Monetary Policy and Long-Term Interest Rates in South Africa

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Abstract

This paper examines how the short-term and long-term interest rates react to supply, demand and monetary policy shocks in South Africa. Use is made of the impulse response functions obtained from the structural vector autoregressive model with long-term restrictions. We find a positive correlation between the two interest rates after a monetary and demand shock and a negative correlation after a supply shock. The finding of this paper signifies that the operation of the monetary transmission mechanism should be effective in South Africa. Furthermore, the finding of this paper provide an approach to identify supply shocks in the South African business cycle

1 Introduction

The subject of the monetary policy transmission mechanism (MPTM) has received growing interest internationally and in South Africa in particular, with a growing number of theories and empirical studies (see Mishkin (1995), Peersman (2001), Smal and Jager (2001) and De Angelis, Aziakpono and Faure (2005)). The MPTM describes a chain of developments through which a change in monetary policy stance is transmitted to achieve goals such as stable and low inflation and economic growth (Mishkin, 1995). The key channel through which monetary policy actions are transmitted to the economy is through their effects on market interest rates (Taylor, 1995). This is known as the interest rate channel of the MPTM. With reference to the interest rate channel, the MPTM is effective if monetary policy action is capable of affecting a spectrum of interest rates, from the short- to long-term interest rates. However, while there is considerable evidence that monetary policy has predictable effects on short-term rates, the connection between monetary policy actions and long-term rates appears to be weaker and less reliable (Roley and Sellon, 1995).

Moreover, from a theoretical perspective, Taylor (1995) contends that it is difficult to determine which of the interest rates (the short-run interest rate or the long-term interest rate) has a greater effect on economic activity (consumption and investment demands). However, for the author, there is a priori reason to believe that for long-term decisions, such as investing in plant and equipment, the long-term interest rate should be a variable that receives more attention. To the extent that it is the long-term interest rate that matters for investment or consumption demands, the effectiveness of the MPTM, in as far as the interest rate channel is concerned, should depend on how monetary policy affects the long-term interest rate.

A number of studies have confirmed that monetary policy actions have predictable effects on short-term interest rates. For example, the results of the study by Aziakpono *et al.* (2007) show high responses of the overnight prime interbank lending rates (PIBR) and the three-month negotiable certificate of deposit (NCD) to monetary policy actions in South Africa between 1973 and 2004.

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Roley and Sellon (1995) show that short-term rates in the US follow the same trend as the federal funds rate (monetary policy instrument in the US). Dale (1993) measures the short-term response of the UK market rates to monetary policy actions by the Bank of England. The results of Dale's study show that policy actions by the Bank of England have significant positive effects on interest rates of all maturities. Nevertheless, these effects decline as maturity lengthens.

While there seems to be agreement that monetary policy actions have significant positive effects on short-run or money market interest rates, the relationship between monetary policy actions and long-term interest rates is not clear. With reference to the theories of the term structure of interest rates, changes in the short-term interest rate, due to monetary policy action, affect the long-term interest rates differently. According to the expectations theory of the term structure, monetary policy affects long-term interest rates by influencing short-term interest rates and by changing market expectations of future short-term rates (Walsh, 2003). In this framework, there is no simple relationship between monetary policy actions and long-term interest rates. The reaction of the long-term rates to monetary policy actions can be highly variable, depending on how market participants change their views as to how they perceive the future direction of monetary policy. The way market participants form their expectations of the future direction of monetary policy will impact on the expected future short-term rates (forward rates) and thus, the long-term interest rates (Roley and Sellon, 1995). However, the market segmentation theory (MST) of the term structure of interest rate conjectures that there need be no relationship between interest rates of different maturities. The rationale of the market segmentation theory is that investors and borrowers have strong maturity preferences that they try to attain when they invest in or issue fixed income securities. As a result of these preferences, the financial markets are segmented into a number of smaller markets, with supply and demand forces unique to each segment determining the equilibrium yields (interest rates) for each segment. Thus according to MST, the major factors that determine the interest rate for a maturity segment are supply and demand conditions unique to the maturity segment. A variant of the MST, the preferred habitat theory, combines the elements of the expectations and the segmented-markets hypotheses and it says that investors have a preference for debt securities of a given term, but that they are willing to substitute away from their preferred terms if they expect to be compensated for doing so through earning a risk or term premium (Baye and Jansen, 1995).

The mixed empirical results obtained from different studies confirm the complexity of the relationship between monetary policy and long-term interest rates. Cook and Hahn (1989) examine the effect of changes in the Federal Funds rate on market rates in the United States at various maturities close to and on the day of changes in the Federal Funds rate in the 1970s. The authors find that changes in the Federal Funds rate caused large movements in short-term rates and smaller but significant movements in intermediate- and long-term rates. Thornton (1998) also studies the market rate's reaction to Federal Funds rate changes, but only on the day of the change in the Federal Funds rate during the period between October 1989 and December 1997. Thornton finds that the response of the 10-year and 30-year Treasury rates to changes in the Federal Funds rate was not statistically significant. The author interprets these results as being due to a revision by market participants of the market's outlook for inflation. According to Romer and Romer (2000), the positive response of the long-term interest rate to monetary policy action is inconsistent with standard monetary theory and should be seen as a puzzle. For Romer and Romer, an increase in the Federal Funds rate should reduce inflation expectations, and hence reduce the level of the long-term interest rates. Romer and Romer suggest that the puzzle can be resolved if market participants can have access to the central bank's forecast of inflation. Thus information asymmetry between the central bank and market participants is reduced to a minimum.

Hardy (1998) shows that the market interest rates reaction to change in the official interest rate in Germany depends on the extent to which the change is anticipated, and on how it is interpreted as a signal for future policy. Hardy finds that German market interest rates responded significantly to changes in the official rates during the 1990s, and these responses become even stronger when the changes in official rates are decomposed into anticipated and unanticipated changes. Kaketsis and

Sarantis (2006) investigate the transmission process between the Bank of Greece's operating interest rates instruments and the market interest rates at various maturities during the transition period of the 1990s. The results of their study show an increase in anticipation and learning responses of market rates to policy changes during the transition period and a pronounced decline in responses along the maturities spectrum.

For Ellingsen and Södeström (2001), the response of the long-term interest rate to monetary policy actions depends on how the change in monetary policy comes about. For Ellingsen and Södeström, changes in monetary policy can come about for two distinct reasons: either the monetary authorities react to new and probably private knowledge about the economy (for instance demand and supply shocks), or to their policy preferences change (monetary policy shocks). In the first case, policy is essentially endogenous, reflecting new input into a given objective function; in the second case, policy is exogenous because the input is the same but the objective function is new. After an endogenous policy action, Ellingsen and Södeström predict that interest rates of all maturities will move in the same direction. However, short- and long-term interest rates move in opposite directions after an exogenous policy action. While explaining the reasons why short- and long-term interest rates move in opposite directions after an exogenous policy action, Peersman (2002), referring to the Ellingsen and Södeström (2001) study, remarks that if a central bank becomes more averse to inflation, the weight of inflation in the objective function increases and this is translated by a positive exogenous monetary policy shock that results in an unexpected increase in the short-term interest rate. Nonetheless, because the preference of the monetary policy has changed, economic agents adjust their inflation expectations downward. Thus, positive exogenous monetary policy shock decreases the long-term interest rates.

This paper makes use of the impulse response functions (IRF) obtained from the structural vector autoregressive (SVAR) model with long-term restrictions to mainly characterise the dynamic responses of the short- and long-term interest rates to supply, demand and monetary policy shocks in South Africa. In so doing, the paper tests the relevance of the theory of Ellingsen and Södeström in the South African context. A similar methodology is used by Peersman (2002) for the investigation of the reaction of the term structure of interest rates to supply, demand, exchange rate and monetary shocks in Germany.

To the best of our knowledge, there is no study that has dealt specifically with the dynamic reactions of the short- and long-term interest rates to supply, demand and monetary shocks in South Africa. Nevertheless, as a corollary to this topic, Ballim and Moolman (2005) as well as Aron and Muellbauer (2007) use the forward rate agreements (FRAs), as a proxy for interest rate expectations, to examine whether market traders correctly predict the South African Reserve Bank (SARB) interest rate decision before each MPC meeting. Balim and Moolman find that most of the movement in market rates occurs in anticipation of policy action, rather than on the day the interest rate decision is made by the SARB. Moreover, Arize *et al.* (2002) examine the long-run relation between short-term and long-term interest rates in 19 countries, including South Africa, over the quarterly period 1973 to 1998. The results of their study support the expectations hypothesis in all countries, except the United Kingdom.

The paper is structured as follows. Section 2 discusses the trend of the yield curve in South Africa, section 3 lays out the SVAR methodology, section 4 presents a discussion on the data and the results of the empirical analysis and section 5 concludes the paper.

2 The South African Yield curve

This section analyses the trend of interest rates or yields of financial instruments (money market and capital market instruments) of different maturities in South Africa. This is known as the yield curve. The yield curve is the plot of the yields or interest rates on bonds with different terms to maturity but the same risks, liquidity and tax considerations (Mishkin, 2004). Very often, the yield on government bonds of different maturity is used to represent the yield curve. For example, Nel (1996) and Khomo and Aziakpono (2007) have used the yields on the 10-year government bond and the 3-month Treasury bill (TB) to derive the yield spread in South Africa . For these authors, the yields on the 10-year government bond and the 3-month Treasury bill are the benchmarks for representing the long- and short-term interest rates respectively in South Africa.

Figure 1 illustrates the relationship between the short- and long-term interest rates, in the period between December 1979 and December 2007 in South Africa. The shaded area in figure 1 represents the periods classified as official recession by the SARB.

[Insert Figure 1 about here]

Very often, longer term interest rates are higher than shorter term interest rates. This is called a "normal yield curve" and is thought to reflect the higher "inflation-risk premium" that investors demand for long-tem bonds. Nevertheless, Figure 1 shows that, since December 1979, the relationship between the yields on the 3-month TB and the 10-year government bond has been erratic in South Africa. Further, Figure 1 shows that the yield curve becomes inverted prior to recessions, with the short-term interest rate being higher than the long-term interest rate during recessions. This phenomenon should indicate a changing pattern of inflation risk-premium that certainly affects the expectations of the future short-term interest rates by market participants and thus, the long-term interest rates. This phenomenon can lend support to the argument that the expectations theory of the term structure holds in South Africa. By linking the phenomenon of inverted yield curve prior and during recession to the expectations hypothesis, Mishkin (2004) shows that if a central bank tightens monetary policy by raising the short-term rates during the recession, market participants will view this as a temporary shock, and therefore they will expect the future short-term rates (forward rates) to rise by less than the current change in short-term interest rates. Thus, according to the expectation hypothesis, long-term rates will rise by less than the current short rate during the recession. Conversely, during upswings, high inflation expectations should result in expected future short-term interest rates rising by more than the current short-term interest rates, thus the long-term interest rates rise by more than the current short-term interest rates.

Figure 2 shows the relationship between the repo rate (policy instrument by the SARB) and the yield on the 3-month TB in South Africa from the period between March 1998 and December 2007. The positive relationship between the two interest rates confirms that the SARB operates on the short end of the yield curve and therefore directly influences the short-term interest rates. Figure 2 confirms the high correlation between short-term interest rates in South Africa supported by a number of studies (see Aziakpono *et al.*, 2007). Nevertheless, the erratic relationship between the short-term and long-term interest rates in South Africa, as observed in Figure 1, warrants further scrutiny. This is actually the motivation behind this paper.

[Insert Figure 2 about here]

3 The SVAR methodology

The aim of the SVAR model is to deduce a structural-form relationship from the reduced-form VAR. In this way, a VAR is the reduced form of a general dynamic structural model. To understand the link between a reduced-form VAR and SVAR, consider equation 1 below, which represents a dynamic structural model. The reparameterisation of equation 1 leads to a reduced-form relationship represented by equation 2.

$$\Gamma Y_t \ = \ \mathrm{B}(L)Y_t \ + \ e_t \tag{1}$$

$$Y_t \ = \ \Gamma^{-1}\mathrm{B}(L)Y_t \ + \ \Gamma^{-1}e_t or Y_t \ = \ \mathrm{B}^*(L)Y_t \ + \ \mu_t \tag{2}$$

Where Y_t is a $(n \times 1)$ vector of endogenous variables and $\mathrm{B}(L)$denotes a polynomial in the lag operator. Γ and B are parameters. e_t is the residual of the model.

It can be inferred from the equations 1 and 2 that –

$$\mathrm{B}^{*} = \Gamma^{-1}\mathrm{B} \quad (3)$$

$$\mu_t = \Gamma^{-1}e_t \quad (4)$$

Equation 4 is the core representation of the SVAR model whereby the reduced-form disturbance μ_t is related to the underlying structural shocks e_t. The identification of Γ and B are required to obtain the structural parameterB^{*}. This paper applies the long-term restriction proposed by Blanchard and Quah (1989) and extended by Clarida and Gali (1994) to identify structural shocks and thus assess the response of long-term interest to supply, demand and monetary policy shocks. Blanchard and Quah (1989) used long-run restrictions in a bivariate model to identify the aggregate supply and demand shocks by assuming that some shocks have a temporary effect on certain endogenous variables and other shocks have temporary effects on these variables. Clarida and Gali (1994) further disentangle the demand shock. This paper uses the four-variable VAR made of output growth, inflation, real short-term and long-term interest rates to identify aggregate supply and demand shocks. The demand shocks are subsequently subdivided into pure demand shocks, monetary shocks and long-term yield shocks. The vector of endogenous variables is:

$$Y_t^{'} = [\Delta y_t \;\; \Delta p_t \; RS, \;\; RL]$$

With Δy_t denoting output growth, Δp_t the rate of inflation, RS is the short-term interest rate, represented by the 3-month TB and RL is the long-term interest rate, represented by 10-year government bond. The vector of structural shocks is:

$$e_t^{Y} = \left[e_t^{S} \;\; e_t^{D} \;\; e_t^{M} \;\; e_t^{RL}\right]$$

with, respectively, a supply, demand, monetary policy and long-term yield shocks. In order to identify the supply shock, we assume that there is no long-run impact of demand, monetary policy and long-term yield shocks on output growth. This supports the view that only supply shocks have long-run impact on output growth. We further allow the supply and demand shocks to have long-run impact on the short-term and long-term interest rates. Lastly, the long-term interest rate has a long-run response to all shocks in the system.

4 Data Analysis and Results

The model was estimated with seasonally adjusted quarterly time series data starting from the fourth quarter of 1979 to the fourth quarter of 2007. Table 1 shows the variables used for model specification. The variables are all sourced from the I-Net Bridge database. Blanchard and Quah (1989) suggest that all variables be stationary when identifying structural shocks with the aid of long-term restrictions in the SVAR model. Table 2 presents the results of the stationarity test of all the time series data. The paper employs the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) methodology for testing the null hypothesis of stationarity for the time series data. The results of the stationarity test, reported in Table 2, show that Δy_t, Δp_t, RS and RL are all stationary.

The reduced form VAR model is estimated with a lag length of two (suggested by the Akaike Information Citeria). More importantly, the root lag structure in Table 3 indicates that no root lies outside the unit circle; hence the VAR satisfies the stability condition.

[Insert Tables 1, 2, 3 about here]

Figures 3, 4, 5 and 6 show the impulse response functions for output growth, inflation, short-term and long-term interest rates respectively to the four identified structural shocks for the period of 10 quarters. The impulse responses of variables to one positive standard deviation innovation are calculated by making use of Monte Carlo integration with 500 replications. It is worth noting that all the series are standardised to keep the same scale for comparison of the effects of shocks.

The results of the IRF in Figure 3 show the dynamic effect of output growth to supply, demand, monetary and long-term yield shocks. Output growth responds positively to supply shocks up to the second quarter where the response becomes negative. The response of output growth to supply shocks becomes neutral from the seventh quarter. The response of output growth to demand shocks is slightly positive until the second quarter and becomes negative from the second to the fourth quarter. Output growth responds negatively to monetary shocks (contractionary monetary policy) from the second to the fifth quarter. The results are statistically significant from the third to the fourth quarter. The response of output growth to long-term yield (long yield) shocks almost resembles its response to monetary shocks, except that the negative effect of output growth to long-term yield shocks is short-lived and not statistically significant.

[Insert Figure 3 about here]

The results of the IRF in Figure 4 show that inflation rate responds negatively to supply shocks and positively to demand shocks. These results are as expected and similar to the ones obtained by other studies (see Peersman, 2002). As the textbook predicts, a supply shock has a negative influence on prices while a demand shock has a positive effect impact on prices. The inflation rate responds positively to monetary policy shocks up to the seventh quarter where the effect becomes neutral. The response of inflation to long-term yield shocks is also positive. It is worth noting that the positive response of the inflation rate to monetary policy shocks is a common occurrence in VAR empirical analysis. This is known as price puzzle (see Sims, 1992). One explanation of the price puzzle proposed by Sims (1992) is that the Federal Reserve steadily responds to expectations of higher future inflation by raising the federal funds rate but by not enough to prevent inflation from actually rising.

[Insert Figure 4 about here]

The results of the IRF in Figure 5 show that the short-term rates (S/T rate) react positively to supply shocks and the effect becomes neutral from the fourth period. Other studies have found the same results. For example, Balke and Emery (1994) found that the Federal Reserve responds to the supply shock by raising the federal funds rates in order to extinguish the inflationary consequences of the supply shock. Short-term rates respond positively to demand shocks. This is an expected result. Likewise, short-term rates respond positively to monetary policy shocks. As mentioned earlier, the SARB operates on the short end of the yield curve and therefore directly influences short-term interest rates. Figure 5 also shows that long-term rate shocks do not contemporaneously influence the short-term rate. Nevertheless, there is a lag positive effect of the long-term shocks on the short-term rates.

[Insert Figure 5 about here]

The results of the IRF in Figure 6 show that long-term rates respond negatively to supply shocks and positively to demand shocks. Likewise, the long-term rates respond positively to monetary policy shocks. The last graph of Figure 6 shows that the response of long-term rates to its own shocks is positive.

[Insert Figure 6 about here]

4.1 *Discussion of Results*

These results show that after demand and monetary policy shocks, short- and long-term interest rates move in the same direction. However, after a supply shock, short- and long-term rates move in the opposite direction, especially in the first four quarters. These findings contradict the theory of Ellingsen and Södeström (2001) that predicts the short- and long-term interest rates will move in the same direction after supply shocks.

The observed reactions of short- and long-term interest rates to supply, demand and monetary policy shocks should indicate that the expectations theory of the term structure of interest rates holds in South Africa. Explaining, for example, why long-term rates decrease and short-term rates increase after the supply shocks, it can be argued that market participants are assumed to believe that policy tightening (increase in the repo rate and all short-term rates) as a reaction to supply shocks, will not only be temporary, but will also lead to a significant easing of monetary policy in the future. This will result in the fall of the expected future short-term rates (forward rates). As a result, the long-term rates should fall while the short-term rates increase. This is in line with the expectations theory of the term structure of interest rate (Mishkin, 2004). Moreover, the expectation theory of the term structure of interest rates could provide insights as to why short- and long-interest rates increase after the demand shocks. In actual fact, when the short-term interest rates increase to react to demand shocks, market participants expect a further increase in the short-term interest rate due to high inflation expectations. This will result in the rise of the expected future short-term rates (forward rates) and therefore an increase in the long-term interest rate. Likewise, the positive reaction of short- and long-term interest rates to monetary policy shocks is due to market participants expecting forward rates to increase.

With regard to the finding of this paper that the short- and long-term interest rates react positively to monetary policy shocks, this should indicate that the SARB can influence long-term rates by operating at the short end of the market. Given the fact that monetary policy action is capable of moving the short- and long-term interest rates in the same direction and thus has an intended impact on economic activities, this implies that the operation of the monetary transmission mechanism should be effective in South Africa.

Another implication related to the findings of this paper concerns the identification or the characterisation of the positive supply shocks within the South African business cycle. While it is evident that the yield curve can be used to forecast the likelihood of recession in South Africa (see Moolman, 2002 and Khomo and Aziakpono, 2007), this paper shows that periods when the short-term rates increase and the long-term rates decrease are informative of the periods characterised by positive supply shocks in the South African business cycle. Given the fact that positive supply shocks entail expansion in a country's business cycle, this paper contends that periods when the short-term rates increase and the long-term rates decrease are informative of the presence of the supply shocks and thus, expansion in South Africa. This inference is supported by the finding in Figure 7. In Figure 7, a replica of Figure 1, the arrows are used to identify periods in the South African business cycle where an increase in the short-term interest rates coincides with a decrease in the long-term interest rates, which is thus reflective of periods characterised by the supply shocks. It can be observed from Figure 7 that in the period between 2002 and 2003, as well as 2006 and 2007, the decrease in the long-term rates coincides with the increase in the short-term interest rates. As this phenomenon is attributed to the presence of supply shocks, it is also shown in Figure 7 that these periods coincide with expansion in the South African business cycle, indicating evidence of positive supply shocks. To confirm this finding, Du Plessis *et al.* (2007) find a positive correlation between the output effect of fiscal policy and the cumulative supply shocks in the period between 2002Q1 and 2006Q4. Also, the authors find a high correlation between the output effect of the monetary policy and supply shocks in the period between 2004Q4 and 2006Q4.

5 Conclusion

This paper has provided an examination of the responses of the short- and long-term interest rates to monetary, demand and supply shocks for South Africa over the quarterly period 1979 to 2007. The empirical analysis conducted in this paper makes use the SVAR methodology with long-run restrictions. The paper finds that the effects of monetary and demand shocks result in the short- and long-term interest rates moving in the same direction. Nevertheless, the short- and long-term interest rates move in different directions in the presence of positive supply shocks. These findings contradict the theory of Ellingsen and Södeström (2001) that predicts the short- and long-term interest rates will move in the same direction after the supply shocks. A number of inferences are obtained from the findings of this paper. Firstly, the findings of this paper imply that the monetary authority in South Africa, the SARB, can influence the long-term interest rates by operating at the short end of the market. Given that monetary policy action is capable of moving the short- and long-term interest rates in the same direction and thus has an intended impact on economic activities, this implies that the operation of the monetary transmission mechanism should be effective in South Africa. Secondly, the finding of the paper (i.e. short-term interest rates increase while the long-term interest rates decrease as reactions to positive supply shocks) is used to identify periods characterised by positive supply shocks in the South African business cycle. The paper shows that positive supply shocks not only result in expansion but also cause the short-term interest rate to increase and the long-term interest rate to decrease in South Africa.

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Table 1 Variables used for model specification

Variable	**Description**
Δy_t	First difference of the log of real GDP
Δp_t	First difference of the log of CPI, all item metro
RS	RSA- 3-month TB tender rate
RL	RSA- yield on 10–year government bond

Table 2 Unit root test of different series

Variables	**KPSS (LM-statistics)**
Δy_t	0.108446
Δp_t	0.111877
RS	0.305279
RL	0.598680

Notes: KPSS is the Kwiatkowski-Phillips-Schmidt-Shin test for which the null hypothesis is that the series is stationary. The stationarity test for Δy_t and Δp_t are conducted by including trend and intercept. The 1% level asymptotical critical value of 0.216000 is used for the two series. The stationarity test of RS and RL includes only intercepts and the 1% level asymptotical critical value of 0.739000 is used for the two series. The null hypothesis is not rejected at the 1% level; therefore the series used are stationary.

Table 3 Stability condition of the VAR process

Root	Modulus
0.914432	0.914432
0.805012	0.805012
0.674834	0.674834
-0.127439 – 0.652626i	0.664991
-0.127439 + 0.652626i	0.664991
-0.555942	0.555942
0.330419 – 0.160275i	0.367240
0.330419 + 0.160275i	0.367240

Notes: Variables: Δy_t, Δp_t, RS and RL

No root lies outside the unit circle. VAR satisfies the stability condition

Figure 1 Relationship between the 10-year government bond and 3-month TB rate

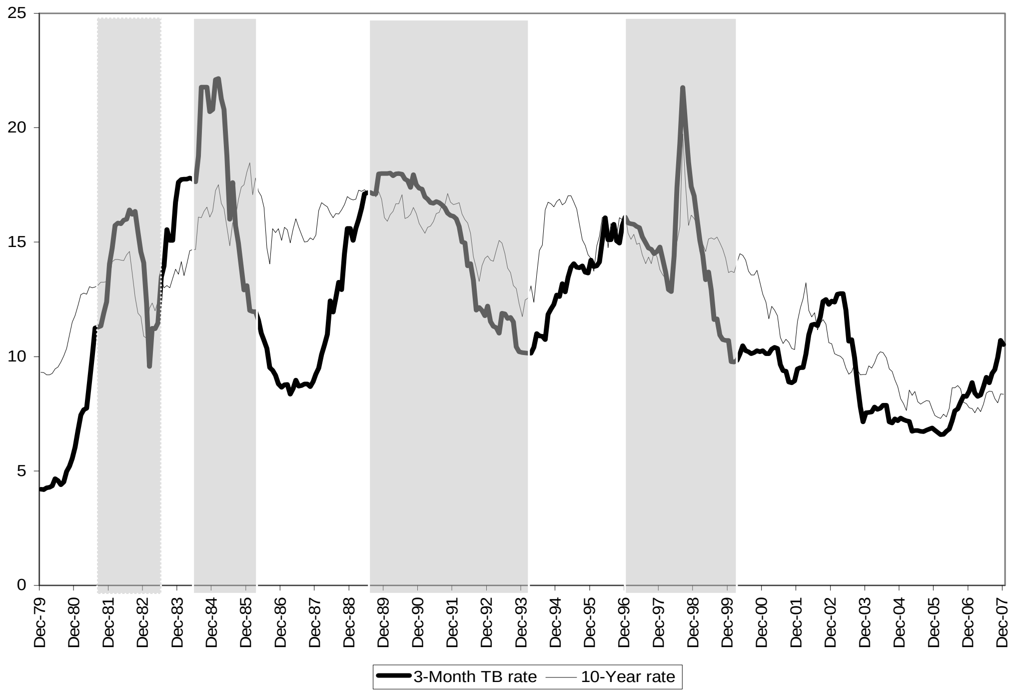


Figure 2 The repo rate and the 3-month Treasury Bill rate

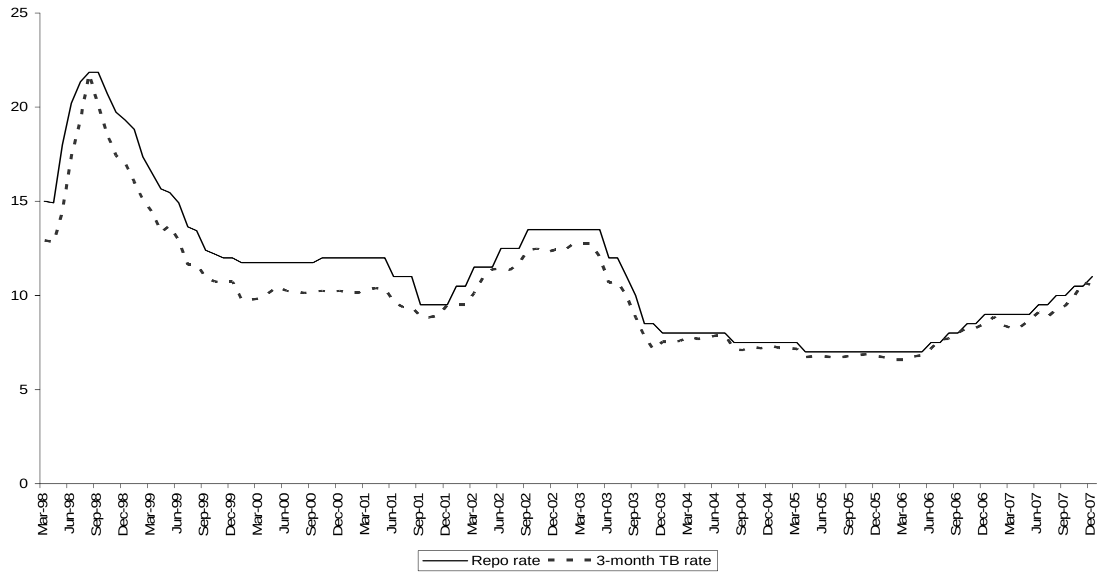


Figure 3 Responses of output growth to one-standard deviation structural shocks

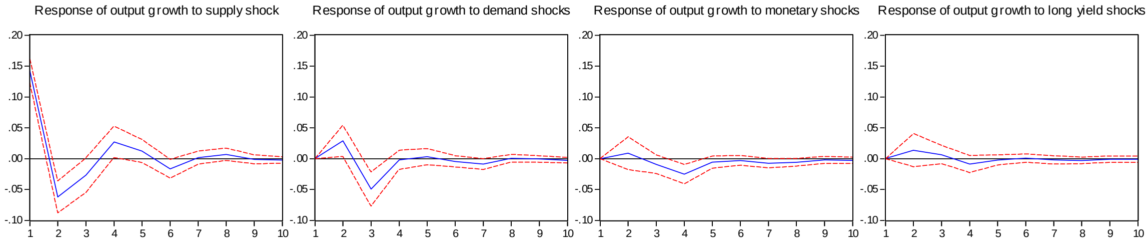


Figure 4 Responses of inflation rate to one-standard deviation structural shocks

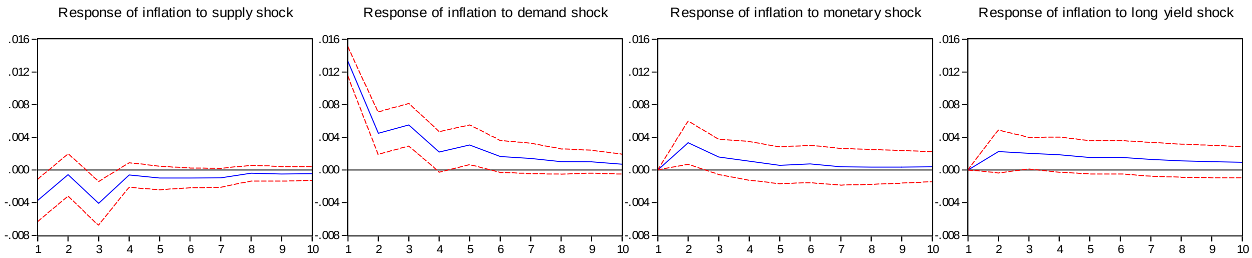


Figure 5 Responses of short-term rate to one-standard deviation structural shocks

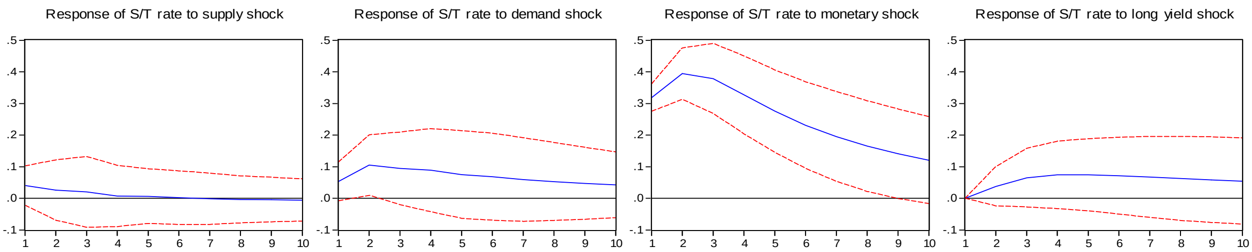


Figure 6 Responses of long-term rate to one-standard deviation structural shocks

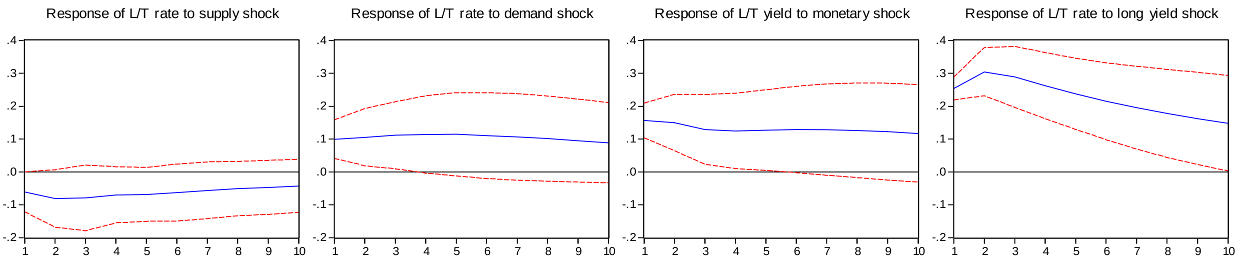
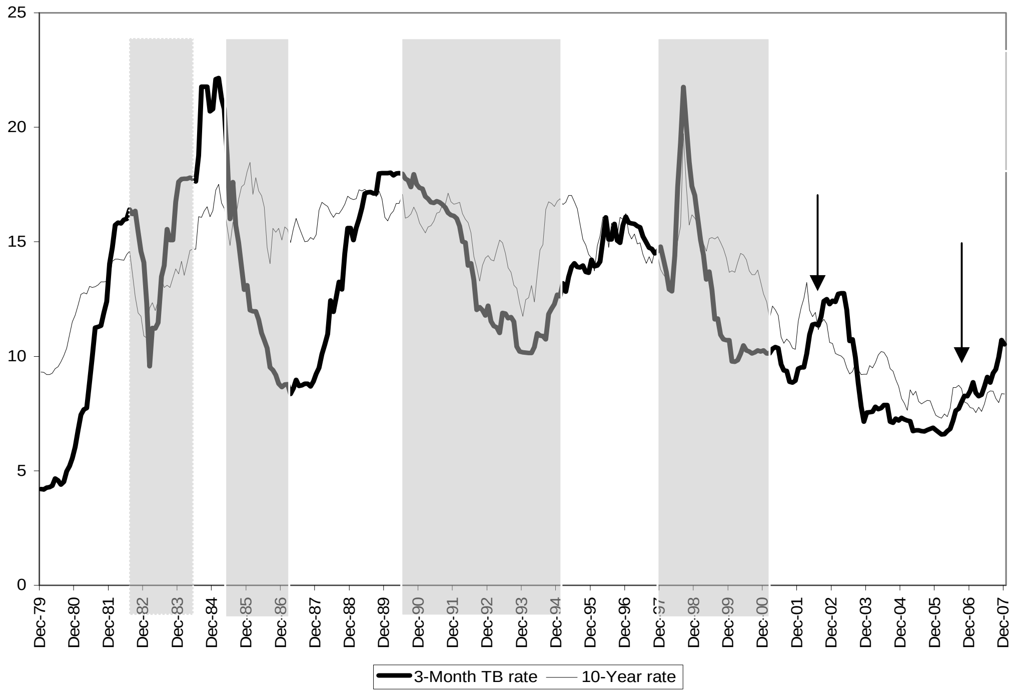


Figure 7 Identification of the supply shocks



Note: Dark areas correspond to downswings. Arrows indicate periods characterised by positive shocks.