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The Instrument of Monetary Policy for Germany. A Structural VAR Approach

Prepared by
Stefania Piffanelli
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Yakin Ertürk
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Stefania Piffanelli
Stefania Piffanelli is an economist in the Division for the Advancement of Women of the Department of Economic and Social Affairs. The author is also a Ph.D. candidate in the Department of Economics of New York University. The views expressed in this paper do not necessarily represent the views of the United Nations. Comments should be addressed to the author at Two United Nations Plaza, Room DC2-1236, New York, NY 10017, Phone (212) 963-7977, Fax (212) 963-3463, E-mail piffanelli@un.org. Additional copies of the paper are available from the author.

United Nations
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Abstract

The paper tries to answer the question of what is the best indicator for German monetary policy. Several VAR studies about Germany use the call rate or other short term market interest rates as a measure of German monetary policy relying on the analogy to the US federal funds rate. Although Bundesbank operations have become increasingly similar to those of the Fed over time, historically there are some differences. It might therefore be risky to use the call rate as indicator of monetary policy. Because the Bundesbank lacked the tools to target open-market interest rate precisely, it seems possible that short-term innovations in market rates might have reflected non-policy factors in the economy, such as shifts in the demand for reserves, as well as policy innovations. If shocks to the call rate reflect non-policy influences, then measured impulse responses to call rate innovations are no longer "clean" estimates of the effects of monetary policy shocks on the economy.

Key words: Monetary Policy, VAR

JEL classification: E52, E58, C22

1 Introduction

This paper tries to answer the question of what is the best indicator for Germany monetary policy. The question is motivated by the following consideration. Several VAR studies about Germany use the call rate or other short term market interest rates as a measure of German monetary policy relying on the analogy to the US federal funds rate. Although Bundesbank operations have become increasingly similar to those of the Fed over time, historically there are some differences.

In contrast to US practice, the Bundesbank has seen considerably more evolution in its instruments of policy. Prior to about 1980, the German Central Bank did not make frequent use of open market operations. Instead, in the earlier period it implemented desired changes in monetary policy in three ways. Firstly, it made relatively frequent changes in reserves requirements. Secondly, it eased (tightened) policy by increasing (reducing) discount-window borrowing quotas for banks. Since the discount rate in Germany is below the market rate of interest, banks always borrow up to their quota. Thus, changes in quotas translated directly into changes in the quantity of reserves available to the banking system. Finally, the Bundesbank could affect the quantity of loans through its second borrowing facility (Lombard loans) by changing the rate charged banks for those loans (the Lombard rate). In the earlier period the Lombard rate was typically held below the market rate for reserves (the call rate), but above the discount rate, and thus functioned analogously to the US discount rate.

Therefore, the Bundesbank operating procedures before 1980 lacked flexibility. All three tolls - reserve requirements, discount window quotas, and Lombard rate - could be changed only on a discrete rather than a continuous basis. Thus the Bundesbank lacked the ability, enjoyed by the Fed, of finely targeting market interest rates. However, over the past two decades, that situation has changed. The Bundesbank has begun dealing in repurchase agreements (repos) with banks. Repos provide a means by which the Bundesbank can make short term loans to the banking system. Furthermore, aided by a deepening of security markets, the Bundesbank has made increasing use of the US-style open-market operations. These two development have greatly increased the Bundesbank ability to fine-tune movements in market interest rates, such as the call rate.

This change of regime might have implications on the choice of a monetary indicator for Germany. Bernanke and Mihov (1997) comment that it might be risky to use the call rate as indicator of monetary policy at least prior to 1980 or so. Because the Bundesbank lacked the tolls to target open-market interest rate precisely, it seems possible that short-term innovations in market rates might have reflected non-policy factors in the economy, such as shifts in the demand for reserves, as well as policy innovations. If shocks to the call rate reflect non-policy influences, then measured impulse responses to call rate innovations are no longer "clean" estimates of the effects of monetary policy shocks on the economy. Indeed, they find that the Lombard rate better describe the German monetary policy.

2 The Model

I will explore a model similar in spirit to Clarida and Gertler (1996) over the period 1962-1997 to analyze the response function of the Bundesbank when it uses the call rate and then the Lombard rate as instruments. Further, I will make a similar analysis splitting the sample period into two: pre and post 1980. A comparison of the estimated responses of the Central Bank with the narrative evidence, i.e. with the actual operating procedures of the Central Bank, will select the most suitable indicator for Germany monetary policy. As a piece of narrative evidence, the Bundesbank is known for aggressively raising short-term interest rates in response to perceived inflationary pressures.

2.1 The VAR methodology to identify policy rules

The economy is described by a dynamic system whose structural form is as follows:

$$y_t = C \cdot y_t + \sum_{i=1}^{\infty} A_i \cdot y_{t-1} + e_t \qquad (1)$$

Where y_t is a vector of macroeconomic variables and e_t is an associated vector of disturbances. The elements of e_t are mutually orthogonal i.i.d. disturbances. They are the primitive disturbances of the economy. C and A_i are conformable coefficient matrices, and where the diagonal elements of C are equal to zero. Equation (2.1) states that each variable may depend on its own lagged values plus the current and lagged values of the other variables in the system.

In order to identify the system, i.e. in order to identify the matrix C, I have to place a priori restrictions on the contemporaneous interactions among variables. Once the estimates of the elements of C are available, I can identify the dynamic impact of the structural shocks on y_t.

Subtracting from both sides of equation (2.1) $E_{t-1}\{y_t\}$ and defining $u_t = y_t - E_{t-1}\{y_t\}$ as the forecast error to obtain:

$$u_t = C \cdot u_t + e_t \qquad (2)$$

where u_t is the forecasted error of the reduced form of equation (2.1).

Comparing equations (2.1) and (2.2) it appears that the restrictions among the contemporaneous interactions among variables coincide with the restrictions on contemporaneous interactions among the reduced form innovations.

I identify the model using a non-recursive approach as proposed by Clarida-Gertler (1996).

Following Bernanke-Mihov (1995) I divide the variables contained in y_t into policy and non-policy variables.

A policy variable is any variable that the Central Bank may influence within the current period. In the model they are: the Central Bank's direct policy instrument, i.e. the call rate, but also the exchange rate and the money supply.

A non-policy variable only respond with a lag to movements in the policy variables. Thus innovations in these variables are exogenous to innovations in the policy variables. These variables follow a recursive structure.

I use seven variables to describe the German macroeconomy. Four are non-policy variables. Of these, two are meant to characterize the state of the German economy: industrial production (ip); and the consumer price level (p). The other two reflect important external factors that influence German economy: the real world commodity prices (cp) (meant to capture supply shocks); and the US federal funds rate (ff).

The three Bundesbank policy variables are: the real money supply (m) (specifically the broad money aggregate M3 divided by the price level); and the real DM/dollar exchange rate (er). The last policy variable is the Bundesbank policy instrument. I will first use the call rate (rs) as in Clarida-Gertler (1996) and then the Lombard rate as suggested by Bernanke-Mihov (1996).

The restrictions on the contemporaneous interactions among the four non-policy variables are such that between them there is a recursive causal relationship, ordered as follows: commodity prices, industrial production, the price level, and the funds rate.

The reduced form money and interest rate innovations (i.e. the money supply and demand innovation) are given by:

$$u^{rs} = \beta_1 \cdot u^{cp} + \beta_2 \cdot u^{m} + \beta_3 \cdot u^{er} + e^{rs} \qquad (3)$$

$$u^{m} = \alpha_1 \cdot u^{ip} + \alpha_2 \cdot u^{rs} + e^{m} \qquad (4)$$

Equation (2.3) is the money supply equation and it represents the Central Bank reaction function. The Bundesbank adjusts interest rate to contemporaneous innovations in commodity prices, money demand and exchange rate since these variables. This is the key equation as it represents the reaction function of the Central Bank.

Equation (2.4) is a standard money demand function where real money balances depend on output and nominal interest rate.

The exchange rate innovation may be influenced by any of the other innovations in the system.

To proceed I rewrite equation (2.2) as:

$$(I - C) \cdot u = e \tag{5}$$

and inverting the matrix $(I - C)$ I obtain:

$$u = (I - C)^{-1} \cdot e \tag{6}$$

as I want to relate the forecasted innovations to the structural ones.

I will then make use of the impulse response functions of the variables of the system to structural shocks, and in particular I will concentrate on the reaction of the Bundesbank, through its instruments, to shocks to the economy.

I will compare the reaction of the Central Bank when it uses the call rate first and then the Lombard rate as its instrument with the narrative evidence on the conduct of the monetary policy in Germany over time.

3 Estimation

3.1 Data

The series considered are commodity prices, industrial production, consumer price index, the real exchange rate, the monetary aggregate M3 divided by the price level, and the domestic interest rates, in particular call rate and Lombard rate. The foreign variable that matters for the conduct of monetary policy is the US short-term rate, specifically the federal funds rate. All variables are expressed in logarithms except for the interest rates. The choice of the levels instead of first differences is motivated by the existence of cointegration between industrial production and money. The data have a monthly frequency.

3.2 Sample period

The sample period is 1960 to 1997. I use the entire sample first and then I split it into two sub-samples: 1960-1979 and 1980-1997. I will use both the call and the Lombard rate as instrument of monetary policy. Notice that the sample includes the reunification period (1989). Previous studies, in particular Clarida-Gertler (1996) and Bernanke-Mihov(1997), show that the analysis does not change when considering for the reunification.

I include 6 lags of each variable, but I stagger the lags as follows: 1,2,3,6,9,12. Convention dictates including 12 lags with monthly data to avoid problems of seasonality. The number of observations is such that is not harmful to include that many lags.

3.3 Estimation

The estimation is by instrumental variables. Non-policy variables are estimated recursively. The non recursive part of the system is estimated as follows. For the u^{rs} equation the instruments are u^{cp} u^{ip}. u^{p} u^{ff} . For the u^{m} equation, the instruments are u^{cp} u^{ip}. u^{p} u^{ff} e^{rs}. For the u^{er} equation, the instruments are u^{cp} u^{ip}. u^{p} u^{ff} e^{rs} e^{m}.

4 Empirical results

The variables respond to a 5% structural shock to each of them.

4.1 Estimation over the entire sample period

Figure 1 shows the reaction of the Bundesbank to a shock to commodity prices. This shock can be interpreted as a supply shock. The expected consequence is output decline and inflation rise and a sharp increase of the interest rate from the part of the Bundesbank that responds to inflationary pressures. The impulse response of the two interest rates is somehow in accordance with the narrative evidence.

The Bundesbank reacts in a similar way to a shock to output. Figure 2 shows a coherent behavior again of both interest rates. Although the response of the call rate is significantly stronger.

The Bundesbank reaction to a currency depreciation is likely to be a rise of both nominal and real rate. Figure 3 shows ambiguous results for the call rate but an increase in the Lombard rate. Given inflation dynamics, clearly both nominal and real Lombard rate increase.

What motivated in particular the concern of Bernanke-Mihov on the suitability to use the call rate as the Bundesbank instrument even before 1980 is the persistence of the "price puzzle" for Germany. For example, Sims (1992) found that the price level rises following a positive innovation in the call rate, despite the presumption that an increase in the call rate represents a tightening of monetary policy. Sims found that perverse response of prices persist Germany even when commodity prices and the exchange rate are included in the system to control for unanticipated future inflation. Sims sample begins in 1961, and thus includes a lengthy period prior to the introduction of repos and the expanded use of open-market operations. However, Clarida and Gertler (1996) data begins in the mid-1970s and also find a positive response of prices to call rate innovations. Figure 4 displays the "price puzzle" when the call rate is used as instrument while it disappears, i.e. inflation goes down, when the Lombard rate is considered.

To summarize, over the entire sample period, the Lombard rate would seem marginally better in interpreting the narrative evidence.

4.2 Estimation over sub-sample periods

4.2.1 Sub-sample period 1962 1979

Over this period I expect the Lombard rate to perform better than the call rate as the instrument of German monetary policy. As mentioned above, the Bundesbank operating procedures before 1980 lacked flexibility. All three tolls - reserve requirements, discount window quotas, and Lombard rate - could be changed only on a discrete rather than a continuous basis. Which means that the Bundesbank lacked the ability, enjoyed by the Fed, of finely targeting market interest rates.

In response to a supply shock - a 5% shock in commodity prices - both call and Lombard rate increase in accordance with the narrative evidence. Figure 5.

Both rates coherently behave also in response to a 5% positive shock to output. Although the response of the call rate is sharper. Figure 6.

The reaction to a currency depreciation should be a rise in both nominal and real rate. Figure 7 shows that the two rates respond negatively to a 5% depreciation. However, inflation rises mildly for two period and then decreases. The effect on real Lombard rate could then be positive at least for one year. Notice that the Lombard rate perform overall better. The response of the call rate is puzzling as it jumps down on impact and then fluctuates.

With respect to the price puzzle, it is displayed when the call rate is used. Interestingly enough, it is not as clearly eliminated as on the entire sample case above when the Lombard rate is used. Although a sort of negative relationship between the interest rate and inflation is preserved in the impulse response. Figure 8.

To conclude, for the period before 1980 the Lombard rate seems to perform better that the call rate. The result is in accordance with Bernanke-Mihov (1997) where a different model is used. Thus, the result seems to be robust to the model specification.

4.2.2 Sub-sample period 1980 1997

Over the past two decades, that situation has changed. The Bundesbank has begun dealing in repurchase agreements (repos) with banks. Repos provide a means by which the Bundesbank can make short term loans to the banking system. Furthermore, aided by a deepening of security markets, the Bundesbank has made increasing use of the US-style open-market operations. These two development have greatly increased the Bundesbank ability to fine-tune movements in market interest rates, such as the call rate. The call rate seems to be the best candidate to indicate the monetary policy of the Bundesbank.

Figure 9 shows that in response to a supply shock - 5% positive shock to commodity prices - the both rate rise. In response to a 5% increase in output the call rate responds positively and aggressively. Not quite so for the Lombard rate.

The response of the call rate to a shock to exchange rate, which was not totally satisfactorily over the entire sample period and over the first sub-period, behaves now according to the narrative evidence. That is the Bundesbank is likely to react to a currency depreciation by rising both nominal and real rate. The behavior of the Lombard rate is qualitatively similar but stronger. Figure 10. The similar pattern of the two interest rates may indicate a higher correlation between each other after 1980. The graph of the two series is proposed in figure11.

An interesting result though appears with respect to the price puzzle. It tends to disappear when the call rate is used, while a clean negative relationship between the Lombard rate and inflation is no longer visible. The conclusion could be that limiting the use of the call rate for periods after 1980 mitigates the problem of the price puzzle.

From the analysis of the impulse response functions the call rate well perform as instrument of monetary policy for Germany for the period post 1980.

Another piece of information comes from the decomposition of variance. Table 1 reports the results. Over the period 1962-1979 inflation first and money second explain most of the innovation in the two rates. The important contribution of money could be a consequences of the tools of monetary policy available to the Central Bank over this period, i.e. reserve requirements, discount window quotas, and Lombard rate.

Also over the period 1980-1997 inflation first and money second explain innovations in the two interest rates. However, the contribution of money to the innovation of the call rate is much lower than for the Lombard rate. This would be in line with the current conduct of monetary policy in Germany where the Bundesbank 'actually' behaves as inflation 'targeter' and the call rate is its policy tool.

5 Conclusion

I used a model similar to Clarida-Gertler (1996) to investigate what is the best instrument for monetary policy in Germany. I found that when the sample is divided into two sub-periods: 1962-1979 and 1980-1997 the Lombard rate performs better for the first period and the call rate for the second. The first period refers to when the Bundesbank operating procedures lacked flexibility. The three tools - reserve

requirements, discount window quotas, and Lombard rate - could be changed only on a discrete rather than a continuous basis. Thus the Bundesbank lacked the ability, enjoyed by the Fed, of finely targeting market interest rates. Over the second period the Bundesbank has begun dealing in repurchase agreements (repos) with banks. Repos provide a means by which the Bundesbank can make short term loans to the banking system. Furthermore, aided by a deepening of security markets, the Bundesbank has made increasing use of the US-style open-market operations. These two development have greatly increased the Bundesbank ability to fine-tune movements in market interest rates, such as the call rate.

On the basis of the empirical analysis performed in this paper, I agree with Bernanke-Mihov (1997) that it is risky to use the call rate as indicator of monetary policy at least prior to 1980 or so. Because the Bundesbank lacked the tools to target open-market interest rate precisely, short-term innovations in market rates might have reflected non-policy factors in the economy, such as shifts in the demand for reserves, as well as policy innovations. If shocks to the call rate reflect non-policy influences, then measured impulse responses to call rate innovations are no longer "clean" estimates of the effects of monetary policy shocks on the economy. Indeed the Lombard rate is at least marginally better over the first period.

For the second period, 1980-1997, the call rate well interprets the data and can therefore be taken as the Bundesbank monetary policy instrument.

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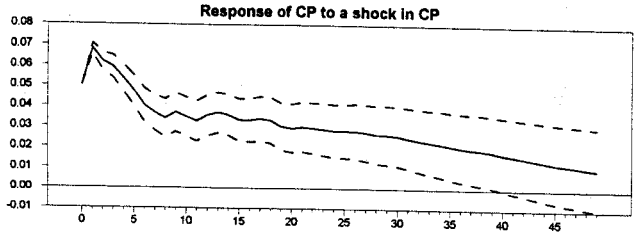
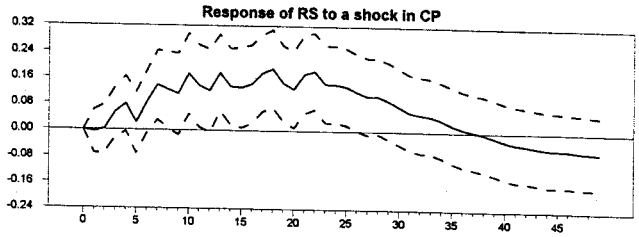
Fig.1


Response of CP to a shock in CP
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
-0.01
0 5 10 15 20 25 30 35 40 45


Response of RS to a shock in CP
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0.24
0.16
0.08
0.00
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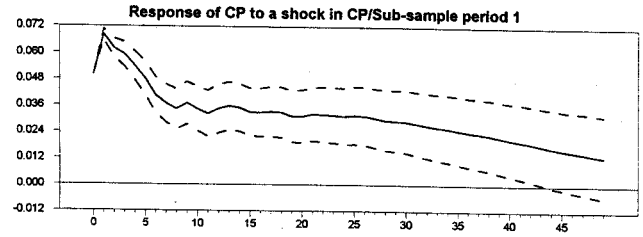
-0.16
-0.24
0 5 10 15 20 25 30 35 40 45


Response of CP to a shock in CP/Sub-sample period 1
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0.060
0.048
0.036
0.024
0.012
0.000
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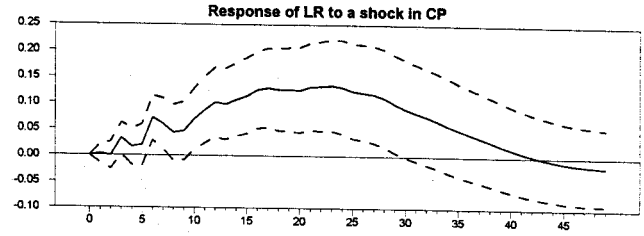
0 5 10 15 20 25 30 35 40 45


Response of LR to a shock in CP
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0.05
0.00
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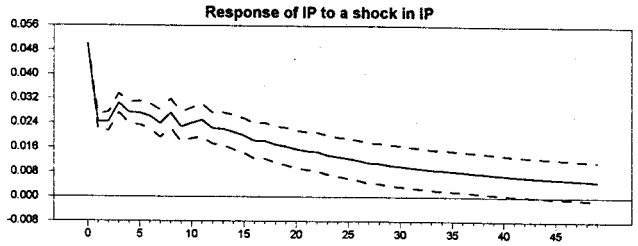
0 5 10 15 20 25 30 35 40 45

Fig.2


Response of IP to a shock in IP
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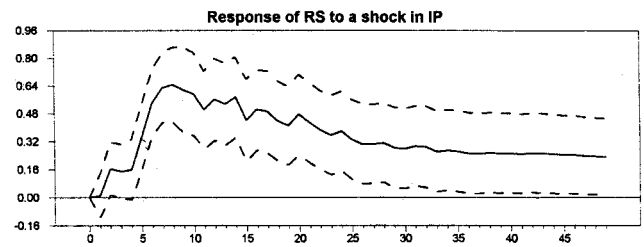
0.040
0.032
0.024
0.016
0.008
0.000
-0.008
0 5 10 15 20 25 30 35 40 45


Response of RS to a shock in IP
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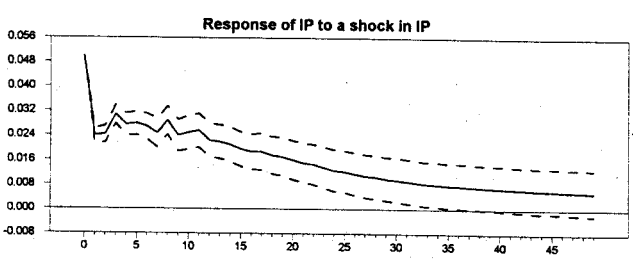
0.64
0.48
0.32
0.16
0.00
-0.16
0 5 10 15 20 25 30 35 40 45


Response of IP to a shock in IP
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0.016
0.008
0.000
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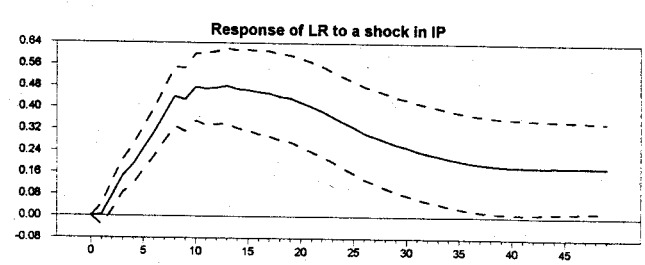
Response of LR to a shock in IP
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0.56
0.48
0.40
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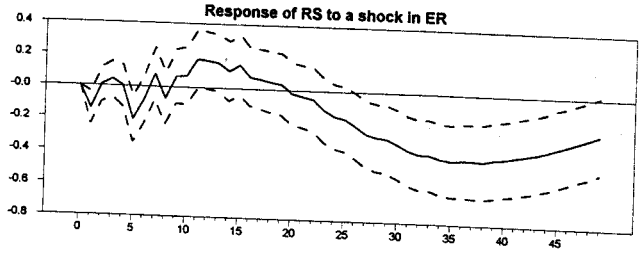
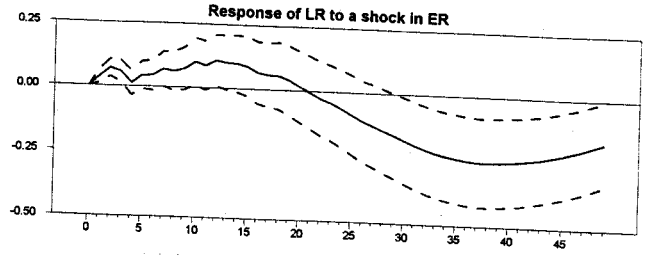
0.24
0.16
0.08
0.00
-0.08
0 5 10 15 20 25 30 35 40 45

Fig.3


Response of RS to a shock in ER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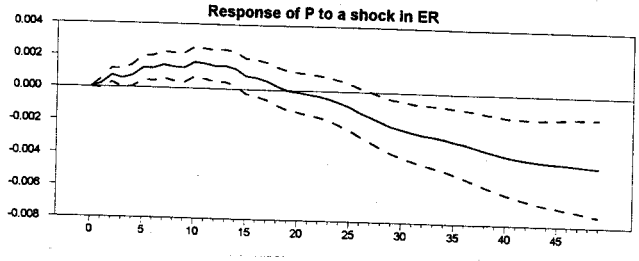

Response of P to a shock in ER

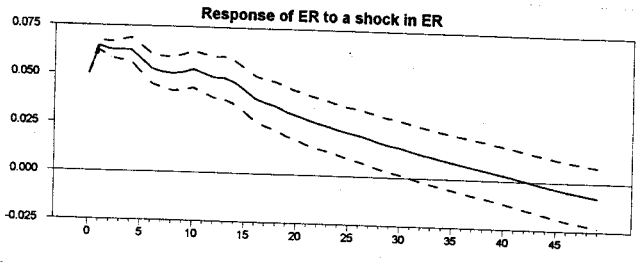
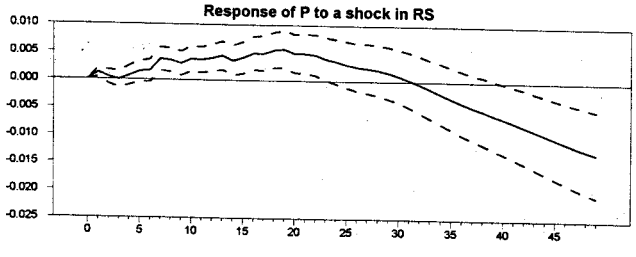
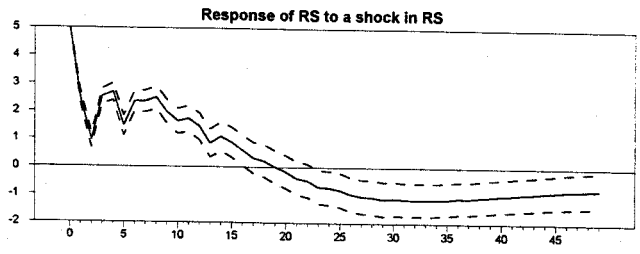
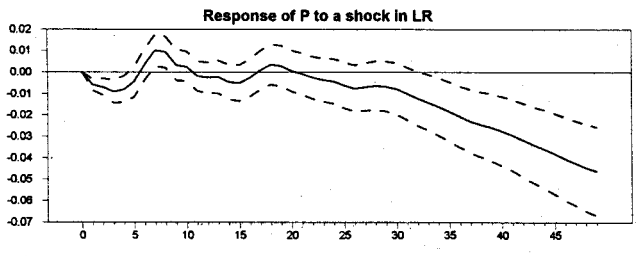

Response of ER to a shock in ER

Fig.4


Response of P to a shock in RS


Response of RS to a shock in RS


Response of P to a shock in LR

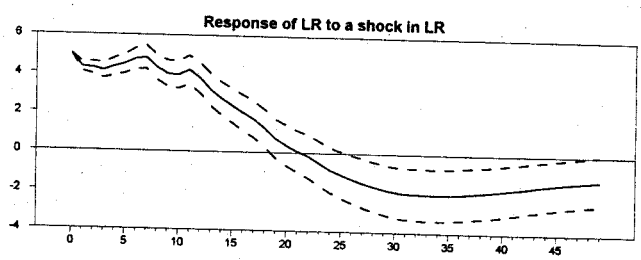
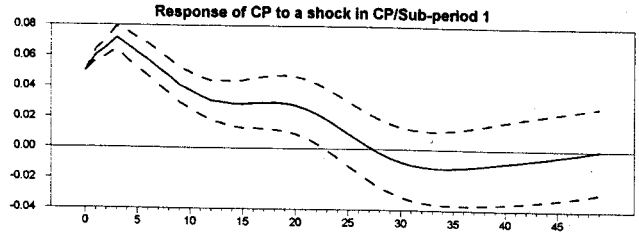
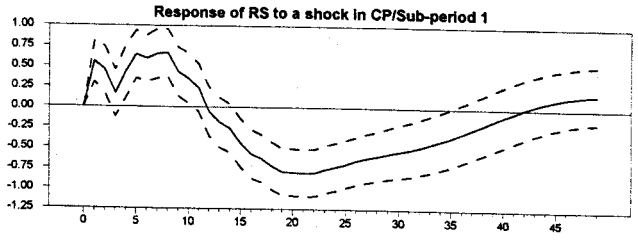

Response of LR to a shock in LR

Fig.5


Response of CP to a shock in CP/Sub-period 1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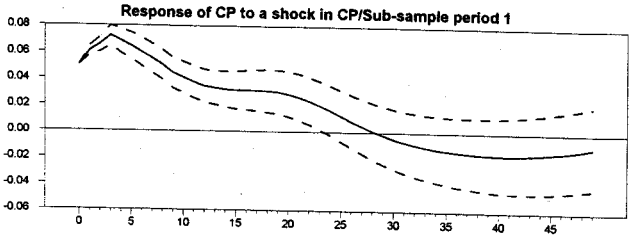

Response of CP to a shock in CP/Sub-sample period 1

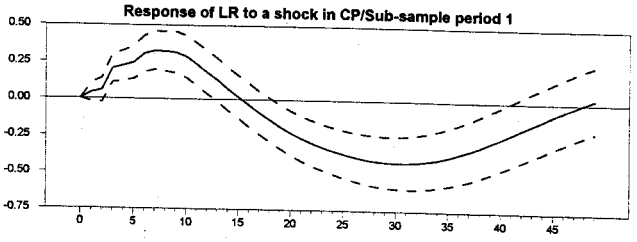
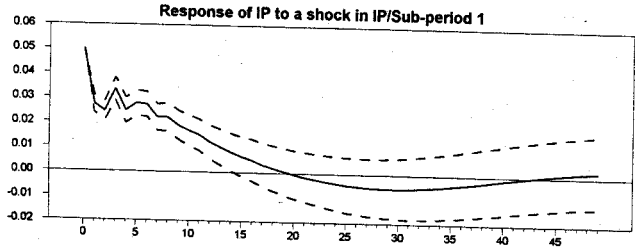
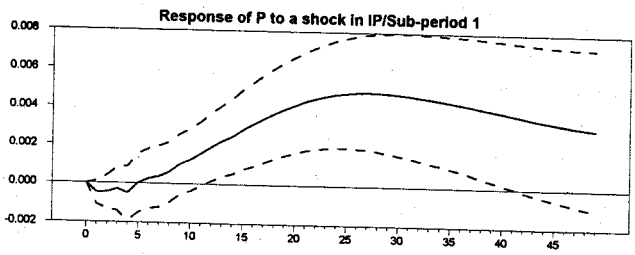
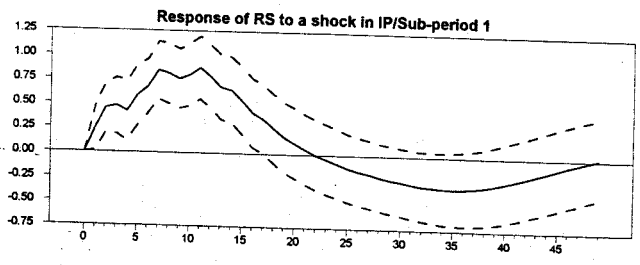

Response of LR to a shock in CP/Sub-sample period 1

Fig.6


Response of IP to a shock in IP/Sub-period 1


Response of P to a shock in IP/Sub-period 1


Response of RS to a shock in IP/Sub-period 1

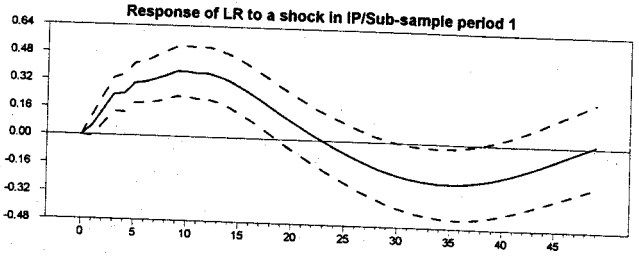
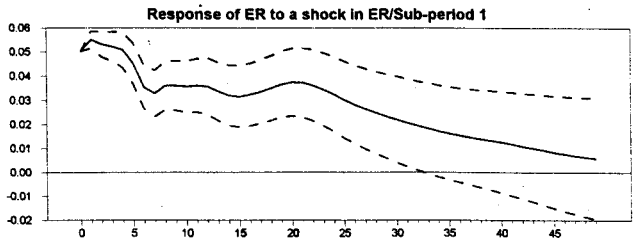
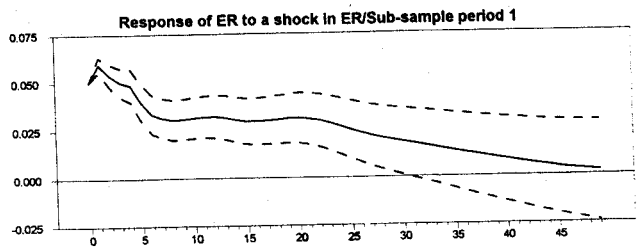
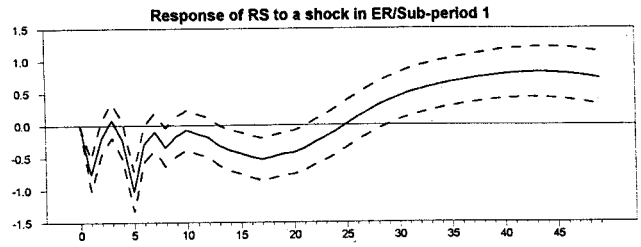
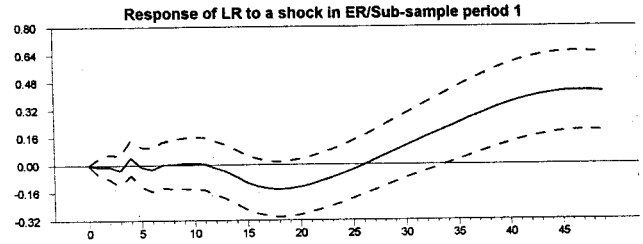

Response of LR to a shock in IP/Sub-sample period 1

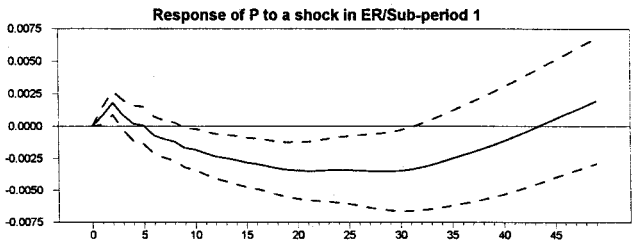
Fig.7


Response of ER to a shock in ER/Sub-period 1


Response of ER to a shock in ER/Sub-sample period 1


Response of RS to a shock in ER/Sub-period 1


Response of LR to a shock in ER/Sub-sample period 1


Response of P to a shock in ER/Sub-period 1

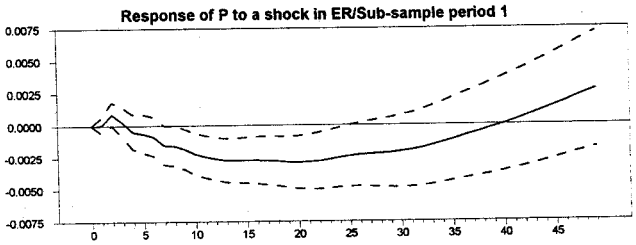
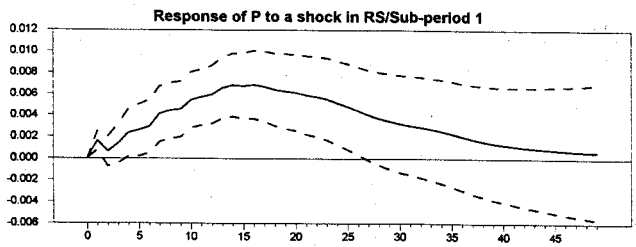
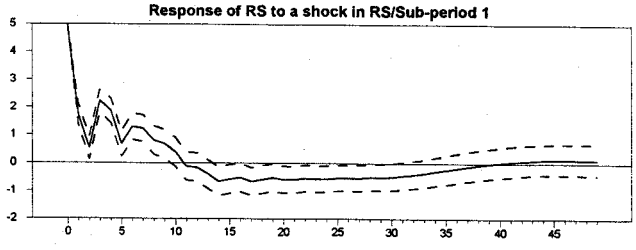
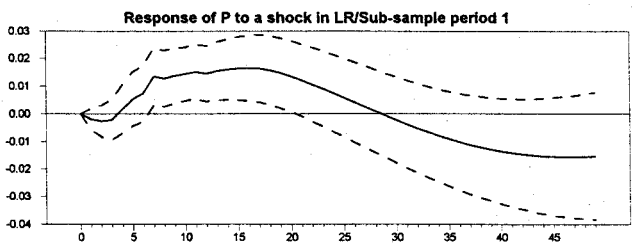

Response of P to a shock in ER/Sub-sample period 1

Fig.8


Response of P to a shock in RS/Sub-period 1


Response of RS to a shock in RS/Sub-period 1


Response of P to a shock in LR/Sub-sample period 1

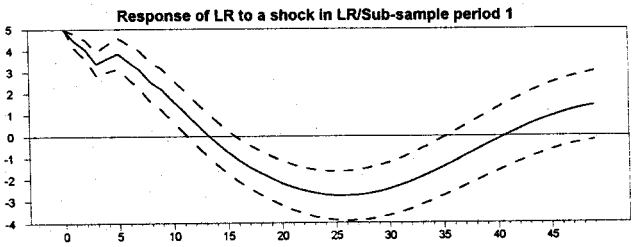
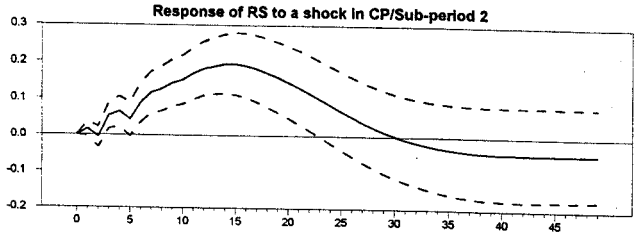
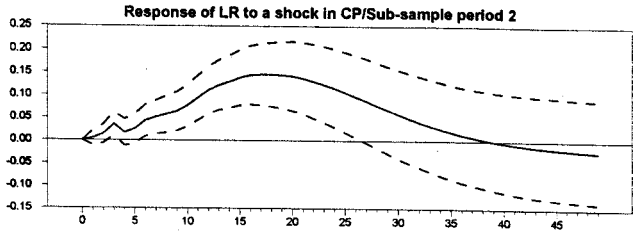
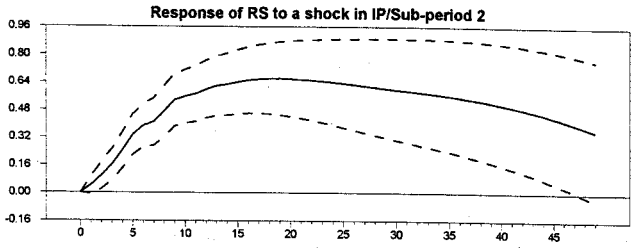

Response of LR to a shock in LR/Sub-sample period 1

Fig.9


Response of RS to a shock in CP/Sub-period 2


Response of LR to a shock in CP/Sub-sample period 2


Response of RS to a shock in IP/Sub-period 2

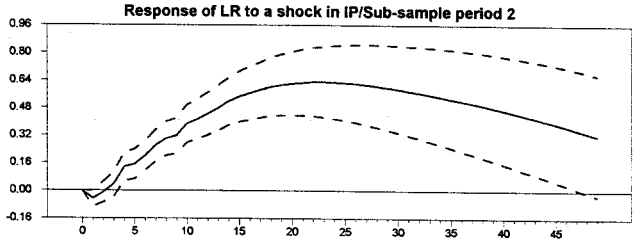
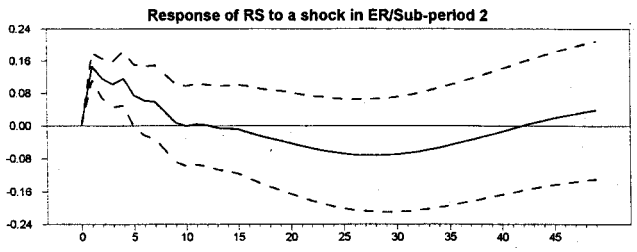
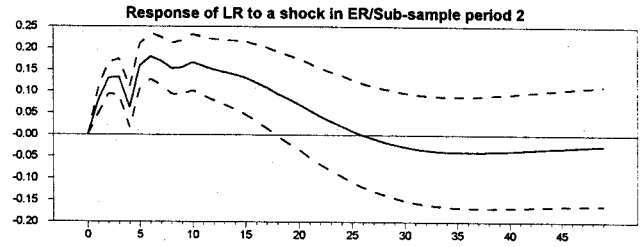
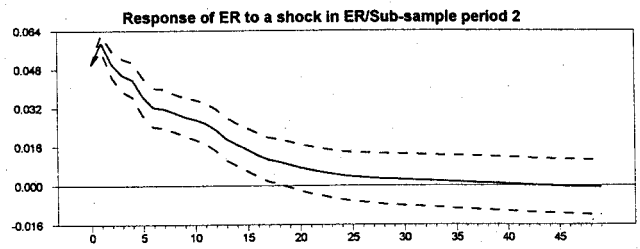

Response of LR to a shock in IP/Sub-sample period 2

Fig.10


Response of RS to a shock in ER/Sub-period 2


Response of LR to a shock in ER/Sub-sample period 2


Response of ER to a shock in ER/Sub-sample period 2

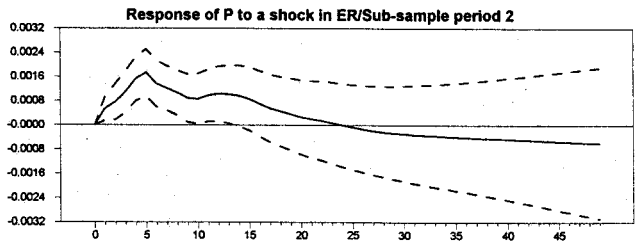
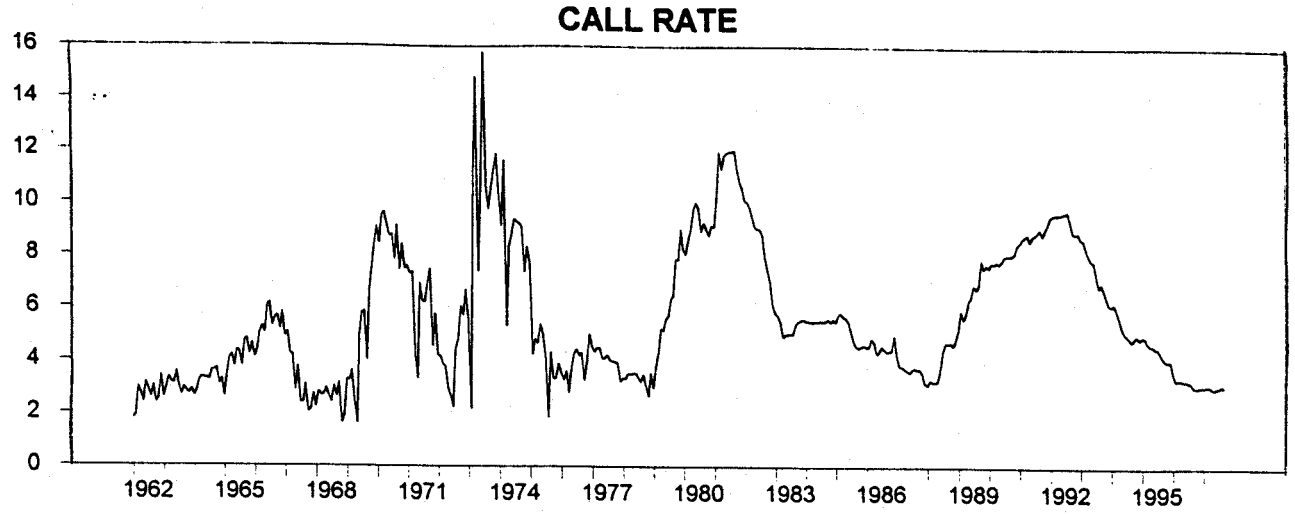

Response of P to a shock in ER/Sub-sample period 2

FIG. 11


CALL RATE
16
14
12
10
8
6
4
2
0
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995

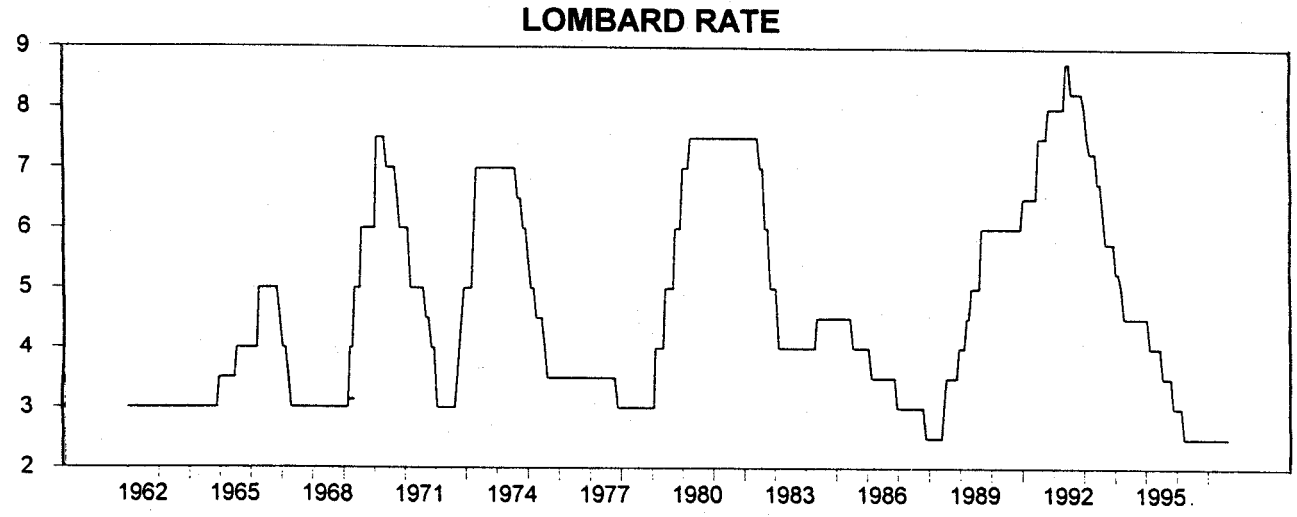
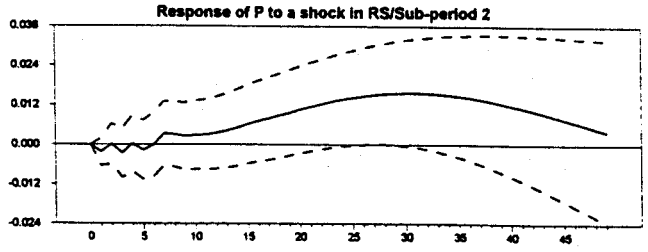
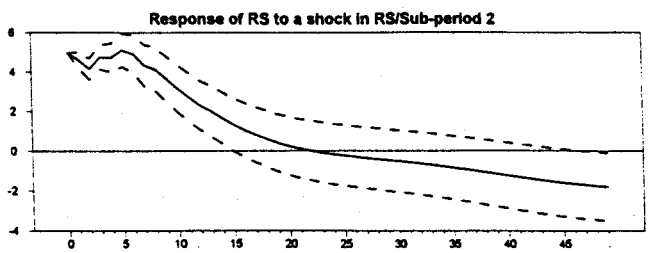
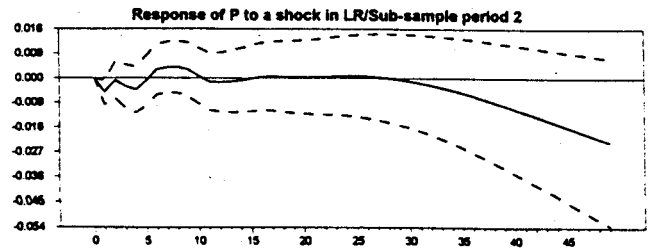

LOMBARD RATE
9
8
7
6
5
4
3
2
1962
1965
1968
1971
1974
1977
1980
1983
1986
1989
1992
1995

FIG. 12


Response of P to a shock in RS/Sub-period 2
0.036
0.024
0.012
0.000
-0.012
-0.024
0
5
10
15
20
25
30
35
40
45


Response of RS to a shock in RS/Sub-period 2
6
4
2
0
-2
-4
0
5
10
15
20
25
30
35
40
45


Response of P to a shock in LR/Sub-sample period 2
0.016
0.008
0.000
-0.008
-0.016
-0.027
-0.038
-0.045
-0.054
0
5
10
15
20
25
30
35
40
45

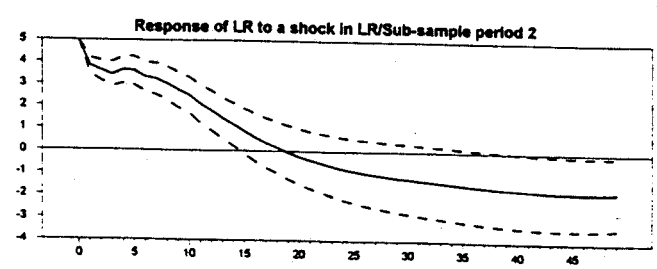

Response of LR to a shock in LR/Sub-sample period 2
5
4
3
2
1
0
-1
-2
-3
-4
0
5
10
15
20
25
30
35
40
45

Table 1

Variance Decomposition for interst rate - call and Lombard rate

Sample Period 1962-1979

Lags	CP		IP		P		FF		RS/LR		M		ER	
	rs	lr	rs	lr	rs	lr	rs	lr	rs	lr	rs	lr	rs	lr
6	1.54	0.2	0.1	1.8	85.3	81.7	0.006	0.002	0.005	0.01	13.4	14.7	0.5	1.6
12	2.6	0.2	0.4	3.9	85.2	83	0.007	0.002	0.003	0.01	11.3	12.1	0.5	0.7
24	6.6	2.6	0.43	3.8	79.7	79.8	0.007	0.002	0.003	0.01	13.6	12.4	0.7	1.4
48	6.8	3.1	0.39	3	77.4	79.6	0.007	0.002	0.002	0.01	12.6	11	2.8	3.4

Sample Period 1980-1997

Lags	CP		IP		P		FF		RS/LR		M		ER	
	rs	lr	rs	lr	rs	lr	rs	lr	rs	lr	rs	lr	rs	lr
6	0.1	0.04	7.1	5.9	89.4	60.9	0.02	0.006	0.03	0.2	3	14.2	0.4	18.7
12	0.2	0.88	25.2	25.8	25.2	38.2	0.02	0.02	0.02	0.01	3.8	15.7	0.2	19.3
24	0.5	1.6	49.3	13.6	49.3	24.6	0.01	0.003	0.01	0.01	6.1	57.4	0.1	2.8
48	0.4	1.4	50.4	13.8	41.9	29.3	0.007	0.002	0.02	0.001	7.2	54	0.1	1.6

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