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Exchange Rate and Consumer Prices in Mozambique: A cointegration Approach

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Abstract

Using monthly data from 2001:1 to 2006:12, this paper applies the cointegration approach and the associated error correction model to study the importance of money, exchange rate and South African prices in explaining consumer price changes in Mozambique, focusing on the estimation of the long-run pass-through coefficient. Consistent with previous research, the paper finds that money, the exchange rate and inflation are important determinants of inflation in Mozambique. In particular, one per cent exchange rate depreciation leads to 0.15 per cent increase in the price level. In addition, money and the South African prices are the most important variables in explaining the variation in prices. Compared with the exchange rate, money explains a relatively larger variation in prices but its relative importance seems to have diminished.

Keywords: Money, exchange rate, consumer prices, cointegration, vector error correction model.

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1 Introduction

Mozambique has been successful in reducing inflation from levels above 30 per cent per year in the late 1980s and early 1990s to single digit starting in 1997. One of the most important policy actions in bringing inflation down was the control of money growth through tight monetary policy (Ubide 1997). However, inflation continues volatile (Figure 1 in Appendix A) driven mainly by seasonal factors such as droughts, floods, the adjustments of regulated prices and speculation during Christmas (Bank of Mozambique 2002). Beyond these seasonal factors and money, the exchange rate (particularly between the Mozambican metical and the South African Rand) behavior has been identified as an important determinant of inflation in Mozambique (Ubide 1997; Omar 2003; Banco de Moçambique 2005)[3]. For example, Ubide (1997), Omar (2003) and Cirera and Nhate (2007) report pass-through coefficients between 0.18 and 0.74 suggesting that, *ceteris paribus*, a 1 per cent depreciation of the Metical/Rand exchange rate leads to an increase in the Consumer Price Index between 0.18 and 0.74 per cent in the long run.

Ubide (1997) used monthly data for the period 1989:1 to1996:12 to study the determinants of inflation in Mozambique. He finds that unpredictable factors in agricultural sector, monetary expansion and the depreciation of the Metical/Rand exchange rate are the main drivers of inflation. Based on a cointegrated Vector Autoregression (VAR) including the Mozambican CPI (used as the normalizing variable), the South African CPI, money and the exchange rate, he reports a long-run exchange rate pass-through of 0.18, a long-run coefficient of 1.64 for the South African prices and 0.72

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[3] Exchange rate changes affect inflation directly and indirectly (Kahn 1987). For example, the depreciation of the Metical against the South African Rand raises the price that Mozambican consumers pay on imported goods from South Africa, feeding directly into overall price level depending on the weight of imported goods in the Consumer Price Index (CPI) basket. The indirect effect operates through the incentive that domestic producers of importable goods have to raise their prices in line with the rise of the imported goods. It also operates through the induced increase in production costs as a result of an increase in the price of imported inputs.

for money. Similarly, Omar (2003) replicated Ubide's methodology using data covering the period 1993:M1 to 2001:M12. He estimates a parameter of 0.74 for the Metical/Rand exchange rate and 0.34 for money. Contrary to expectations, he finds a negative relationship between the South African and domestic prices.

Moreover, Cirera and Nhate (2007) estimated a model including monthly data on consumer prices, import prices, Metical/Rand exchange rate, border taxes, transport costs and markups. The sample covered the 2000-2005 period and included 25 agricultural and light processed products. They find that the pass-through from import prices to consumer prices is low (0.2 per cent on average) while the pass-through from exchange rate to domestic prices is high (between 50 and 70 per cent depending on the model specification).

It is interesting to note that despite differences in model specification and econometric methodology (cointegration versus single equation), both Omar and Cirera and Nhate report similar results pointing to a higher exchange rate pass-through in Mozambique. Taken together, the results suggest that the benefits of a flexible exchange rate regime may be limited (Coricelli et. al. 2004)[4] and monetary policy cannot be conducted independently without concerns about the exchange rate, making inflation targeting relatively harder to implement (Choudhri and Hakura 1998).

In general, these findings support three main consensus in the literature. Firstly, that the pass-through is incomplete - changes in nominal exchanges rates are not fully passed into prices suggesting that prices are less volatile than exchange rates (Pollard and Coughlin

[4] However, it should be noted that higher pass-through to import prices is desirable in order to induce the expenditure switching in favor of goods produced domestically and therefore improving the trade balance. But, it is undesirable at consumer prices level because it prevents the real depreciation to occur by raising the domestic inflation at a given level of foreign inflation (Ito and Sato 2006).

2005)[5]. Secondly, that the pass-through decreases along the production chain (McCarthy 2000) being higher at import price level and falling as one moves down the chain (to manufacturing and consumer prices[6]). Thirdly, the degree of pass-through varies across countries and studies.

McCarthy (2000) uses a VAR model consisting of eight endogenous variables (oil price inflation in domestic currency, the output gap, exchange rates, short-term interest rates, money, producer , import and consumer price inflation) to track the impact of exchange rate and import prices shocks on the CPI and the PPI inflation in nine developed countries[7] during the 1976:Q1-1998:Q4 period. Based on impulse response analysis, he finds a relatively larger pass-through from exchange rates to import prices but less to PPI and CPI inflation. In addition, he finds that PPI inflation responds more to import prices shocks than the CPI inflation. Nevertheless, both exchange rate and import price shocks account for a small fraction in the overall variation of inflation.

Campa and Goldberg (2005) investigated the pass-through to import prices in 23 OECD countries from 1975:Q1 to 2003:Q4. They concluded that 46 per cent of the short-run variation in import prices reflects exchange rate fluctuations. In the long-run, the pass-through increases to 65 per cent. Exception was a relatively lower pass-through of 23 per cent in the short-run and 42 per cent in the long-run for the USA. Surprisingly, the short-run pass-through estimated by Campa and Goldberg is close to the long-run pass-through of 24 per cent obtained by Kim (1998) using a cointegrated VAR (CVAR) model.

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[5] The reasons for incomplete pass-through include imperfect competition and strategic pricing (pricing to the market) whereby foreign producers accept temporary margin erosion in order to maintain their market share (Dornbush 1985). In addition, the existence of menu costs (the cost of changing prices constantly) may prevent exchange rate depreciation to be fully passed into prices so long as the depreciation is perceived as temporary (Billmeier and Bonato 2002; Goldberg and Knetter 1997)

[6] The lower pass-through into consumer prices is partially explained by the inclusion of the non-traded goods in the basket used for their computation. The evidence of a decrease of the pass-through coefficient along the production chain applies to Cirera and Nhate (2007).

[7] United States, United Kingdom, France, Japan, Germany, Belgium, the Netherlands, Sweden, and Switzerland.

Billmeier and Bonato (2002) applied a recursive and cointegrated VAR to study exchange rate pass-through along the production chain in Croatia using monthly series of the average exchange rate between the kuna and the deutsche mark, the retail and manufacturing price indexes, the output gap and the raw materials price index, spanning the period 1994:M4 to 2001:M1. In a recursive VAR setting, they find that manufacturing prices react to innovation in exchange rates but the retail price index does not. In addition, using a CVAR including only the exchange rate, the manufacturing and the retail price indexes, they report a log-run pass-through t of 33 per cent o retail prices

These differences in the degree of pass-through reflect country heterogeneity and model specifications. For example Dornbush (1987) points to differences in market concentration, import penetration and substitutability of domestic and imported products as important factors explaining the differences in pass-through across sectors and countries. Other authors (Devereux and Yetman 2002; McCarthy 2000) identify differences in inflations levels, exchange rate volatility[8] and shares of imported goods in domestic demand. However, Campa and Goldberg (2005) argue that macroeconomic factors including inflation and exchange rate variability play a little role in explaining pass-through differences among OECD countries. With regard to model specification, (Kahn 1987) claims that in general, studies reporting larger pass-through coefficients fail to account for other determinants of inflation particularly energy price changes and economic policy shocks.

Using monthly data from 2001:1 to 2006:12, this paper applies the cointegration approach and the associated error correction model to study the importance of money, exchange rate and South African prices in explaining consumer price changes in Mozambique, focusing on the estimation of the long-run pass-through coefficient.

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[8] Devereux and Yetman argue that countries with annual inflation above 25 per cent and higher exchange rate volatility, pass-through tends to be complete because importing firms' benefit of adjusting prices offset its cost (the menu costs) of keeping the prices fixed in domestic currency. This is because higher inflation erodes current profit margins if prices are kept constant as the exchange rate depreciates.

Impulse response analysis is used to disentangle the response of consumer prices to shocks in money, exchange rate and South African prices while the decomposition of the error forecast variance of prices is applied to assess the importance of each of three variables in explaining domestic price variations.

The study contributes to the understanding of the pass-through literature in Mozambique in two ways. First, it updates Ubide and Omar's studies by using a recent dataset. Secondly, it tests whether the domestic and foreign prices 'puzzle' reported by Omar reflects a general feature between the Mozambican and South Africa prices, or can be regarded as sample specific. However, unlike these two studies which concentrated in the estimation of full inflation models for Mozambique, this paper focus in the estimation of the pass-through coefficient using the same variables used before. By doing so, important comparisons can be made.

Consistent with previous research, the paper finds that money, the exchange rate and inflation are important determinants of inflation in Mozambique. In particular, a 1 per cent exchange rate depreciation leads to 0.15 per cent increase in the price level. In addition, impulse response analysis indicate that following a shock, prices adjust quickly towards their new long-run equilibrium. Moreover, money and the South African prices are the most important variables in explaining the variation in prices. Compared with the exchange rate, money explains a relatively larger variation in prices but its relative importance seems to have diminished.

Following this introduction, Section 2 describes the data used in the estimation. Section 3 outlines the analytical framework and the methodology including the Augmented Dicky-Fuller test for stationarity and the Johansen cointegration procedure. Section 4 presents and discusses the results and section 5 concludes.

2 Data

The empirical analysis is conducted using monthly data spanning the period from 2001:M1 to 2006:M12. The choice of the sample period was conditioned by the availability of exchange rate data. The exchange rate (e_t) is the average nominal bilateral exchange rate between the Mozambican Metical and the South-African Rand[9]. Ii is defined as the number of Meticais per unit of a Rand such that an increase in the exchange rate means depreciation and a decrease means appreciation. As proxies for domestic (p_t) and foreign (p_t^*) price levels, monthly consumer price indexes (2000:M12=100) are used. Money (m_t) is proxied by M2 which comprises the currency in circulation and total deposits (demand, time and advance notice deposits) in national and foreign currency.

Data on exchange rate comes from the Bank of Mozambique. The domestic CPI series were obtained from the National Institute of Statistics online database while the South African price index and M2 were accessed from the IMF International Financial Statistics online database. In the analyses that follow, LCPI, LCPISA, LM2 and LZAR are respectively the logarithms of the domestic CPI, the South African CPI, money and the exchange rate. All the variables are detrended using X12 program.

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[9] The South African rand was used as a proxy for foreign prices on the grounds that South Africa is the Mozambique's major trading partner. South Africa accounts for more than 50 per cent of the Mozambican imports. Its importance is also reflected by the weight of the Rand (54.3 per cent against 39.3 6.4 per cent for the Euro and Dollar respectively) in the calculation of the Metical effective exchange rate (Bank of Mozambique 2005).

3 Analytical Framework and Methodology

This section develops a simple theoretical model that forms the bases for the empirical analysis and the choice of the variables. Following Kim (2001) and Ubide (1997), the general price in the economy (P_t) is defined as the weighted average of the price of the non-traded good (P_t^N) and the price of the traded good (P_t^T) such that,

$$P_t = \alpha P_t^T + (1-\alpha)P_t^N \text{, where } 0<\alpha<1 \qquad (1)$$

It is assumed that the price of the traded good is determined in international markets and depends on the nominal exchange rate (E_t) and the foreign price level (P_t^*). Assuming that the absolute version of the purchasing power parity holds ($P_t^T = EP_t^*$), the price of the traded good in logarithms can be expressed as:

$$p_t^T = e_t + p_t^* \qquad (2)$$

It is also assumed that the determination of the price of the non-traded good takes places in the domestic market and is a function of the overall demand in the economy which depends on the equilibrium in the money market ($M^d / P = M^s / P$). Hence,

$$p_t^N = \phi(m^s - m^d) \qquad (3)$$

where ϕ is a 'scale factor representing the relationship between the economy-wide demand and demand for non-traded good' (Ubide 1995:15). A complete and conventional specification would specify the demand for money as function of real income and interest rates. However, studies for developing countries have replaced interest rates by expected inflation on the grounds that there is a limited substitutability between money and interest bearing assets due to the underdevelopment of financial markets. Thus,

$$m^d = f(y_t, E(\pi_t)) \qquad (4)$$

After performing the substitution and collecting terms we obtain:

$$p_t = f(e_t, m_t, p_t^*, y_t, E(\pi_t)) \qquad (5)$$

where the domestic price level depends on money supply, expected inflation, foreign prices, the exchange rate and income[10]. Except the real income, the increase in all other variables would be expected to push up the price level.

In order to investigate the pass-through from exchange rate to inflation, this paper will estimate a four-variable cointegrated VAR of domestic consumer prices, exchange rates, money and South African consumer prices. The model is specified as a vector, $x_t = (p_t, e_t, m_t, p_t^*)$, where, $p_t, e_t, m_t,$ and p_t^* are the logarithms of the domestic consumer price index, the nominal exchange rate, money supply and the South African consumer price index[11].

The advantages of using a cointegrated VAR is that it is based on a VAR methodology under which the behavior of each variable in the model is explained by its own past values and the past values of the other variables. The VAR methodology is very attractive because it does not impose a priori identification constraints on the variables thereby avoiding endogeneity problems. Since there is no certainty as to how money, exchange rates and prices interact, the VAR approach seems to be an appropriate modeling strategy (Deravi et al. 1995). In addition, the dynamics of the variables can be analyzed through impulse response analysis and the relative importance of a group of variables in the model in explaining the variations of a particular variable can be assessed using variance decompositions. Moreover, unlike the unrestricted VAR, cointegration takes into account the long-run relationships between variables.

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[10] Usually, the direction of causation cannot be assigned *a priori*.

[11] It is clear that zero restrictions on income and expectations were imposed in equation (4) due to lack of data.

Beyond the implications of the derived theoretical model, the inclusion of money, exchange rate and foreign prices as key determinants of domestic price level is consistent with previous studies on Mozambique (Ubide 1997 and Omar 2003) and reflects the relevance attributed to these variables by the IMF and the Central Bank of Mozambique in their explanations about inflation dynamics. For example, the Bank of Mozambique identifies exchange rate depreciation as one of the factors explaining annual inflation in all of its annual reports from 2000 to 2006. In many of its reports, the bank also points out money growth beyond the target as a key factor behind missed inflation targets. Similarly, the IMF (2003) names the same factors but with particular emphasis on excessive money growth.

Nevertheless, it should be noted that the model fails to account for demand and supply shocks due to lack of data. In many studies (for example Gueorguiev 2003 and McCarthy 2000) these shocks have been proxied by the output gap[12] and oil prices[13] respectively. In addition, the model does not include proxies for seasonal factors which their importance in explaining inflation dynamics has been confirmed empirically by Ubide (1997). It is expected that some of these seasonal factors can be accounted for by seasonal adjustment of the series. On balance, it is hoped that although this specification only captures monetary and external (imported inflation and exchange rate depreciation) factors of inflation, it can be useful in drawing important policy implications.

[12] Many studies apply the Hodrick and Prescott filter to estimate the potential or trend output required to estimate the output gap as the deviations of the actual output from its potential level. Given the uncertainty involved in the estimation particularly when the underlying data is unreliable, such exercise was deemed irrelevant.

[13] Despite being available, oil prices were not included in the model due to their lack of variability.

Stationarity test

It is important to investigate the statistical properties of the series before moving to the empirical tests. The Augmented Dicky-Fuller test (ADF) is used to determine the order of integration of the series. The test equation is specified as:

$$\Delta p_t = \gamma_0 + \delta p_{t-1} + a_1 t + \sum_{i=1}^{p} \phi_i \Delta p_{t-i} + \varepsilon_t$$

Similar equations can be constructed for e_t, m_t and p_t^*. Δ denotes the first differences of e_t, p_t, m_t and p_t^*. γ_0, δ, ϕ and a_1 are constants, p is the lag length and t a time trend[14]. ε_t is a normally distributed error with mean zero. For series that do not display a time trend (the exchange rate and South African CPI), a_1 is set to zero. The null hypothesis that a particular series has a unit root is rejected if $\delta \neq 0$. However, given the lack of power of the ADF test to reject the null of hypothesis of unit root (Enders 2004), the Phillips-Perron test is used to supplement the ADF results.

If the variables are non-stationary and integrated of the order, one should search for the possibility of cointegration – the existence of a linear combination between the variables which is stationary.

Johansen's cointegration test and error-correction model

Engle and Granger (1987) have shown that cointegration implies the following vector error correction representation:

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[14] The inclusion of a trend in the test equation allows for the possibility of trend stationarity.

$$\Delta x_t^{'} = \mu + \pi x_{t-1}^{'} + \sum_{i=1}^{p} \Gamma_i \Delta x_{t-1}^{'} + \varepsilon_t$$

where μ, $\Gamma_1,\ldots,\Gamma_p$ are (1xn) vectors of parameters, p is the lag length and ε_t is a (1xn) vector of normally distributed disturbances with mean zero. The term $\pi r_{t-1}^{'}$ is the error correction component which augments the traditional Vector Autoregression (VAR) in first differences to account for the error correction mechanism. Its introduction recovers the information lost in the differencing process thereby allowing the model to capture both long-run equilibrium relationships and short-run dynamics (Ang and Mckibbin 2005). It should be moted that n is the number of endogenous variables in the model (in this particular case n=4).

The Johansen's maximum likelihood procedure examines the rank of matrix π. If rank $(\pi) = r < n$, then it can be concluded that there are r cointegrating vectors and matrix π can be written as $\pi = \alpha\beta'$, where β is a matrix containing r cointegrating vectors and α is a (1xn) vector of error correction terms or the speed of adjustment coefficients towards the long-run equilibrium (Enders 2004 and Jonsson 1999). Based on the estimated characteristic roots of π two test statistics (λ_{max} and λ_{trace}) are calculated (Enders 2004:352-353). Both statistics test the null of r=k cointegrating vectors against the alternative of r>k.

4 Empirical results and analysis

The results of the ADF and Phillips-Perron tests are reported in Table 1 in Appendix A. Both tests show that the series a non-stationary in levels but after taking first differences the null hypothesis of a unit root can be rejected at 5 per cent level of significance. Therefore, money, exchange rate and price indexes are I(1).

Motivated by the evidence that the four variables under consideration are I(1), the Johansen cointegration test was applied to domestic CPI, South African CPI, money and the exchange rate. Given the sensibility of the cointegration results to the lag length, the test was preceded by a lag length selection based on the Likelihood Ratio after estimating an unrestricted VAR in first differences. The proposed optimal lag is p=5. This lag was maintained in all the estimations undertaken in this paper.

The results are reported in Table 2 in Appendix A. Both λ_{trace} statistic suggest one cointegrating vector at 5 per cent level of significance. Further evidence of cointegration is provided by the significance of at least one error correction term in Table 3 in the Appendix . Therefore, it can be concluded that money, exchange rate and prices do not move far apart from each other over time.

Using the domestic price level as the normalizing variable the long run relationship can be expressed as:

$$logCPI = 1.25 + 0.10logCPISA + 0.51logM2 + 0.15logZAR$$

The results are consistent with theoretical expectations given that all the estimated parameters have the correct signs and are significant at 5 per cent level of significance. Hence, in the long run, the exchange rate, the South African inflation and excessive money growth have positive impact on domestic price level. Specifically, a 10 per cent increase in money leads to 5.1 per cent increase in the price level. Similarly, a 10 per cent exchange rate depreciation leads to a 1.5 per cent increase in the price level. Moreover, if the South African price level increases by 1 per cent, domestic prices increase by 0.15 per cent.

The associated error correction model is reported in Table 3. When estimating the models, the dependent variable is the monthly percentage change in a particular variable (for example money) and the independent variables are the lagged error correction terms (calculated based on the estimated cointegrating vector) and the lagged values of all the variables in the system. Given that the coefficient of the error correction terms measure the speed of adjustment (short-run dynamics) of a particular variable towards the equilibrium, it can be observed that only domestic prices do adjust following a disequilibrium in the long run relationship. This conclusion, which is supported by the significance and correct sign (negative) of the adjustment coefficient in the price equation, suggests that domestic prices are endogenous. The -0.27 coefficient in the domestic price equation implies that approximately one-third of the disequilibrium in adjusted within one month[15].

Impulse response analysis

A further approach of evaluating the dynamic relationship between the four variables, in particular the effect of money, the South African prices and the exchange rate on domestic prices is to analyze the orthogonal impulse response functions reported in Figure 2. The shocks are standardized to one percent shock so that the vertical axis shows the approximate percentage change in a particular variable[16]. The results indicate that following a one per cent shock in money the price level increases and reaches a peak after 10 months and stabilizes at a long-run effect of 0.4 percent. Similarly, one per cent shock to South African prices stabilizes at the same long-run effect but it takes approximately 15 months which suggests more persistence. In response to a one percent shock in the exchange rate, domestic prices rise during approximately seven months before reaching a

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[15] A less clear result is the suggested exogeneity of money and exchange rates implied by the insignificance of their respective adjustment coefficients.

[16] In estimating the impulse responses, the ordering from the estimation of the log-run cointegration equation was maintained. Domestic inflation was ordered first followed by South African price level and then money and exchange rate.

peak and fall thereafter before becoming negative[17]. The general conclusion from these impulse response functions is that the adjustment process is faster and many of them display the same pattern as in Ubide (1997).

Variance decompositions

The relative importance of the three variables in explaining the domestic price level is assessed by decomposing the variance in the forecast error of inflation into the portions explained by money, South African prices and exchange rates. In orthogonalzing the system, the South African prices are ordered first, followed by money, the exchange rate and prices. This ordering treats the South African prices as the most exogenous variable with contemporaneous effects on the other remaining variables. Money is allowed to affect the exchange rate and prices contemporaneously but not the opposite although in practice, monetary policy can react immediately to shocks in prices and exchange rates. The results are reported in Table 4 in Appendix A for a period of 36 months. They show that most of the variance in the Mozambican consumer prices can be attributed to the South African prices, which accounts for 46 per cent after three periods. Money is found to be relatively more important than the exchange rate at all horizons although none of the variables account for more than 10 per cent of the variation before six months. The results are not robust to alternative ordering at least at short horizons (Table 5 in Appendix A).

Relation with previous results

The coefficients of the estimated long-run relationship between prices, exchange rate and money vary between the three studies despite all having applied the same methodology.

[17] This reversed negative may suggest instability in the underlying VAR

These differences can be attributed primarily to sample variability. Compared to the two previous studies (Ubide and Omar), this paper finds the lowest pass-through coefficient (0.15) although it is not very different from the one obtained by Ubide (0.18). This similarity between the two coefficients could be interpreted as result of a prevalence of similar economic environments during the 1989-1996 and the 2001:2006 periods. However, such conclusion is misleading. What the results seems to indicate is a balance between two determinants of exchange rate pass-through as suggested by Devereux and Yetman (2002). While Ubide's estimation period can be characterized by a relatively higher inflation and less volatile exchange rate, the period covered in this paper features lower inflation and volatile exchange rate as result of current monetary and exchange rate policy. It follows that the relatively higher inflation during 1989-1996 may have exerted a upward pressure on the pass-through while less exchange rate volatility tended to lower the pass-through. The opposite seems to have happened during the 2001-2006 period. Therefore, *ceteris paribus*, the two pass-through coefficients would tend to converge.

It is also interesting to compare whether the relative importance of money and exchange rate changed since Ubide's study. In order to assess that hypothesis, the error forecast variance of domestic prices is decomposed imposing the same ordering used by Ubide. The results (Table 5) show that money still explains a relatively larger share of prices variability than exchange rate although its relative importance diminished. For example, in the 1989-1996 period the exchange rate explained 2.4 per cent of the forecast error variance of prices while money explained 12.44 per cent after 10 months. During 2001-2006, money explained 28 per cent and the exchange rate 9 per cent of the variance during the same time horizon.

Taking the three studies together, the domestic/foreign prices puzzle report by Omar (2003) can be regarded as sample specific and not a general description of the relationship between the Mozambican and South African prices. This is consistent with the Bank's of Mozambique assessment on its annual reports and with the existing strong trade links between the two economies.

Overall, the results are in line with previous findings. First, they confirm that money, the exchange rate and the South African prices are important factors explaining inflation in Mozambique. Second, they add additional evidence to consensus that that pass-through is incomplete. Nevertheless, they leave unresolved the issue regarding to the true size of the pass-through in Mozambique since other two studies (Cirera and Nhate 2007 and Omar 2003) reported a relatively higher pass-through. In addition, pass-through coefficients in countries with better macroeconomic fundamentals have been higher than the one obtained in this study. Therefore, one should be careful when interpreting this results which in part may reflect the small sample problem and the limitation of the modeling strategy (inclusion of only monetary and external factors).

5 Conclusion and policy implications

This paper applied a cointegrated VAR and the associated error correction model to investigate the relationship between domestic prices, South African prices, money and exchange rate in Mozambique. Impulse response analysis were used to trace the response of consumer prices to shocks in money, exchange rate and South African prices while the decomposition of the error forecast variance of prices was applied to assess the importance of each of three variables in explaining domestic price variations.

Consistent with previous studies, it finds that money, exchange rate and South African prices are important factors in explaining inflation in Mozambique. In particular, a 1 per cent exchange rate depreciation leads to a 0.15 per cent increase in the price level, *ceteris paribus*. The impulse response analysis confirm the positive impact of these three variables on domestic prices and provide additional information indicating the adjustment process is fast. Variance decompositions under alternative ordering suggest that the South African prices and money explain most of the variation in domestic prices. In addition, they show that money is relatively more important than the exchange rate in explaining the forecast error variance of the domestic prices although its relative importance seems to have diminished compared to 1989-1996 period. The paper also finds that South African and Mozambican CPIs are positively related which suggests that Omar's results are sample specific and do not reflect a general relationship between the prices levels in the two countries.

However, the present findings should be interpreted with cautious given the methodological and sample limitations. Despite such limitations, the results have important policy implications. First, money, exchange rate and South African prices should continue to be used as important leading indicators of inflation. Second, money can be used as an intermediate target in the conduct of monetary policy given its strong link with prices although its effectiveness can be limited by the importance played by the South African prices in the determination of the domestic prices. Lastly, measures to ensure the exchange rate stability are required not only to provide a predictable environment to exporters but also to support a low inflation monetary policy.

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Appendix A

Figure 1 Inflation and exchange rate growth, 2001:M1-2006:M12

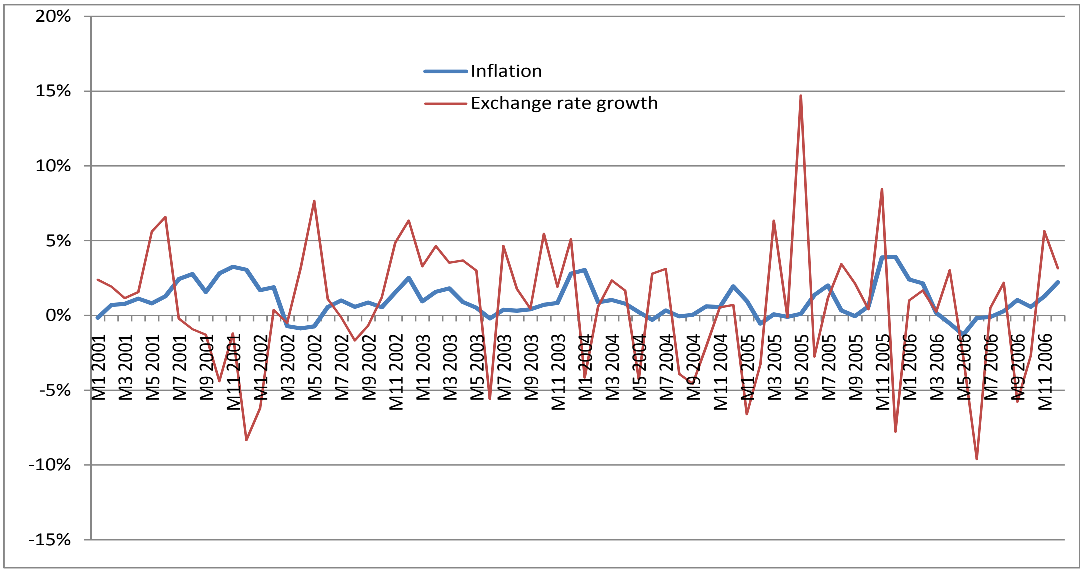

Table 1 Unit root test,

H_0: The series has a unit root					
	Variables in levels (logs)		Variables in first differences		Order of
	ADF statistic	Philliip-Peron Statistic	ADF statistic	Philliip-Peron Statistic	integration
cpi	-2.832**	-2.021**	-4.605*	-4.568*	I(1)
cpisa	-2.758**	-2.756**	-6.964*	-6.970*	I(1)
M2	-3.223**	-3.206**	-8.827*	-8.827*	I(1)
zar	-1.419**	-1.483**	-7.892*	-7.999*	I(1)

Notes: M2 and CPI test include a trend. 5% critical value is -3.473 for M2 and CPI, -2.902 for CPISA and -2.903 for ZAR. *denotes rejection of H_0. **denotes non-rejection of H_0.

Table 2 Cointegration test

Cointegration results, 2001:M1-2006:M12					
H_0	p^a	λ_{trace}	λ_{trace} (5% CV)	λ_{max}	λ_{max} (5% CV)
r = 0	8	51.27	47.86	32.88	27.58
r ≤ 1		18.38	29.80	12.81	21.13

Table 3 Cointegrating vectors and error-correction model

Cointegrating vectors				
p_t^a	p_t*	m_t	e_t	c
1.00	0.84*	-0.33	-0.97*	-2.544374
	[2.09]	[-1.51]	[-3.55]	
Error correction terms				
$d(p_t)$	$d(p_t*)$	$d(m_t)$	$d(e_t)$	
-0.27*	-0.33	0.11	-0.03	
[-5.05]	[-1.22]	[0.59]	[-0.08]	

[a]Used as a normalizing variable. T-statistics in parenthesis. *Significant at 5 per cent level of significance.

Figure 2 Accumulated Orthogonal Impulse Response of Mozambican prices

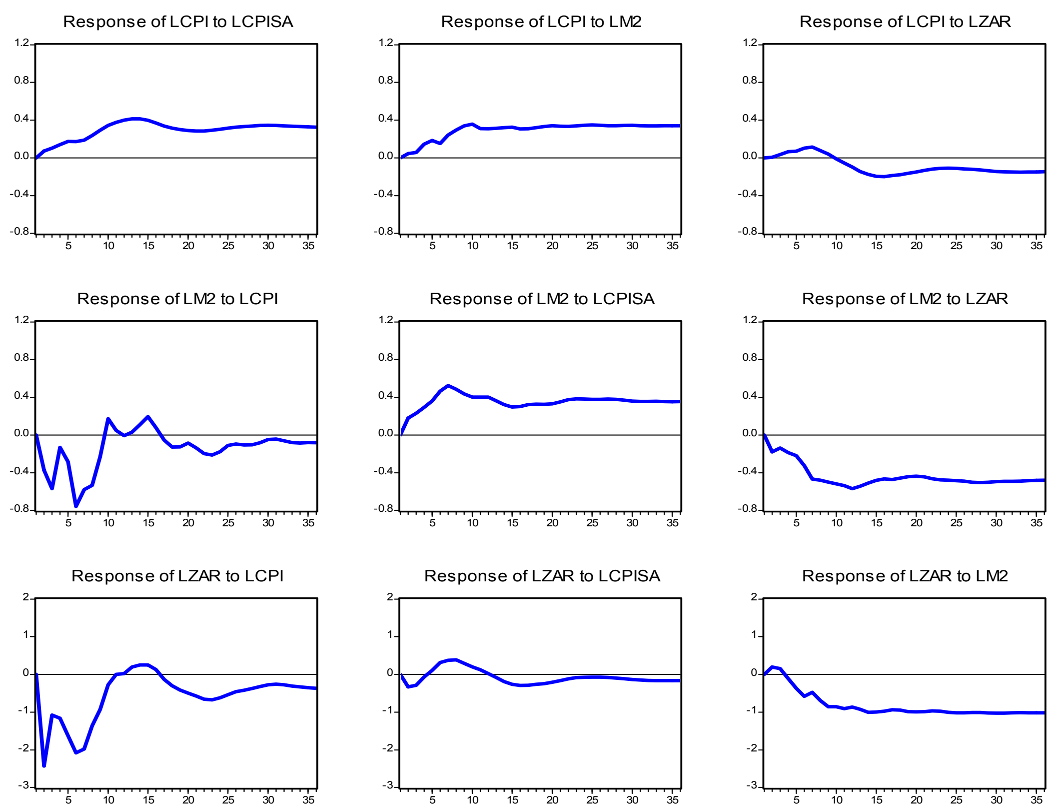

Table 4 Percentage of Variance in Domestic CPI explained by innovations in South African Prices (LCPISA), Money (LM2) and exchange rate (LZAR).

Horizon	LCPI	LCPISA	LM2	LZAR
1	100.0000	0.000000	0.000000	0.000000
3	81.53277	15.79796	1.775061	0.894203
6	39.15046	45.78637	10.06894	4.994227
9	19.11958	58.07488	18.13149	4.674056
12	12.88302	63.62791	19.74684	3.742228
15	11.21582	62.01618	19.52794	7.240055
18	10.91893	58.61033	20.02885	10.44189
21	10.66554	56.31921	21.56242	11.45283
24	10.25557	55.58438	22.89470	11.26534
27	9.738471	55.50775	23.71761	11.03616
30	9.355563	55.31172	24.14661	11.18610
33	9.122309	54.82959	24.45225	11.59585
36	8.969639	54.27817	24.80257	11.94961

Table 5 Table 6 Percentage of Variance in Domestic CPI explained by innovations in South African Prices (LCPISA), Money (LM2) and exchange rate (LZAR).

Horizon	LCPI	LCPISA	LM2	LZAR
1	100.0000	0.0000	0.0000	0.0000
3	83.6399	12.7550	1.4940	2.1111
6	43.3575	32.0403	9.1895	15.4126
9	23.5594	40.1402	10.1143	26.1861
12	18.1893	40.4780	8.2485	33.0842
15	16.1565	36.8244	8.1509	38.8682
18	14.6680	33.4849	8.5241	43.3231
21	13.6814	31.0712	8.1020	47.1455
24	12.9640	29.2671	7.7508	50.0181
27	12.3362	27.9829	8.0558	51.6251
30	11.8210	27.0055	8.8898	52.2837
33	11.4118	26.1979	9.9743	52.4160
36	11.0734	25.5297	11.1032	52.2938

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