle using a two-stage framework instead of the direct PT from the exchange rate to consumer inflation. The advantage of this framework is that it quantifies separately the two stages through which the nominal exchange rate affects domestic consumer prices. Moreover, the analysis based on the entire sample might be subject to the so-called Lucas critique, which postulates that economic relationships are mainly affected by policy and shocks prevailing at specific points in time. Taking the critique into account, the current study examines the possibility of a change in the PT over time using the rolling-window regression. Finally, there is evidence that retailers pass the costs incurred from exchange rate depreciation to consumers more rapidly when the economy is expanding relative to periods when the economy is extremely weak. In addition to the rolling-window analysis, this paper examines the asymmetry in the PT.

The literature on ERPT provides evidence of the decline in PT which coincides with the adoption of the IT framework. The rationale is that PT is muted when the central bank anchors inflation expectations in a way that is consistent with its objective. To test this hypothesis, the analysis includes quarterly data from 1994Q1 to 2015Q2, which comprises the country's first democratic elections, the opening of the capital account to non-residents, and the adoption of the IT regime. Furthermore, the sample size is long enough to include the Global Financial Crisis (GFC).

The results show evidence of complete PT in the first stage and incomplete PT in the second stage. In addition, the first-stage ERPT seems rapid where 50 per cent of deviation from the long-run equilibrium is recovered in the first two quarters, while

second-stage ERPT is weak and very slow. Moreover, first-stage ERPT declines towards the end of the sample, which coincides with the GFC, from 93 per cent to 63 per cent in 2011, before rebounding to 70 per cent in 2014. Second-stage ERPT also portrays a decline which coincides with the adoption of the IT framework. It suggests that the perception of the public in general is that the central bank will act to keep inflation anchored when the economy is affected by negative shocks. Finally, there is evidence of asymmetry in both first- and the second-stage ERPTs. Both the first- and second-stage ERPTs tend to rise in the upturn phase of the economy compared to the downturn.

The ERPT is complete if the full extent of the exchange rate movement is transferred to domestic prices. Conversely, a partial transmission of exchange rate movement to domestic prices implies an incomplete ERPT. The Law of One Price (LOP), which equates the domestic price of traded goods to the foreign price of identical goods at the exchange rate level, is prevalent in a world with perfect competition and no barriers to entry. Put differently, the LOP postulates a one-to-one relationship between the domestic price of traded goods and the foreign price of identical goods. It means that exchange rate movements are expected to have a noticeable effect on domestic prices. In practice, though, this relationship is seldom observed. Domestic and foreign goods are rarely identical, trade barriers such as tariffs and taxes exist, and importers often incur transportation, insurance, and distribution costs. In the presence of additional costs incurred, domestic retailers are expected to pass the full extent of the additional costs to consumers. However, it may be in the interest of domestic retailers not to do so. Ozkan and Erden (2015) argue that domestic retailers set their prices in advance and raise prices only if additional costs incurred due to exchange rate movements are persistent. The degree to which domestic retailers pass the costs incurred from exchange rate movements to consumers is thus important to monetary policy authorities. It is possible for policymakers to reduce the ERPT to inflation through the successful stabilization of inflation around its long-term trend.

The literature provides evidence of modest ERPT in the first stage in most advanced economies (AEs) with a decreasing trend (Campa and Goldberg, 2005; Gagnon and Ihrig, 2004; McCarthy, 2000; Ozkan and Erden, 2015). However, Campa and Goldberg (2005) and McCarthy (2000) show that while the PT seems partial in the short term, it is complete in the long term. It is large in countries with a large import share and in countries with high exchange rate and inflation variability. Particularly, Campa and Goldberg (2005) find the average first-stage PT in the short- and long-term to be 46 and 64 per cent respectively for 23 Organisation for Economic Co-operation and Development (OECD) countries. However, the ERPTs differ across countries. Changes in the ERPT reflect changes in the composition of import bundles and the currency of

invoicing of importing countries (Campa and Goldberg, 2005; Gopinath, 2015; Gopinath et al., 2010). Gopinath (2015) estimates a PT close to 1 for goods priced in dollars and close to 0 for goods priced in non-dollars. The variation of ERPT depends also on the types of goods. For example, ERPT is partial for manufactured and food products and it is close to one for energy and raw material.

EMEs tell a slightly different story. The ERPT is larger in EMEs than in AEs. It is particularly high in EMEs with a historically high inflation rate (Calvo and Reinhart, 2000; Devereux and Yetman, 2010; Ozkan and Erden, 2015). This is because the transmission from costs to profit margins is closely linked to the level of average inflation. In addition, inflation volatility explains variations in ERPT in EMEs (Gagnon and Ihrig, 2004; Ozkan and Erden, 2015; Taylor, 2000). It means that a stronger emphasis on inflation stabilization reduces PT to domestic prices. For Singapore, Chew et al. (2011) estimate a complete ERPT to import prices at 93 per cent over the period 1980Q1 to 2010Q3. They show that the PT is complete after six quarters. However, the ERPT to consumer price is incomplete at 55 per cent and occurs within 17 quarters which suggests that the movement of second-stage PT to a long-term equilibrium is lethargic. McFarlane (2009) finds that both first- and second-stage ERPT has generally declined over time in Brazil, Jamaica, Mexico, and Trinidad and Tobago.

Evidence for South Africa demonstrates that the ERPT has declined over time (Aron et al., 2014; Jooste and Jhaveri, 2014; Karoro et al., 2009; Parsley, 2010). Ozkan and Erden (2015) attribute the declining ERPT in most EMEs to the role played by the IT policy as the decline in the ERPT coincides with the adoption of the IT regime following the currency crisis of the 1990s. The IT regime is mostly associated with an increase in credibility and stability of monetary policy (Mishkin and Savastano, 2000; Ozkan and Erden, 2015; Schmidt-Hebbel and Werner, 2002).

Karoro et al. (2009) find the first-stage ERPT in South Africa to be incomplete in the long run between 75 and 81 per cent, depending on the different weighting scheme of the nominal effective exchange rate. Parsley (2010) finds an even lower first-stage ERPT at 60 per cent. Aron et al. (2014) estimate the ERPT to import prices at between 44 and 50 per cent depending on different specifications. Furthermore, Aron et al. (2014) and Jooste and Jhaveri (2014) attest that the volatility of the exchange rate in South Africa reduces PT in the short term. Parsley (2010) shows that, as in AEs, the composition of import bundles affects the ERPT in South Africa, where the PT to final goods is lower than that to services. Contrary to most studies, he suggests that the decline in the ERPT observed over time is not explained by change in monetary policy or the pricing behaviour of firms, but by change in the composition of the aggregate price indexes of the consumer price index (CPI). He continues that ERPT will remain low even in

the face of high inflation as long as the recent composition of the CPI stays the same. However, our results do not support Parsley's (2010) findings. Instead, we find that the credibility of the monetary authority plays a significant role in explaining the reduction of ERPT into consumer price inflation as the decline in the ERPT coincides with the adoption of the IT policy.

Besides Chew et al. (2011), there are few empirical studies on the asymmetric behaviour of the ERPT, especially over the business cycle. They isolate the impact of the exchange on import prices while controlling for foreign prices in the first-stage estimation and the impact of the latter variable on consumer prices while also controlling for unit labour cost (ULC) in the second-stage. It is worth noting that they extract the cyclical components of all variables and then use dummy variables to capture the upswing and downswing phases based on the cyclical component of the gross domestic product (GDP). These authors find that producers and retailers in Singapore pass on significantly more of the exchange rate movements to prices in periods of upswings to consumers than they do during economic downturns. In the second-stage, importers pass on a smaller portion of the exchange-related cost-saving during expansionary phases, while consumers opt to spend less during contractionary phases. For South Africa, Aron et al. (2014) find that the asymmetry in the ERPT depends mainly on the direction of the movement of the domestic currency. Their results show that small appreciations lead to higher PT while only depreciations above a certain threshold increase PT. Contrarily, Karoro et al. (2009) provide evidence of higher ERPT to import prices for depreciations than for appreciations at 72 per cent and 64 per cent respectively. It means that foreign firms pass on the cost of rand depreciations (if invoices are rand-denominated) to local importers. On the other hand Jooste and Jhaveri (2014) suggest that the ERPT is sensitive to market conditions and seems lower during recessionary periods or periods of slow economic growth.

The rest of the paper is organised as follows. Section 2 discusses the theoretical models used in the estimation of the first- and second-stage ERPT. It includes the specification of long-run models, error-correction models, and models which are suitable to deal with asymmetry in the ERPT. We describe the data and data transformation in Section 3. Section 4 discusses the empirical results of the first- and second-stage ERPT using long-run estimations, rolling-window regressions, and asymmetric specifications. Section 5 concludes the paper.

2 The Models

As mentioned in the introduction, the ERPT can be specified in two stages. First-stage ERPT refers to the impact of the exchange rate on domestic import prices, and in the second stage importers pass costs due to exchange rate movements to consumers. This section provides the analytical framework underlying the estimation of the ERPT. We divide this section accordingly by specifying first-stage PT first and then second-stage PT.

2.1 First-Stage Exchange Rate Pass-Through

First-stage ERPT is based on the LOP and can be measured as

$$IPI_t = \frac{FWPI_t^{\beta}}{NEER_t^{\gamma}} \tag{1}$$

where IPI is domestic import prices, $FWPI$ represents the foreign wholesale price index weighted by 20 major South African trading partners, and $NEER$ denotes the nominal effective exchange rate, expressed in terms of units of domestic currency per unit of foreign currency.

Applying the natural logarithm in (1), we have

$$ipi_t = \alpha + \beta fwpi_t - \gamma neer_t + \xi_t \tag{2}$$

where $0 \leq \beta \leq 1$ and $0 \leq \gamma \leq 1$, and ξ_t is an *iid* error term which follows a normal distribution with a constant variance. Equation (2) represents the long-run first-stage ERPT. The ERPT is complete when $\gamma = 1$ and it is incomplete when $\gamma = 0$. In general, first-stage ERPT is complete for small open economies as they are price-takers, while it is perceived to be incomplete for AEs. Recently, Ghosh and Rajan (2009a), Sekine (2006), Chew, Ouliaris, and Tan (2011), Gopinath (2015), Forbes, Hjortsoe, and Nenova (2015) have used equation (2) to estimate the first-stage ERPT for South Korea and Thailand, industrial countries, Singapore, a panel of AEs and EMEs, and the United Kingdom respectively. In addition, the consensus literature points to the time-varying nature of the ERPT.[1] We use the rolling-window regression of equation (2) to account for the possibility of change in the ERPT over time.

If equation (2) is cointegrated, it can be correctly specified with the error correction model (ECM) to reconcile the long-run relation in equation (2) with short-term dynamics

[1] See, for example, Ihrig, Marazzi, and Rothenberg (2006), Ghosh and Rajan (2009b), and Ozkan and Erden (2014).

as follows

$$\Delta ipi_t = \lambda_0 + \sum_{i=0}^{n} \lambda_{1i} \Delta ipi_{t-i} + \sum_{i=0}^{n} \lambda_{2i} \Delta fwpi_{t-i} + \sum_{i=0}^{n} \lambda_{3i} \Delta neer_{t-i} + \kappa(ipi_{t-1} - \beta fwpi_{t-1} + \gamma neer_{t-1}) + \epsilon_t \tag{3}$$

where κ measures the speed of adjustment from short-term deviations.

To determine the existence of asymmetric ERPT over the business cycle, we extract the cyclical components of variables and re-estimate equation (2) as follows

$$ipi_t^c = \alpha + \beta fwpi_t^c - \gamma_1 neer_t^c - \gamma_2 neer_t^c \times gap_t^+ - \gamma_3 neer_t^c \times gap_t^- + \xi_t \tag{4}$$

where ipi_t^c, $fwpi_t^c$, and $neer_t^c$ are cyclical components of ipi_t, $fwpi_t$, and $neer_t$ respectively.[2] Similarly, we extract the cyclical component of the GDP, the output gap, to examine the asymmetric behaviour of the ERPT. The asymmetry is captured by dummy variables gap_t^+ and gap_t^-, which are specified as

$$gap_t^+ = \begin{cases} 1 \text{ if the previous } gap \geq 1\% \\ 0 \text{ otherwise} \end{cases}$$

and

$$gap_t^- = \begin{cases} 1 \text{ if the previous } gap \leq -1\% \\ 0 \text{ otherwise} \end{cases}$$

Hence, interaction terms $neer_t^c \times gap_t^+$ and $neer_t^c \times gap_t^-$ represent asymmetry in the ERPT over the business cycle. Assume that the output gap of the previous period is less than 1 in absolute terms; then equation (4) then becomes equation (2), which implies a linear relationship between the exchange rate and import prices over the business cycle.

There are three possible scenarios of asymmetry. First, the ERPT is high in the upswing phase of the economy but muted in the downswing. Second, the ERPT is rapid in the downswing but low when the economy is very strong. Lastly, we can have a high degree of ERPT in both extremes, i.e. when the economy is very strong and when it is very weak. Specifically, if γ_2 is statistically different from 0 and γ_3 is statistically insignificant, it means that the ERPT is higher when the economy is doing extremely well, i.e. the previous output gap is above 1 per cent. In this case, the ERPT is $\gamma_1 + \gamma_2$ instead of γ_1. Likewise, when γ_3 is statistically significant and γ_2 is statistically insignificant, i.e. when the economy is extremely weak, the overall ERPT becomes $\gamma_1 + \gamma_3$ rather than γ_1. Finally, the extreme case occurs when both γ_2 and γ_3 are statistically

[2] We obtain the cyclical components of all time series by removing the trend in the data with the Hodrick-Prescott (HP) filter. The results are qualitatively the same when we use other filters which are not subject to the end-point problem, such as the ideal band pass filter developed by Corbae, Ouliaris, and Phillips (2002),.

significant. The ERPT when the output gap is above one per cent is $\gamma_1 + \gamma_2$, whereas it is $\gamma_1 + \gamma_3$ with negative gap below -1 per cent. It is γ_1 with the output gap below 1 per cent, but above -1 per cent.

2.2 Second-Stage Exchange Rate Pass-Through

As mentioned in the introduction, second-stage ERPT refers to the transmission of import prices to retail prices. Consumer inflation is based on the markup model of inflation where consumer inflation depends on import prices and ULC. Hence, the long-run second-stage ERPT relationship is expressed as follows

$$CPI_t = \alpha \times ULC_t^{\beta} \times IPI_t^{\gamma} \tag{5}$$

In logs, we have

$$cpi_t = \lambda + \beta ulc_t + \gamma ipi_t + \xi_t \tag{6}$$

where where $\lambda = \log(\alpha)$ is the retail markup over costs, β and γ are elasticities, and $\xi_t \sim N(0, \sigma_\xi^2)$ is an *iid* error term. Note that equation (2) can be augmented with GDP to account for demand pressure. However, Kabundi, Schaling, and Some (2016) and Fedderke and Liu (2016) have recently provided evidence of a flat Phillips curve for South Africa. It means that the marginal gain from including GDP in equation (6) is very small. We expect $\beta + \gamma \approx 1$ in the long run, since the consumer prices of goods and services change proportionally with costs. Importantly, β and γ are not always constant; different factors, such as a change in monetary policy, may induce their changes.

In addition, the equilibrium relationship in equation (6) entails that it can be correctly expressed as an ECM of the form

$$\Delta cpi_t = \lambda_0 + \sum_{i=0}^{n} \lambda_{1i} \Delta cpi_{t-i} + \sum_{i=0}^{n} \lambda_{2i} \Delta ulc_{t-i} + \sum_{i=0}^{n} \lambda_{3i} \Delta ipi_{t-i} + \kappa(cpi_{t-1} - \beta ulc_{t-1} - \gamma ipi_{t-1}) + \epsilon_t \tag{7}$$

where κ, like in equation (3), is the adjustment factor which reconciles the equilibrium relationship to the short-term disequilibrium.

Like equation (4), the asymmetry over the business cycle in the second-stage ERPT is

$$cpi_t^c = \alpha + \beta ulc_t^c + \gamma_1 ipi_t^c + \gamma_2 ipi_t^c \times gap_t^+ + \gamma_3 ipi_t^c \times gap_t^- + \xi_t \tag{8}$$

where cpi_t^c, ulc_t^c, and ipi_t^c are the cyclical components of cpi_t, ulc_t, and ipi_t respectively. Dummy variables gap_t^+ and gap_t^- are identical to those in equation (4). The analysis of asymmetric behaviour of the ERPT in the second stage is done in the same way. Coefficients γ_2 and γ_3 point to the existence of nonlinearity in the ERPT over the business cycle.

3 Data and Data Transformation

This paper uses quarterly data for South Africa from 1994Q1 to 2015Q2, which comprise the country's first democratic elections, the opening of the capital account to non-residents, and the adoption of the IT regime.[3] Furthermore, the sample size is large enough to include the GFC.

The variables used in this dataset are defined in a standard way, as seen in Table A.1 of the Appendix. The import-price-excluding-oil index is constructed by the authors. To construct this index, we obtain the current and constant prices of the imports of goods and services as well as oil imports from the SARB using 2010 as the base year. We then construct the current and constant prices of the imports of goods and services less oil imports using the same base year. We finally divide the newly constructed current prices by the newly constructed constant prices of imports less oil and index it to 2010.

The import price excluding oil and food is constructed in a similar fashion. We use data, available from the SARB, on the current prices of the imports of total agriculture,[4] of raw hides, skins and articles, and of processed foods and beverages. To calculate the import prices of food, we add the imports of processed foods and beverages to the imports of total agriculture and subtract the imports of raw hides, skins and articles. We then construct the constant prices of the imports of food prices by dividing the current prices of the imports of food with a commodity food price index.[5] We finally construct the import-price-excluding-oil-and-food index as we did the import-price-excluding-oil index above.[6]

Figure 1 depicts the movement of the domestic import price index (IPI) and the nominal effective exchange rate (NEER). It is evident that the IPI and NEER comove. Furthermore, the NEER leads the IPI by approximately 1-2 quarters. Unit root tests in Table A.2 of the Appendix show that all variables are non-stationary at 1 per cent. The results of the cointegration test in Table A.3 of the Appendix indicate that there is at least one cointegrating equation in each stage.

[3] We use quarterly data from 1980Q1 to 2015Q2 for the rolling regressions.

[4] Imports of total agriculture include live animals and animal products, vegetable products, raw hides, skins and articles, and animal or vegetable fats and oils.

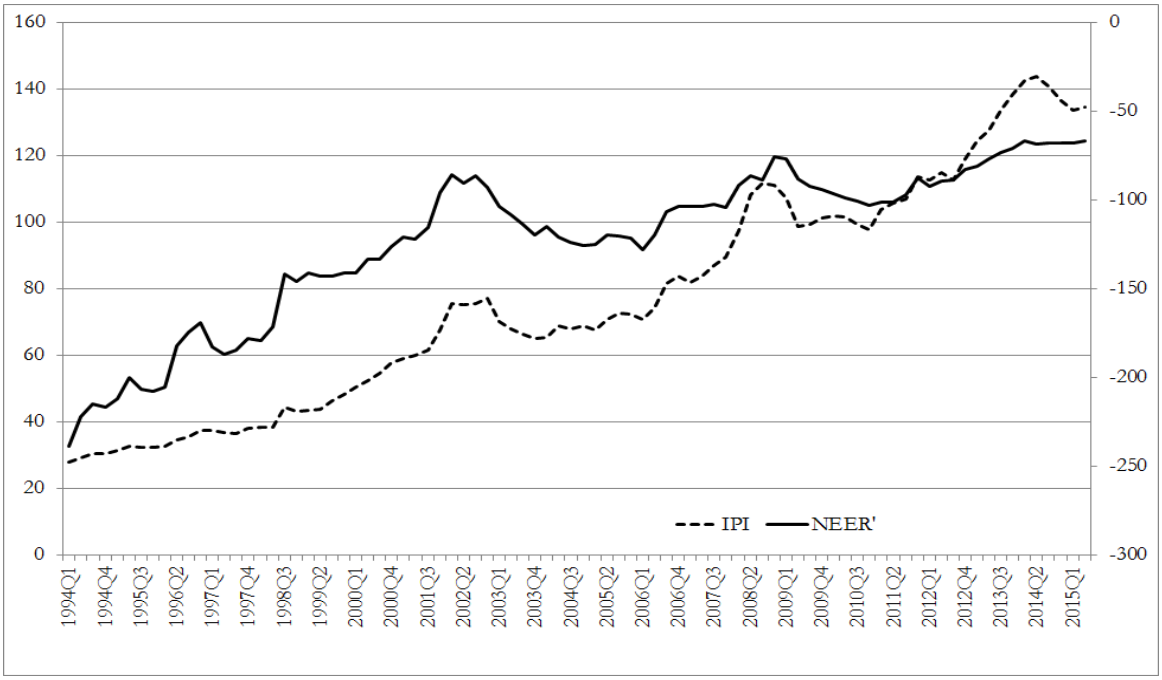
[5] We use this index as a proxy for the South African food price index. It includes the cereal, vegetable oils, meat, seafood, sugar, banana, and orange price indices and is obtained from the International Monetary Fund (IMF).

[6] This series uses data from 1994Q1 to 2013Q3 (1980Q1 to 2013Q3 for the rolling regressions) due to data availability.

4 Empirical Results

We divide the empirical section into two subsections, namely, the first- and the second-stage ERPT. We first discuss the long-term ERPT for both stages and then we assess the possibility of changes in the PT over time. We then estimate an ECM equation to reconcile the long-run dynamics to the short-term disequilibrium. Finally, we assess the asymmetric behaviour in the PT over the business cycle.

Figure 1: Import Price Index and Nominal Effective Exchange Rate



Note: The nominal effective exchange rate is inverted.

4.1 First-Stage Exchange Rate Pass-Through

Table 1: First-Stage Pass-Through

	(1)	(2)	(3)
$neer_t$	-0.933***	-0.921***	-1.01***
	(0.031)	(0.041)	(0.043)
$fwpi_t$	0.492**	1.324***	1.264***
	(0.144)	(0.108)	(0.112)
$ipioil_t$	0.171***		
	(0.026)		
N	86	86	83
$Adj.R^2$	0.99	0.99	0.99

*,**,*** denote significant at 10%, 5%, and 1% respectively.

Values in parentheses are standard errors

(1) import prices, (2) import prices excluding oil prices

(3) import prices excluding oil and food prices

Table 1 depicts the results of long-run ERPT in the first stage, as indicated in equation (2). Note that the estimation (1) controls for oil prices to isolate its effects on the PT. It is evident from the results that first-stage PT is qualitatively the same in all three estimations. The average PT over the entire sample is almost complete at 93 per cent, indicating that almost 100 per cent of the movement in the domestic currency is transferred to import prices. It is possible that the price of Brent crude oil is the main driving force behind the results. To account for its impact, we conduct the same estimation with import prices excluding the oil price.[7] The long-term first-stage PT is almost complete at 92 per cent, similar to the PT estimated with the import prices including oil price.[8] Hence, our analysis is mainly based on estimation (1). The Johansen test indicates one cointegrating relationship when we use one or two lags, with an intercept and no trend. It means that the estimations in Table 1 should account for the short-term disequilibrium. We therefore estimate their respective ECMs, represented in equation (3) in Table 2.

It is clear from Table 2 that all three estimations give identical results. Notice that ecm_{t-1} represents the cointegrating equation. The estimated κ indicates that the adjustment process is rather quick. The half-life is approximately three quarters, which

[7] Throughout this note, we run the same regressions excluding both oil and food prices and find the results similar to those excluding oil prices only.

[8] The first-stage PT excluding both oil and food prices is complete at 100 per cent.

means that 50 per cent of the deviation from the equilibrium is recovered within a year. Such a high speed of adjustment is common in first-stage ERPT. However, as discussed in the introduction, the relationship between the exchange rate and import prices may be altered by policy changes and/or shocks affecting the economy. Thus, we use a rolling-window regression to capture these changes.[9]

Table 2: First-Stage Pass-Through ECM

	(1)	(2)	(3)
ecm_{t-1}	-0.196**	-0.218***	-0.247***
	(0.059)	(0.064)	(0.063)
Δipi_{t-1}	-0.239***	-0.259**	-0.245**
	(0.084)	(0.101)	(0.099)
$\Delta neer_t$	-0.54***	-0.525***	-0.563***
	(0.032)	(0.045)	(0.049)
$\Delta neer_{t-1}$	-0.276***	-0.262***	-0.255**
	(0.063)	(0.075)	(0.080)
$\Delta neer_{t-2}$	0.066*	0.096*	0.126**
	(0.033)	(0.048)	(0.051)
$\Delta fwpi_t$	1.143***	1.540***	1.323***
	(0.259)	(0.266)	(0.290)
$\Delta fwpi_{t-1}$		0.751**	0.748**
		(0.304)	(0.321)
$\Delta ipioil_t$	0.03*		
	(0.017)		
$\Delta ipioil_{t-1}$	0.059***		
	(0.017)		
N	86	86	83
Adj. R^2	0.85	0.72	0.72

*,**,*** denote significant at 10%, 5%, and 1% respectively

Values in parentheses are standard errors

(1) import prices, (2) import prices excluding oil prices

(3) import prices excluding oil and food prices

[9] All rolling-window regressions use the window size of 40 quarters or 10 years.

Figure 2: Rolling-window regression of first-stage exchange rate pass-through

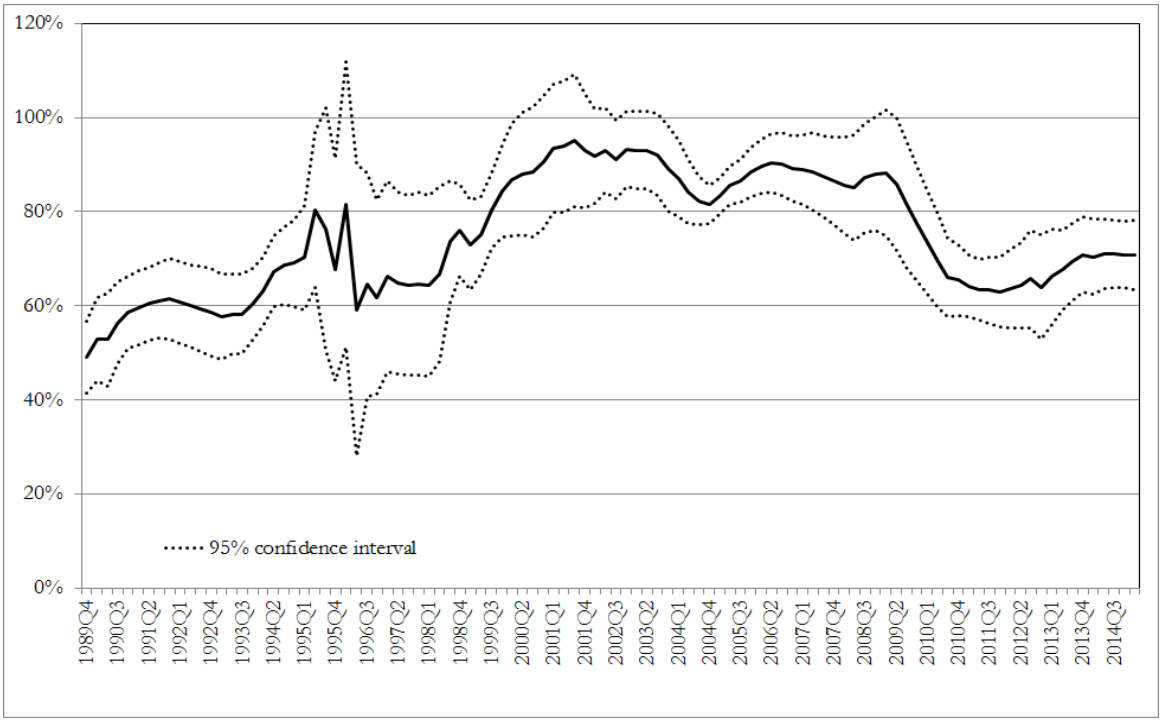


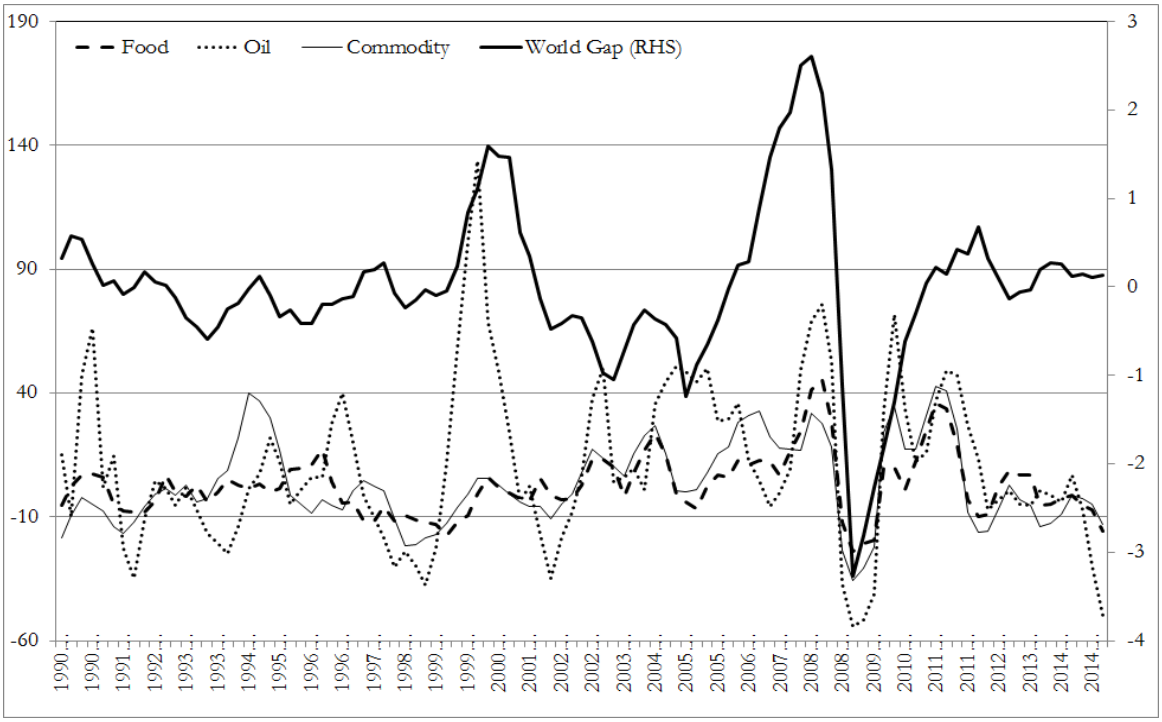
Figure 2 presents the results of the time-varying PT for the first stage.[10] The results confirm the changing pattern of the first-stage PT. The PT was incomplete in the 1990s at about 60 per cent, and then increased sharply in the late 1990s. From 2000 to 2009, the long-term first-stage PT was almost complete, at around 90 per cent. Interestingly, it dropped markedly after the GFC, reaching a low of 63 per cent in 2011 before rebounding to 70 per cent in 2014. The decline in the first-stage PT can be attributed to weak global demand coupled with the decline in global energy and food prices. Notice in Figure 3 that these three factors are highly correlated. Weak global demand puts downward pressure on commodity prices and energy prices. In general, world demand leads commodity and energy prices by more than one quarter. This is consistent with a recent study by Forbes, Hjortsoe, and Nenova (2015) who find that ERPT depends to a large extent on the source of the exchange rate movement. They argue that global supply and demand shocks, monetary policy shock, and domestic supply and demand shocks play a considerable role in explaining the PT to import prices. In addition, the literature suggests that the decline in first-stage ERPT is a result of low competition in the product market. When faced with weak domestic demand, foreign firms pass less of the exchange rate movement through to import prices; instead they increase their markups, taking advantage of low competition from domestic firms. Jooste and Jhaveri (2014) argue that the ERPT

[10] Notice in Figure A.1 of the Appendix that the results are unchanged when we exclude oil and food prices.

in South Africa declines as the product market becomes more concentrated because imperfectly competitive firms are able to absorb the increases in their marginal costs. This is consistent with the recent findings by Klein (2011) and Fedderke, Kularratne, and Mariotti (2007) that markups in South Africa tend to be countercyclical because of a higher degree of concentration across industries in the manufacturing sector.

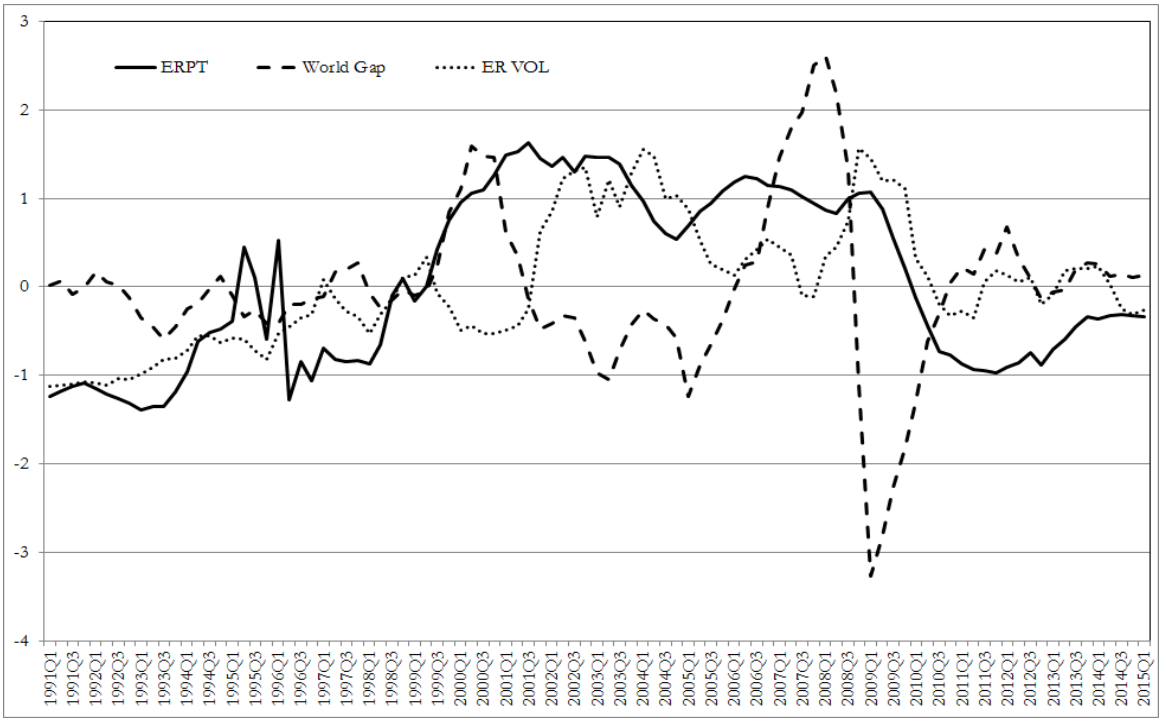
Besides the microeconomic factors affecting ERPT, theory identifies volatility in exchange rates, inflationary states, and global factors as key macroeconomic variables explaining movements in first-stage ERPT.[11] Figure 4 shows the relationship between the estimated ERPT, the world output gap (World Gap), and the variability in the exchange rate (ER VOL). There is evidence of a close relationship between ERPT and these macroeconomic variables. Except between 2001Q3 and 2003Q1, the South African ERPT closely mimics the behaviour of the world gap. Costs arising from the exchange rate movement are passed on to importers when the global economy is in an expansionary phase, and the opposite occurs in a contraction, such as during the most recent GFC.

Figure 3: World Gap, Commodity Prices and Food Inflation



[11] See Ozkan and Erden (2015) and Ghosh and Rajan (2009a) for more details on the macroeconomic fundamentals behind the movement in first-stage ERPT.

Figure 4: ERPT, World Gap, and Exchange Rate Volatility[12]



To analyse the asymmetry of PT to import prices over the business cycle, we estimate equation (4) and the results are shown in Table 3. We extract the cyclical components of all variables - namely ipi_t^c, $fwpi_t^c$, and $neer_t^c$ - for the domestic import prices, the NEER, and the foreign wholesale prices respectively.[13] The overall PT over the business cycles - as depicted in (1), (3), and (5) - is the same across different specifications, and it varies between 64 per cent and 67 per cent, substantially lower than the long-term PT of 93 per cent. Importers tend to retain a certain percentage of cost-savings caused by an appreciated currency when the economy is performing extremely well. It is therefore worth assessing the asymmetries of the PT over the business cycle. To assess the PT asymmetries over the business cycle, we include a dummy variable which accounts for a strong expansionary phase, i.e. when the output gap is greater than 1 per cent in the previous quarter, and another dummy variable which deals with extremely weak economic conditions, i.e. when the output gap is below -1 per cent in the previous quarter. The results of an asymmetric PT are shown in specifications (2), (4), and (6) of Table 3. The results in specification (2) support the notion of asymmetry, with PT at 62 per cent in the expansion phase and at 46 per cent during the contractionary phase.

[12] We standardise the ERPT and the ER VOL to obtain the same unit of measurement. ER VOL is calculated by dividing the monthly range of the NEER by the monthly average and then averaging this series into quarters.

[13] We use the HP filter to extract the cyclical components of the three variables. The results are qualitatively the same with other methods.

This suggests that importers pass on a large portion of the exchange-related cost-savings, whereas they pass on a smaller portion of costs in a downturn. When we use import prices excluding oil (i.e. regression (4)), the overall PT for the entire sample becomes 64 per cent over the business cycle. The asymmetric PT is approximately 66 per cent and 38 per cent in the upswing and downswing respectively.[14] Once again, these results are similar to those obtained when energy prices are included. They are also similar to the findings of Chew, Ouliaris, and Tan (2011) for Singapore and of Forbes, Hjortsoe, and Nenova (2015) for England.

Table 3: First-Stage Pass-Through over the Business Cycle

	(1)	(2)	(3)	(4)	(5)	(6)
$neer_t^c$	-0.67***	-0.71***	-0.64***	-0.66*	-0.67***	-0.68***
	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
$fwpi_t^c$	0.74**	0.90***	1.15***	1.21***	0.94***	1.00***
	(0.21)	(0.21)	(0.15)	(0.15)	(0.17)	(0.17)
$ipioil_t^c$	0.05**	0.05**				
	(0.02)	(0.02)				
$eer_t^c \times gap_t^+$		0.09*				
		(0.052)				
$eer_t^c \times gap_t^-$		0.25**		0.28**		0.25**
		(0.09)		(0.11)		(0.12)
N	86	86	86	86	83	83
$Adj.\ R^2$	0.92	0.93	0.87	0.88	0.86	0.87

*,**,*** denote significant at 10%, 5%, and 1% respectively. Values in parentheses are standard errors

(1) and (2) import prices, (3) and (4) import prices excluding oil prices, (5)

and (6) import prices excluding oil and food prices

[14] The long-term PT is 68 per cent when we exclude both energy and food prices. We find evidence of asymmetry even when energy and food prices are excluded. The PT is 68 per cent and 43 per cent during expansionary and contractionary phases respectively.

4.2 Second-Stage Exchange Rate Pass-Through

Table 4: Long-run Second-Stage Pass-Through

	CPI		Core CPI	
	(1)	(2)	(3)	(4)
ipi_t	0.361***	0.287***	0.364***	0.335***
	(0.038)	(0.042)	(0.038)	(0.022)
ulc_t	0.554***	0.465***	0.577***	0.602***
	(0.052)	(0.054)	(0.051)	(0.031)
gdp_t		0.330**		
		(0.119)		
N	86	86	86	86
Adj. R^2	0.99	0.99	0.99	0.99

*,**,*** denote significant at 10%, 5%, and 1% respectively.

Values in parentheses are standard errors

(1) Import prices (2) Import prices and control for demand pressure (3) Import prices excluding oil prices

(4) Import prices excluding oil and food prices

Table 4 presents the results of long-run ERPT in the second stage in line with equation (6). Estimation (2) controls for demand pressure, represented by the logarithm of GDP at constant prices. In addition, specifications (1) and (2) use headline CPI as the dependent variable whereas (3) and (4) use core CPI.[15] The striking similarity of the different specifications is worth mentioning. In all specifications, the coefficients of both import prices and ULCs are statistically significant at 1 per cent, which indicates that these variables explain quite well the long-run dynamic of inflation in South Africa. The results point to a second-stage ERPT of 36 per cent, implying an incomplete PT in the second stage which is consistent with the literature. The low ERPT in the second stage can be attributed to different factors. First, import prices are transmitted indirectly to consumer prices because imported goods are first sold to wholesalers who sell it to retailers who sell them to final consumers. There are different markup rates along the supply chains which in turn face different market conditions. Hence, firms do not adjust prices automatically at each level of the supply chains. Second, the state of competition in the market affects the extent to which wholesalers and retailers set their prices. They may choose to abstain from adjusting their prices and instead prefer to maintain their market share. Third, import costs are just a fraction of the overall costs that retailers

[15] Core CPI is constructed as headline CPI excluding food, non-alcoholic beverages, petrol, and energy.

face. For example, included in the overall costs are fixed costs which are not part of import costs. Retailers may choose to absorb some costs by increasing their margins instead, especially in an environment of imperfect competition like South Africa.

Like in the first-stage phase, the appropriate estimation of long-run ERPT is with an ECM. The results in Table 5 show similarity in the estimation using different measures of CPI. It is worth noting that, in the short run, ULC comes out insignificant across the different models. In addition, the demand component is insignificant for the short-term specification. Although significant, the speed of adjustment is very slow, with the lowest half-life of approximately 14 quarters. It means that 50 per cent of deviation from the long-run equilibrium is recovered within more than three years. This is higher than the speed of adjustment for Singapore.[16]

Table 5: Second-Stage Pass-Through ECM

	CPI		Core CPI	
	(1)	(2)	(3)	(4)
ecm_{t-1}	-0.054**	-0.087**	-0.070**	-0.063**
	(0.024)	(0.028)	(0.032)	(0.031)
Δipi_t	0.104***	0.101***	0.088***	0.074***
	(0.017)	(0.017)	(0.022)	(0.021)
Δulc_t	-0.045	0.024	0.032	0.017
	(0.031)	(0.036)	(0.043)	(0.044)
Δgdp_t		-0.159		
		(0.129)		
Δcpi_{t-1}	0.533***	0.498***	0.420***	0.445***
	(0.078)	(0.077)	(0.092)	(0.094)
N	86	86	86	83
Adj. R^2	0.52	0.55	0.32	0.31

*,**,*** denote significant at 10%, 5%, and 1% respectively. Values in parentheses are standard errors. (1) import prices, (2) import prices and control for demand pressure, (3) import prices excluding oil prices, (4) import prices excluding oil and food prices.

Recall that we deal with Lucas' critique by running a rolling-window regression. Interestingly, Figure 5 clearly shows a sharp decline in second-stage PT which coincides with the adoption of the IT regime. Mishkin (2008) attributes the recent decline in the

[16] Chew, Ouliaris, and Tan (2011) estimate the speed of adjustment for Singapore to be 0.032.

ERPT to the adoption of improved monetary policies in both AEs and EMEs. Taylor (2000) provides evidence of correlation between the degree of ERPT and inflation. The ERPT tends to be low in a low-inflation environment with a credible monetary policy. The PT plummeted from 76 per cent in 1998 to about 20 per cent in 2002. It is worth mentioning that the second-stage PT depends largely on the state the economy. It depicted an increase, from 19 per cent to 33 per cent, during the boom phase between 2004 and 2007, and then declined marginally to 31 per cent. The PT for the entire sample is 36 per cent when we use import prices excluding oil and core CPI.[17] Similarly, the rolling-window results using the different measures of CPI, as depicted in Figure A.2 of the Appendix, show the same pattern. There is an abrupt decline in PT which coincides with the adoption of the IT policy. Besides the few instances of a considerable rise in inflation to above the upper end of the target band, such as in 2001 and prior to the 2008 GFC, the monetary policy authority has managed to stabilise inflation at around the official target range, albeit closer to the target ceiling. This suggests that the perception of the public in general is that the central bank will act to keep inflation anchored when the economy is affected by shocks, such as the exchange rate. Hence, shocks are perceived as temporary. The first-stage ERPT has remained constant since the GFC.

Next, we estimate equation (8) to assess the asymmetry in the second-stage ERPT over the business cycle. Estimation (1) in Table 6 gives a PT of 17 per cent over the business cycle, significantly lower than the long-term PT of 36 per cent. In general, we obtain the same results in regressions (3) and (4) based on different measures of CPI.[18] Looking at asymmetries over the cycle, i.e. estimation (2), the PT is approximately 27 per cent in the upswing and approximately 14 per cent in the contraction. It seems that retailers are reluctant to pass import costs to consumers when the economy is weak, and that they prefer cutting their margins and/or maintaining sales. This is in line with recent observation where the massive depreciation of the rand has not translated into higher inflation. Similar to the results including energy, the PT (excluding oil prices) is approximately 33 per cent in the upswing and approximately 13 per cent in the contraction.[19] The results point to the asymmetric behaviour of the ERPT which depends largely on the state of the economy. There are two instances where the exchange rate and inflation move in different directions, namely in 2001 and most recently. Interestingly, in both cases the economy has been very weak.

[17] See Figure A.2 in the Appendix for the second-stage ERPT based on different measures of CPI.

[18] We obtain 18 per cent when oil prices are excluded and 16 per cent when both oil and food prices are excluded.

[19] The PT, excluding oil and food prices is 25 per cent and 13 per cent in the upswing and downswing respectively.

Figure 5: Rolling-Window Regression for the Second-Stage Exchange Rate Pass-Through

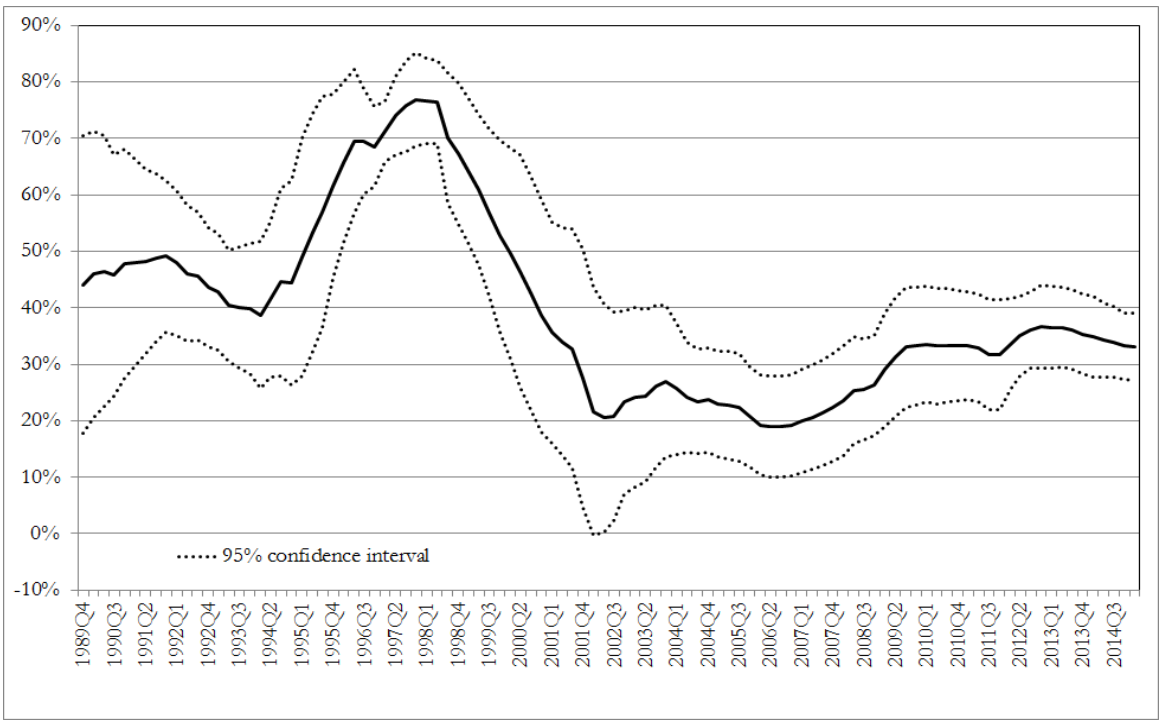


Table 6: Second-Stage Pass-Through over the Business Cycle

	CPI		Core CPI			
	(1)	(2)	(3)	(4)	(5)	(6)
ipi_t^c	0.17***	0.14**	0.18***	0.16***	0.13**	0.13**
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
ulc_t^c	0.29***	0.31***	0.28***	0.28***	0.32***	0.29***
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
$ipi_t \times gap_t^+$		0.13**			0.20**	0.12**
		(0.05)			(0.06)	(0.06)
N	86	86	86	86	86	86
Adj. R^2	0.34	0.37	0.39	0.34	0.38	0.38

*,**,*** denote significant at 10%, 5%, and 1% respectively. Values in parentheses are standard errors. (1) and (2) import prices, (3) and (4) import prices excluding oil prices, (5) and (6) import prices excluding oil and food prices

Figure 6: Rolling-Window Regression of overall Exchange Rate Pass-Through

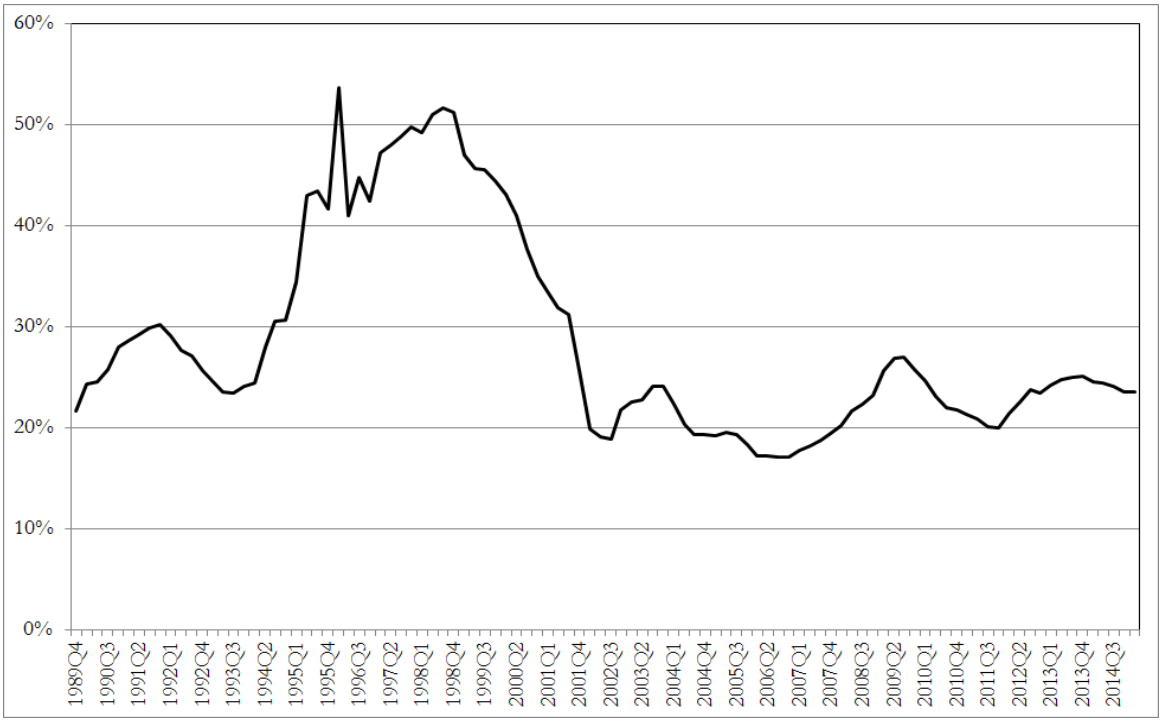


Figure 6 presents the combined first- and second-stage ERPT. We can clearly see a significant decline with the IT regime from 50 per cent to 19 per cent. There is a slight increase following the economic boom of 2004-2007, followed by a gradual decline coinciding with the GFC episode. The PT then reaches approximately 23 per cent towards the end of the period. Our estimation of overall ERPT is consistent with recent studies for South Africa by Gopinath (2015) and Albagli, Naudon, and Vergara (2015), who find a PT of 16 per cent and 14 per cent respectively. It is important to note that the results based on the entire sample can be misleading, as the PT changes with time.

5 Conclusion

This paper assesses the variation of the ERPT for South Africa from 1994 to 2014. Unlike most research which focuses on the direct effects of the exchange rate on inflation, the current analysis is based on the classic representation of the ERPT, which divides the PT into two phases. The first stage examines the impact of the exchange rate movement on import prices, and the second stage focuses on the transmission of import prices to consumer prices. Like in most of EMEs, the results indicate that the ERPT for South Africa is complete in the first stage and incomplete in the second stage. The results from the second stage reveal that retailers do not pass all costs incurred to consumers.

However, first-stage ERPT has declined slightly since the GFC. Weak domestic demand and possibly concentration of firms in the manufacturing sector are main forces behind this low PT. In addition, there is evidence of asymmetry in the first-stage ERPT in that it tends to rise in the upturn phase of the economy compared to the downturn. Importantly, the second-stage PT shows a considerable decline since the adoption of the IT regime. It suggests that monetary policy has played a considerable role in bringing the second-stage ERPT down in stabilising inflation around the official target band. Similar to the first-stage case, the PT is muted in the downturn but rises in the expansionary phase.

References

[1] Albagli, E., Naudon, A., and Vergara, R. (2015). "Inflation Dynamics in LATAM: a Comparison with Global Trends and Implications for Monetary Policy," Central Bank of Chile working Paper 58.

[2] Aron, J., Farrell, G., Muellbauer, J., Sinclair, P. (2014). "Exchange rate pass-through to import prices, and monetary policy in South Africa," *Journal of Development Studies*, 50(1): 144-164.

[3] Calvo, G.A., and Reinhart, C.M. (2000). "Fixing for your life," NBER Working Paper 8006.

[4] Campa, J.M., and Goldberg, L.S. (2005). "Exchange rate pass-through into import prices," *The Review of Economics and Statistics*, 87(4): 679–690.

[5] Chew, J., Ouliaris, S., and Tan, S.M. (2011). "Exchange Rate Pass-Through over the Business Cycle in Singapore," IMF Working Paper 11/141.

[6] Corbae, D., Ouliaris, S., and Phillips, P.C.B. (2002). "Band Spectral Regression with Trend Data," *Econometrica*, 70: 1067-1109.

[7] Devereux, M.B., and Yetman, J. (2010). "Price adjustment and exchange pass-through," *Journal of International Money and Finance*, 29: 181–200.

[8] Fedderke, J. and Liu, Y. (2016). "Inflation in South Africa: An Assessment of Alternative Inflation Models," South African Reserve Bank, Working Paper 16/03.

[9] Fedderke, J.W., Kularatne, C., and Mariotti, M. (2007). "Mark-up Pricing in South African Industry," *Journal of African Economies*, 16(1): 28-69.

[10] Forbes, K., Hjortsoe, I., and Nenova, T. (2015). "Improving our Estimates of Exchange Rate Pass-Through," Bank of England Working Paper 43.

[11] Gagnon., J.E. and Ihrig., J. (2004). "Monetary policy and exchange rate pass-through," *International Journal of Finance and Economies*, 9(4): 315-338.

[12] Ghosh, A. and Rajan, R. (2009a). "Exchange Rate Pass-Through in Korea and Thailand: Trends and Determinants," Japan and the World Economy, 21: 55-70.

[13] Ghosh, A. and Rajan, R. (2009b). "What is the extent of Exchange Rate Pass-Through in Singapore? Has it Changed Over Time?" *Journal of Asia Pacific Economy*, 14(1): 61-72.

[14] Gopinath, G. (2015). "The International Price System," forthcoming in J*ackson Hole Symposium Proceedings*.

[15] Gopinath, G., Oleg, I., and Roberto, R. (2010). "Currency choice and exchange rate pass-through," *American Economic Review*, 100(1): 304-336.

[16] Ihrig, J., Marazzi, M., and Rothenberg, A. (2006). "Exchange Rate Pass-Through in the G-7 Countries," Board of Governors of the Federal Reserve System, Discussion Paper 85.

[17] Jooste, C., and Jhaveri, Y. (2014). "The determinants of time-varying exchange rate pass-through in South Africa," *South African Journal of Economics*, 82(4): 603-615.

[18] Kabundi, A., Schaling, E., and Some, M. (2016). "Estimating a Time-Varying Phillips Curve for South Africa," South African Reserve Bank, Working Paper 16/05.

[19] Karoro, T.D., Aziakpono, M.J., and Cattaneo., N. (2009). "Exchange rate pass-through to import prices in South Africa: Is there asymmetry?" *South African Journal of Economics*, 77(3): 380-398.

[20] Klein, N. (2011). "South Africa: The Capital Behavior of the Markups and its Implications for Monetary Policy," IMF Working Paper 11/204.

[21] McCarthy, J. (2000). "Pass-through of exchange rate and import prices to domestic inflation in some industrialized economies," Federal Reserve Bank of New York Staff Report 3.

[22] McFarlane, L. (2009). "Time-varying exchange rate pass-through: An examination of four emerging market economies," Bank of Jamaica. Draft.

[23] Mishkin, F. (2008). "Exchange rate pass-through and monetary policy," NBER Working Papers 13889

[24] Mishkin, F., and Savastano, M. (2000). "Monetary policy strategies for Latin America," NBER working Paper 7617.

[25] Ozkan, I. and Erden, L. (2015). "Time-Varying Nature and Macroeconomic Determinants of Exchange Rate Pass-Through," *International Review of Economics and Finance*, 38: 56-66.

[26] Parsley, D.C. (2010). "Exchange rate pass-through in South Africa: panel evidence from individual goods and services," South African Reserve Bank ,Working Paper 10/03.

[27] Schmidt-Hebbel, K., and Werner, A. (2002). "Inflation targeting in Brazil, Chile and Mexico: Performance, credibility and the exchange rate," Central Bank of Chile, Working Paper 171.

[28] Sekine, T. (2006). "Time-Varying Exchange Rate Pass-Through: Experiences of Some Industrial Countries," BIS Working Paper 202.

[29] Taylor, J. (2000). "Low inflation, pass-through and the pricing power of firms," *European Economic Review*, 44: 1389–1408.

Appendix

Table A.1: Data list

Variable	Description	Source
IPI	Imports of goods and services price index	South African Reserve Bank
IPI less oil	Imports of goods and services less oil price index	Authors calculations
IPI less oil and food	Imports of goods and services less oil and food price index	Authors calculations
NEER	Nominal effective exchange rate of the Rand (20 trading partners): average for the period	South African Reserve Bank
FWPI	Foreign wholesale price index	South African Reserve Bank
IPI oil	Price of Brent and Crude oil in US dollars	South African Reserve Bank
CPI	Consumer Prices Index: all urban areas	Statistics South Africa*
Core CPI	Consumer Prices Index excluding food, non-alcoholic beverages, petrol and energy	South African Reserve Bank (Macro Model Unit)
ULC	Unit Labour Costs for manufacturing sector	South African Reserve Bank
GDP	Gross Domestic Product at constant prices, 2010 basis	South African Reserve Bank

Note: All variables are seasonally adjusted (with the exception of the NEER and IPI oil) and are expressed in natural logarithm.

*This series uses primary urban areas up to and including December 2008. It then uses all urban areas from January 2009.

Table A.2: Unit root tests

Variables	Test Statistics	
	KPSS	PP
IPI	1.144	-1.444
IPI less Oil	1.191	-1.130
IPI less Oil and Food	1.183	-1.162
NEER	1.038	-1.445
Foreign Wholesale Price	1.138	-0.568
IPI Oil	1.088	-1.508
CPI	1.179	-1.370
Core CPI	1.179	1.301
Unit Labour Cost	1.156	0.565
GDP	1.176	-1.152

*,**,*** denote significance at 10%, 5%, and 1% respectively

Table A3: Johansen Cointegration Test

Model	Trace Test at 5% level
(1)	2*
(2)	1*
(3)	1*
(4)	2**
(5)	1*
(6)	1*

Number of cointegrating equations. *,** denote intercept no trend, and, no intercept no trend, respectively

(1) import prices, nominal effective exchange rate, foreign whole prices, oil price.

(2) import excluding oil prices, nominal effective exchange rate, foreign whole prices.

(3) import excluding oil and food prices, nominal effective exchange rate, foreign whole prices.

(4) consumer prices, import prices, unit labour costs

(5) consumer prices (core), import excluding oil prices, unit labour costs

(6) consumer prices (core), import excluding oil and food prices, unit labour costs

Figure A.1: Time-varying First-Stage ERPTs

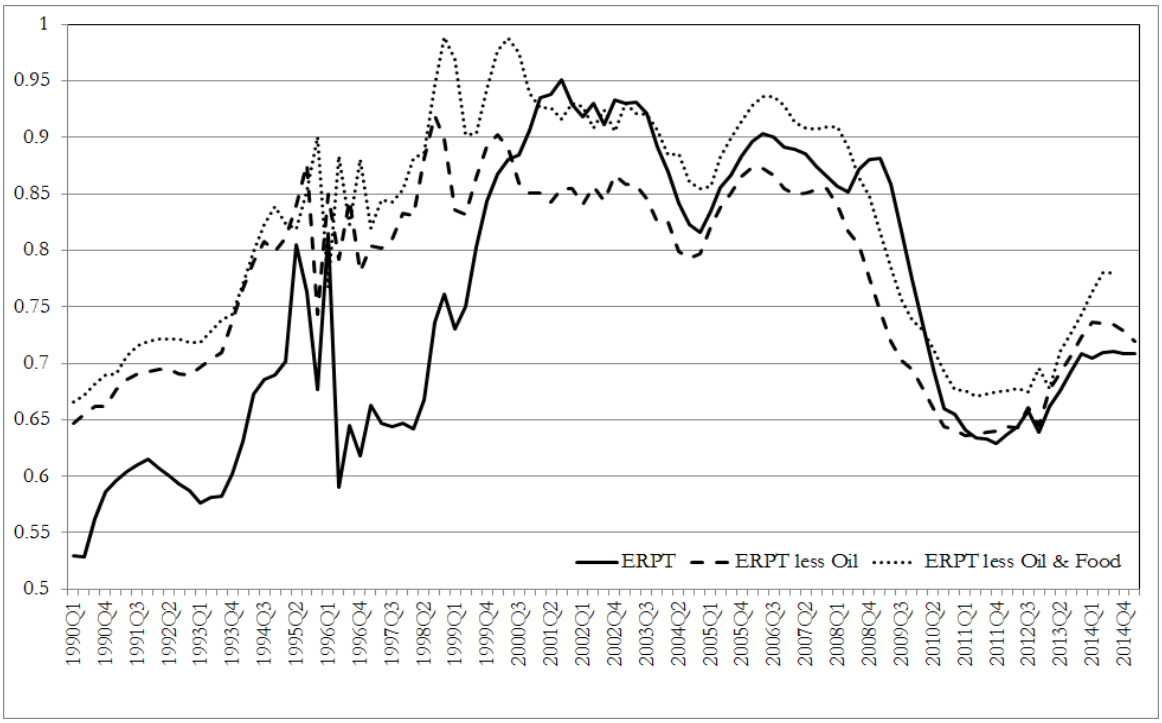


Figure A.2: Time-varying Second-Stage ERPTs