# A Look at South Africa's Monetary Policy

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**Abstract**

South Africa has the highest level of unemployment in G-20. The levels are close to those of the United States during the Great Depression. Much of this can be attributed to the lingering effects of the apartheid policies once pursued. In 2000, South Africa began to use inflation targeting monetary policy. Hence, it will be interesting to see how this change in policy affects the economy.

**JEL Classification:** E44, F43, F62, E52

## 1 Introduction

The Rand was worth about .78 per dollar from its inception in 1961 to about 1981. Around 1981, political pressure started to build up and with the combination of sanctions due National Party still upholding and enforcing racial segregation (know as apartheid), the Rand started to depreciate in value.

In 1985, Pieter Willem Botha, the president of South Africa, gave the so called Rubicon speech. Before the speech, it was anticipated that Botha would abolish the apartheid system and release Nelson Mandala. However, Botha clearly stated that he will not abolish the apartheid system and that Nelson Mandela would not be pardoned. Unfortunately, the speech had serious repercussion on the economy of South Africa. The Rand fell drastically and this trend continued until around 1994. In 1990 the president, Frederik Willem de Klerk, began negotiations to end the apartheid. Furthermore, he lifted the bans on the African National Congress (ANC) and released Nelson Mandela. These negotiations[1] where conducted with the African National Congress (ANC) and other political organizations and by 1993, apratheid system was abolished.

The following year, was the first year all races could vote. In the 1994 elections ANC's nominee Nelson Madela (ironically) won the election by a landslide. However, during this time period of huge uncertainty, the Rand depreciated drastically. In 1998, Tito Mboweni was elected the new governor of the

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1. Took place against a backdrop of political violence in the country, including allegations of a state-sponsored third force destabilising the country

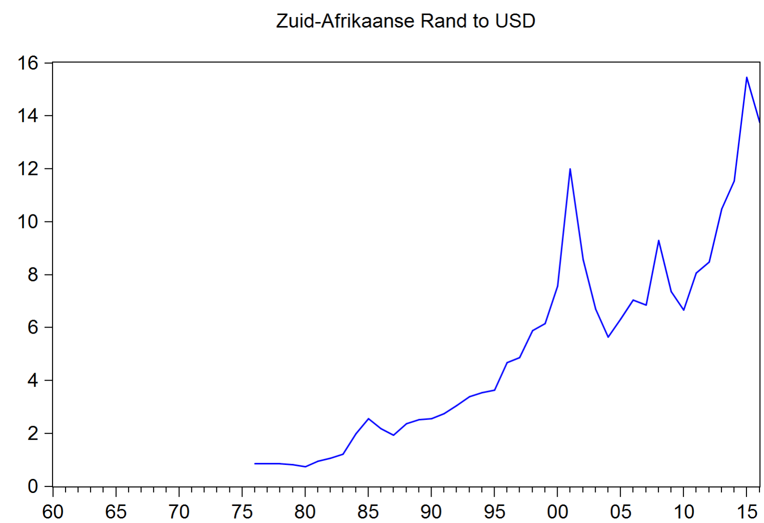


Figure 1: Rand to USD

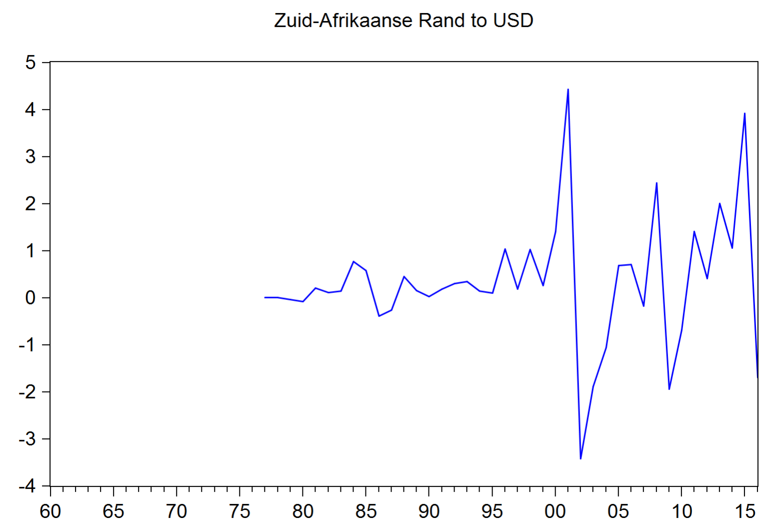


Figure 2: First difference of Rand to USD. 1990-2005

South African Reserve Band and brought drastic change to their policies. Additionally, Thabo Mbeki succeeded Nelson Mandela as president of South Africa.

Around this time period, Zimbabwe started with its controversial land reform program and following the attacks on USA in 2001, the Rand was a its lowest level.

South Africa has the highest level of unemployment in G-20. Much of this can be attributed to the lingering effects of the apartheid policies once pursued. Hence, it can be interesting to see the effects of their policies before and after the abolishment of the apartheid system. While monetary policy has little in impact in restructuring a severely distorted economy, its impact on employment and growth is not negligible and should be considered. In this paper we will be comparing two models. One in which we consider South Africa's switch to a inflation target-based monetary policy in the early 2000s[2] and a second model that we use exchange rate as the tool that drives the economy.

# 2 Literature Review

A strong belief of monetary policy-making is that a surprise increase in the short-term interest rate will lower price inflation. Thus, it has been troubling to macroeconomics that many empirical estimates have suggested that a surprise interest rate increase is followed immediately by a sustained increase in the inflation rate. This result has been know as the "price puzzle".

In 1980, Chris Sim developed a VAR technique for providing a theory-free method to estimate economic relationships. Modern economic literature can contain many "puzzles" that arise empirically when comparing to what the theory predicts. However, this should come to no surprise; it is more weird to expect correct results from incomplete and flawed theories than otherwise. Some of these puzzles include (from Kim and Roubini (2000)[3])

- **Liquidity Puzzle.** A shock in the money aggregates that cause the market interest rate to increase rather than what the theory predicts: decrease.

- **Price Puzzle.** A positive shock in the interest rate causes the inflation rate to increase which, again, is inconsistent with macroeconomic theory.

- **Exchange Rate Puzzle.** A positive shock in the interest rate causes the home currency to depreciate which is inconsistent, once more, with economic theory.

- **Delayed Overshooting Puzzle.** The Uncovered Interest Rate Parity (UIP) is a parity condition stating that the difference in interest rates between two countries is equal to the expected change in exchange rates between the countries' currencies. However, it has been found that following a positive shock in the home countries' interest rate, the currency kept appreciating for a longer time that expected. before depreciating.

2. This is a reason as to why there is very little papers on monetary policy of South Africa.
3. and Econ 505 Notes

The price puzzle was first noted by Eichenbaum (1992). However, finding the puzzle is not enough to explain it[4]. Hanson (2004) showed that is not easy to explain away the puzzle, especially pre-1980. Moreover, Kim and Roubini (2000) state that Grilli and Roubini (1995) used money stock as the primary monetary policy and found the "delayed overshooting puzzle". Kim and Roubini note that the unrestricted VAR approach with measure of expected inflation resolve the exchange rate puzzle for most countries is a limited approach. For example, consider an open economy that wants to obtain the impact of interest rate on exchange rate. They would have the sequence of orderings

$$X_{1t} = [\ldots \text{ domestic interest rate, exchange rate } \ldots].$$

If the open economies is concern about the effects of exchange rate depreciate on their inflation rate might, they might react quite rapidly to exchange rates shocks. With that said, for most developed nations, monetary policy is the most useful too of the central bank to impact their economy.

Balcilar et al. (2014) and Oni (2013) both do not find puzzles in their estimations. Balcilar et al. (2014) estimated a Bayesion MS-VAR model with a linear VAR indicator, to investigate the oil prices in different states: high growth-low oil price volatility and low growth-high oil price volatility from 1960Q2 to 2013Q3. Moreover, they find that oil price shocks increase the probability to be in a low growth state. The impulse responses showed that the oil price shocks tend to be more persistent during low growth states compared to high growth states and that the impact on real output growth is statistical significant. Oni (2013) investigated the inflation targeting policy South Africa adopted in the early 2000s. Oni finds that the inflation rate responds to by a 2.1% to a positive monetary policy compared to a 1% percent in the pre-inflation period.

# 3 Daten

## 3.1 Sources

The data was acquired from the following sources.

4. and apparently saying the theory is flawed is not sufficient

| | |
|---|---|
| Short-term interest rates (% per annum) | https://data.oecd.org/interest/short-term-interest-rates.htm |
| GDP (current US$) | http://data.worldbank.org/indicator/NY.GDP.MKTP.CD |
| GDP deflator (annual %) | http://data.worldbank.org/indicator/NY.GDP.DEFL.KD.ZG |
| $\frac{RAND}{USD}$ | https://fred.stlouisfed.org/series/DEXSFUS#0 |
| Unemployment Rate | http://www.indexmundi.com/south_africa/unemployment_rate.html |
| Inflation | https://fred.stlouisfed.org/series/FPCPITOTLZGZAF |
| 10Yr Bonds | https://fred.stlouisfed.org/series/IRLTLT01ZAM156N |

## 3.2 Overview

We plot South Africa's GDP (Figure 3), short-term interest rate (Figure 4), and GDP deflator (Figure 5).

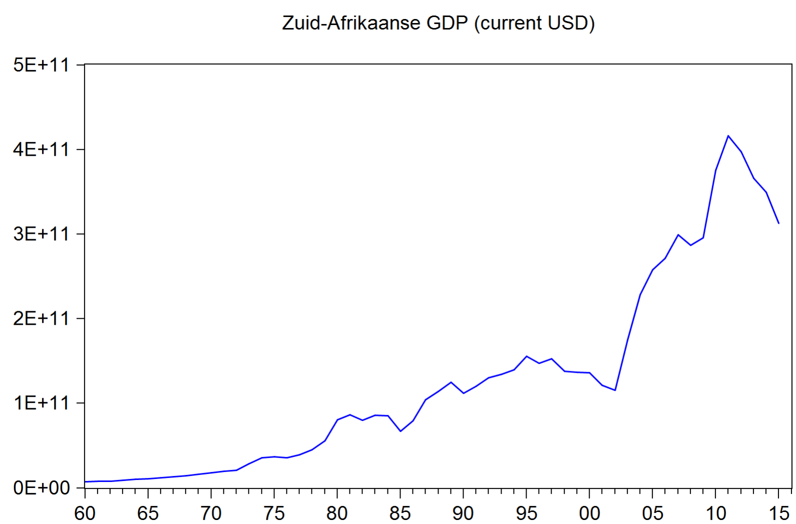


Figure 3: Zuid-Afrikaanse GDP (current US$). 1961-2015

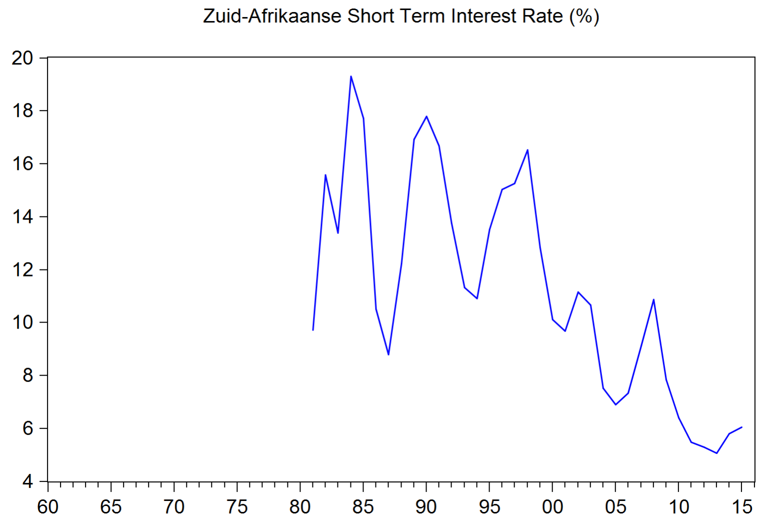


Figure 4: Zuid-Afrikaanse Short-term interest rates (% per annum). 1961-2015

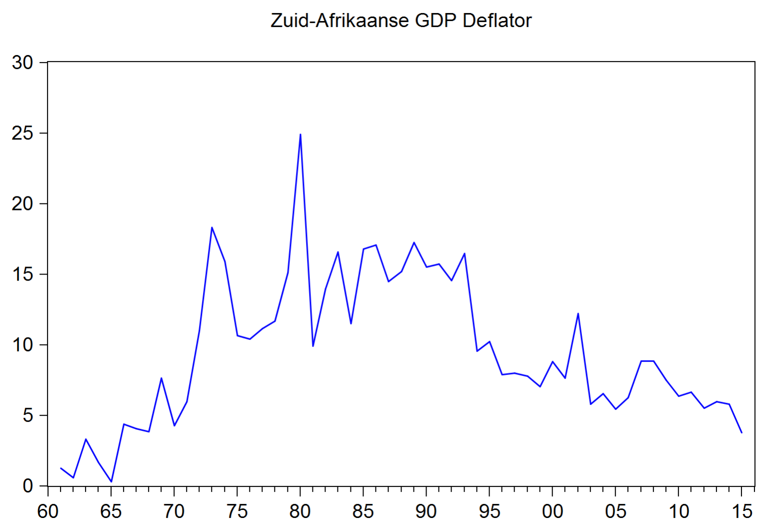


Figure 5: Zuid-Afrikaanse GDP deflator (annual %). 1961-2015

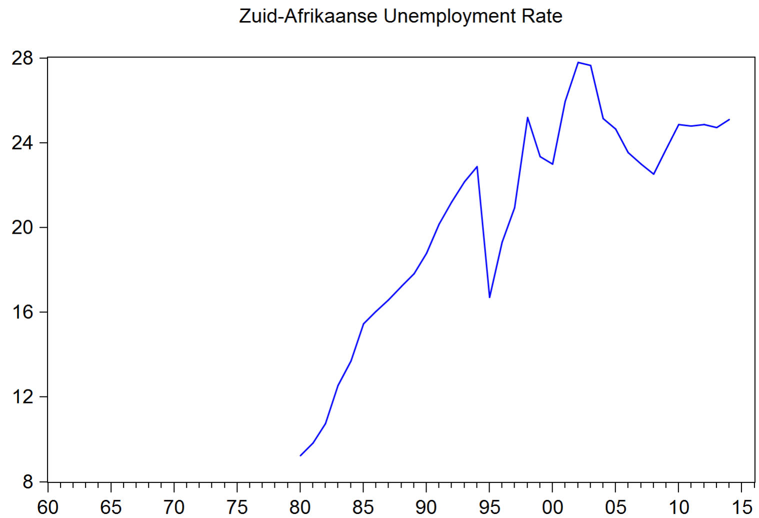


Figure 6: Zuid-Afrikaanse Unemployment (annual %). 1961-2015

### 3.2.1 Compared to USA

Now, we will compare South Africa's GDP (Figure 7), short-term interest rate (Figure 8), and GDP deflator (Figure 11) to the United States, respectively.

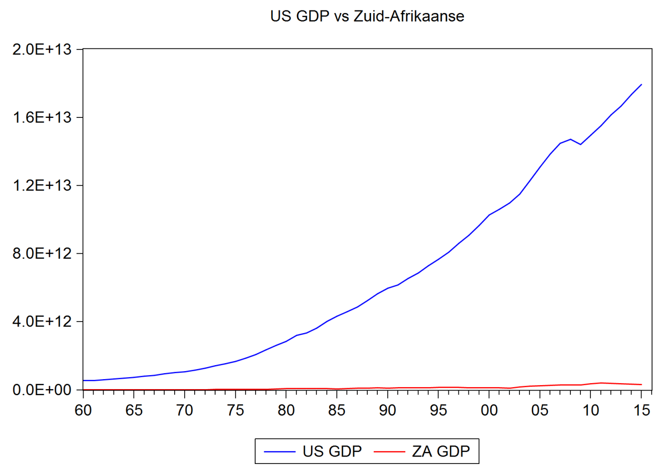


Figure 7: Zuid-Afrikaanse vs USA GDP (current US$). 1961-2015

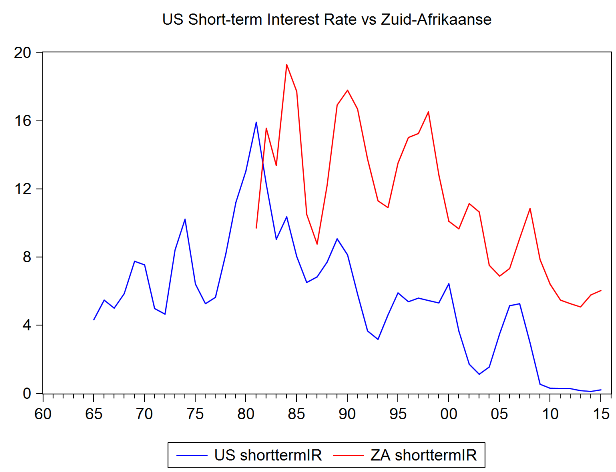


Figure 8: Zuid-Afrikaanse vs USA Short-term interest rates (% per annum). 1961-2015

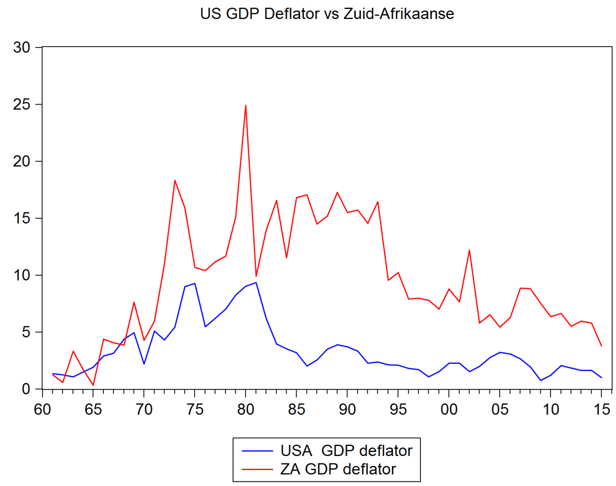


Figure 9: Zuid-Afrikaanse vs USA GDP deflator (annual %). 1961-2015

## 3.3 Creating Variables to Study

We create the following variable: real GDP growth

$$\Delta(GDP) = 400(\log(GDP_t) - \log(GDP_{t-1}))$$

and year to year change in log of unemployment

$$\Delta(Unemployment) = (\log(Unemployment_t) - \log(Unemployment_{t-1})).$$

Both of the plots are given, respectively.

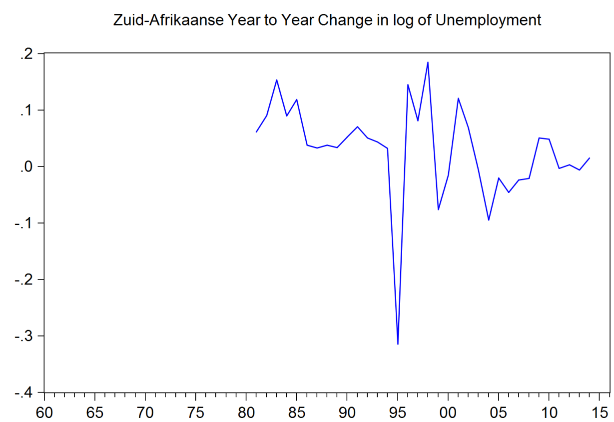


Figure 10: Zuid-Afrikaanse real GDP growth. 1961-2015

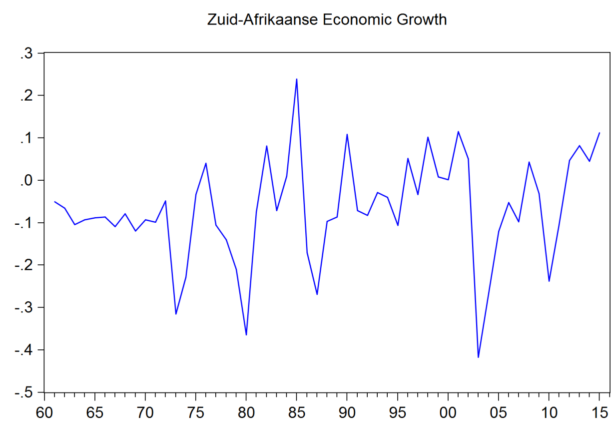


Figure 11: Zuid-Afrikaanse real GDP growth. 1961-2015

# 4 VAR Model

Consider a VAR model that describes a set of endogenous $k$ variables over the same sample period. The p-th order VAR, VAR(p), is given by,

$$y_t = c + \sum_{i=1}^{p} A_i L^i y_t + e_t$$

where $L^i$ is the lag operator that denotes the $i$-th lag. Moverover, we impose the following restrictions on the structural shock (error term),

- $E(e_t) = 0$
- $E(e_t e_t') = \Omega$
- $E(e_t e_{t-k}') = 0.$

If we used matrix notation, our model is reduced to

$$\begin{pmatrix} y_{1,t} \\ y_{2,t} \\ \vdots \\ y_{k,t} \end{pmatrix} = \begin{pmatrix} c_1 \\ c_2 \\ \vdots \\ c_k \end{pmatrix} + \sum_{i=1}^{p} \begin{pmatrix} a_{1,1}^i & a_{1,2}^i & \cdots & a_{1,k}^i \\ a_{2,1}^i & a_{2,2}^i & \cdots & a_{2,k}^i \\ \vdots & \vdots & & \vdots \\ a_{k,1}^i & a_{k,2}^i & \cdots & a_{k,k}^i \end{pmatrix} \begin{pmatrix} y_{1,t-i} \\ y_{2,t-i} \\ \vdots \\ y_{k,t-i} \end{pmatrix} + \begin{pmatrix} e_{1,t} \\ e_{2,t} \\ \vdots \\ e_{k,t} \end{pmatrix}.$$

In our model we will be using a VAR(1) with 2 endogenous variables,

$$\begin{pmatrix} 1 & b_{12} \\ b_{21} & 1 \end{pmatrix} \begin{pmatrix} y_{1,t} \\ y_{2,t} \end{pmatrix} = \begin{pmatrix} b_{10} \\ b_{20} \end{pmatrix} + \begin{pmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{pmatrix} \begin{pmatrix} y_{1,t-1} \\ y_{2,t-2} \end{pmatrix} + \begin{pmatrix} e_{1,t} \\ e_{2,t} \end{pmatrix}.$$

If we multiply our previous equation by $\begin{pmatrix} 1 & b_{12} \\ b_{21} & 1 \end{pmatrix}^{-1}$, our new equation will have the form

$$\begin{pmatrix} y_{1,t} \\ y_{2,t} \end{pmatrix} = \begin{pmatrix} 1 & b_{12} \\ b_{21} & 1 \end{pmatrix}^{-1} \begin{pmatrix} b_{10} \\ b_{20} \end{pmatrix} + \begin{pmatrix} 1 & b_{12} \\ b_{21} & 1 \end{pmatrix}^{-1} \begin{pmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{pmatrix} \begin{pmatrix} y_{1,t-1} \\ y_{2,t-2} \end{pmatrix} + \begin{pmatrix} 1 & b_{12} \\ b_{21} & 1 \end{pmatrix}^{-1} \begin{pmatrix} e_{1,t} \\ e_{2,t} \end{pmatrix}$$

$$\begin{pmatrix} y_{1,t} \\ y_{2,t} \end{pmatrix} = \begin{pmatrix} d_{10} \\ d_{20} \end{pmatrix} + \begin{pmatrix} d_{11} & d_{12} \\ d_{21} & d_{22} \end{pmatrix} \begin{pmatrix} y_{1,t-1} \\ y_{2,t-2} \end{pmatrix} + \begin{pmatrix} \epsilon_{1,t} \\ \epsilon_{2,t} \end{pmatrix}$$

The advantage of the last equation is that we can now find the contemporaneous effect of $y_{1,t}$ on $y_{2,t}$ and vice versa. The reason is that in this form, the regressors are not correlated with the error term. The last equation is known as the reduced form VAR,

$$x_t = D_0 + D_1 x_{t-1} + \epsilon_t.$$

Now, observe that we can, after $n$ iterations, write $x_t$ as

$$x_t = (\sum_{i=0}^{n} (D_1)^i) D_0 + D_1^{n+1} x_{t-(n+1)} + \sum_{i=0}^{n} (D_1)^i \epsilon_{t-i}$$

where $(D_1)^0 = I$ is the identity matrix and imposing the stability condition

$$\lim_{n \to 0} D_1^{n+1} = 0$$

yield the following expression

$$x_t = \mu + \sum_{i=0}^{n} D_1^i \epsilon_{t-1}.$$

Now, expressing this equation in matrix form to get the Vector Moving Average (VMA),

$$\begin{aligned}\begin{pmatrix} y_{1,t} \\ y_{2,t} \end{pmatrix} &= \begin{pmatrix} \langle y_1 \rangle \\ \langle y_2 \rangle \end{pmatrix} + \sum_{i=0}^{\infty} \begin{pmatrix} d_{11} & d_{12} \\ d_{21} & d_{22} \end{pmatrix}^i \begin{pmatrix} \epsilon_{1,t-1} \\ \epsilon_{2,t-1} \end{pmatrix} \\ &= \begin{pmatrix} \langle y_1 \rangle \\ \langle y_2 \rangle \end{pmatrix} + \sum_{i=0}^{\infty} \begin{pmatrix} d_{11} & d_{12} \\ d_{21} & d_{22} \end{pmatrix}^i \begin{pmatrix} 1 & b_{12} \\ b_{21} & 1 \end{pmatrix}^{-1} \begin{pmatrix} e_{1,t-1} \\ e_{2,t-1} \end{pmatrix} \\ &= \begin{pmatrix} \langle y_1 \rangle \\ \langle y_2 \rangle \end{pmatrix} + \sum_{i=0}^{\infty} \begin{pmatrix} \phi_{11}(i) & \phi_{12}(i) \\ \phi_{21}(i) & \phi_{22}(i) \end{pmatrix} \begin{pmatrix} e_{1,t-1} \\ e_{2,t-1} \end{pmatrix}.\end{aligned}$$

This will allow us to find the effects of the shocks $e_{\alpha,t-1}$ on our endogenous variables $y_{\alpha,t}$. For example, $\phi_{11}(i)$ is the coefficient of the effects of $e_{1,t-i}$ on $y_{1,t}$.

## 4.1 Impulse Response Function

One of the reason Chris Sims develop this framework was because of his interest in describing how the economy reacts over time to exogenous impulses (i.e our shocks). The system of equation that comes from our VMA model is

$$\begin{cases} y_{1,t} = \langle y_1 \rangle + \sum_{i=0}^{\infty} \phi_{11}(i) e_{1,t-i} + \sum_{i=0}^{\infty} \phi_{12}(i) e_{2,t-i} \\ y_{2,t} = \langle y_2 \rangle + \sum_{i=0}^{\infty} \phi_{21}(i) e_{1,t-i} + \sum_{i=0}^{\infty} \phi_{22}(i) e_{2,t-i}. \end{cases}$$

This form of the VMA allows us to find the effect of the shocks on our endogenous variables. As an example, suppose $i = 0$, then the coefficient $\phi_{21}(0)$ is the effect of $e_{1,t}$ on $y_{2,t}$. In general,

- $\phi_{11}(i)$ is the effect of $e_{1,t-i}$ on $y_{1,t}$
- $\phi_{12}(i)$ is the effect of $e_{2,t-i}$ on $y_{1,t}$
- $\phi_{21}(i)$ is the effect of $e_{1,t-i}$ on $y_{2,t}$
- $\phi_{22}(i)$ is the effect of $e_{2,t-i}$ on $y_{2,t}$.

## 4.2 Variance Decomposition

To get insight on the VMA, let us rearrange it as follows:

$$\begin{cases} y_{1,t} - \langle y_1 \rangle = \sum_{i=0}^{\infty} \phi_{11}(i) e_{1,t-i} + \sum_{i=0}^{\infty} \phi_{12}(i) e_{2,t-i} \\ y_{2,t} - \langle y_2 \rangle = \sum_{i=0}^{\infty} \phi_{21}(i) e_{1,t-i} + \sum_{i=0}^{\infty} \phi_{22}(i) e_{2,t-i} \end{cases}$$

This last equation is the deviation from its mean. Hence, if we are given any two stationary time series, we can express them in terms of their mean values $(\langle y_1 \rangle,\ \langle y_2 \rangle)$ and how $y_{1,t}$ and $y_{2,t}$ deviate from their means. Moreover, we can calculate the percentage movement in our endogenous variables due to shocks in the other endogenous variables. For instance, the percentage of the moments in $y_1$ due to shock in $y_1$ is given by

$$\frac{\sum_{i=0}^{\infty} \phi_{11}(i) e_{1,t-i}}{\sum_{i=0}^{\infty} \phi_{11}(i) e_{1,t-i} + \sum_{i=0}^{\infty} \phi_{12}(i) e_{2,t-i}},$$

and the percentage of the moments in $y_1$ due to shock in $y_2$ is,

$$\frac{\sum_{i=0}^{\infty} \phi_{12}(i) e_{1,t-i}}{\sum_{i=0}^{\infty} \phi_{11}(i) e_{1,t-i} + \sum_{i=0}^{\infty} \phi_{12}(i) e_{2,t-i}}.$$

A similar expression can be written for percentage of the moments in $y_2$ due to shock in $y_1$ or $y_2$. These expressions are know as Variance Decomposition.

# 5 VAR Model Estimates Results

Using Eviews we have the following variables:

- DEXSFUS: Exchange Rate (Rand to USD)
- DZAGDP: GDP growth variable we created
- ZA_SHORTTERMIR: South Africa Short-term Interest Rate
- DUNEM: Year to Year Log Change of Unemployment
- ZA_GDP_DEFLATOR: Inflation

We will run two 3 lag 4 variable models with the orderings:

$$X_{1t} = [\text{ZA\_SHORTTERMIR, ZA\_GDP\_DEFLATOR, DUNEM, DZAGDP}]^\top$$

and

$$X_{2t} = [\text{DEXSFUS, ZA\_GDP\_DEFLATOR, DUNEM, DZAGDP}]^\top,$$

respectively. The contemporaneous matrix for either ordering is given by

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ \alpha_{21} & 1 & 0 & 0 \\ \alpha_{31} & \alpha_{32} & 1 & 0 \\ \alpha_{41} & \alpha_{42} & \alpha_{43} & 1 \end{pmatrix}.$$

So in the first model, the short-term interest rate will affect the remaining variables. This will especially true for the model that includes post 2000s. Moreover, we assume the short-term interest rate is unaffected contemporaneously. In this model, the exchange rate is only affected by the short-term interest rate. The last two were chosen since a increase in unemployment leads to less people working and so a decline in GDP. Hence, GDP growth will decline. In the second model, we are assuming the economy is driven based on what the world is doing. From a historical point of view, this is what happened to South Africa. Prior to 2000, their monetary policy was practically non-existent and the economy was moved depending on external factors.

## 5.1 Four-variable VAR using 3 lags Pre-2001

For the other impulse responses please see Appendix B.1 and Appendix B.2

### 5.1.1 Model 1

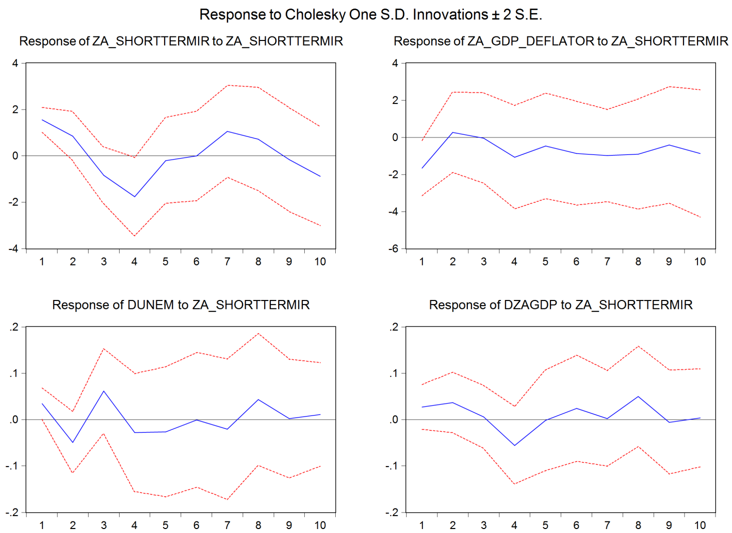


Figure 12: Responses of due to one unit shocks of Short-term Interest Rate

Responses of due to one unit shocks of Short-term Interest Rate (Figure 12) on

a. **Short-term Interest Rate**. We see a 1.8 point contracting shock that is significant for about one time period.

b. **GDP Deflator**. Initially there will be a 1.8 point decrease in inflation. However, this shock is not significant.

c. **Year to Year Log Change of Unemployment**. There is an increase of about .04 points to DUNEM. However, this shock is not significant.

f. **GDP growth variable**. Similarly, there is no significant change to GDP growth.

### 5.1.2 Model 2

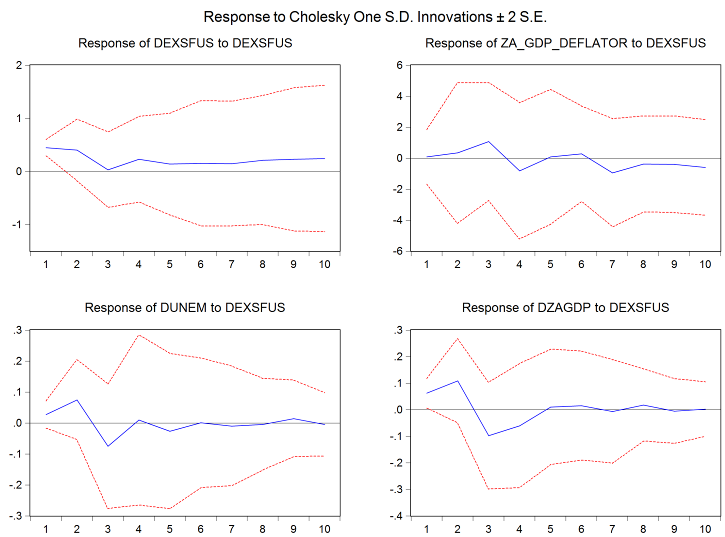


Figure 13: Responses of due to one unit shocks of Exchange Rate

Responses of due to one unit shocks of the Exchange Rate (Figure 13) on

a. **Exchange Rate**. We see a .4 expanding policy. This is coming from how South Africa interacts with the US in particular. Again, this is significant for about two periods.

b. **GDP Deflator**. There is no significant change to inflation.

c. **Year to Year Log Change of Unemployment**. There is a small increase to DUNEM. However, this shock is not significant.

f. **GDP growth variable**. GDP growth increase about .08 points, but this shock is not significant.

## 5.2 Four-variable VAR using 3 lags Post-1998

For the other impulse responses please see Appendix B.3 and Appendix B.4

### 5.2.1 Model 1

Responses of due to one unit shocks of Short-term Interest Rate (Figure 14) on

a. **Short-term Interest Rate**. We see a 1.5 point contracting shock that is significant for about one-half time periods.

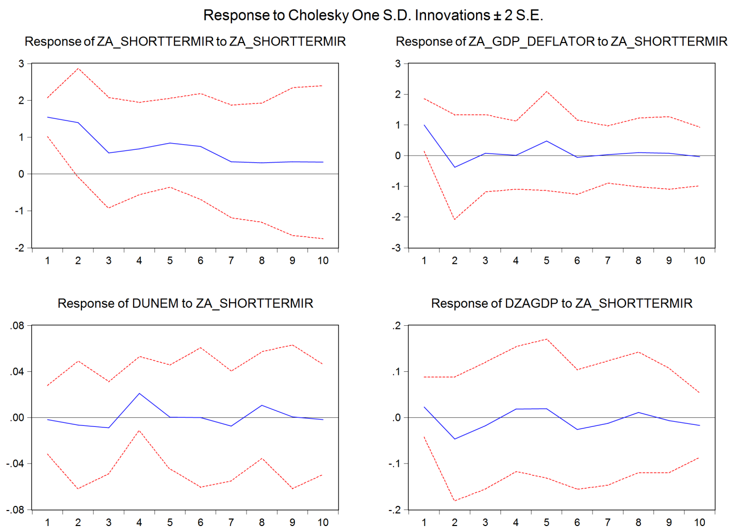


Figure 14: Responses of due to one unit shocks of Short-term Interest Rate

b. **GDP Deflator**. Initially there will be a 1 point significant shock to inflation. This level of significance persist for one period. "Price Puzzle"

c. **Year to Year Log Change of Unemployment**. There is no significant shock to DUNEM.

f. **GDP growth variable**. Similarly, there is no significant change to GDP growth.

### 5.2.2 Model 2

Responses of due to one unit shocks of the Exchange Rate (Figure 15) on

a. **Exchange Rate**. We see a 2 point expanding policy. This is significant for about one-half periods.

b. **GDP Deflator**. There is a 1 point decreasing shock to inflation. This is significant for one period.

c. **Year to Year Log Change of Unemployment**. There is a significant shock of about .03 points to DUNEMS for one period.

f. **GDP growth variable**. GDP growth increase about .1 points. This is significant for about one-half periods.

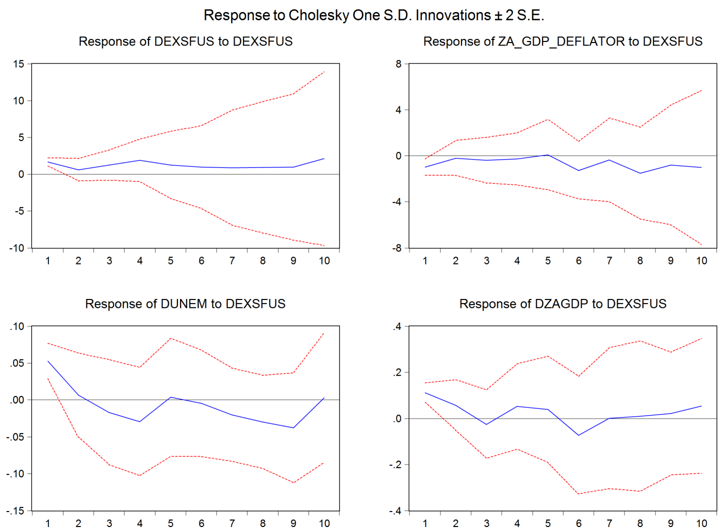


Figure 15: Responses of due to one unit shocks of Exchange Rate

## 5.3 Forecast Variance Decomposition

### 5.3.1 Model 1 Pre 2000

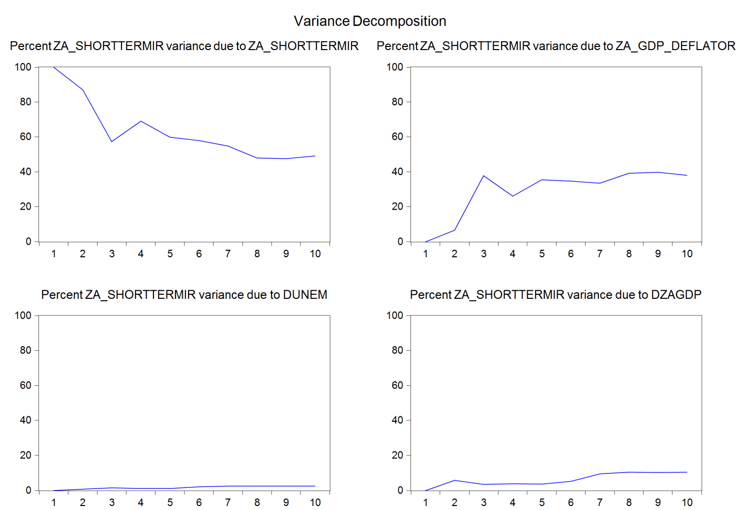


Figure 16: Forecast Variance Decomposition Model 1 Pre 2000. 10 periods

Forecast variance of the Short-term Interest Rate (Figure 16).

a. **GDP Deflator.** Inflation can explain roughly 40 percent of the forecast variance of the Short-term Interest Rate.

b. **Year to Year Log Change of Unemployment** DUNEM can explain about 2 percent of the forecast variance.

c. **GDP growth variable** GDP growth can explain roughly 10 percent of the forecast variance.

#### 5.3.2 Model 1 Post 1998

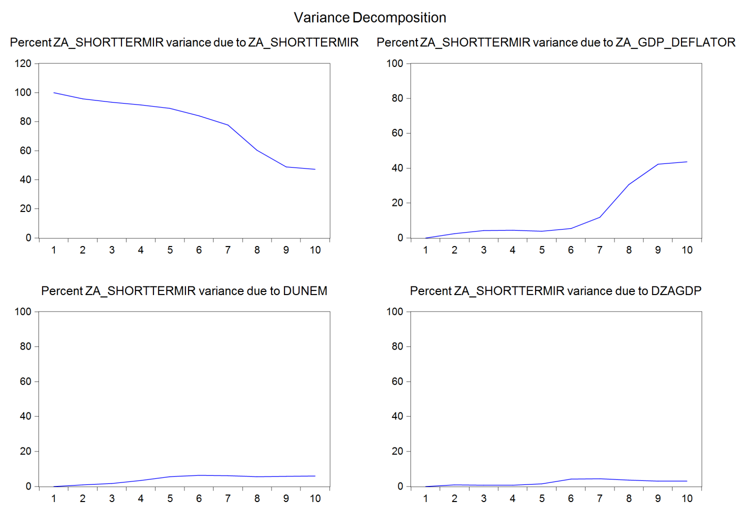


Figure 17: Forecast Variance Decomposition Model 1 Post 1998. 10 periods

Forecast variance of the Short-term Interest Rate (Figure 17).

a. **GDP Deflator.** Inflation can explain roughly 44 percent of the forecast variance of the Short-term Interest Rate.

b. **Year to Year Log Change of Unemployment** DUNEM can explain about 2 percent of the forecast variance.

c. **GDP growth variable** GDP growth can explain roughly 10 percent of the forecast variance.

#### 5.3.3 Model 2 Pre 2000

Forecast variance of the Exchange Rate (Figure 18).

a. **GDP Deflator.** Inflation can explain roughly 85 percent of the forecast variance of the Exchange Rate.

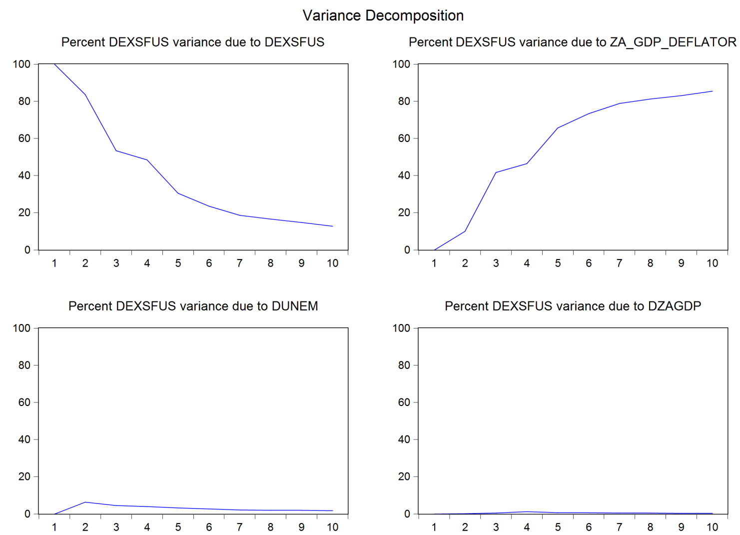

Figure 18: Forecast Variance Decomposition Model 2 Pre 2000. 10 periods

b. **Year to Year Log Change of Unemployment** DUNEM can explain about 2 percent of the forecast variance.

c. **GDP growth variable** GDP growth can explain roughly 0 percent of the forecast variance.

#### 5.3.4 Model 2 Post 1998

Forecast variance of the Exchange Rate (Figure 19).

a. **GDP Deflator.** Inflation can explain roughly 26 percent of the forecast variance of the Shor-term Interest Rate.

b. **Year to Year Log Change of Unemployment** DUNEM can explain about 11 percent of the forecast variance.

c. **GDP growth variable** GDP growth can explain roughly 0 percent of the forecast variance.

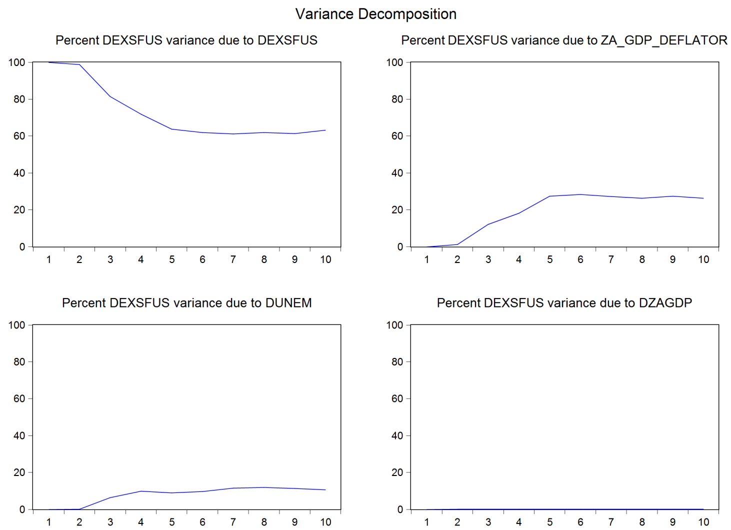


Figure 19: Forecast Variance Decomposition Model 2 Post 1998. 10 periods

# 6 Conclusion

In this paper, we used a unstructured VAR models to examine how the post 1998 inflation targeting policy compared to the previous no policy[5]. In the Pre 2000 period, we find that Short-term Interest Rate to have a stronger effect on inflation short-term. However, Short-term Interest Rate has little impact on the shocks of year to year change of log of unemployment (DUNEM) and GDP growth. In this same period, the exchange rate has a longer impact on inflation (reaching 1 percent around the 3 period mark). On the other hand, when we compare the variance decomposition of both of these variables, respectively, we get that inflation can explain roughly 40 percent of the forecast variance of the Short-term Interest Rate and 85 percent of the Exchange Rate, which is unsurprising. Since this is an open economy, much of the domestic variables are going to be shocked by world variables.

On the post-1998 period, we get that shocks due to Short-term Interest Rate are significant similar to how it was before. However, there is a greater impact of the Exchange rate. A lot of the shocks are significant and from the variance decomposition, we get that inflation can explain roughly 44 percent of the forecasted variance of the Short-term Interest Rate. Additionally, we find a "Price Puzzle" in model 1 as our 1.5 point shock in short term-interest rate lead to a 1 point increase in inflation. Moreover, inflation can explain about 26 percent of the forecasted variance of the Exchange Rate. In Appendix A, we see just that. We consider a 3 variable VAR with exchange rate, short-term

5. Please see Appendix A for a discussion of a different ordering and VAR

interest rate, GDP deflator. Furthermore, we compare two different orderings and see that inflation explains more of the variance of short-term interest rate post 2000 and most of the variance of exchange rate pre-2000.

For developing countries, monetary policy is not as strong as in developed countries and thus its effects are rather small. In most closed economies, the central bank impacts inflation via the short-term interest rate. However, this luxury is not shared with small open economies since the effect of other countries affects them more so than their own domestic changes. South Africa is a small open economy and thus the results presented in this paper should make sense. In the post 1998 the central bank is actively trying to target inflation via the Short-term Interest Rate. Whereas before, they really did not do anything but hope things ended well. In that case the world variables (and sanctions due to upholding the apartheid system) molded the economy.

# References


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## Appendix A: Modeling a 3 variable VAR with 3 lags

After seeing the impulse responses, we decided to run two distinct orderings for a 3 variable VAR during the same period constraint as before. In this we compared the following two orderings:

$$Y_{1t} = [\text{DEXSFUS, ZA\_SHORTTERMIR, ZA\_GDP\_DEFLATOR}]^\top$$

and

$$Y_{2t} = [\text{ZA\_SHORTTERMIR, DEXSFUS, ZA\_GDP\_DEFLATOR}]^\top$$

respectively. The contemporaneous matrix for either ordering is given by

$$\begin{pmatrix} 1 & 0 & 0 \\ \alpha_{21} & 1 & 0 \\ \alpha_{31} & \alpha_{32} & 1 \end{pmatrix}.$$

### Appendix A1: $Y_{1t}$ Pre 2000

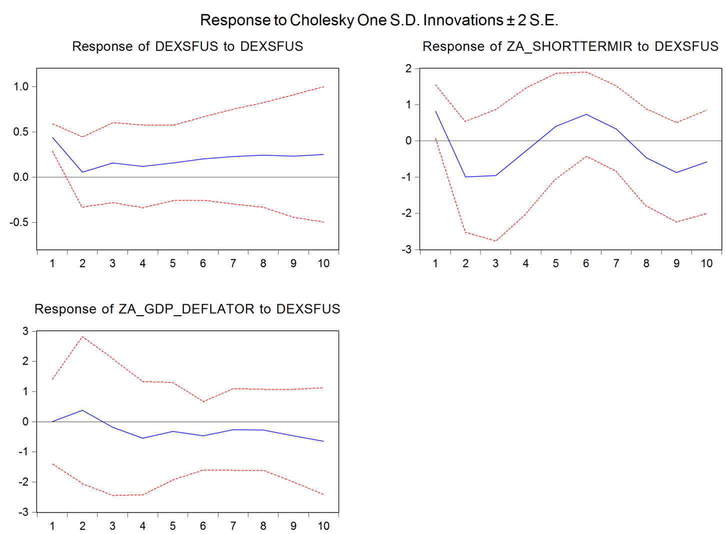



Figure 20: Responses of due to one unit shocks of Exchange Rate

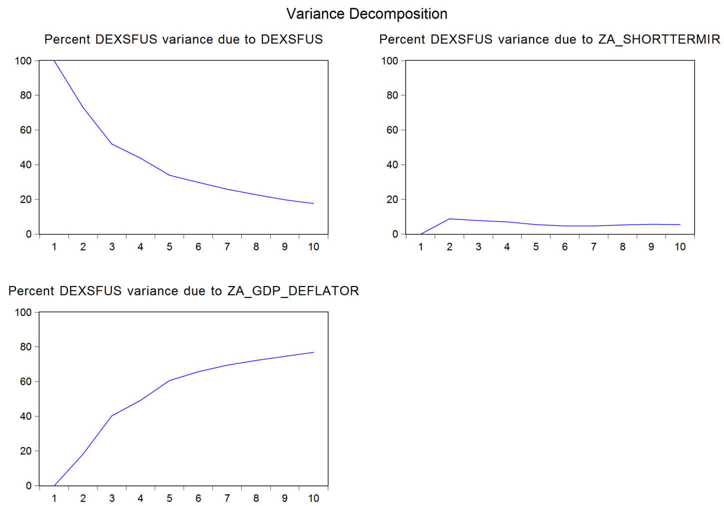



Figure 21: Forecast Variance Decomposition. 10 periods

## Appendix A2: $Y_{2t}$ Pre 2000

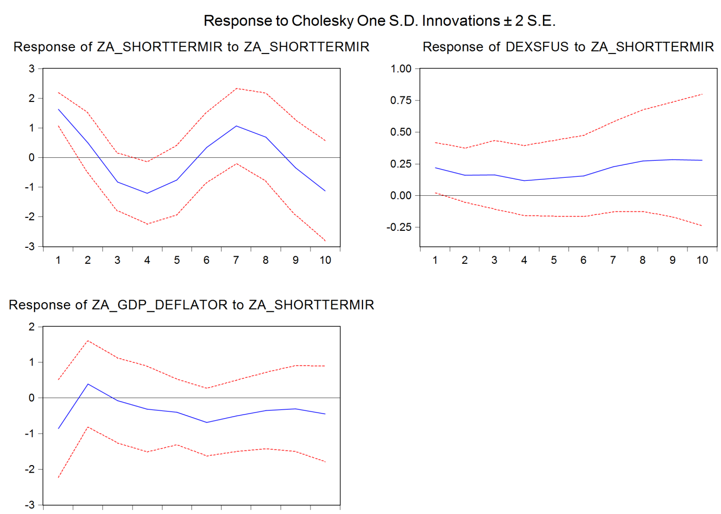



Figure 22: Responses of due to one unit shocks of Short-term Interest Rate

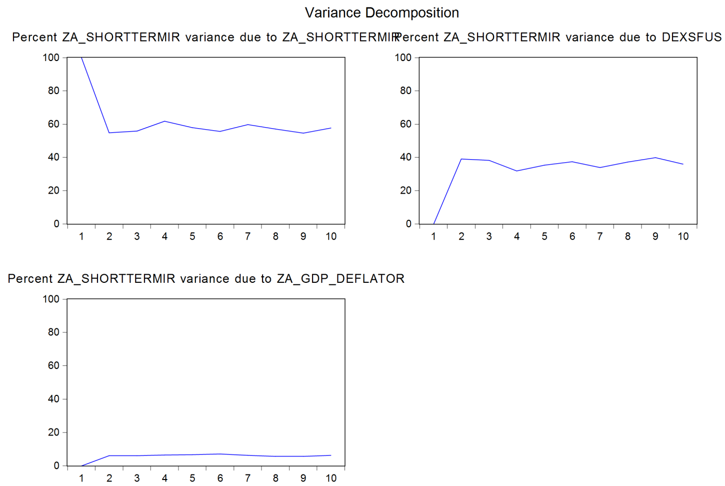



Figure 23: Forecast Variance Decomposition Model. 10 periods

## Appendix A3: $Y_{2t}$ Post 1998

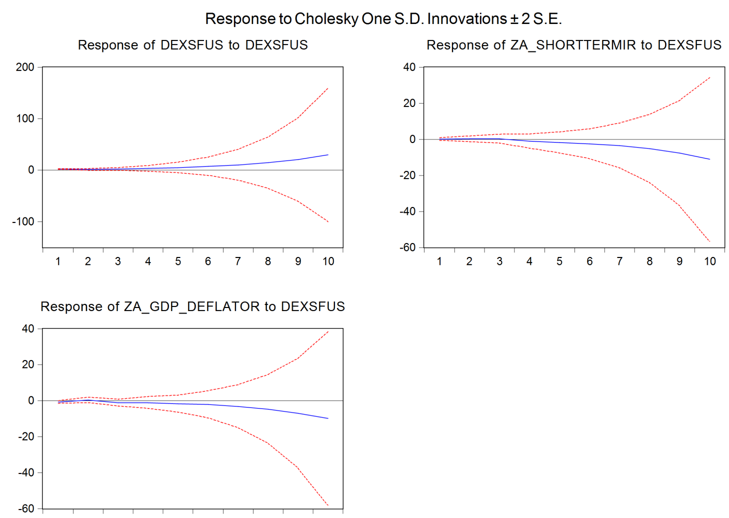



Figure 24: Responses of due to one unit shocks of Exchange Rate

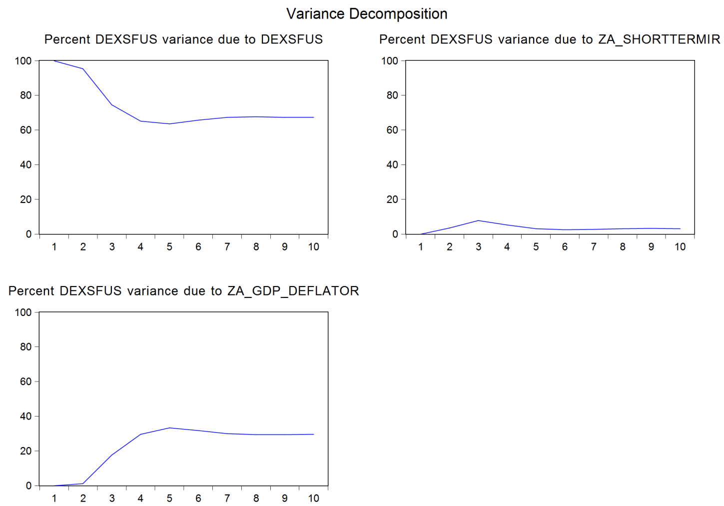



Figure 25: Forecast Variance Decomposition. 10 periods

## Appendix A4: $Y_{2t}$ Post 1998

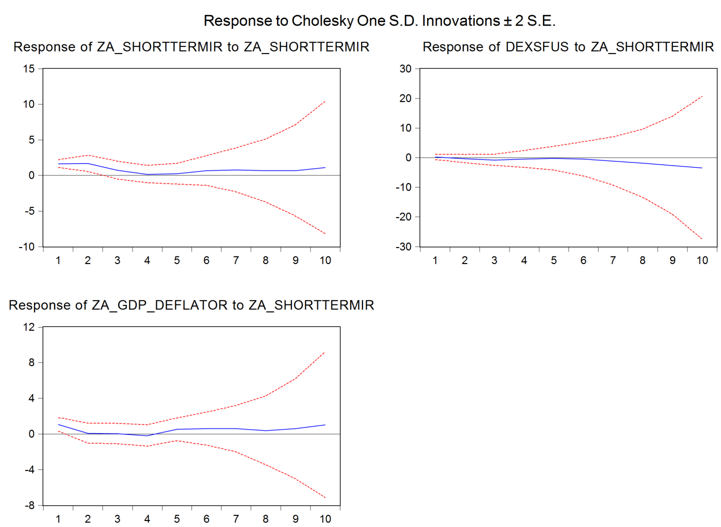



Figure 26: Responses of due to one unit shocks of Short-term Interest Rate

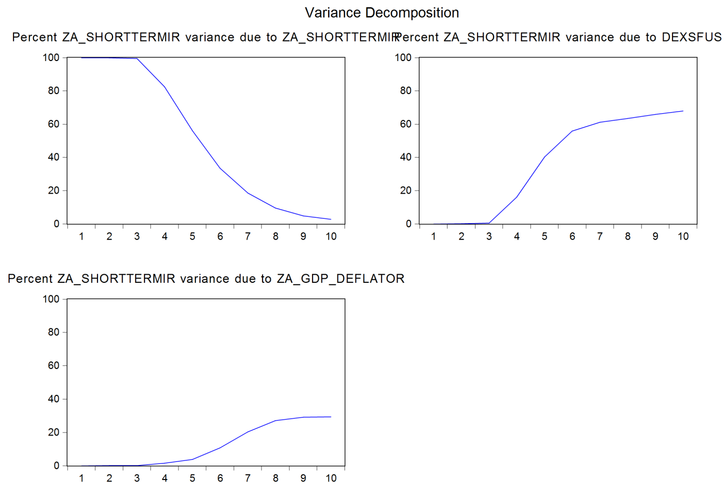



Figure 27: Forecast Variance Decomposition. 10 periods

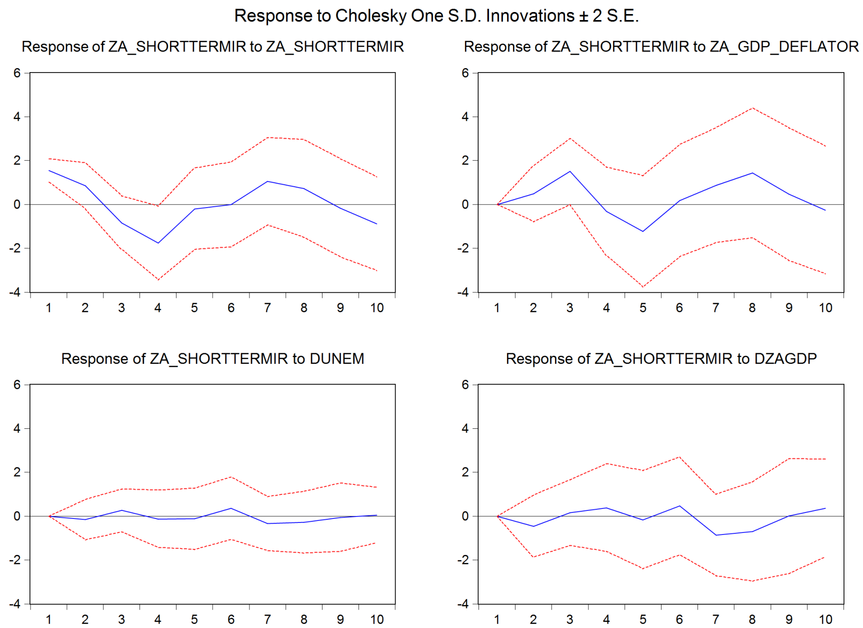
### Appendix A5: Discussion

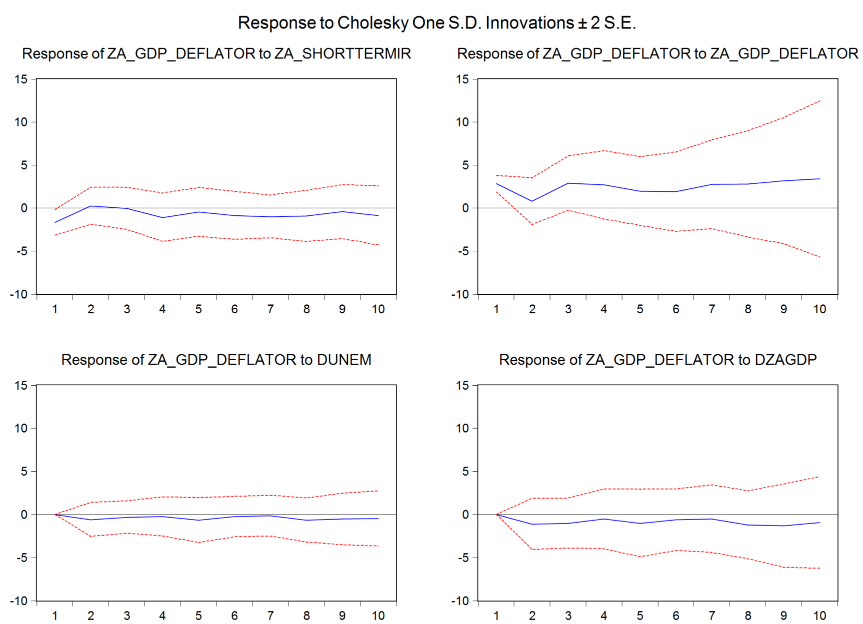
In the $Y_{1t}$ model prior 2000, we see a .4 point positive shock to the exchange rate leads to a .9 point shock to the short-term interest rate. Moreover, this shock is significant for about one period. Interestingly enough, this shock doesn't shock GDP deflator, however when looking at the variance decomposition we get that about 78 percent of the variance is explained through inflation. On the other-hand, we see that about 5 percent of the variance is explained through the short-term interest rate. For the $Y_{2t}$ model prior 2000, a 1.8 point shock to short-term interest rates leads to a .9 contraction shock to inflation. The short-term interest rate shock is significant for the first period and between the third and fourth period. Unsurprisingly, the variance decomposition shows that inflation roughly explains 6 percent of the variance of short-term interest rate.

Now, in the time period after 1998. The first model $Y_{1t}$, show interesting behavior of the exchange rate. A 2 point shock to the exchange rate has no significant impact on short-term interest rates or inflation. Also, we see that inflation explains about 30 percent of the variation in exchange rate. On the other-hand, the second model $Y_{2t}$ has that 1.6 percent shock leads to a 1 percent shock to inflation. The short-term interest rate shock is significant for about the first two periods and the shock to inflation only for the first period. Now, we see inflation explains about 29 percent of the variation of short-term interest rate.

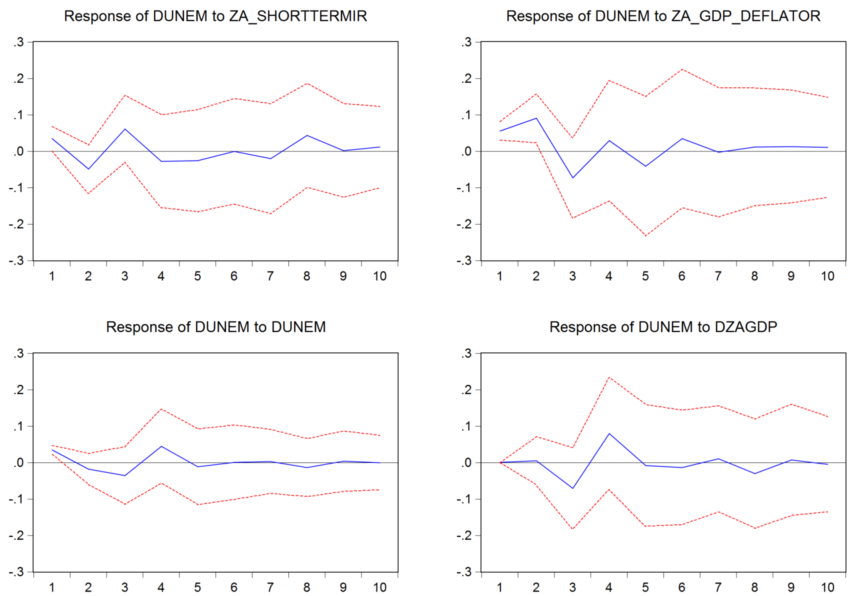
## Appendix B: VAR Estimate

### Appendix B1: Model 1 Pre 2000 Impulse Responses

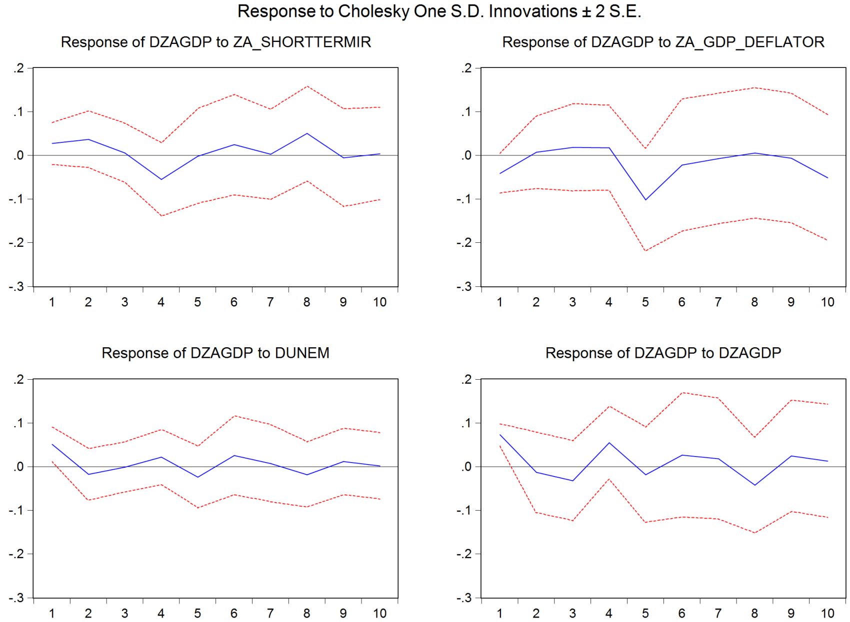

Response to Cholesky One S.D. Innovations ± 2 S.E.
Response of ZA_SHORTTERMIR to ZA_SHORTTERMIR
Response of ZA_SHORTTERMIR to ZA_GDP_DEFLATOR
Response of ZA_SHORTTERMIR to DUNEM
Response of ZA_SHORTTERMIR to DZAGDP
6
4
2
0
-2
-4
1 2 3 4 5 6 7 8 9 10


Response to Cholesky One S.D. Innovations ± 2 S.E.
Response of ZA_GDP_DEFLATOR to ZA_SHORTTERMIR
Response of ZA_GDP_DEFLATOR to ZA_GDP_DEFLATOR
Response of ZA_GDP_DEFLATOR to DUNEM
Response of ZA_GDP_DEFLATOR to DZAGDP
15
10
5
0
-5
-10
1 2 3 4 5 6 7 8 9 10

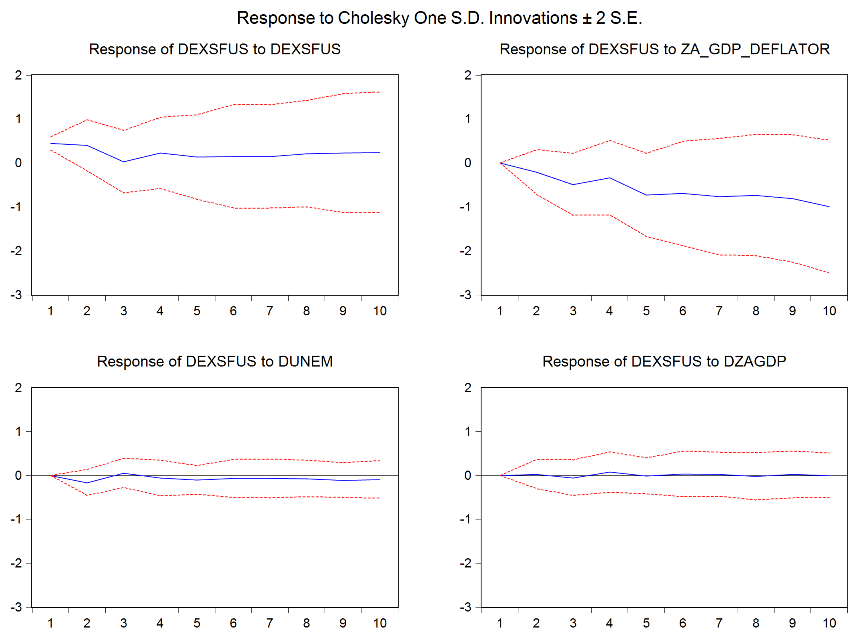
Response to Cholesky One S.D. Innovations ± 2 S.E.

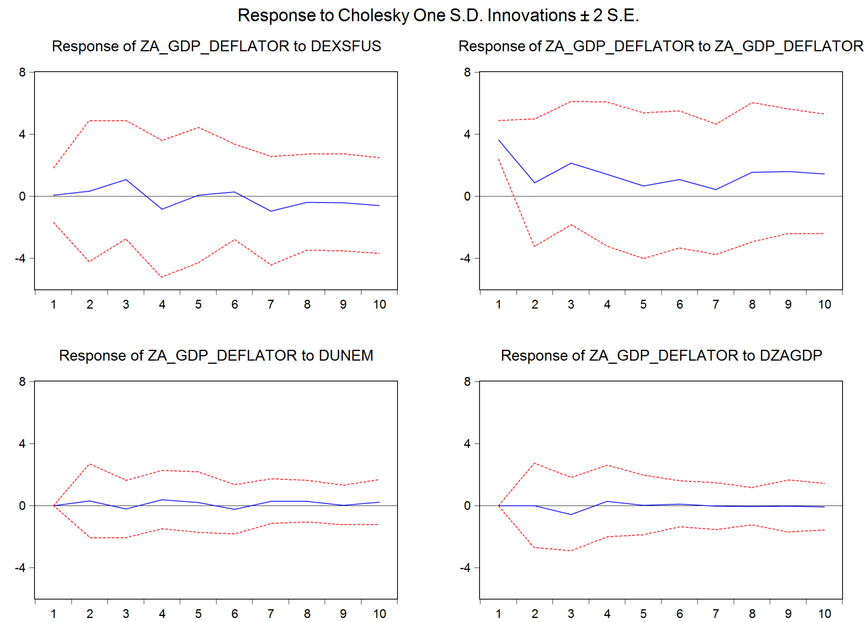


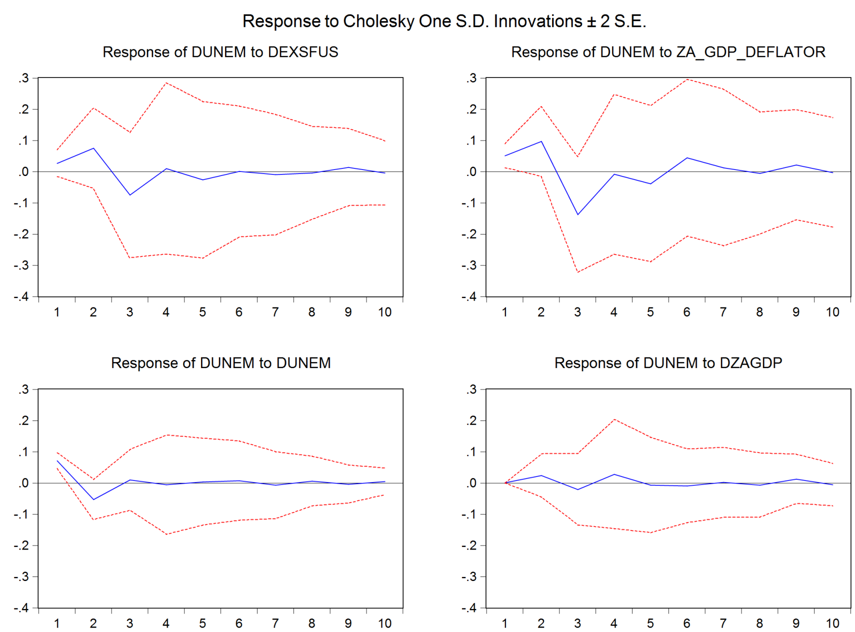

Response to Cholesky One S.D. Innovations ± 2 S.E.

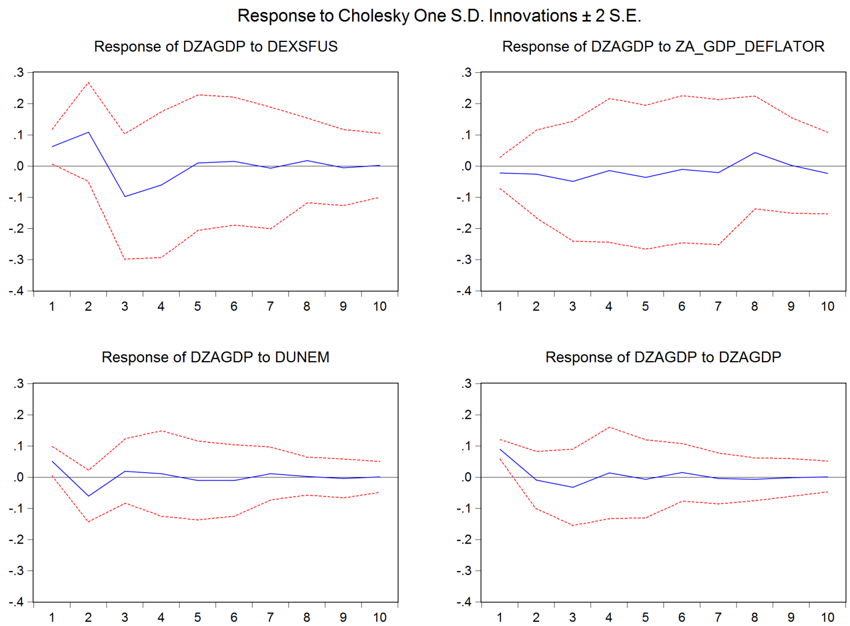


## Appendix B2: Model 2 Pre 2000 Impulse Responses

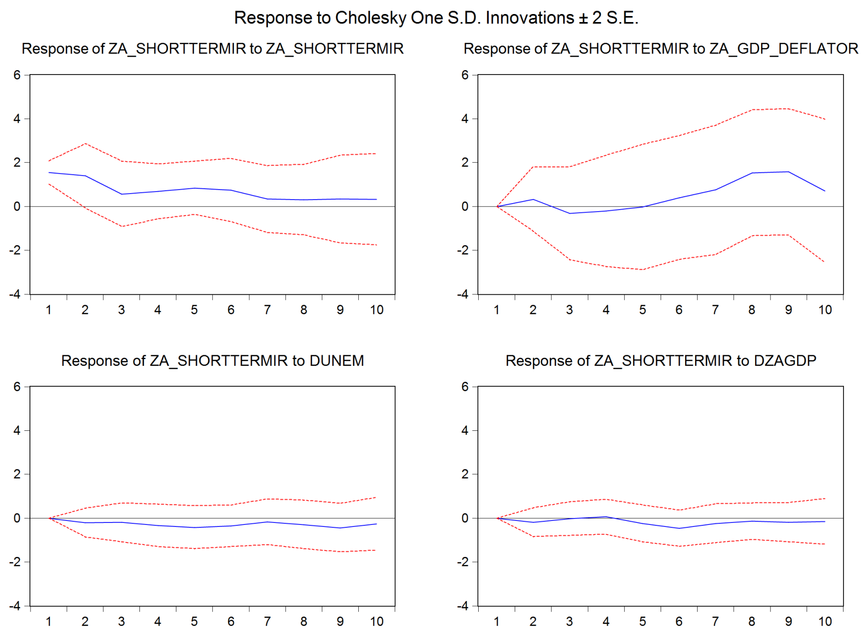


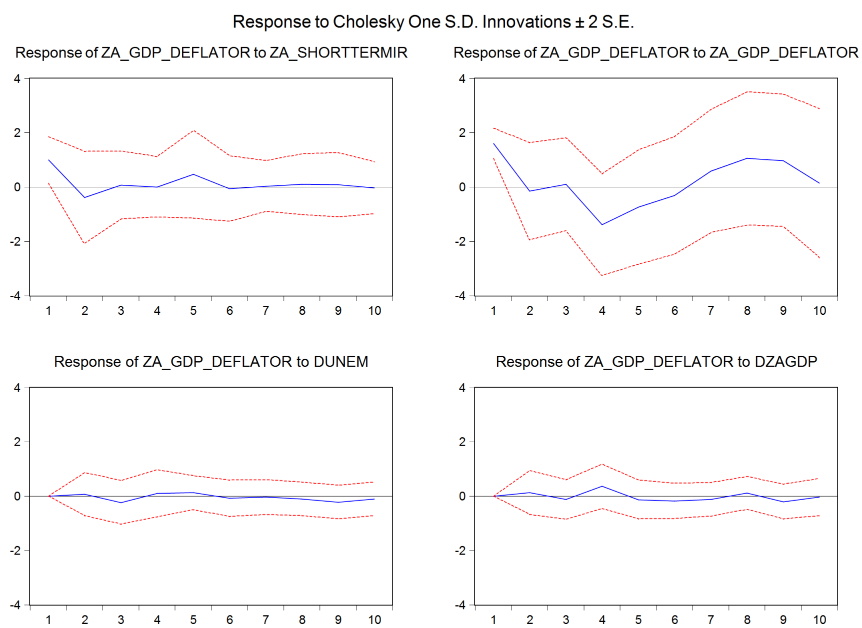

Response to Cholesky One S.D. Innovations ± 2 S.E.
Response of ZA_GDP_DEFLATOR to DEXSFUS
Response of ZA_GDP_DEFLATOR to ZA_GDP_DEFLATOR
Response of ZA_GDP_DEFLATOR to DUNEM
Response of ZA_GDP_DEFLATOR to DZAGDP

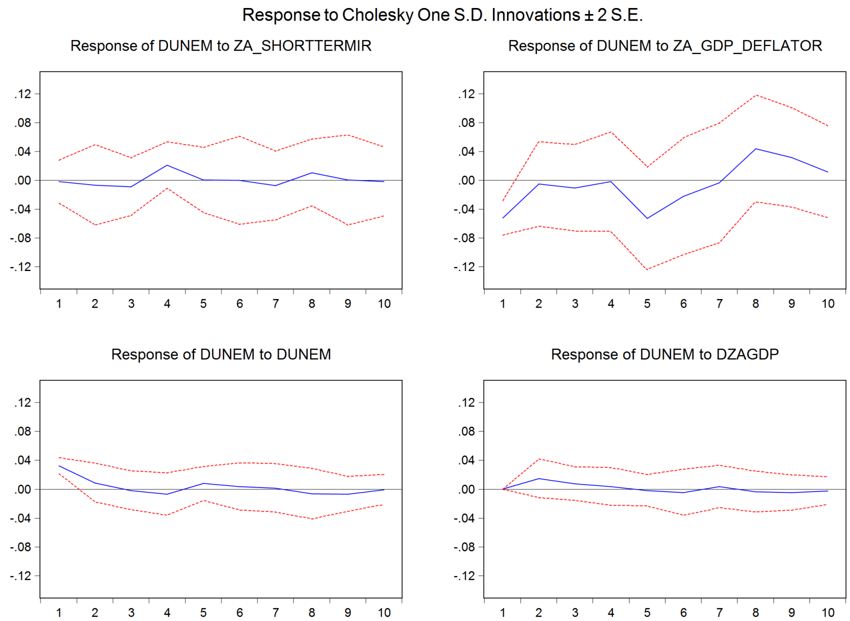

Response to Cholesky One S.D. Innovations ± 2 S.E.
Response of DUNEM to DEXSFUS
Response of DUNEM to ZA_GDP_DEFLATOR
Response of DUNEM to DUNEM
Response of DUNEM to DZAGDP

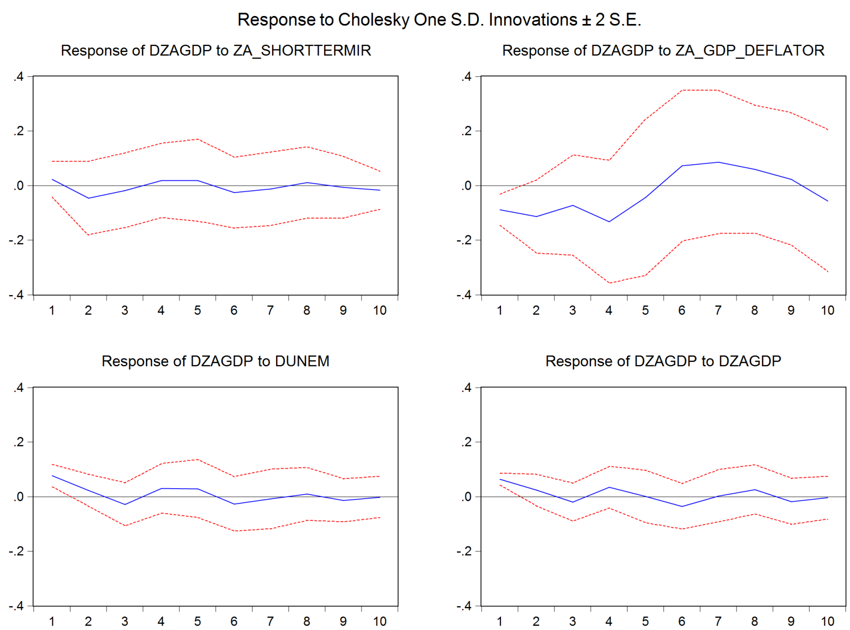



## Appendix B3: Model 1 Post 1998 Impulse Responses

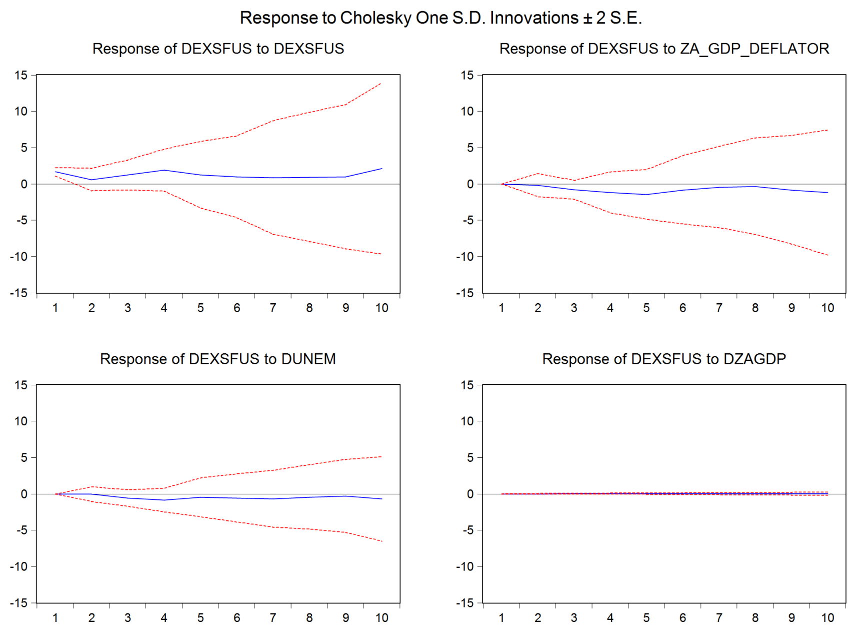

Response to Cholesky One S.D. Innovations ± 2 S.E.
Response of ZA_SHORTTERMIR to ZA_SHORTTERMIR
Response of ZA_SHORTTERMIR to ZA_GDP_DEFLATOR
Response of ZA_SHORTTERMIR to DUNEM
Response of ZA_SHORTTERMIR to DZAGDP

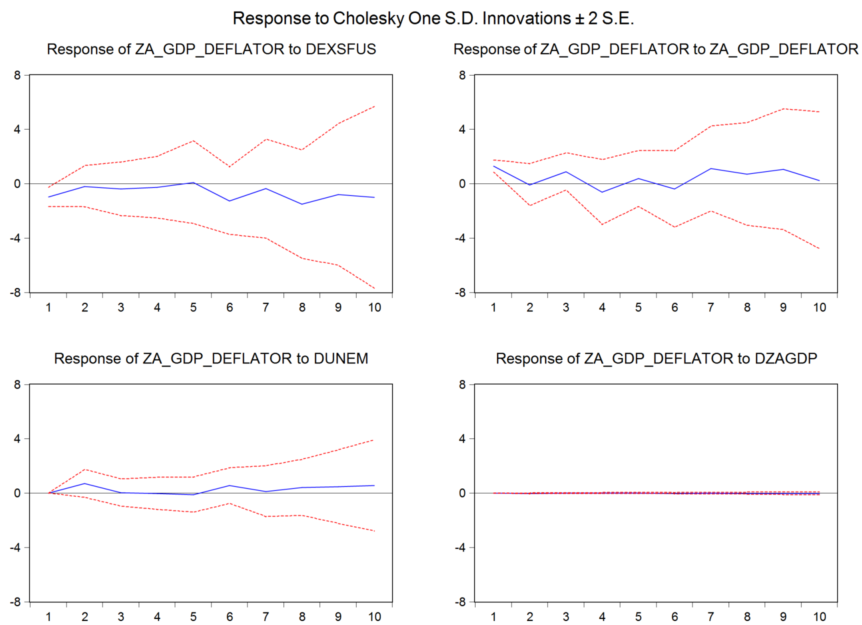

Response to Cholesky One S.D. Innovations ± 2 S.E.
Response of ZA_GDP_DEFLATOR to ZA_SHORTTERMIR
Response of ZA_GDP_DEFLATOR to ZA_GDP_DEFLATOR
Response of ZA_GDP_DEFLATOR to DUNEM
Response of ZA_GDP_DEFLATOR to DZAGDP

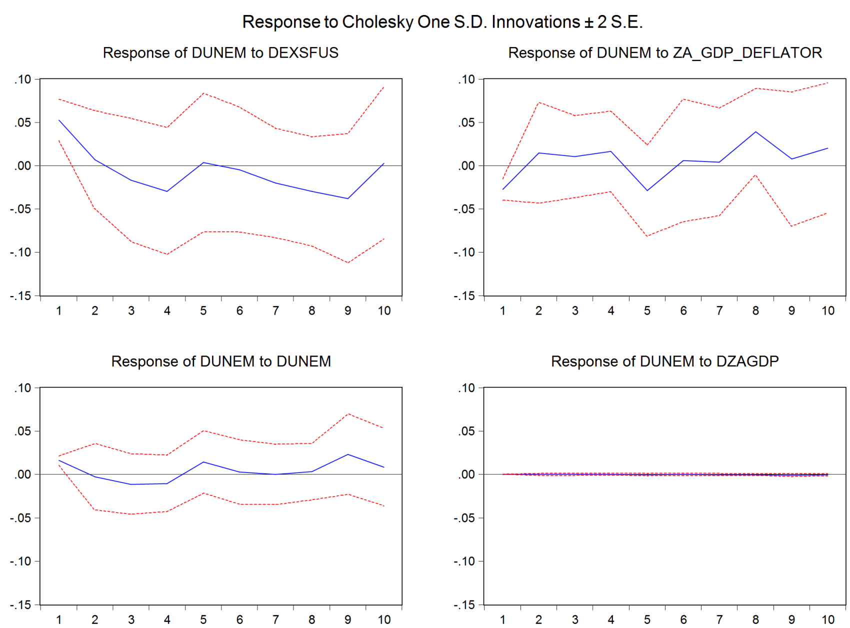

Response to Cholesky One S.D. Innovations ± 2 S.E.
Response of DUNEM to ZA_SHORTTERMIR
Response of DUNEM to ZA_GDP_DEFLATOR
Response of DUNEM to DUNEM
Response of DUNEM to DZAGDP

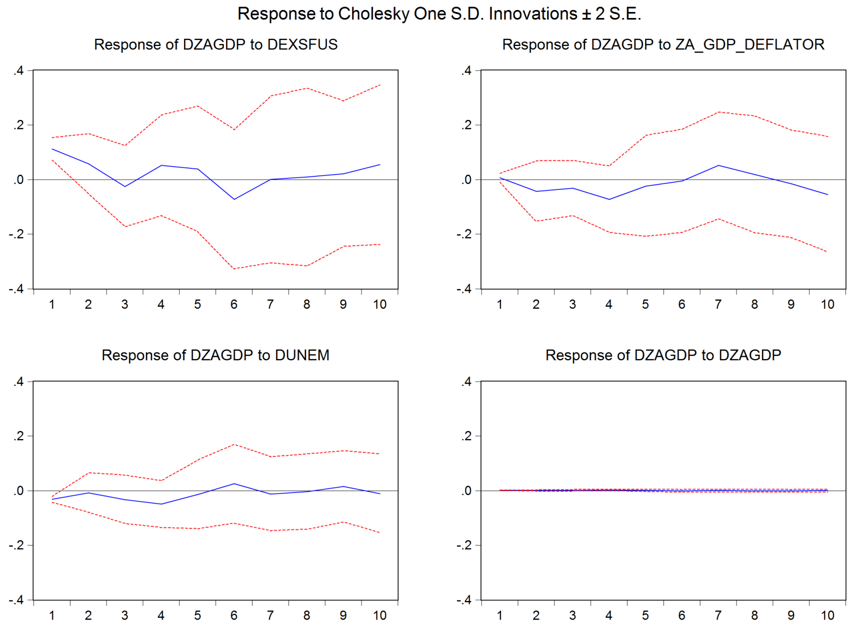

Response to Cholesky One S.D. Innovations ± 2 S.E.
Response of DZAGDP to ZA_SHORTTERMIR
Response of DZAGDP to ZA_GDP_DEFLATOR
Response of DZAGDP to DUNEM
Response of DZAGDP to DZAGDP

## Appendix B4: Model 2 Pre 1998 Impulse Responses




Response to Cholesky One S.D. Innovations ± 2 S.E.
Response of ZA_GDP_DEFLATOR to DEXSFUS
Response of ZA_GDP_DEFLATOR to ZA_GDP_DEFLATOR
Response of ZA_GDP_DEFLATOR to DUNEM
Response of ZA_GDP_DEFLATOR to DZAGDP


Response to Cholesky One S.D. Innovations ± 2 S.E.
Response of DUNEM to DEXSFUS
Response of DUNEM to ZA_GDP_DEFLATOR
Response of DUNEM to DUNEM
Response of DUNEM to DZAGDP




## Appendix C: EViews Code

```
' Import the data
cd "K:\Work\College\Econ 590 Monetary Economics (Fall 2016) - Dr.
    Gabriela Best (CSUF)\Term Paper"


'Plotting Exhange Rate
graph exch.line dexsfus
exch.addtext(t) Zuid-Afrikaanse Rand to USD
exch.save(t=PNG, d=300, trans) p1

'First difference Exchange Rate
series fdDEXSFUS = (DEXSFUS - DEXSFUS(-1))
graph fdexch.line fdDEXSFUS
fdexch.addtext(t) Zuid-Afrikaanse Rand to USD
fdexch.save(t=PNG, d=300, trans) p2


'Plotting ZA GDP
graph zagdp.line ZA_GDP
zagdp.addtext(t) Zuid-Afrikaanse GDP (current USD)
zagdp.save(t=PNG, d=300, trans) p3
```

```
'Plotting ZA Short Term Interest Rate
graph zasir.line ZA_SHORTTERMIR
zasir.addtext(t) Zuid-Afrikaanse Short Term Interest Rate (%)
zasir.save(t=PNG, d=300, trans) p4


'Plotting ZA GDP Deflator
graph zadef.line ZA_GDP_DEFLATOR
zadef.addtext(t) Zuid-Afrikaanse GDP Deflator
zadef.save(t=PNG, d=300, trans) p5

'Plotting ZA Unemployemnt
graph zaunem.line ZA_UNEM
zaunem.addtext(t) Zuid-Afrikaanse Unemployment Rate
zaunem.save(t=PNG, d=300, trans) p5a


'Plotting ZA and USD GDP for comparison
graph grgdp.line US_GDP ZA_GDP
grgdp.addtext(t) US GDP vs Zuid-Afrikaanse
grgdp.save(t=PNG, d=300, trans) p6

'Plotting ZA and USD Short term interest rate for comparison
graph grstir.line US_SHORTTERMIR ZA_SHORTTERMIR
grstir.addtext(t) US Short-term Interest Rate vs Zuid-Afrikaanse
grstir.save(t=PNG, d=300, trans) p7

'Plotting ZA and USD GDP Deflator for comparison
graph grgdpdef.line USA__GDP_DEFLATOR ZA_GDP_DEFLATOR
grgdpdef.addtext(t) US GDP Deflator vs Zuid-Afrikaanse
grgdpdef.save(t=PNG, d=300, trans) p8


'Creating Variables to Study

'Year to Year Change in log of Unemployment
series dunem = -log(ZA_UNEM(-1))+log(ZA_UNEM)
graph dsunem.line dunem
dsunem.addtext(t) Zuid-Afrikaanse Year to Year Change in log of
    Unemployment
dsunem.save(t=PNG, d=300, trans) p9

'GDP Growth
series dzagdp = log(ZA_GDP(-1))-log(ZA_GDP)
graph dzagd.line dzagdp
dzagd.addtext(t) Zuid-Afrikaanse Economic Growth
dzagd.save(t=PNG, d=300, trans) p10


'VAR pree 2000
```

```
'Running a VAR for model 1
smpl if @year<2001
var mod1_pre.ls 1 3 ZA_SHORTTERMIR ZA_GDP_DEFLATOR DUNEM DZAGDP
var mod2_pre.ls 1 3 DEXSFUS ZA_GDP_DEFLATOR DUNEM DZAGDP

'Impulse response fct Model 1
freeze(var1_1) mod1_pre.impulse(10,m, se=a) za_shorttermir @
    za_shorttermir za_gdp_deflator dunem dzagdp
var1_1.save(t=PNG, d=300, trans) a1

freeze(var1_2) mod1_pre.impulse(10,m, se=a) za_gdp_deflator @
    za_shorttermir za_gdp_deflator dunem dzagdp
var1_2.save(t=PNG, d=300, trans) a2

freeze(var1_3) mod1_pre.impulse(10,m, se=a) dunem @ za_shorttermir
    za_gdp_deflator dunem dzagdp
var1_3.save(t=PNG, d=300, trans) a3

freeze(var1_4) mod1_pre.impulse(10,m, se=a) dzagdp @ za_shorttermir
    za_gdp_deflator dunem dzagdp
var1_4.save(t=PNG, d=300, trans) a4


'Impulse response fct Model 2
freeze(var2_1) mod2_pre.impulse(10,m, se=a) DEXSFUS @ DEXSFUS
    ZA_GDP_DEFLATOR DUNEM DZAGDP
var2_1.save(t=PNG, d=300, trans) a5

freeze(var2_2) mod2_pre.impulse(10,m, se=a) za_gdp_deflator @ DEXSFUS
    ZA_GDP_DEFLATOR DUNEM DZAGDP
var2_2.save(t=PNG, d=300, trans) a6

freeze(var2_3) mod2_pre.impulse(10,m, se=a) dunem @ DEXSFUS
    ZA_GDP_DEFLATOR DUNEM DZAGDP
var2_3.save(t=PNG, d=300, trans) a7

freeze(var2_4) mod2_pre.impulse(10,m, se=a) dzagdp @ DEXSFUS
    ZA_GDP_DEFLATOR DUNEM DZAGDP
var2_4.save(t=PNG, d=300, trans) a8


'Runnign reponses due to main variable
freeze(var1_s) mod1_pre.impulse(10,m, se=a) za_shorttermir
    za_gdp_deflator dunem dzagdp @ za_shorttermir
var1_s.save(t=PNG, d=300, trans) s1

freeze(var2_s) mod2_pre.impulse(10,m, se=a) DEXSFUS ZA_GDP_DEFLATOR DUNEM
     DZAGDP @ DEXSFUS
var2_s.save(t=PNG, d=300, trans) s2
```

```
'Variance Decomposition
'model 1
freeze(deva1) mod1_pre.decomp(10,m) za_shorttermir
deva1.save(t=PNG, d=300, trans) w1

'model 2
freeze(deva2) mod2_pre.decomp(10,m) DEXSFUS
deva2.save(t=PNG, d=300, trans) w2


'VAR post 1998
'Running a VAR for model 1
smpl if @year>=1998
var mod1_post.ls 1 3 ZA_SHORTTERMIR ZA_GDP_DEFLATOR DUNEM DZAGDP
var mod2_post.ls 1 3 DEXSFUS ZA_GDP_DEFLATOR DUNEM DZAGDP

'Impulse response fct Model 1
freeze(var21_1) mod1_post.impulse(10,m, se=a) za_shorttermir @
    za_shorttermir za_gdp_deflator dunem dzagdp
var21_1.save(t=PNG, d=300, trans) b1

freeze(var21_2) mod1_post.impulse(10,m, se=a) za_gdp_deflator @
    za_shorttermir za_gdp_deflator dunem dzagdp
var21_2.save(t=PNG, d=300, trans) b2

freeze(var21_3) mod1_post.impulse(10,m, se=a) dunem @ za_shorttermir
    za_gdp_deflator dunem dzagdp
var21_3.save(t=PNG, d=300, trans) b3

freeze(var21_4) mod1_post.impulse(10,m, se=a) dzagdp @ za_shorttermir
    za_gdp_deflator dunem dzagdp
var21_4.save(t=PNG, d=300, trans) b4


'Impulse response fct Model 2
freeze(var22_1) mod2_post.impulse(10,m, se=a) DEXSFUS @ DEXSFUS
    ZA_GDP_DEFLATOR DUNEM DZAGDP
var22_1.save(t=PNG, d=300, trans) b5

freeze(var22_2) mod2_post.impulse(10,m, se=a) za_gdp_deflator @ DEXSFUS
    ZA_GDP_DEFLATOR DUNEM DZAGDP
var22_2.save(t=PNG, d=300, trans) b6

freeze(var22_3) mod2_post.impulse(10,m, se=a) dunem @ DEXSFUS
    ZA_GDP_DEFLATOR DUNEM DZAGDP
var22_3.save(t=PNG, d=300, trans) b7

freeze(var22_4) mod2_post.impulse(10,m, se=a) dzagdp @ DEXSFUS
    ZA_GDP_DEFLATOR DUNEM DZAGDP
var22_4.save(t=PNG, d=300, trans) b8
```

```
'Runnign reponses due to main variable
freeze(var21_s) mod1_post.impulse(10,m, se=a) za_shorttermir
    za_gdp_deflator dunem dzagdp @ za_shorttermir
var21_s.save(t=PNG, d=300, trans) s3

freeze(var22_s) mod2_post.impulse(10,m, se=a) DEXSFUS ZA_GDP_DEFLATOR
    DUNEM DZAGDP @ DEXSFUS
var22_s.save(t=PNG, d=300, trans) s4


'Variance Decomposition
'model 1
freeze(deva3) mod1_post.decomp(10,m) za_shorttermir
deva3.save(t=PNG, d=300, trans) w3

'model 2
freeze(deva4) mod2_post.decomp(10,m) DEXSFUS
deva4.save(t=PNG, d=300, trans) w4


'Appendix A
'3 variable VAR with time periods
'Pre 2000
smpl if @year<2001
'VAR for both models
var mod21_pre.ls 1 3 DEXSFUS ZA_SHORTTERMIR ZA_GDP_DEFLATOR
var mod22_pre.ls 1 3 ZA_SHORTTERMIR DEXSFUS ZA_GDP_DEFLATOR
'Runnign reponses due to main variable
freeze(avar1_s) mod21_pre.impulse(10,m, se=a) DEXSFUS ZA_SHORTTERMIR
    ZA_GDP_DEFLATOR @ DEXSFUS
avar1_s.align(2, 1, 1)
avar1_s.save(t=PNG, d=300, trans) z1

freeze(avar2_s) mod22_pre.impulse(10,m, se=a) ZA_SHORTTERMIR DEXSFUS
    ZA_GDP_DEFLATOR @ ZA_SHORTTERMIR
avar2_s.align(2, 1, 1)
avar2_s.save(t=PNG, d=300, trans) z2

'Variance Decomposition
'model 1
freeze(deva21) mod21_pre.decomp(10,m) DEXSFUS
deva21.align(2, 1, 1)
deva21.save(t=PNG, d=300, trans) d1

'model 2
freeze(deva22) mod22_pre.decomp(10,m) za_shorttermir
deva22.align(2, 1, 1)
deva22.save(t=PNG, d=300, trans) d2
```

```
'VAR post 1998
'Running a VAR for model y1t and y2t
smpl if @year>=1998
var mod21_post.ls 1 3 DEXSFUS ZA_SHORTTERMIR ZA_GDP_DEFLATOR
var mod22_post.ls 1 3 ZA_SHORTTERMIR DEXSFUS ZA_GDP_DEFLATOR
'Runnign reponses due to main variable
freeze(avar21_s) mod21_post.impulse(10,m, se=a) DEXSFUS ZA_SHORTTERMIR
    ZA_GDP_DEFLATOR @ DEXSFUS
avar21_s.align(2, 1, 1)
avar21_s.save(t=PNG, d=300, trans) z3

freeze(avar22_s) mod22_post.impulse(10,m, se=a) ZA_SHORTTERMIR DEXSFUS
    ZA_GDP_DEFLATOR @ ZA_SHORTTERMIR
avar22_s.align(2, 1, 1)
avar22_s.save(t=PNG, d=300, trans) z4

'Variance Decomposition
'model 1
freeze(deva23) mod21_post.decomp(10,m) DEXSFUS
deva23.align(2, 1, 1)
deva23.save(t=PNG, d=300, trans) d3

'model 2
freeze(deva24) mod22_post.decomp(10,m) za_shorttermir
deva24.align(2, 1, 1)
deva24.save(t=PNG, d=300, trans) d4
```