Monetary Policy and Exchange Rate Shocks on South African Trade Balance

Mthuli NCUBE and Eliphas NDOU
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(1) Mthuli Ncube and Eliphas Ndou are respectively Chief Economist and Vice President of the African Development Bank, Tunis, Tunisia (M.Ncube@afdb.org) and Researcher at the South African Reserve Bank, Research Department, Pretoria, South Africa (Eliphas.Ndou@resbank.co.za).
Abstract

This paper compares the effects of contractionary monetary policy and exchange rate appreciation shocks of one standard deviation in size, on the South Africa trade balance using recursive and sign-restriction vector autoregressive models. We find that an exchange rate appreciation shock lowers the trade balance as a percentage of the gross domestic product significantly, and over many quarters but not permanently relative to contractionary monetary policy shocks. These findings do not violate the neutrality of exchange rate effects in the long run economic growth. The contractionary monetary policy shocks affect the trade balance through the expenditure switching channel rather than the income channel. The real effective exchange rates explain relatively higher fluctuations in trade balance movements than monetary policy shocks. Both the exchange rate appreciation and monetary policy shocks worsen the trade balance through the imports rather than the exports component. Lastly, contractionary monetary policy worsens the trade balance at the peak in five quarters by more than 0.01 percentage points when allowed to directly affect the exchange rate relative to when its effect is left unrestricted.

**JEL Classifications:** E50, F32, F4

**Key Words:** Monetary policy, trade balance, exchange rate, expenditure-switching effect

Corresponding author’s e-mail address: Eliphas.Ndou@resbank.co.za
1. Introduction

This paper investigates the effects of contractionary monetary policy and exchange rate appreciation shocks on the South African trade balance using vector autoregressions (VARs). We identify the dominant channel between income and expenditure switching through, which monetary policy impact the trade balance and whether policy shocks are transmitted through exports or imports components.¹

There are two theoretical hypotheses linking monetary policy to both exchange rates and the trade balance in open economies discussed in Ivrendi and Guloglu (2010). Firstly, the overshooting hypothesis by Dornbusch suggests that a contractionary monetary policy shock initially leads to the appreciation of the exchange rate followed by a gradual depreciation. The second hypothesis suggests that monetary policy affects the trade balance through either the expenditure switching or the income channel. The expenditure switching effect suggests that contractionary monetary policy leads to currency appreciation through capital inflows, which worsens the trade balance.² In contrast, the income effect shrinks real income and real imports, leading to a trade balance improvement. These opposing effects operate simultaneously, whenever the expenditure-switching effects dominate the income effects, the trade balance deteriorate and vice versa. A depreciation (appreciation) of the domestic currency against other currencies improves (deteriorates) the trade balance, but might worsen (improve) it in the short run, generating a J-curve.

A number of studies have empirically investigated the effects of monetary policy on the trade balance or current account. Nadenichek (2006) investigated the dynamic responses of the trade balance to movements in the real exchange rates between the United States (US) and other Group of Seven (G-7) countries and found evidence of a J-curve in five. Lee and chin (1998, 2006) analysed the relationship among monetary policy, current account and real exchange rate variables for seven industrialised countries, and found that monetary policy shocks explained high volatility of the US current account. Kim (2001) found little evidence of the J-curve in investigating the effects of monetary policy shocks on the trade balance in the United Kingdom (UK), France and Italy. Prasad and Gable (1988) found that an expansionary

¹ The average contributions of South African net exports to real output growth has been negative for long periods, for example, a negative one percentage point (2001-2010) and a negative 0.4 percentage points (1990-2010).
² An exchange rate appreciation makes the values of imported goods and services cheaper relative to exports.
monetary policy improved the trade balance of industrialised economies in the short run and has significant effects on the fluctuations in their trade balances.

This study is motivated by the institutional policy framework and lack of empirical studies that separate the income and expenditure switching effects through which monetary policy affect the trade balance. Firstly, this analysis contributes methodologically by using the sign restriction approach based on the existing empirical literature and structural models, to quantify the trade balance deterioration attributed to exchange rate changes related to the direct and indirect monetary policy effects on exchange rate. In consistency, with South Africa policy discussion, we focus on contributions of trade balance to gross domestic product (GDP); assess the long run neutrality effects of both exchange rate and monetary policy on trade balance. We endeavour to assist policymakers focusing on the trade balance as a potential driver of the economic growth, to identify which component of trade balance between exports and imports is sensitive to these policy shocks. In addition, we identify how much of trade balance deterioration can be attributed to monetary policy directly relative to indirectly affecting the exchange rate, ceteris paribus. We also examine evidence of the overshooting exchange rate puzzle.

Second, the institutional policy issues raised in the New Growth Path (NGP) plan points to growth phase in 2000s with imbalances in the economy shown by persistent trade deficits. Figure 1 shows the gap between the real imports and exports merchandise as percentage of gross domestic output widened since 2003Q4. The NGP also further suggests that trade deficits are funded with short-term capital flows attracted by relatively higher South African interest rates by international standards. Furthermore, the document alludes that strong currency, which allows reductions in interest rates, leads to cheaper imports, lowers manufacturing and tradable-goods sectors competitiveness, and generates consumption in the country’s upper income group. The NGP`s proposed strategies require stronger focus on exports to regions including the rapidly growing economies. At the same time, the NGP plan articulates that monetary policy should do more to support a competitive exchange rate and reduce real interest rates. As shown in Figure 1, the study needs to find whether it is contractionary monetary policy or exchange appreciation that is responsible for widening trade gap since 2003 i.e. the shaded portion.
It is due to these reasons, that an understanding of how monetary policy affects trade balance is very important to give support to competitive exchange rates. In addition, it is very important to distinguish the appropriate channel in which monetary policy affects trade balance either through the expenditure switching channel through adjusting exchange rates or through the income effect. In a bid to identify factors driving the trade gap, this paper includes the relative interest rates, consumption, and exchange rates variables identified in the New Growth Path.

We find that a one standard deviation exchange rate appreciation shocks lower the trade balance as a percentage of GDP significantly over more quarters compared to contractionary monetary policy shocks using recursive and sign restricted VARs. We find weak expenditure switching evidence in a recursive VAR and attribute this to the existence of price and exchange rate puzzles. Removing the price and exchange rate puzzles using the sign restriction confirmed that contractionary monetary policy shock significantly reduces the trade balance indicating the expenditure switching channel rather than the income one. The expenditure-switching evidence suggests that, in the short run, *ceteris paribus*, monetary policy can change the direction of demand between domestic output and imported goods through the exchange rate adjustment. We fail to find evidence of exchange rate overshooting puzzle. Both the exchange rate appreciation and monetary policy shocks worsen the trade balance through the imports rather than the exports component. Monetary policy worsens the trade balance by more than 0.01 percentage points at the peak when allowed to directly affect the exchange rate relative to when the channel is left unrestricted. This means when
fundamental determinants of exchange rate as in sticky price or flexible exchange rate models are weak, changes in monetary policy magnify trade balance decline via the exchange rate.

We organised the paper such that section 2 reviews the literature. In section 3 we explain the recursive VAR models. Section 4 presents the data, while section 5 discusses the empirical results and sign restriction approach. Section 6 gives the conclusion.

2. Literature review

Empirical evidence on the effects of monetary policy on exchange rate has been controversial and most findings confirm that contractionary monetary policy shock effects on an exchange rate are not contemporaneous. Eichenbaum and Evans (1995) found that through following a monetary policy shock, the domestic currency appreciates for a substantial period, which is inconsistent with the predictions of overshooting hypothesis. Grilli and Roubini (1995) analyzed the response of the exchange rate to a contractionary monetary policy shock and found initially a gradual appreciation of the exchange rate and then the appreciation is followed by gradual depreciation. This exchange rate response is referred to as delayed overshooting puzzle and is a violation of the uncovered interest parity condition. Scholl and Uhlig (2008) indicated that there may be a forward discount puzzle even without delayed overshooting. Jang and Ogaki (2004) using SVECM found that a contractionary monetary policy leads to an appreciation in domestic currency after the shock and the peak response occurs within four months and carried on for five years. They claimed that they found evidence for the overshooting behavior of exchange rate.

The other hypothesis that relates monetary policy to trade balance is called the J-Curve hypothesis. This hypothesis suggests a real depreciation of domestic currency lowers the relative price of domestically produced goods, which in turn increases the exports and reduces the imports of the country. The J Curve argues the trade balance adjustment is not

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3. This violation is referred to as forward discount puzzle. It is also reported in Leeper et al. (1996), Clarida and Gali (1994), and Kim (2001, 2005).

4. The theoretical literature on monetary policy and trade (or current account) imbalances has recently focused on open macroeconomic models that allow short-run price (or wage) rigidities, market imperfections and international capital mobility. These models let researches to analyze the impact and dynamic effects of monetary policy shocks, in the presence of sticky prices, market imperfection and capital movements, on various macroeconomic variables.
immediate since quantities of imports and exports do not adjust leading but the value of imports rise leading to a trade balance deficit. This means that the trade balance deteriorates due to the depreciation of domestic currency in the short run. The expansionary monetary policy on trade balance causes a trade deficit and then leads to a trade surplus giving an impression of J curve.

Koray and McMillin (1999) also found that the trade balances’ response to monetary policy confirmed the evidence for the J-curve hypothesis. Nadenicheck (2006) investigated the dynamic responses of the trade balance to movements in the real exchange rates between the US and other G-7 countries and found evidence of a J-curve in five countries. Lee and Chin (1998, 2006) analysed the relationship among monetary policy, the current account, and real exchange rate variables for seven industrialised countries. They found a J-curve and that monetary policy shocks explained high volatility of the US current account. Lane (2001) used a set of VAR models using different alternative schemes in exploring the role of monetary policy shocks in the US current account, and found evidence consistent with a J-curve and that monetary policy explained high volatility of the US current account.

The traditional Mundell–Flemming–Dornbusch (MFD) predicts that a monetary expansion leads to depreciation in the nominal exchange rate and a deterioration of the terms of trade. This adjustment resulting in improved trade balance is known as the expenditure-switching effect however the income-absorption effect occurs when this same policy stimulate domestic demand, through increase in imports worsening the trade balance. While the two effects move the trade balance in opposite directions, the movements of the trade balance are determined by the dominant effect (Kim 2001). Kim (2001)’s results are consistent with the expenditure switching effect, but there is little evidence of the J-curve effect. Ivrendi and Guloglu (2010) found that a contractionary monetary policy shock leads to an improvement in the trade balance, contradicting the findings of trade puzzles reported in many empirical studies. Prasad and Gable (1998) concluded that monetary expansion in most industrial economies is linked, in the short run, to the improvement in the trade balance and has significant effects on trade-balance fluctuations.
The effects of monetary policy and the exchange rate on the trade balance are an important topic among academics and policy-makers because of the policy implications. However, the empirical results tend to provide conflicting results. The econometric investigations of monetary policy shocks on the trade balance have been done using multivariate models such as VAR, SVAR, SVECM and VECM. Various models estimated used certain assumptions such as the cointegration relationship among variables and through imposing other structural restrictions. Ivrendi and Guloglu (2010) argue that most of the conflicting empirical results in empirical literature are due to the consequences of restrictions imposed on the models stated above.

Ivrendi and Guloglu (2010) investigated the relationships among monetary policy shocks, the exchange rate and the trade balance in five inflation-targeting countries using SVECM, with both long-run and short-run restrictions. These parametric VAR models are criticised for failing to produce models where shocks have the desired properties resulting in price and exchange rate puzzles. These puzzles have been reported in literature applying recursive VAR approach. In addition, recursive results are sensitive to changes in the ordering of variables (Sarno and Thornton, 2004). An alternative approach to overcoming the criticism was proposed by Uhlig (2005), a less structured approach in which the shock is identified by sign restrictions satisfying the prior economic understanding of how a particular shock should behave. Fratzscher et al. (2010) used sign restrictions to analyse the US current account.

3. VAR methodology
We estimate two VAR models, a recursive model and a sign-restricted VAR model (see Uhlig, 2005; Mountford and Uhlig, 2009). The latter model imposes sign restrictions on the impulse responses of a set of variables. We adopt the methodology in Fratzscher et al. (2010) to estimate a VAR in an open-economy framework to account for the international transmission mechanism. We express these variables in a vector $Y_t$ in equation [4].

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5 Structural Vector Autoregression models (SVAR), Structural Vector Error Correction Models (SVECM), Vector Error Correction Models (VECM).
6 The long-run restriction imposed in the model suggests that money has no effect on the real macroeconomic variable in the long run. This assumption is consistent with both the Keynesian and monetarist approaches.
7 Uhlig (2005) imposed the sign restrictions for several periods. Unlike Canova and de Nicolò (2002), the Uhlig (2005) identification was based on impulse responses and not on cross correlations.
\[ Y_t = [c - c^*, p - p^*, i - i^*, exch, tb]' \]

where South African variables are consumption \( (c) \) and the exchange rate \( (exch) \), inflation rates \( (p) \), the money-market interest rate \( (i) \) and the trade balance \( (ib) \) expressed as a percentage of the South African GDP. Ivrendi (2010) used the trade balance (TB) approximately measured in terms of logarithms of the ratio of nominal exports to nominal imports following the precedent in Koray and McMillin (1999) and Singh (2002). They indicated that the log form of the ratio of export to import is either the export/import ratio or the export coverage of imports, which is true. Their reason for using the logarithm of the ratio of export to import approach was to reduce the scale and not to destroy the statistical properties of the cointegration equations. They were aware that some authors defined the trade balance as exports minus imports, such as Fisher and Huh (2002) and Kim (2001). However, we use the difference between exports and imports, and interpret the information in terms of trade balance as a percentage of GDP. US variables are private consumption \( (c^*) \), inflation \( (p^*) \) and federal funds rate \( (i^*) \). We define the private consumption gap by \( (c - c^*) \), the inflation gap by \( (p - p^*) \) and the interest rate gap is denoted by \( (i - i^*) \), and we use the real effective exchange rate \( (REER) \) in the main analysis. We use relative variables because both the trade balance and exchange rates are essentially relative flows or prices as done in Fratzscher and Straub (2009). Expressing consumptions, inflation rates and interest rates as relative variables is consistent with this empirical specification.

The study controls for the US effects due to a number of reasons. Firstly, the global economy has remained uncertain following the onset of the 2007 US financial crisis and the subsequent global recession in 2008. Secondly, an unexpected decline in US consumption due to a recession reduces demand for foreign goods, distorting the foreign trade balance and unprecedented currency changes.\(^9\) Thirdly, the unexpected huge US quantitative easing programme lowered interest rates and widened the relative rates, prompting capital flows into emerging markets, and appreciating these currencies hence distorting trade balances. All

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\(^9\) Current-account theory suggests that a country with trade balance deficit should expect its currency to depreciate but this will depend on elasticity of demand and supply of goods and the Marshal Lerner condition.
these unexpected effects induced global trade imbalances, thereby affecting growth projections since 2010.

3.1 The recursive VAR model

We start the methodological analysis by describing the recursive model and explain the ordering of variables. The relative consumption \( (c - c^*) \) is ordered first, indicating that the variable is affected with a lag by other variables and we assume that the variable is mainly determined by exogenous factors. The relative inflation rate \( (p - p^*) \) is ordered second, suggesting that relative consumption affects it contemporaneously, consistent with demand–pull inflation. The relative interest rate \( (i - i^*) \) variable is ordered third, indicating that both relative consumption and inflation rates have a contemporaneous impact. This is consistent with a monetary policy reaction that considers demand factors such as consumption and inflation rate variables in decision-making process. The exchange rate is ordered fourth, suggesting contemporaneous impacts from the consumption, inflation rates and interest rates. The trade balance is ordered fifth, implying all other variables have a contemporaneous effect on it.

There are policy implications for monetary authorities that are consequential from the manner in which contractionary monetary policy shocks affect the trade balances.\(^{10}\) The negative trade balance response indicates the dominance of the expenditure-switching effect over the income effect. In this instance, a higher interest rate worsens the trade balance through appreciating the exchange rate. A positive trade balance response points to the dominance of income effects over expenditure-switching effects. The income effect shrinks real GDP and real imports, leading to a trade balance improvement. Finding any evidence consistent with expenditure switching implies that monetary policy can influence the shift between domestic and imported goods through the exchange rate adjustment. Lastly, theory predicts that exchange rate appreciation worsens the trade balance whereas depreciation improves it, assuming the Marshal Lerner condition holds. However, the trade balance may deteriorate (improve) in the short run before improving (worsening) in the long run, giving a J-curve effect after a currency depreciation (appreciation).

\(^{10}\) These effects move the trade balance in opposite directions, hence the dominant effect determines the sign on the trade balance.
4. Data

We use quarterly (Q) data obtained from the International Monetary Fund’s (IFS) database in the period of financial liberalisation, beginning in the first quarter of 1983 and ending in the second quarter of 2010.\textsuperscript{11} South African variables include inflation rates, interest rate, consumption values, the nominal effective exchange rate (\textit{NEER}), the all-share stock price index, the real effective exchange rate (\textit{REER}), rand–dollar exchange rate (\textit{RAND}) and the trade balance as a fraction of GDP.\textsuperscript{12} The US variables are the federal funds rate representing the interest rate, S&P 500 for stock prices index, the inflation rate and the consumption index. We calculated the consumption indices by deflating the values by their 2005 average value as the base year. Indices are independent of units of measurement and eliminate problems of using currencies as units of measurement.

Figure 2 shows the time paths of all variables for South Africa and US. We plot some variables together. The first column in Figure 2 compares the South African variables with the US equivalents. The solid lines represent South African variables and the dotted lines represent US variables. Firstly, the South African consumption index was lower than the US consumption index between 1983 and 2005. Secondly, the South African inflation rates were higher than the US inflation rates except in two periods between early 2000 and around 2004. Thirdly, over all the horizons, the South African money-market interest rates exceed the US federal funds rate, in most cases mimicking the trends of the US federal funds rate. Fourthly, the South African Al-Share Index (Alsi) tracked the US S&P 500 stock index for most periods until it rose above it in 2006.

\textsuperscript{11} Aron et al. (2001) indicated that 1983 saw the ending of agreements among commercial banks which limited competition and it was a period that saw a large number of new banks being allowed to start new operations.

\textsuperscript{12} The trade balance is divided by gross domestic product. The variables are extracted from the IFS data and the initial study was across many countries.
5. Empirical results

This section report results from the recursive VAR and those from the sign-restriction approach. All shocks are one standard deviation in size. We estimate the VARs using three lags selected by the Akaike information Criterion (AIC). The estimation strategy in both approaches starts from a simple VAR and moves upwards in terms of the model size. The interest rates, inflation rates and trade balance variables are in percentage form. However, all other variables are estimated in logged levels and multiplied by 100 to express them as a
percentage deviation from their trend. This analysis compares mainly the exchange rate appreciation and contractionary monetary policy shocks effects on the trade balance in South Africa. In the next section, we discuss the impulse responses from the sign-restriction VAR arising from two shocks in a benchmark VAR with shocks set to last at least four quarters. This follows similar specification in literature.

5.1 Recursive VAR results

The analysis starts by focusing on the effects of monetary policy and exchange rate shocks using the recursive VAR–Choleski approach with variables ordered as in equation [4]. The recursive VAR is estimated with three lags chosen by AIC and three dummies namely, (1) South Africa’s adoption of inflation targeting framework, (2) the Asian crisis and (3) the recession in 2009. The impulse responses are shown in Figure 2, with columns denoting the shocks and rows the responses.

The two main shocks we discuss in detail are shown in columns three and four in Figure 2. The exchange rate appreciation shock denoted by a rise in real effective exchange rate (REER) worsens the trade balance between three and eight quarters. This suggests that exchange appreciation works through lowering exports or increasing imports. As predicted by theory, the exchange rate appreciation significantly lowers the inflation differentials but insignificantly reduces consumption, whereas the interest rate declines significantly on impact only.

The second shock is a monetary policy shock, which increases relative interest rates. This policy shock leads to a significant rise in interest rate and insignificantly worsens the trade balance. The slight deterioration (although insignificant) in the trade balance suggests that the monetary policy shock affects the trade balance through the expenditure switching channel in the short run. We find a significant rise in inflation rates, indicating a price puzzle, while the exchange rate depreciation upon impact points to an exchange rate puzzle. These empirical puzzles can be eliminated by applying the sign-restriction VAR methodology.
The consumption shock, which tends to be persistent in nature, leads to a transitory significant increase in inflation rate; however, the upward pressure on the interest rate is insignificant. The inflation shock has no significant impact on consumption and the trade balance while the exchange rate depreciates slightly. The transitory rise in interest rate suggests that the interest rate tends to rise to dampen inflation pressures. Lastly, the trade balance shock has a significant positive effect on consumption, suggesting perhaps the positive impact of income linked to higher earnings from exports on consumption. The persistent increase in consumption puts insignificant upward pressures on inflation rate.
5.2 Adding equity shock

The robustness test includes the relative equity variable motivated by unexpected developments in 2010 after the US quantitative easing programme that lowered interest rates towards zero. Large amounts of capital inflows tend to appreciate exchange rates, which influence the trade balance. Asset-price movements are more positive correlated globally, such that an increase in equity values in South Africa may reflect an even stronger rise in equity values in the United States.\(^1\) Moreover, during the 2010 foreigners invested their capital into the stock and bond market in South Africa and the carry-trade activity appreciated the trade-weighted exchange rates and domestic currency. The relative equity \((eq - eq^*)\) variable represents the difference between the South African Alsi \((eq)\) and the US S&P 500 index \((eq^*)\). There are two reasons for including this variable. Firstly, the relative equity variable is included due to unprecedented capital inflows to the bonds and stock markets of emerging-market economies in 2010. We suggest that the stock market variables affect the trade balance indirectly by affecting the exchange rate and directly through the wealth channel. Secondly, Tobin’s q theory suggests that when the market price of the firms is high relative to replacement cost of capital, new plants and equipment become cheaper relative to the market value of the firm (Mishkin, 2007). An investment spending will increase since firms can buy many new investment goods with small issuance of equity. An increase in investment should worsen the trade balance.\(^{13}\)

Figure 3 shows the expanded version of the recursive VAR after including relative equity prices. The relative equity is ordered above the trade balance. We also placed relative equity below the trade balance, suggesting that equity markets respond to all variables. The inclusion of the equity variable did not alter the conclusions from a smaller VAR model. The monetary policy leads to significant declines on the relative equity variable. This suggests that the initial findings are robust to the inclusion of equity shocks. Consistent with empirical findings, the equity shock has a transitory positive effect on consumption and exerts slight inflation pressures. The relative equity shock has no significant impact on the trade balance.

\(^{13}\) This arises from defining the trade balance (TB) equals national savings (NS) minus investment (I), that is, TB = NS - I. Hence, investment on capital purchased from abroad would deteriorate the trade balance.
Based on these findings, we conclude that the exchange rate appreciation shock lowers the trade balance as a percentage of GDP significantly and for longer periods compared to monetary policy effects. The conclusion is robust to the model size, and is independent of the ordering of variables such as placing relative equity before exchange rate or equity before and after trade balance, to alternative exchange rates such as NEER and rand–dollar rates. We find that the exchange rate and price puzzles due to a monetary policy shock persists after the inclusion of relative equity variables. As such, the next section applies a sign-restriction VAR approach to eliminate the exchange rate and price puzzles by imposing signs based on economic theory as shown in Table 1. In addition, the sign-restriction VAR is not affected by the ordering of the variables.
5.3 Sign restriction VAR

We make two distinct specifications of the sign restriction method for two purposes (1) to correct the wrong exchange rate response and examine exchange rate overshooting hypothesis (2) to examine expenditure switching effects.

There are several advantages of using sign-restriction VAR relative to the recursive VAR model. Firstly, by design, this methodology eliminates the price and exchange rate puzzles. Secondly, Fry and Pagan (2007) argue, on balance, that sign-restriction methodology has provided a useful technique for quantitative analysis, especially when variables are determined simultaneously, such as the exchange rate and interest rate, making it harder to justify any parametric restrictions to resolve the identification problem.14 Thirdly, Granville and Mallick (2010) argue that the sign-restriction method is robust to the non-stationarity of series, including structural breaks. Fourthly, methodological Fratzscher et al. (2010) argues that the sign restrictions gives results independent from the chosen decomposition of the variance–covariance matrix because different ordering does not change the result.

The benchmark sign restriction VAR specification in Table 1 identifies the contractionary monetary policy and exchange rate appreciation shocks, which should last at least four quarters (see Fratzscher, 2010 and Uhlig 2005). The signs imposed follow the literature empirical specifications that uniquely identify these shocks and not shocks that are already included, or those excluded in the model specification and have economic meaning. Consequently, the model does not impose any long-run restrictions on any variables.15 The long-run effects of these shocks on the trade balance are left open by design for the data to decide. The contractionary monetary policy and exchange rate appreciation shocks represent an unanticipated one-standard deviation increase.16

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14 However, Scholl and Uhlig (2008) rejected to embrace Fry and Pagan’s (2007) argument related to the non-uniqueness of the median impulse response in sign restrictions as an issue arising generally with all identification procedures. Even the latter authors admit that identification issues affect all forms of VARs, not only those using sign restrictions. Structural vector autoregression models (SVARs), structural vector error correction models (SVECMS), vector error correction models (VECM).

15 According to Rafiq and Mallick (2008), the sign restriction approach does not impose any cointegrating long-run relationship between variables and does not preclude their existence.

16 The trade balance is a gap variable between aggregated exports and imports from trading partners.
The signs in Table 1 follow the predictions of conventional theories and previous empirical evidence. However, there is a specific transmission sequence of these effects. The monetary policy shocks suggest that interest rate increases lead to currency appreciation that exerts downward pressure on inflation through lowering the import component. In addition, the effect of monetary policy shocks on consumption is unrestricted and left for the model to decide. In addition, the effect of contractionary monetary policy shocks on consumption is unrestricted and left for the model to decide. The aggregated consumption measure comprises of durable, non-durable and services components. These components react differently to an interest rate shock, with most literature suggesting durable goods being more interest sensitive than both nondurable and services. Therefore, the specifications leaves consumption unrestricted to avoid prejudging such an outcome for the model to decide. The exchange rate appreciation shock is defined by decreases in both relative inflation and interest rates, whereas relative consumption increases. An exchange rate appreciation would lower the domestic prices of imports hence the inflation rate, prompting a decrease in the interest rate that stimulates domestic consumption. Table 2 shows the specification where the effect of monetary policy on the exchange rate is left unrestricted. This specification suggests the exchange rate may respond in either direction reflecting many fundamentals rather than monetary policy effects. Hence, we will be in position to identify the expenditure switching effect after eliminating the price puzzle.

### Table 1 Sign restriction VAR specification (Model 1)

<table>
<thead>
<tr>
<th>Shocks</th>
<th>c-c*</th>
<th>p-p*</th>
<th>i-i*</th>
<th>exch</th>
<th>tb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monetary</td>
<td>?</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>?</td>
</tr>
<tr>
<td>Appreciation</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>?</td>
</tr>
</tbody>
</table>

17 The restrictions identifying the monetary policy shocks are standard and widely accepted in the sense that restrictive monetary policy shocks cause interest rates to increase the exchange rate to appreciate price level to fall (not clear).

18 Rafiq and Mallick (2008) imposed a similar restriction that a positive interest rate shock should appreciate the exchange rate. Moreover, Krugman (2003) shows diagrammatically that a high interest rate should appreciate the domestic currency.

19 Pilbeam (2006) showed that the consumer price index is calculated using the weighted exports and import components. Hence, a domestic currency appreciation should lower import component of consumer price index. Fratzscher (2010) showed the same sequence of events using the similar logic.
We proceed to use sign restriction approach and impose the signs to remove the exchange rate and price puzzle. Hence, we remove not only the wrong exchange response but also the delayed overshooting phenomenon reported in literature. We start by examining the distribution of the initial impacts of exchange rate and trade balance response to contractionary monetary policy using a VAR with two lags selected by AIC. We are more interested in the direction of the initial response, which might be negative, positive, or no response at all. We do this for two reasons (1) to see if we had eliminated the wrong exchange rate impulse response (2) to examine if there are differential responses to monetary policy shock under two scenarios; leaving unrestricted the effect of policy rate on exchange rate and when monetary policy can affect exchange rate. The responses are shown in Figure 5.

**Figure 5. Initial responses of exchange rate and trade balance to monetary policy shocks**

Figure 5 shows the distributions of the initial responses of both exchange rate and trade balance responses to a monetary policy shock. The first part of the Figure 5 shows the two variable’s responses to policy rate shock when monetary policy directly affect the exchange rate. The second part shows same variable’s responses to same shock when monetary policy effects are not restricted to affect exchange rate. While there is any equal chance that exchange appreciates on impact, the more bars to right hand side of zero in each graph imply
appreciation. Hence, we conclude that REER is more likely to appreciate on impact. Similarly, the trade balance distribution is more skewed to the left side indicating a much more likelihood to fall from the indirect compared to direct policy effects on exchange rate. These dynamics on initial impact show that the effects of contractionary monetary policy on both exchange rate and trade balance tend to be more pronounced when getting rid of the exchange rate puzzle.

5.3.1 Examining the delayed overshooting exchange rate evidence

The overshooting exchange rate puzzle takes place when an increase in interest rate differential on domestic assets is associated with persistent appreciation of domestic currency due to contractionary monetary policy shock as shown in Figure 6. This delayed overshooting exchange rate is consistent with evidence that the forward exchange rate is a biased predictor of future spot rate. If uncovered interest parity holds, it implies a positive innovation in domestic interest rate relative to foreign ones should lead to persistent depreciation of the domestic currency over time after impact appreciation. The solid (dotted) line in Figure 6 shows the path of REER after contractionary monetary policy shock as predicted by uncovered interest rate parity (overshooting exchange rate puzzle).

**Figure 6 Delayed exchange rate overshooting puzzle**

![Delayed exchange rate overshooting puzzle](image)

NB. An increase in Rand/dollar implies a domestic currency depreciation following a positive interest rate differential. In addition, a decrease in REER implies depreciation to similar shock.

The sign-restriction VAR approach uses shocks defined in
Table 1 with the impulse responses representing the median impulse and the bands represent the 16 and 84 percentiles based on our inferences on 10,000 replications. Figure 7 shows the comparison of the REER appreciation and monetary policy shocks on the trade balance measured by one-standard deviation shocks. An REER appreciation shock as defined in Table 1 significantly worsens the trade balance between 2 and 11 quarters, and the maximum decline occurs between 3 and 4 quarters. The interaction between the interest rate and the exchange rate conforms to the dynamics implied by the forward discount bias routinely recorded in empirical work on exchange rates. The forward discount bias predicts currency depreciation after an exchange rate appreciation. Our finding is consistent with the interpretation of an interest rate response indicated by a monetary policy reaction function. Thus, an exchange rate appreciation shock lowers the inflation rates, leading to a reduction in the short-term interest rates as price pressures subside.

**Figure 7 Exchange rate appreciations and contractionary monetary policy shocks**

NB. All shocks are one standard deviation in size

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20 According to Uhlig (2005), the quantiles represent a one-standard deviation under the normal distribution. While in empirical studies the 2.3 per cent and 97.7 per cent quantiles represent a two-standard deviation band in a normal distribution. A high number of replications introduce higher uncertainty surrounding the estimates of the percentiles.
5.3.2 Examining the expenditure switching evidence

This section investigates the expenditure switching evidence through leaving unrestricted the direct impact of monetary policy on exchange rate, that is, we let the data to decide the response of exchange rate to contractionary monetary policy shock. The expenditure-switching evidence implies that monetary policy can influence the shift in the composition of domestic output between domestic goods and imported goods over the identified period. The results are shown in Figure 8. Similarly to the earlier, the significant decline in trade balance response between 2 and 5 quarters to the contractionary monetary policy shock, suggests that the expenditure-switching effect dominates the income effect over this period. These conclusions are robust to different quarters, such as 6 and 8 quarters for which the shock effects were expected to last.

Figure 8 Examining expenditure switching effects

NB. All shocks are one standard deviation in size
We compare the responses of trade balance to the two versions of monetary policy shocks in Figure 9. We graph the two impulses together to find if there are significant differences in the sizes of the trade balance responses differences between two definitions of contractionary monetary policy. Both parts A and B show no significant differences in trade balance decline. Part C shows the exchange rate responses to monetary policy shocks. The exchange rate appreciates more when monetary policy affects it directly (Model 1) than when it is left unrestricted (Model 2). This possibly explains why the trade balance deteriorates more when monetary policy is restricted to appreciate the exchange rate. Part D of Figure 9 shows the difference in the responses of trade balance (bar graph) to monetary policy shocks using models 1 and 2. The trade balance gap between the two impulse responses suggests that monetary policy effects are potent via the exchange rate. 21

Figure 9 Quantifying the trade balance decline due policy rate via exchange rate

NB. All shocks are one standard deviation in size. Thick solid line represents the error bands of impulse responses while thin and dotted middle line denote the impulse responses. The bands in A are from Model 1 while bands from B are from Model 2. The thin middle line represents trade balance response to various shocks with contractionary monetary defined using Model 1 and dotted line similar shock using Model 2.

21 Gap is difference in trade balance responses when monetary policy is restricted to appreciate exchange rate and when its effects are not restricted.
We also test the channels through, which the exchange rate and monetary policy shocks affect the trade balance through looking at imports and exports as percentage of gross domestic output. Exports and imports variables are left unrestricted in both specifications. The results shown in Figure 10 shows that exchange rate appreciation (first row) and monetary policy shocks (second row) worsen the trade balance through the imports rather than the exports channel. However, the rise on import variable suggests this component is significantly responsive to exchange rate appreciation than to monetary policy shocks in both figures. In addition, the imports rise by more when monetary policy influences the exchange rate than when it is left unrestricted.

Figure 10 Imports and exports responses to one standard deviation monetary and exchange rate shocks

NB: All shocks are one standard deviation in size. Thick solid line represents the error bands of impulse responses while thin and dotted middle line denotes the impulse responses. The thin middle represents trade balance response to various shocks with contractionary monetary defined using Model 1 and dotted line similar shock using Model 2.
The analysis goes a step further to assess the robustness of the preceding findings to using two shocks using the G7 as trading partner. Similar to the findings in the preceding sections, the exchange rate appreciation shock worsens the trade balance as percentage of gross domestic output in Figure 11 more than the monetary policy shocks. Differences are visible in the magnitudes upon impact and peak periods and the trade balance response with US data (solid line) lies below the same variable response using G7 data (dotted line). This points to the importance of US developments on South African trade balance. A similar trend is visible when assessing the trade balance responses to the contractionary monetary policy which has left exchange rate unrestricted (Model 2).

**Figure 11 Comparing trade balance responses using US and G7 data on expenditure switching effect**

![Graphs showing trade balance responses](image)

NB. All shocks are one standard deviation in size. Solid median line refers to model with US variable and dotted middle line refers to model with G7 data. Changes in trade balance refer to differences between median impulse using US and G7 data. Bands are from model with US variables.

Furthermore, we find purging the direct effects of monetary policy on exchange rate using the G7 data makes monetary policy less powerful.\(^{22}\) The trade balance as percentage of gross domestic output in Figure 11 more than the monetary policy shocks. Differences are visible in the magnitudes upon impact and peak periods and the trade balance response with US data (solid line) lies below the same variable response using G7 data (dotted line). This points to the importance of US developments on South African trade balance. A similar trend is visible when assessing the trade balance responses to the contractionary monetary policy which has left exchange rate unrestricted (Model 2).

\(^{22}\) See Figure A.3 for more full effects of exchange rate appreciation and contractionary monetary policy on trade balance using G7 data.
domestic output declines (insignificantly) suggesting that monetary policy shock still operates through the expenditure switching channel. We conclude that letting the monetary policy to impact exchange rate anyhow using the G7 data alters the significance and not the expenditure switching effect suggesting that aggregation introduced some biases in the results.

5.4 Robustness based on augmented VAR model

The robustness tests rely on three additional shocks defined through the inclusion of the relative equity variable motivated by unexpected developments in 2010. The relative equity \((eq – eq^*)\) variable represents the difference between the South African Alsi \((eq)\) and the US S&P 500 index\((eq^*)\). Two additional shocks defined in Table 3 are equity appreciation and private absorption shocks. Private absorption is very important because consumption contributes about 59–63 per cent to the South African GDP. This is by far the highest contribution relative to other components of the GDP.

Table 3 Additional shocks for robustness analysis

<table>
<thead>
<tr>
<th>Shocks:</th>
<th>c- c</th>
<th>p-p</th>
<th>i-i</th>
<th>exch</th>
<th>eq-eq</th>
<th>tb</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equity</td>
<td>+</td>
<td>?</td>
<td>+</td>
<td>?</td>
<td>+</td>
<td>?</td>
</tr>
<tr>
<td>Private absorption</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

Table 3 defines the equity shock by imposing restrictions such that an increase in relative equity prices leads to increases in both relative interest rates and consumption (see Fratzscher et al., 2010). The signs imposed on the relative equity variable have empirical VAR support. Bjørnland and Leitemo (2009) found that short-term interest rates increased following a positive stock price shock using a VAR with a combination of short- and long-run restrictions. In addition, Rigobon and Sack (2003) found that interest rates significantly increased in response to higher equity prices using an identification method based on heteroscedasticity of the data. A 10 per cent stock-market wealth appreciation increases consumption by 1 per cent in South Africa (IMF, 2004). Consumption rises in response to a

---

23 Aron et al. (2007) found significant wealth effects for South Africa. They found the marginal propensity to consume (MPC) out of net liquid wealth estimate of 0.2; an MPC out of directly held illiquid financial wealth of around 0.08 and MPC out of housing of 0.10.
positive equity shock through the canonical wealth effect (Fratzscher et al., 2010, Di Giorgio and Nistico, 2007).

Barnett and Straub (2008) suggest that private absorption shocks may be caused by a change in the time preferences rate hence Table 3 adopts their restrictions. Private absorption shock is defined by imposing positive restrictions on relative consumption, inflation rates, and interest rates. We make sure that the shocks in Table 3 do not define shocks already specified in the main model. Both private-absorption and monetary policy shocks lead to an increase in interest rates. However, private absorption leads to increases in consumption and inflation rates, but the latter variable declines under a monetary policy shock representing a shift in the consumption function towards domestically produced goods, which exerts upward pressure on prices and interest rates. According to Krugman (2003), the exchange rate should appreciate but we left the sign on this variable unrestricted for the model to decide.

Some shocks identified using sign restrictions may, partly reflect other shocks, for example, increases in equity price may be due to productivity shocks.24 Our identification procedure ensures that the productivity shocks differ from equity shocks (see Fratzscher et al., 2010). The productivity shocks lead to increases in equity prices but lower interest rates and domestic prices, while the latter rise in response to equity price shocks. On the contrary, a productivity shock that increases output would reduce unemployment that puts upward pressure on wages and consumer price inflation. In this situation, monetary authorities concerned with price stability would tighten the interest rates. Even under this transmission channel, the equity shock differs from the productivity shock as the relative price levels are left unrestricted.25

24 Moreover, we impose no zero restrictions to avoid the difficulties in rationalising structure in the basis of conventional theories of the current account.
25 They showed the signs of the responses of relative consumption. Relative interest rates were similar in response to both house and equity prices shocks. However, equity shocks differ from housing shocks, as these are identified as the shocks with the largest contemporaneous impact on equity prices, whereas the response of house prices to equity is uncertain.
Figure 12 Trade balance responses to various shocks

NB. All shocks are one standard deviation in size. Thick solid line represents the bands of impulse responses while thin and dotted middle line denotes the impulse responses. The thin middle represents trade balance response to various shocks with contractionary monetary defined using Model 1 and dotted line similar shock using Model 2. The bands are from model using main shocks.

The dynamics of the trade balance in Figure 12 are virtually identical to preceding results. The collective responses from the various shocks are in Appendix A. The trade balance deteriorates significantly between 2 and 11 quarters after an exchange rate appreciation shock, which is relatively a longer period compared to effects of the monetary policy shocks. This suggests that an exchange rate appreciation shock dominates the monetary policy shock by significantly worsening the trade balance. In contrast, neither the private absorption nor equity appreciation shocks have significant influence on the trade balance movements. Figure 13 plots all four shocks to trade balance for comparative analysis. The contractionary monetary policy shocks have a big effect on trade balance in first four quarters than exchange rate appreciation shocks and the later remains persistent depressed. The equity appreciation and private absorption shocks show similar trends.
5.5 Variance decomposition

This section examines the variability between monetary policy, exchange rates and other shocks in explaining trade balance fluctuations. We show in Table 4 the forecast error variance decompositions for various shocks. All shocks tend to explain a smaller fraction from the first quarter and converge to high values over the longer horizons. The REER shocks explain more volatility in trade balance movements than monetary policy shocks, whereas the rand appreciation induces slightly less variability over all horizons. The equity and private absorption shocks explain less variability in the trade balance over all horizons. We suggest that the high variability of both trade-weighted exchange rates possibly justifies why REER depress the trade balance more than the monetary policy shocks.

Table 4 Variance decomposition of various shocks

<table>
<thead>
<tr>
<th>Steps</th>
<th>Equity</th>
<th>Monetary</th>
<th>REER</th>
<th>Private Absorption</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10.1%</td>
<td>9.8%</td>
<td>10.3%</td>
<td>10.0%</td>
</tr>
<tr>
<td>4</td>
<td>13.0%</td>
<td>13.6%</td>
<td>13.8%</td>
<td>13.6%</td>
</tr>
<tr>
<td>8</td>
<td>14.5%</td>
<td>15.3%</td>
<td>15.5%</td>
<td>15.0%</td>
</tr>
<tr>
<td>10</td>
<td>14.7%</td>
<td>15.5%</td>
<td>15.7%</td>
<td>15.2%</td>
</tr>
<tr>
<td>12</td>
<td>14.9%</td>
<td>15.7%</td>
<td>15.8%</td>
<td>15.4%</td>
</tr>
</tbody>
</table>
6. Conclusion

This paper compares the effects of one standard deviation contractionary monetary policy and exchange rate appreciation shocks on the South African trade balance using recursive and sign-restriction VAR approaches. We find that the trade-weighted exchange rate appreciation shocks worsen the trade balance as percentage of GDP for longer periods than contractionary monetary policy shocks. The contractionary monetary policy operates through the expenditure-switching channel rather than the income channel in the short run to lower the net trade balance.\(^\text{26}\) There are two policy implications from this analysis. Firstly, a significant deterioration in the net exports due to exchange rate appreciation shocks indicates that the contribution of net exports to GDP will remain depressed for longer periods but not permanently. Hence, this finding does not violate the neutrality of exchange rate effects in long run economic growth. Secondly, the evidence of the expenditure-switching channel, \textit{ceteris paribus}, suggests, in the short run, that monetary policy can be used to change the direction of demand between domestic output and imported goods through exchange rate adjustment.\(^\text{27}\)

\(^{26}\) We concluded similarly using the exchange rate depreciation shocks and expansionary monetary policy shocks.

\(^{27}\) This recommendation might be affected by dynamics of elasticity and the composition of trade components might be at play such that mining exports may be declining as manufacturing increase
References


Appendix

Figure A 1 Exchange rate, monetary policy, private absorption and equity appreciation shocks
Figure A 2 Effects of exchange rate, monetary policy, private absorption and supply shocks
Figure A 3 Exchange rate appreciation and contractionary monetary policy shocks using G7 data
Figure A 4 Trade balance impulse responses using G7 data

Trade balance responses

NB solid median line refers to model with US variable and dotted middle line refers to model with OECD data. Changes in trade balance refer to differences between median impulse and OECD data. Bands are from model with US variables. Similar findings are visible in figure below which uses OECD bands.
Figure A 5

Exchange rate appreciation

Contractionary monetary policy

Changes in trade balance

Figure A 6 Examining expenditure switching evidence

Exchange rate appreciation

Contractionary monetary policy

Changes in trade balance
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<thead>
<tr>
<th>№</th>
<th>Year</th>
<th>Author(s)</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>168</td>
<td>2013</td>
<td>Anthony Musonda SIMPASA</td>
<td>Competition and Market Structure in the Zambian Banking Sector</td>
</tr>
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</tr>
<tr>
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<td>2012</td>
<td>Christopher Adam, David Kwimbere, Wilfred Mbowe and Stephen O’Connell</td>
<td>Food Prices and Inflation in Tanzania</td>
</tr>
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<tr>
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<td>2012</td>
<td>Mthuli Ncube , Elphas Ndou and Nombulelo Gumata</td>
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<td>Wolassa L. Kumo</td>
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</tr>
<tr>
<td>159</td>
<td>2012</td>
<td>Ousman Gajigo and Mary Hallward-Driemeier</td>
<td>Why do some Firms abandon Formality for Informality? Evidence from African Countries</td>
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