South African Reserve Bank
Working Paper Series
WP/19/02

The role of the rand as a shock absorber

Luchelle Soobyah and Daan Steenkamp

Authorised for distribution by Chris Loewald

May 2019

South African Reserve Bank

Information on South African Reserve Bank Working Papers can be found at
http://www.resbank.co.za/Research/ResearchPapers/WorkingPapers/Pages/WorkingPapers-Home.aspx

Enquiries

Head: Economic Research and Statistics Department
South African Reserve Bank
P O Box 427
Pretoria 0001

Tel. no.: +27 12 313-3911
0861 12 SARB (0861 12 7272)

The role of the rand as a shock absorber

Luchelle Soobyah*   Daan Steenkamp.†

May 17, 2019

Abstract

This paper investigates the impact of rand shocks on industry output and various other South African macroeconomic variables. We use a factor augmented model, which has the key advantage of providing a rich narrative about the disaggregated impacts of exchange rate shocks. We show that the currency tends to react to changes in the relative fundamentals of the economy, such as those captured by commodity export prices, and that the independent impact on the economy of exchange rate changes that are unrelated to fundamentals is estimated to be small. The results suggest that the exchange rate tends to act as a shock absorber to the shocks that hit the economy: a large proportion of the variation in the rand can be explained by other shocks, while rand shocks themselves explain a relatively small proportion of South Africa's macroeconomic volatility. That said, the role that the exchange rate plays as a shock absorber appears to be weaker in South Africa than for other commodity exporters like Australia and New Zealand.

JEL Classification: C38,F31,F41
Keywords: FAVAR, exchange rate shocks
Corresponding author's email address: daan.steenkamp@resbank.co.za

*South African Reserve Bank, PO Box 427, Pretoria, South Africa, 0001. Email: luchelle.soobyah@resbank.co.za. The views expressed are those of the author(s) and do not necessarily represent those of the South African Reserve Bank or Reserve Bank policy. While every precaution is taken to ensure the accuracy of information, the South African Reserve Bank shall not be liable to any person for inaccurate information or opinions contained herein.

†*Corresponding author*. Email: daan.steenkamp@resbank.co.za.

Contents

List of Tables

List of Figures

1 Introduction[1]

Exchange rate changes affect domestic prices, trade flows and output and can therefore have implications for the conduct of monetary policy. There have been few recent assessments of the impacts of exchange rate movements on the South African economy. One exception is Parsley (2012), who estimated the extent of exchange rate pass-through to disaggregated consumer prices and imports using an error correction approach.

Looking to international studies, papers such as Hahn (2007) and Manalo et al. (2015) focus on the industry impacts of exchange rate shocks by using different models for each industry grouping. This paper is also related to earlier work that examine the role of exchange rate fluctuations in risk sharing or domestic stabilisation or its role as an independent source of macroeconomi volatility (such as structural vector autoregression (SVAR) approaches used by Farrant and Peersman 2005, Artis and Ehrmann 2006 or Mumtaz and Sunder-Plassmann 2013).

This paper quantifies the effects of rand exchange rate (ZAR) shocks on the South African economy using a factor augmented vector autoregression (FAVAR) model. There are three main advantages of the FAVAR approach in this context. The first is that we can quantify the impact of exchange rate shocks from the *same model* on hundreds of variables, including various industry series. Second, whereas SVAR papers use only a small number of variables, we can use information from hundreds of series to look at whether movements in the exchange rate reflect changes to the economy's relative fundamentals. Third, we are able to assess the contributions of exchange rate shocks to macroeconomic fluctuations relative to shocks to other fundamentals of the economy. We present a comparison of the results to other studies that use similar approaches, and show how differences in the model specification and data used affect the estimates for South Africa.

The remainder of the paper is structured as follows: Section 2 introduces the model that will be used, Section 2 provides the estimation results, Section 4 provides comparisons to other models, Section 5, Section 6 Is questions whether the exchange rate is a source of shock or a shock absorber, while Section 7 assesses whether fundamentals can account for exchange rate movements in South Africa. Section 8 concludes.

[1]Thanks to David Fowkes, Chris Loewald, Alex Smith, Rudi Steinbach and Theo Janse van Rensburg for useful comments.

2 Model description

This paper applies the approach introduced by Bernanke et al. (2005), which can be represented in a state space form, with the transition equation as follows:

$$\begin{bmatrix} F_t \\ Y_t \end{bmatrix} = \beta(L) \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + u_t, \tag{1}$$

where F_t denotes a set of estimated factors, and Y is a vector, which in this paper includes the policy (repo) rate and the exchange rate, while $\beta(L)$ is a lag polynomial of order p and u_t denotes error terms. The observation equation is:

$$X_{i,t} = \Lambda^F F_t + \Lambda^Y Y_t + e_t, \tag{2}$$

where X_t is a data vector of dimension N by 1, Λ^F has dimension N by K and Λ^Y is N by 1, while the error terms e_t have a dimension of N by 1, where N is the number of series in the data set and K is the number of factors.

Our dataset includes a large range of domestic and international macroeconomic series, including GDP, and measures of the business cycle and financial conditions (177 series, see Table 8 Appendix). The factors are extracted using a principal components approach.[2] To identify our shocks of interest, exchange rate shocks, we use a Cholesky identification approach. We order the estimated factors first, followed by the monetary policy rate, and then the exchange rate. Exchange rate shocks from the model are therefore identified as changes in the exchange rate that do not reflect changes in South African data or foreign macroeconomic data. To account for the fact that some variables are 'fast moving' and might be responding to current quarter movements in the interest rates or exchange rate, we follow the technique of Bernanke et al. (2005) to remove these contemporaneous effects from the factors.

We use the Reserve Bank's South African real effective exchange rate (REER) as our measure of the exchange rate, for three reasons. These are that it captures the broad value of the ZAR, will not be as sensitive to developments that affect specific cross-rates and the logarithm of the series has been stationary over the sample used.[3] All variables are seasonally adjusted if necessary, transformed to be stationary and then standardised so that individual series do not exert disproportionate effects on the extracted principal components.

Our benchmark model incorporates 5 factors as we want to control for as much of

[2]Principal component analysis involves extracting linearly uncorrelated factors that summarise the co-movements between groups of series.

[3]While changes in the nominal exchange rate will eventually affect relative prices and therefore the real exchange rate, the nominal and real exchange rates are highly correlated over the short term.

the macroeconomic variation that could affect the ZAR as degrees of freedom would allow. We use data from 1992Q2 to 2017Q1 and use 2 lags in our benchmark specification, as suggested by the Akaike information criterion. Figure 3 in the Appendix plots the extracted principal components. We do not attempt to interpret what the factors represent as our focus is on examining the extent to which the factors can explain variation in South African macroeconomic data.

Table 7 in the Appendix shows how much of the variation in key series can be explained by the estimated factors. Although the factors from the dataset explain a fairly high proportion of the overall variation in aggregate South African GDP (70 percent), they only explain a small proportion of the variation in some domestic output series such as agriculture and mining (10 percent). This suggests that output for these industries is driven more by sector-specific factors than the fluctuations in the domestic and international series in the dataset. In the case of agricultural output, for example, rainfall and disease outbreaks tend not to be correlated with developments affecting other industries. The extracted factors however explain a high proportion of the variation in global variables like US GDP, the brent crude price and leading indicators of foreign demand.

3 Impact of exchange rate shocks

Our definition of an exchange rate shock is a change in the exchange rate that does not reflect changes in domestic and international variables or the repo rate. Many large ZAR changes reflect other shocks, such as changes in commodity prices. Our approach allows us to more accurately characterise the unique impact of ZAR changes that are independent of changes in the economic and financial environment. Our shock estimates are based on a one percent appreciation shock to the exchange rate (where we scale a one standard deviation shock back into percentage terms). Note that a depreciation shock would have a symmetrical (opposite) impact to an appreciation shock, but we focus on an appreciation shock for comparability with other studies. As GDP has been log differenced, a one percent exchange rate shock is associated with about a 0.04 percent fall in the rate of growth of output, although this is not statistically significant (Table 1). The aggregate impact of exchange rate shocks is smaller than estimates for other economies. For Australia, Manalo et al. (2015) find a decline in the level of GDP by 0.03 percent in response to exchange rate shocks based on a SVAR methodology, whereas Karagedikli et al. (2016) estimate that output growth slows by about 0.02 percent using a similar FAVAR approach as used in this paper.[4]

An appreciation shock is associated with a 0.06 percent fall in real output growth

[4]The approach we have used to ensure that all data is stationary means that impulse responses for some series do not always follow the usual hump shape obtained when assessing the impacts of persistent shocks. Future work could consider using a Bayesian estimation approach instead.

in Mining after 3 quarters after the initial shock, while the impact on Manufacturing output volume growth is larger at around 0.1 percent.[5] The smaller impact on mining output also reflects the co-movement between commodity prices and the rand, implying that rand prices of commodity exports tend to be slightly more stable than world prices (Figure 1). Industries that are typically thought of as non-tradable, such as Construction, are also affected, possibly via their linkages to trade-exposed industries as the peak impact occurs at 5 quarters. The industry estimates are often similar to those of Manalo et al. (2015) for Australia, who find peak impacts of around a 0.1 percent fall in the level of output in mining and manufacturing, while the estimated output growth reductions from Karagedikli et al. (2016) for New Zealand for mining is 0.03 and between 0.01 and 0.06 percent for manufacturing sub-sectors, for example, although not all industry impacts are statistically significant for South African data.

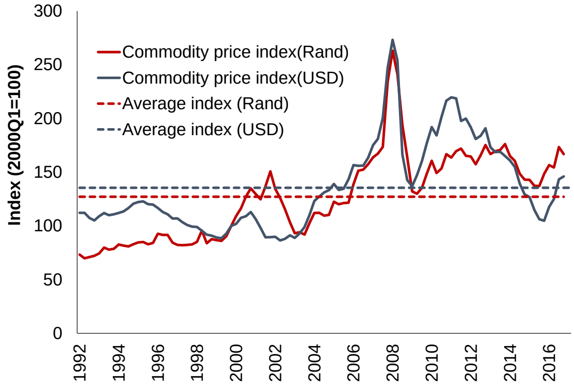
Table 1: Peak responses to 1 percent exchange rate appreciation shock (percent) for selected variables

Variable	Max response	Quarter	Significance
GDP	-0.04	3	
GDP: Agriculture	-0.10	3	
GDP: Mining	-0.06	3	*
GDP: Manufacturing	-0.11	2	*
GDP: Construction	-0.05	5	*
GDP: Wholesale and retail trade	-0.03	3	
GDP: Finance	-0.02	3	
Industrial Production	-0.11	2	
Investment	0.14	2	*
Household consumption	-0.03	3	
Household wealth to disposable income	-0.25	4	*
Employment: Non-agriculture sectors	-0.02	3	
Headline CPI	-0.04	1	*
CPI: Fuel	-1.15	2	*
CPI: Total goods	-0.18	2	*
CPI: Total services	-0.01	2	
PPI: Total	-0.12	1	*
PPI: Intermediate goods	-0.42	2	*
Export volumes	-0.11	3	
Import volumes	0.23	6	*
Import prices	-0.42	2	*
Repo (Basis points)	-6	3	

The table reports the estimated median peak impacts, the quarter when this impact occurs and * denotes statistical significance (i.e. zero is not included in a one standard deviation confidence interval produced using 1000 bootstrap replications) for comparability to Karagedikli et al. 2016.

[5]Unfortunately, data on the sub-industries in the manufacturing sector are only available at an annual frequency, but future work could look at including additional proxies of intra-sectoral output to assess whether the impact on some sub-industries differ, or could construct sector-specific exchange rates.

Figure 1: Real South African commodity prices



Source: SARB, deflated using South African and United States CPI, respectively.

Our framework allows us to investigate possible transmission channels of exchange rate shocks. Our interpretation is that when the ZAR appreciates for reasons unrelated to fundamentals, it tends to be associated with lower output in more trade-exposed industries, and a deterioration in the relative prospects of the economy. The model shows that such shocks are associated with lower business confidence and lower household wealth. Employment and household consumption falls, consistent with the fall in output. But it is interesting that investment actually rises significantly, which could reflect the impact of a stronger rand on the cost of imported capital goods. An unexpectedly stronger currency is associated with lower imported inflation and producer prices as expected. The immediate impact on CPI is to reduce inflation (as the series was log differenced), with similar impacts on the components of CPI inflation. The peak response of fuel prices is (somewhat implausibly) larger than one-for-one. Export volumes fall because of an appreciation shock (but not significantly), while imports rise as expected. Surprisingly, the peak impact on export volumes occurs earlier than in the case of import volumes, although the export volume impact is not statistically significant. The estimated monetary policy response to an exchange rate shock is not statistically significant either, with the estimates suggesting an easing in policy in response to the fall in real activity and weakening inflation pressures. While positive exchange rate shocks do appear to create some income effects via lower import prices, these do not appear to completely offset impacts on activity from lower competitiveness. There are several possible explanations for this finding. As a commodity exporter, a large proportion of South Africa's exports are priced in foreign currency, so that exchange rate changes tend to smooth the rand price of exports, potentially reducing the sensitivity of export volumes to rand movements. Another possibility is that there are structural issues that prevent exports and output from responding to relative price changes. Taking the mining industry as an example, several years of load shedding by the power utility, bottlenecks in rail and port infrastructure and uncertainty around regulatory policy may have constrained the ability of exporters to take advantage of bouts of exchange rate depreciation. Another factor that could explain the low export response is dependence on imported inputs by South African exporters (Edwards et al. 2018). It could also be that the observed long term decline in the output share of the tradables sector has meant that growth outcomes following ZAR depreciation have weakened over time. Unfortunately, we do not have a long enough sample period to do sub-sample comparisons, but future work could investigate using a time-varying FAVAR instead.

4 Comparisons of model estimates

Table 5 compares the peak responses from an exchange rate shock in the current forecasting version of the Reserve Bank's quarterly projection model (QPM, see Botha et al. 2017) to those from the FAVAR. The GDP impact estimates obtained from the FAVAR tend to be slightly smaller than those in QPM, while the impact on headline CPI is similar and the policy rate smaller. It is important to note that we identify a different type of shock to that identified in QPM. The key advantage of our approach is that the use of additional information in the FAVAR structure allows exchange rate shocks to be more precisely estimated - in the sense that we incorporate more information about the contribution of domestic and global macroeconomic factors and financial market conditions to macroeconomic volatility in our FAVAR approach. For this reason, one need not expect all impulse responses to conform with estimates from other models.

Table 2: Model comparison: Peak responses to 1 percent exchange rate appreciation shock (percent)

	FAVAR	QPM	SVAR
GDP	-0.04	-0.1	0.1
GDP: Agriculture	-0.10		0.3
GDP: Mining	-0.06		0.6
GDP: Manufacturing	-0.11		0.2
Exports	-0.11		
Imports	0.23		
Headline CPI	-0.04	-0.05	-0.1
Import prices	-0.42		
Repo	-6 basis points	-10 basis points	31 basis points

Note: The QPM exchange rate shock is assumed to be driven by a portfolio shock and the exchange rate is expressed in nominal terms. The FAVAR is based on the real exchange rate and we interpret shocks as non-fundamental exchange rate changes. The SVAR estimates are based on the real exchange rate, but a standard Cholesky ordering approach is used to identify exchange rate shocks.

We also run simple Structural VAR (SVAR) models for selected series to show that standard models produce less plausible results than those from the FAVAR model.[6] These models produce impulse responses that are positive for appreciation shocks for industry GDP, though the impacts on CPI are more plausible than the estimate from our FAVAR. As mentioned earlier, our approach assesses the impact of the same shock on each variable, whereas SVARs identify different shocks, depending on the variables in each model.

5 Is the exchange rate a source of shock or a shock absorber?

We use variance decompositions to investigate the extent to which the factors in the model can explain fluctuations in the exchange rate. The results suggest that macroeconomic factors drive the majority of exchange rate variability in South Africa, since shocks to the ZAR itself can explain less than half of its fluctuations over the longer term (Table 3). The Table shows that exchange rate forecast errors are mainly explained by shocks to the exchange itself: at 20 quarters the proportion of the forecast error that owes to exchange rate shocks is approximately 46 percent. We interpret this as evidence that the exchange rate plays a shock absorber role in the economy in the sense that it responds to changes in domestic and international financial and real sector developments. That said, the role of exchange rate shocks appears to be larger in South Africa than in advanced commodity exporting economies. The table also compares the estimates to those from models for two other commodity exporters. Our estimates of the forecast error variance of the exchange rate are lower over short horizons than those from a SVAR for Australia by Manalo et al. (2015)[7] but are higher than longer horizon estimates from Manalo et al. (2015) and FAVAR estimates for New Zealand from Karagedikli et al. (2016).[8] Since our model does not identify the factors driving the behaviour of the principal components from the data, our framework cannot be used to think about which specific factors could account for the behaviour of the exchange rate.

Table 3: Forecast Error Variance Decomposition for the exchange rate

Horizon	SA	NZ	AU
1	59	34-46	86
10	49	15-25	45
20	46	14-23	13

Source: Authors' calculations, Manalo et al. (2015), Karagedikli et al. (2016). The table shows the proportion of the forecast error variance of the exchange rate explained by its own shocks.

[6] In the SVARs, we order aggregate GDP first, then industry GDP, followed by CPI, the repo and then the real exchange rate. Using different lag specifications and dummy periods did not materially affect the estimates.

[7] For the period 1985:Q1 to 2013:Q2.

[8] Based on data from 1994Q2 to 2011Q2.

The model also allows us to compare the relative importance of exchange rate shocks to other shocks that hit the economy. We find that while exchange rate shocks generate meaningful movements in macroeconomic variables and industry output, only a small fraction of overall business cycle fluctuations in the economy can be explained by exchange rate shocks themselves. Table 4 shows the contribution of the exchange rate shocks to the variance of domestic variables for the short to long term. Though larger than the estimates by Manalo et al. (2015) and Karagedikli et al. (2016), the identified exchange rate shocks do not explain a large proportion of the variability in most South African macroeconomic quantities. While this might seem surprising, particularly for relatively tradable industries like mining, this reflects the fact that our model controls for a lot of the fundamental factors that affect demand and capacity (as discussed earlier with reference to Table 7). Many exchange rate fluctuations are also themselves responses to other shocks. Our model controls for such movements, and we argue that we more precisely capture the independent role of the exchange rate than models that use a smaller information set.

Table 4: Forecast Error Variance Decomposition for selected domestic variables

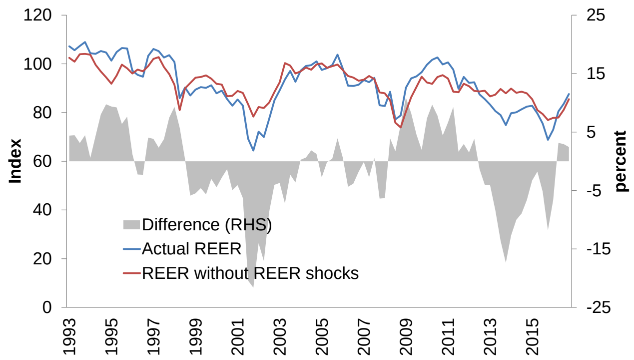
Horizon (quarters)	**2**	**10**	**20**	**40**
GDP	2.0	4.1	4.2	4.2
GDP: Agriculture	0.7	1.7	1.8	1.8
GDP: Mining	1.4	2.1	2.1	2.1
GDP: Manufacturing	1.8	2.4	2.4	2.4
GDP: Finance	1.7	3.5	3.5	3.5
GDP: Transport	1.5	2.9	3.0	3.0
GDP: Other services	1.5	1.8	1.8	1.8
Industrial production	1.8	2.3	2.3	2.3
FCE: Durable	1.6	3.6	3.7	3.7
GDE	1.5	2.1	2.1	2.1
Investment	2.6	3.3	3.4	3.4
GFCF: Mining	1.3	2.0	2.0	2.0
GFCF: Manufacturing	2.1	2.6	2.6	2.7
Total domestic credit extension	1.5	2.1	2.1	2.1
Wages: Private	0.8	1.7	1.7	1.8
Nominal unit labour costs: non-agricultural	1.7	3.6	3.6	3.6
Export volume	1.0	1.3	1.3	1.3
Import volume	1.6	2.6	2.6	2.6
Employment: Total Public	0.9	1.9	1.9	1.9
BER consumer confidence	0.7	1.4	1.4	1.4
JSE All share	2.0	3.3	3.3	3.4
T bill: 91 days tender rate	2.2	5.2	5.3	5.3
1yr gov bond	2.1	5.8	5.9	5.9
PPI	1.0	1.4	1.4	1.4
CPI	1.9	4.4	4.5	4.5

Note: The table shows the proportion of the forecast error variance of a variable explained by shocks to the exchange rate.

6 Can fundamentals account for exchange rate movements?

We can also use our model to assess the extent to which economic fundamentals (as captured by our large dataset) can explain movements in the exchange rate. Figure 2 compares movements in the exchange rate explained by fundamentals with movements in real exchange rate. The figure shows that observed variables in our dataset can explain a large part of movements in the exchange rate. There have, however, been several occasions when the exchange rate fluctuated for reasons unrelated to the variations in the dataset. The model suggests that the fall in the exchange rate following the financial crisis can largely be explained by domestic and international data. On other occasions, such as in late 2016, the real effective exchange rate would have been about 10 percent higher without exchange rate shocks. Likewise, the dramatic fall in the real effective exchange rate in mid-2001 is interpreted as a large exchange rate shock by the model. These estimates are larger than estimates for New Zealand from the FAVAR model by Karagedikli et al. (2016) (where the largest shocks were estimated to be under 10 percent).[9]

Figure 2: Real effective exchange rate with and without exchange rate shocks



7 Robustness checks

Table 5 compares the peak estimates of exchange rate appreciation shocks from the baseline model to those from alternative specifications, including those from a model based on a smaller dataset that excluded disaggregated price series, a specification that uses a greater number of lags, and one where the policy rate is excluded from the VAR. The table shows that the results are largely qualitatively similar if a different number of factors are used in estimation, although specific impulse responses are sometimes affected by the specification and dataset used. Table 6 also shows that the forecast error variance decompositions are similar across different specifications and models.

[9]Future work could consider adding additional variables to our data set to capture some additional factors that may have contributed to ZAR volatility, such as proxies of political and economic uncertainty.

Table 5: Peak responses to 1 percent exchange rate appreciation shock (percent) for selected variables

	Benchmark			Excluding disaggregated prices			4 lags			Excluding repo from VAR		
Variable	Max response	Quarter	Significance	Max response	Quarter	Significance	Max response	Quarter	Significance	Max response	Quarter	Significance
GDP	-0.04	3		-0.04	3		-0.11	3	*	-0.05	3	
GDP: Agriculture	-0.10	3		-0.11	3		-0.41	3	*	-0.11	3	
GDP: Mining	-0.06	3	*	-0.07	3	*	-0.11	2	*	-0.06	3	
GDP: Manufacturing	-0.11	2	*	-0.11	2		-0.16	3		-0.11	2	
GDP: Construction	-0.05	5	*	-0.04	3	*	-0.18	3	*	-0.06	5	
GDP: Wholesale and retail trade	-0.03	3		-0.04	3	*	-0.12	3	*	-0.03	3	
GDP: Finance	-0.02	3		-0.02	3		-0.10	3	*	-0.02	3	
Industrial Production	-0.11	2		-0.11	2	*	-0.15	2	*	-0.11	2	*
Investment	0.14	2	*	0.13	2	*	-0.22	3		0.12	2	*
Household consumption	-0.03	3		-0.04	3		-0.13	3	*	-0.04	3	
Household wealth to disposable income	-0.25	4	*	-0.24	4	*	-0.36	2	*	-0.20	4	*
Employment: Non-agriculture sectors	-0.02	3		-0.02	3		-0.07	3	*	-0.02	3	
Headline CPI	-0.04	1	*	-0.06	2		0.06	3		0.04	5	*
CPI: Fuel	-1.15	2	*									
CPI: Total goods	-0.18	2	*									
CPI: Total services	-0.01	2										
PPI	-0.12	1	*	-0.12	1	*	-0.12	1	*	-0.11	1	*
PPI: Intermediate goods	-0.42	2	*									
Export volumes	-0.11	3		-0.13	3		-0.23	3		0.15	6	*
Import volumes	0.23	6	*	0.22	6	*	0.23	5	*	0.21	6	*
Import prices	-0.42	2	*	-0.38	2		-0.33	1	*	-0.36	2	*
Tbill (basis points)	-9.58	3	*	-9.68	1	*	-9.68	1	*	-9.54	1	*

The table reports the estimated median peak impacts, the quarter when this impact occurs and $*$ denotes statistical significance (i.e. zero is not included in a one standard deviation confidence interval produced using 1000 bootstrap replications) for comparability to Karagedikli et al. 2016.

Table 6: Forecast Error Variance Decomposition for the exchange rate

Horizon	Benchmark	Excluding disaggregated prices	4 lags	Excluding repo from VAR
1	58	59	63	62
10	49	49	51	56
20	46	47	47	55

Note: The proportion of the forecast error variance of the exchange rate explained by its shocks.

8 Conclusion

We find that the rand exchange rate tends to be a shock absorber for the South African economy. We show that the currency tends to react to changes in the relative fundamentals of the economy, such as those captured by commodity export prices, and that the independent impact on the economy of exchange rate changes that are unrelated to fundamentals is estimated to be small.

The estimates show that the impact on overall output is broadly similar to that obtained from other models, although we are able to show that there is heterogeneity in the impacts at industry level. Import prices show the expected reaction to an exchange rate shock, but the model suggests that the impact on exports is not statistically significant. The latter finding may be a consequence of the smoothing impact of the exchange rate on rand denominated commodity prices, dependence on imported inputs by South African exporters, as well as supply-side constraints that prevent exporters from taking advantage of bouts of exchange rate depreciation.

A large proportion of the variation in the exchange rate can be explained by other shocks and its independent role as a source of shock in the wider economy is limited compared to other domestic and foreign factors. That said, the role that the exchange rate plays as a shock absorber appears to be weaker in South Africa than for other commodity exporters like Australia and New Zealand. Understanding why this might be is an important question for future research.

References

Artis, M. and M. Ehrmann (2006, October). The exchange rate - A shock-absorber or source of shocks? A study of four open economies. *Journal of International Money and Finance 25*(6), 874–893.

Bernanke, B., J. Boivin, and P. S. Eliasz (2005). Measuring the effects of monetary policy: A factor-augmented vector autoregressive (favar) approach. *The Quarterly Journal of Economics 120*(1), 387–422.

Botha, B., S. de Jager, F. Ruch, and R. Steinbach (2017). The Quarterly Projection Model of the SARB. South African Reserve Bank Working Paper 17/01.

Edwards, L., M. Sanfilippo, and A. Sundaram (2018, January). Importing and Firm Export Performance: New Evidence from South Africa. *South African Journal of Economics 86*(S1), 79–95.

Farrant, K. and G. Peersman (2005, January). Is the exchange rate a shock absorber or a source of shocks? New empirical evidence. Working Papers of Faculty of Economics and Business Administration, Ghent University, Belgium 05/285, Ghent University, Faculty of Economics and Business Administration.

Hahn, E. (2007). The impact of exchange rate shocks on sectoral activity and prices in the euro area. *ECB Working Paper* (796).

Karagedikli, O., M. Ryan, D. Steenkamp, and T. Vehbi (2016). What happens when the kiwi flies? sectoral effects of exchange rate shocks on the new zealand economy. *Economic Modelling 52*.

Manalo, J., D. Perera, and D. M. Rees (2015). Exchange rate movements and the Australian economy. *Economic Modelling 47*(C), 53–62.

Mumtaz, H. and L. Sunder-Plassmann (2013, April). Time-Varying Dynamics Of The Real Exchange Rate: An Empirical Analysis. *Journal of Applied Econometrics 28*(3), 498–525.

Parsley, D. C. (2012). Exchange rate pass-through in south africa: Panel evidence from individual goods and services. *Journal of Development Studies 48*(7), 832–846.

A Appendix

Figure 3: Estimated Factors

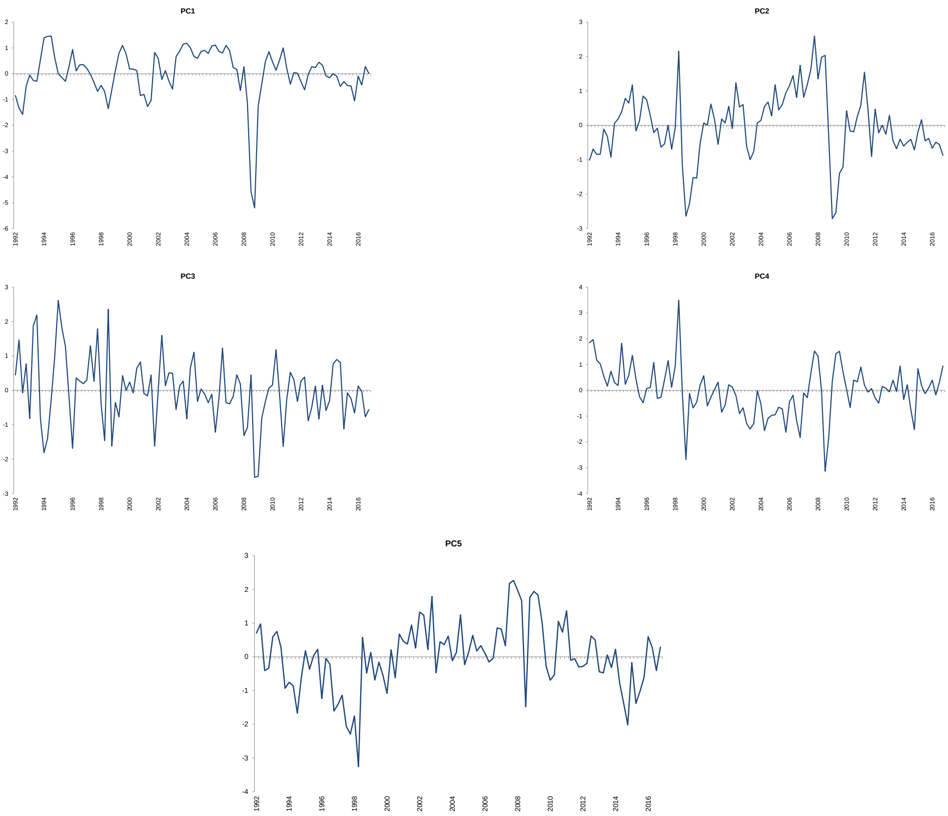


Table 7: R-squared of factors for selected variables

GDP	0.7
GDP: Agriculture	0.1
GDP: Mining	0.1
GDP: Manufacturing	0.6
GDP: Electricity	0.3
GDP: Trade	0.3
GDP: Construction	0.5
GDP: Social	0.5
GDP: Gen gov services	0.5
GDP: Other services	0.1
GDE	0.3
Industrial production	0.4
FCE Total	0.6
Investment	0.7
GNI	0.2
Total domestic credit extension	0.3
H/h wealth to disp income	0.4
Salaries: Total: Non-agri	0.3
Export volume	0.1
Import volume	0.4
Employment: Non-agriculture sectors	0.4
BER consumer confidence	0.0
Coincident business cycle indicator	0.6
Leading business cycle indicator	0.6
Lagging indicator of SA	0.6
Leading indicator:main trading partners excl US	0.8
Leading indicator:main trading partners	0.9
EA: REER	0.2
Japan: REER	0.1
UK: REER	0.2
US: REER	0.5
S&P 500	0.4
FTSE 100	0.4
VIX	0.2
Export prices	0.2
Import prices	0.4
Terms of trade	0.1
Share price: Mining	0.1
Share price: Financials	0.4
Share price: Industrial	0.3
JSE All share	0.3
Prime lending rate	0.6
1yr gov bond	0.7
PPI Total	0.1
PPI Intermediate manufactured goods	0.3
Headline CPI	0.5
CPI fuel	0.4
CPI total services	0.1
Brent crude oil	0.5
US: GDP	0.5
China: GDP	0.2
Japan: GDP	0.4

Table 8: Data

Variable number	Description	Mnemonic	Transformation
1	Gross domestic product (constant 2010 prices, seasonally adjusted)	X1	3
2	Gross domestic expenditure (constant 2010 prices, seasonally adjusted)	X2	3
3	Gross national income (constant 2010 prices, seasonally adjusted)	X3	3
4	GVA: Agriculture (basic prices)	X4	3
5	GVA: Mining (basic prices)	X5	3
6	GVA: Manufacturing (basic prices)	X6	3
7	GVA: Electricity, gas and water (basic prices)	X7	3
8	GVA: Construction (basic prices)	X8	3
9	GVA: Wholesale and retail trade, catering, accommodation (basic prices)	X9	3
10	GVA: Transport, storage, communication (basic prices)	X10	3
11	GVA: Finance, insurance, real estate, business services (basic prices)	X11	3
12	GVA: oOther services (basic prices)	X12	3
13	GVA: Community, social, personal services (basic prices)	X13	3
14	GVA: General government services (basic prices)	X14	3
15	GVA: All industries (basic prices)	X16	3
16	GVA: Other community, social, personal services (basic prices)	X17	3
17	Industrial production	X18	3
18	PCE: Durable goods (constant 2010 prices, seasonally adjusted)	X19	3
19	PCE: Semi-durable goods (constant 2010 prices, seasonally adjusted)	X20	3
20	PCE: Non-durable goods (constant 2010 prices, seasonally adjusted)	X21	3
21	PCE: Services (constant 2010 prices, seasonally adjusted)	X22	3
22	PCE: Total (constant 2010 prices, seasonally adjusted)	X23	3
23	Final consumption expenditure: General government (constant 2010 prices, seasonally adjusted)	X24	3
24	GFCF: Total (constant 2010 prices, seasonally adjusted)	X25	3
25	GFCF: Mining and quarrying (constant 2010 prices, seasonally adjusted)	X26	3
26	GFCF: Manufacturing (constant 2010 prices, seasonally adjusted)	X27	3
27	GFCF: Electricity, gas, water (constant 2010 prices, seasonally adjusted)	X28	3
28	GFCF: Transport, storage, communication (constant 2010 prices, seasonally adjusted)	X29	3
29	GFCF: Fin intermediation, insurance, real estate, business services (constant 2010 prices, seasonally adjusted)	X30	3
30	GFCF: Community, social, personal services (constant 2010 prices, seasonally adjusted)	X31	3
31	GFCF: General government (constant 2010 prices, seasonally adjusted)	X32	3
32	GFCF: Public corporations (constant 2010 prices, seasonally adjusted)	X33	3
33	GFCF: Private business enterprises (constant 2010 prices, seasonally adjusted)	X34	3
34	GFCF: Residential buildings (constant 2010 prices, seasonally adjusted)	X35	3
35	GFCF: Non-residential buildings (constant 2010 prices, seasonally adjusted)	X36	3
36	GFCF: Construction works (constant 2010 prices, seasonally adjusted)	X37	3
37	GFCF: Transport equipment (constant 2010 prices, seasonally adjusted)	X38	3
38	GFCF: Machinery and other equipment (constant 2010 prices, seasonally adjusted)	X39	3
39	GFCF: Transfer costs (constant 2010 prices, seasonally adjusted)	X40	3
40	Money supply: M1	X41	3
41	Money supply: M2	X42	3
42	Money supply: M3	X43	3
43	Total domestic credit extension	X44	3
44	Credit extended to the domestic private sector: Other loans, advances	X45	3
45	Credit extended to the domestic private sector - Bills discounted	X49	3
46	Credit extended to the domestic private sector - Investments	X50	3
47	Ratio of debt-service cost to disposable income (percent)	X51	3
48	Ratio of household net wealth to disposable income (percent)	X52	3
49	Household debt to disposable income of households (percent)	X53	3
50	Government debt to GDP (percent)	X54	3
51	Remuneration per worker in the non-agricultural sector: Public sector	X55	3
52	Remuneration per worker in the non-agricultural sector: Private sector	X56	3
53	Total remuneration per worker: non-agricultural sector	X57	3
54	Total salaries and wages: Non-agricultural sector	X58	3
55	Salaries and wages per worker: Mining	X59	3
56	Total salaries and wages: Electricity	X60	3
57	Salaries and wages per worker: Financial intermediation, insurance	X61	3
58	Salaries and wages per worker: Transport, storage, communication	X63	3
59	Salaries,wages per worker: Trade, Catering, Accommodation	X64	3
60	Total salaries and wages: Financial intermediation, insurance	X65	3
61	Total salaries and wages: Transport, storage,communication	X66	3
62	Salaries and wages per worker: Manufacturing	X67	3
63	Salaries and wages per worker: Construction	X68	3
64	Labour productivity in the non-agricultural sectors	X69	3
65	Nominal unit labour costs in the non-agricultural sectors	X70	3
66	Brent crude oil price in US Dollar	z71	3
67	Exports: goods and services, incl gold (Volumes)	X72	3
68	Imports: goods and services (Volumes)	X73	3
69	Total employment: Public sector	X74	3
70	Employment in the private sector: Mining	X75	3
71	Employment in the private sector: Manufacturing	X76	3
72	Employment in the private sector: Construction	X77	3
73	Employment in the private sector: Trade	X78	3
74	Employment in the private sector: Financial institutions	X79	3
75	Total employment in the private sector	X80	3
76	Total employment: non-agricultural sectors	X81	3
77	BER: Retail trade	X82	1
78	BER: Wholesale trade	X83	1
79	BER: Motor trade	X84	2
80	Unit labour costs in manufacturing	X85	3

Continued on next page

z

Table 8 – *Continued from previous page*

Variable number	Description	Mnemonic	Transformation
81	Value of building plans passed: Residential	X86	3
82	Value of building plans passed: Non-residential	X87	3
83	Value of building plans passed: Total	X88	3
84	Value of buildings completed - add,alterations: Total	X89	3
85	Value of buildings completed: Residential buildings, excl add, alt	X90	3
86	BER: Consumer confidence - Total	X91	2
87	SACCI Business Confidence Index	X92	3
88	RMB / BER Business Confidence Index	X93	3
89	Coincident business cycle indicator	X94	3
90	Leading business cycle indicator	X95	3
91	Lagging indicator of South Africa	X96	3
92	Leading indicator of the US	X97	3
93	Leading indicator of the main trading partner countries excl US	X98	3
94	Leading indicator of all the main trading partner countries	X99	3
95	Coincident indicator of all the main trading partner countries	X100	3
96	Euro Area: Capacity Utilization (seasonally adjusted, percent)	X101	3
97	Euro Area: Economic Sentiment Indicator (seasonally adjusted, average=100)	X102	3
98	Euro Area: 3m Money Market Rate (average, percent)	Z103	2
99	Euro Area: 5yr Government Bond Yield (average, percent)	Z104	2
100	Euro Area: 10yr Government Bond Yield (average, percent)	Z105	2
101	Euro Area: REER (2010=100)	Z106	3
102	Euro Area: CPI (2015=100)	Z107	3
103	Euro Area: Industrial Production (2015=100)	X108	3
104	Japan: Short-Term Prime Lending Rate (percent)	Z109	2
105	Japan: 1yr Government Bond Yield (average, percent)	Z110	2
106	Japan: 5yr Government Bond Yield (average, percent)	Z111	2
107	Japan: 10yr Government Bond Yield (average, percent)	Z112	2
108	Japan: REER (2010=100)	Z113	3
109	Japan: GDP (2011 prices, seasonally adjusted)	X114	3
110	Japan: GFCF (2011 prices, seasonally adjusted)	X115	3
111	Japan: Export Price Index (2015=100, seasonally adjusted)	Z116	3
112	Japan: Import Price Index: All Commodities (2015=100, seasonally adjusted)	Z117	3
113	Japan: Terms of Trade (2011=100)	Z118	3
114	Japan: Industrial Production (2010=100, seasonally adjusted)	X119	1
115	Japan: Unemployment Rate (percent, seasonally adjusted)	X120	3
116	U.K.: Official Bank Rate (percent, end of period)	Z121	2
117	U.K.: 3m London Interbank Offered Rate (average, percent)	Z122	2
118	U.K.: 1yr London Interbank Offered Rate (percent)	Z123	2
119	U.K.: 5yr Government Bonds (average, percent)	Z124	2
120	U.K.: 10yr Government Bonds (average, percent)	Z125	2
121	UK: REER (2010=100)	Z126	3
122	U.K.: GDP (2015=100, seasonally adjusted)	Z127	3
123	U.K.: GFCF (2015=100, seasonally adjusted)	X128	3
124	U.K.: CPI (2015=100, seasonally adjusted)	Z129	3
125	U.K.: Industrial Production (2015=100, seasonally adjusted)	X130	3
126	U.K.: Capacity Utilization (percent, seasonally adjusted)	X131	3
127	U.K.:Unemployment Rate (percent, seasonally adjusted)	X132	3
128	U.K.: Business Sentiment (percent of balance, seasonally adjusted)	X133	1
129	U.K.: Economic Sentiment Indicator (average=100, seasonally adjusted)	X134	3
130	U.S.: Federal Funds Rate (percent)	Z135	2
131	U.S.: 3m London Interbank Offered Rate (percent, average)	Z136	2
132	U.S.: 1yr Treasury Bill Yield (percent)	Z137	2
133	U.S.: 5yr Treasury Note Yield (percent)	Z138	2
134	U.S.: 10yr Treasury Bond Yield (percent)	Z139	2
135	US: REER (2010=100)	Z140	3
136	U.S.: GDP (2009 prices, seasonally adjusted)	X141	3
137	U.S.: CPI (1982-4=100, seasonally adjusted)	Z142	3
138	U.S.: Export Price Index (2000 prices, seasonally adjusted)	Z143	3
139	U.S.: Import Price Index (2000 prices, seasonally adjusted)	Z144	3
140	U.S.: Terms of Trade (2010 prices, seasonally adjusted)	Z145	3
141	U.S.: Unemployment Rate (percent, seasonally adjusted)	X146	3
142	U.S.: Consumer Confidence (1985=100, seasonally adjusted)	X147	3
143	US: Industrial Production Index (2012=100, seasonally adjusted)	X148	3
144	China: Lending Rate: 1yr (percent)	Z149	2
145	China: Prime Lending Rate (percent, average)	Z150	2
146	China: REER (2010=100)	Z151	3
147	China: GDP (2015=100, seasonally adjusted)	X152	3
148	China: Consumer Confidence (100+=optimistic, seasonally adjusted)	X153	3
149	China: CPI (2015=100, seasonally adjusted)	Z154	3
150	China: Industrial Production	X155	3
151	Shangai stock index	Z156	3
152	S&P 500	Z157	3
153	FTSE 100	Z158	3
154	Euro stox 50 index	Z159	3
155	Nikkei stock index	Z160	3
156	VIX	Z161	3
157	Export price index (South Africa)	Z162	3
158	Import prices index (South Africa)	Z163	3
159	Terms of Trade (South Africa)	Z164	3
160	SA Share price index: Mining: Gold	Z165	3
161	SA Share price index: Financial	Z166	3

Continued on next page

z

Table 8 – *Continued from previous page*

Variable number	Description	Mnemonic	Transformation
162	SA Share price index: Industrial: Total	Z167	3
163	SA All share price index	Z168	3
164	SA Prime lending rate (percent)	Z169	2
165	SA Treasury bills: 91 days tender rate (percent)	Z170	2
166	SA: 1yr Government bond yield (percent)	Z171	2
167	SA: 5yr Government bond yield (percent)	Z172	2
168	SA: 10yr Government bond yield (percent)	Z173	2
169	SA: 30yr Government bond yield (percent)	Z174	2
170	SA PPI: Total	Z175	3
171	SA PPI: Intermediate goods	Z176	3
172	SA Headline CPI	Z177	3
173	SA CPI: fuel	Z178	3
174	SA CPI: Total services	Z178	3
175	SA CPI: Total goods	Z179	3
176	SARB Repo rate (percent)	REPO	5
177	Real effective exchange rate of the rand (2010=100)	REER	4

Transformations: 1 is no transformation, 2 is first difference, 3 is logarithm difference, 4 is logarithm, 5 for de-meaned. Slow moving variables are distinguished with a Z in their mnemonic. All series from SARB, further details around underlying data sources obtainable from the authors.