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Liquidity Effect or Anticipated Inflation Dominance? Empirical Evidence for Guatemala.‡

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Abstract

This paper investigates the empirical operation of the theoretical effects of money supply growth on the short-term interest rates in Guatemala. Policy makers tend to take for granted that (at least in the short run) changes in the money supply induce changes in interest rates of the opposite sign, the well known Liquidity Effect. Nevertheless, a higher money growth rate actually can provoke a rise in the interest rates because there could be a rise in the inflationary expectations; so the final effect on interest rates is ambiguous. Since the money-interest rate relationship is used in implementing monetary policy, in this paper we study how interest rates, and other macroeconomic variables, respond to shocks to monetary policy using a recursive vector autoregression (VAR) model. We use different definitions of money running from the Monetary issue to broader aggregates. The monetary policy shocks are measured by some orthogonalized component of the monetary aggregate innovation, since the Guatemalan central bank manages its monetary policy through targeting the money growth.

JEL codes: E5, E52
Key words: liquidity effect, money supply, interest rates.

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I. Introduction

This paper investigates the empirical operation of the theoretical effects of money supply growth on the short-term interest rates in Guatemala. Economists and policy makers tend to take for granted that (at least in the short run) changes in the money supply induce changes in interest rates of the opposite sign, the well known *Liquidity Effect*. This conclusion seems to follow from the liquidity-preference relationship between the level of interest rates and the quantity of money demanded. Even though money is not an interest-bearing asset, the relationship is established by viewing the interest rate as the opportunity cost of holding cash balances: at higher interest rates, *ceteris paribus*, less money will be demanded than at lower rates. Despite this widespread belief (associated with the "Keynesian" stream), formal empirical studies on this issue have yielded mixed results, some of them supporting the liquidity effect hypothesis and others finding that the relationship between innovations in money and interest rates is not negative. On the other hand, the impact of expectations on economic decisions have received considerable attention in recent years. In particular, many analysts have examined the role of inflation expectations in determining interest rates. Judging whether interest rates are high or low requires knowing the degree to which inflation is expected to erode the principal during the term for which the founds are borrowed or lent. This alternative view, associated with a more "neoclassic" way of thought, finds the answer to this counterintuitive results in the inflationary expectations, saying that: "Interest rates might rise in response to higher money growth because there is a rise in inflationary expectations and hence a rise in interest rates through a Fisher effect" Mishkin (1982).

The Fisher effect says nothing about the relationship between the stock of money and interest rates, it only formalizes the relationship between anticipated inflation and interest rates. But, if an increase in the money stock is reflected in future increases in prices, then an increase in the quantity of money will set in motion a Fisher effect, raising the nominal interest rates instead of lowering them. If there is a "one-time" increase in the money stock, prices will adjust to the new quantity of money and will stop changing; if prices stop changing, there's no reason to have high inflationary expectations so the pressure on interest rates will be vanished. A Fisher effect may be generated in the process, but it is unlikely to last and to be sufficiently strong to dominate the liquidity effect. But, if there is a rise in prices and it generates expectations of further rises, interest rates may rise, and the anticipated inflation effect of the monetary expansion will dominate.

Since the money-interest rate relationship is used in implementing monetary policy, and because the liquidity effect plays a central role in conventional views of the monetary transmission mechanism, it is very important that the monetary authorities know how the relation works in their particular economy. They should know how this relationship works in the specific regime under which the monetary policy is conducted and how sensitive the inflationary expectations are to changes in the money stock.

To our knowledge, there is no previous specific investigation on the empirical operation of the liquidity effect in Guatemala. Making the survey of the existing literature on the subject, we found that surprisingly (regardless of the history of high inflations and hyperinflations of some countries), there is no much specific work done for Latin-American economies; in contrast, it is a hotly debated issue for the US economy. The evidence found in early research on the subject in the US case is consistent with the liquidity effect hypothesis (e.g. Cagan and Gandolfi 1969; Gibson 1968; Cagan 1972). Cagan and Gandolfi (1969) used M2 as the measure of money and revised its relationship with the commercial paper rate for the period 1910-65. They succeed in documenting a liquidity effect that reaches its minimum point six months after an increase in money growth. However, Melvin (1983) extends the analysis to the next decade concluding that the liquidity effect was less persistent after 1973, in what he called "the vanishing liquidity effect" and attributes it to a higher inflation sensitivity that causes the liquidity effect be dominated by the Fisher effect. With the arouse of rational expectations in the 80's, studies of the liquidity effect focused on the relationship between *unanticipated* changes in the money stock and interest rates. In this context, Mishkin (1982) documented that the correlation between innovations in money and interest rates is typically positive or zero, but not negative.

In the late 80's and for the 90's, the puzzle continues, we found mixed evidence for the liquidity effect. Cochrane (1989) finds that the liquidity effect reemerges during de 1979-82 period, with a few months persistence. Leeper and Gordon (1992) conclude that the correlation between unanticipated monetary growth and interest rates is never negative. They made their analysis with a VAR model including additional variables (besides of interest rates and money) like prices and production, deviating from the traditional approach[1]. They also use the Base money as the measure of money, arguing that Base money was the Federal Reserve's control variable. In the same year, Christiano and Eichenbaum (1992) argue that the use of broad money aggregates is inappropriate because in aggregates like M_1 or M_2 confound many other shocks, in addition to policy shocks. They perform a VAR model in which the dynamic response of the federal funds rate to a shock in monetary policy is studied using different measures of money, and they find strong evidence for the liquidity effect using non borrowed reserves as the measure of money. Bernanke and Mihov (1998) consider the liquidity effect and the long run monetary neutrality simultaneously in a structural VAR context, finding little basis for rejecting none of this two propositions.

We learned from empirical studies for the US economy that the effect of changes in money stock on interest rates is not granted. It is necessary to have formal empirical studies about how the money-interest rate relationship works in each particular economy in a certain period, and the Guatemalan economy is not the exception. We also learned that it is important to choose an appropriate measure of money and to properly identify policy shocks. For other countries the empirical work is limited, but we found mixed results too. For example, Fung and Gupta (1994) found that shocks to monetary policy are followed by declines in the interest rate in case of the Canadian economy. Halabí and Lastrapes (2000) estimate a structural VAR model for the Chilean economy, finding that unanticipated increases in the money supply lead to persistent increases in the nominal interest rates; the results are consistent with the idea that inflationary expectations are sensitive to money supply shocks in Chile.

Because we don't know for sure what interest rate is the "policy relevant" interest rate in the Guatemalan economy, we used four different interest rates. We also used five different definitions of money running from the excess cash reserves to broader aggregates like M_2. The

[1] In early studies, interest rate was regressed on current and past money growth.

monetary policy shocks are measured by some orthogonalized component of the innovation to the monetary aggregate, since the Guatemalan central bank manages its monetary policy through targeting the money growth.

The paper is organized as follows: in section II we discuss some basic facts about the dynamic correlations between the four interest rates and the five definitions of money; in section III, we present the recursive VAR model and it's implementation; The empirical results are analyzed in section IV; finally in section V, we address some concluding remarks.

II. Money-interest rate relationship: Dynamic Correlations

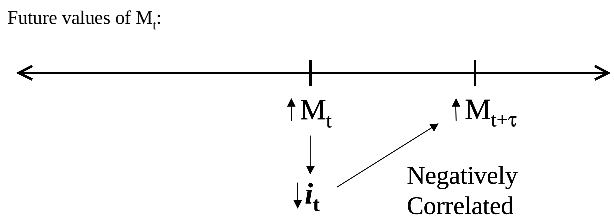
We began our study of the liquidity effect trying to understand how different interest rates interact with different measures of money. In doing so, we estimate some dynamic correlations between each one of the four interest rates (Repos, Omos28, Financial liabilities, and Interbank deposits) and each one of the five definitions of money (Excess reserves, Currency issue, Base money, M_1 and M_2)[2]. We made some stationary-inducing transformations of the data in order to obtain meaningful correlations: we work with the deviations from the Hodrick-Prescott filter's trend and with 12-month growth rates. The analysis presented in this section was made using the HP filtered data but the conclusions are the same using the growth rates. We find strong evidence that different interest rates display negative co-movements with the different measures of money, with few exceptions that we are going to comment below.

First, it is important to mention what pattern of correlations we are expecting to find in presence of a liquidity effect. To characterize this pattern we used the benchmark scenario of Christiano and Eichenbaum (1992) where they assumed that the measure of money -M_t-, is positively correlated over time and the only shocks are to the money supply. With these assumptions and given a liquidity effect, an unanticipated increase in the money supply would be associated with a decline in the interest rate -i_t-, and because M_t is positively correlated over time, high values of M_t would be associated with high values of $M_{t+\tau}$, for $\tau > 0$. *Ceteris paribus*,

[2] Definitions for the interest rates and monetary aggregates can be find in Appendix 1.

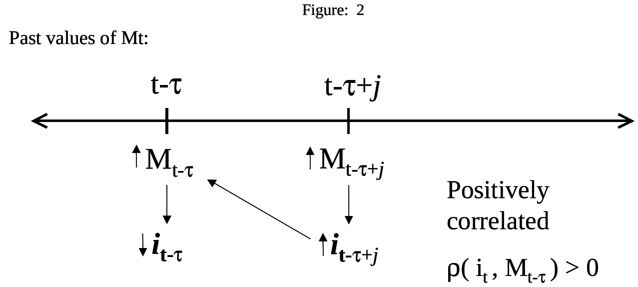
we would expect i_t to be negatively correlated with future values of M_t (as shown in Figure:1); the negative correlation will fade according to the degree of serial correlation of M_t.

Figure: 1



For past values of M_t, suppose that at time t - τ, for $\tau > 0$, there was an unanticipated increase in the money supply. As stated above for time t, this would be associated with a decline in $i_{t\text{-}\tau}$, but again because M_t is positively correlated, high values of $M_{t\text{-}\tau}$ would be associated with high values of $M_{t\text{-}\tau+j}$. This high values of Money will increase at some point the anticipated rate of inflation. For instance, if the liquidity effect lasted only one period the Fisher effect would dominate after one period, rising $i_{t\text{-}\tau+1}$ and making positive the correlation between $M_{t\text{-}\tau}$ and $i_{t\text{-}\tau+1}$ (see Figure: 2). We can generalize this by saying that the correlation between i_t and $M_{t\text{-}\tau}$ is positive for $\tau \geq 1$. If the liquidity effect lasts more than one period, let's say k periods, the correlation between i_t and $M_{t\text{-}\tau}$ will be positive for $\tau > k$ and negative for $\tau \leq k$.

Figure: 2



As stated above, we estimate some dynamic correlations between each one of the four interest rates and each one of the five definitions of money, finding that different interest rates display strong negative co-movements with the different measures of money, except when we use the excess reserves and the Currency issue as measures of money. In Graph: 1, we present our point estimates for $\rho(i_t, M_{t-k})$ [3] for k = -10,…,10, using the Excess reserves as the measure of money and the four different interest rates. Obviously, the pattern of dynamic correlations depicted in this graph is not what we were expecting. Actually it is difficult to establish a logical pattern, especially when we use the Interbank deposits interest rate or the Repo interest rate. This counterintuitive results arouse from the way that the reserve requirement was computed. The depository institutions were obligated to meet the reserve requirement on a monthly basis, only in average of the 30 or 31 days of each month. This reserve requirement averaging allowed sharp fluctuations in day-to-day depository institution's reserve balances and, of course, in the excess cash reserves[4]. The depository institutions have systematically used to run shortfalls in the middle of the month, build excess reserves at the end of the computing period, and hold them approximately for a week into the next month. This procedure suggests that the depository institutions were running shortfalls in the middle of the month to benefit from the money market interest rates exerting down pressures to the repo interest rate. Later in the month, they used to build large excess balances trying to reach (in average) the reserve requirement, rising the Repo interest rate.

This actions of the depository institutions distort the relationship between the excess cash reserves and interest rates, making unreliable the use of the excess cash reserves as a measure of money in our search of the liquidity effect. Furthermore, this actions also increase the volatility of those interest rates offered in the repo operations and the Interbank deposits, where this depository institutions search out for funds. This increased high volatility was affected even more by three banks that during the sample period were facing important liquidity problems, exerting more pressure on this two interest rates. This situation gave us the idea that the Repo rate and the Interbank deposits rate may give some troubles in the search of the liquidity effect in a monthly basis; maybe they would be useful for a day-to-day basis, but finding and explaining monetary policy shocks in a day-to-day basis would be difficult.

When the Currency issue is used as the measure of money (Graph: 2), we find a positive contemporaneous correlation between money and each interest rate used, except for

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[3] $\rho(\bullet, \bullet)$ denotes the correlation operator.
[4] The way of computing the reserve requirement was changed in August 2000, implementing that the depository institutions shall accomplish the reserve requirement in a 15 day average basis instead of the 30 day average basis.

the Interbank deposits rate which shows a negative contemporaneous correlation. This can be rationalized reviewing the component elements of the Currency issue; it consists of the currency outside the central bank held by firms and families (about the 90% of the monetary issue in Guatemala) and the vaulted cash held by depository institutions (the remaining ≈ 10%). The currency (a non interest bearing asset) has no relation with the interest rate *per se*, the level of currency in the economy can affect the interest rates only when economic participants try to draw down their excess balances demanding interest bearing assets. For example, suppose that the money supply is increased by dropping money from a helicopter. By the moment the money touch the ground, will the interest rates fall? Well, they must or else money supply -M^s- will not be equal to money demand -M^d-. But in fact, $M^s \neq M^d$ until economic participants try to reduce their excess balances, and they need time to do it; the interest rates will fall after a certain period of time. Economic participants will try to shift into other assets (interest bearing ones) lowering the interest rates until $M^s = M^d$, otherwise, they would be left holding money they did not want. For a certain period, people can be off their demand for money schedules, since it may take some time to adjust. With this explanation, it is not surprising that a Currency issue, 90% of which is held by the public, does not show the expected correlation pattern with interest rates.

Consider now Graph: 3, it shows the correlations between the four interest rates that we are using and the Base money as the measure of money. Here, when the correlations are estimated using the Financial liabilities interest rate and the Omos28 interest rate, we find the dynamic correlations pattern that we were expecting. The Omos28 rate is negatively correlated with the Base money for nine future months and it is positively correlated after eight past months. This pattern gives the idea that the liquidity effect persists for a nine month period. The Omos28 rate also shows a negative contemporaneous correlation of -0.32 and the maximum negative value of the correlations is observed in M_{t-4} (-0.36). In the case of the Financial liabilities rate, it shows a contemporaneous negative correlation with the Base money of -0.37, the maximum negative correlation appears in M_{t-5} (-0.55). It is negative correlated with 6 future values of money and positively correlated after the 13th past observation of money (not shown in the graph because of the time horizon –10,…,10). For the Repo rate and Interbank deposits there is a contemporaneous negative correlation with the Base money

(-0.29 and -0.40 respectively); however, the pattern shown by this two interest rates if affected by the high volatility explained before.

Graph: 4, depicts $\rho(i_t , M_{t-k})$ for k = -10,…,10 when M_1 is used as the measure of money. The dynamic correlations between the Financial Liabilities interest rate and M_1 are almost what we were expecting, they show a strong negative contemporaneous correlation: -0.49; nine future values of M_1 are negatively correlated with this interest rate and it has a positive correlation with past values of M_1, starting at M_{t-11}. The Omos28 rate is also negatively correlated with nine future values of M_1 and it is positively correlated after M_{t-8}. The Omos28 rate presents a negative contemporaneous correlation of -0.42, which is also the maximum negative correlation value. The Repo rate shows a contemporaneous negative correlation of -0.36, a positive correlation with past values of M_1 after M_{t-3} and a negative correlation with future values of money. The Interbank deposits rate presents a strong contemporaneous correlation of -0.55 and it is negatively correlated with five future values of the measure of money; it starts to show a positive correlation after 10 past values of M_1.

The correlations between interest rates and our last definition of money (M_2) are depicted in Graph: 5. We find strong negative correlations between M_2 and each one of the four interest rates that we have been using. For the Omos28 rate, the maximum negative correlation (-0.56) occurs contemporaneously; it shows a positive correlation with past values of money after eight past values; with future values of money, this interest rate presents a negative correlation up to 11 months. The Financial liabilities rate is contemporaneously correlated with M_2 (-0.61), it's maximum negative correlation appears at M_{t-2} (-0.65) and it is negatively correlated with future values of money up to nine months. For past values of M_2, the Financial liabilities rate is positively correlated with them only after ten past Months. The correlations for the Repos rate and the Financial liabilities with M_2 are quite similar with those presented with M_1 as the measure of money, showing a contemporaneous negative correlation of -0.45 and -0.53 respectively.

The analysis of this correlations is very useful, it shows how the interest rate interacts in very different ways among the different definitions of money. For example, the only difference between the Currency issue an the Base money, are the reserve balances held in the Bank of Guatemala, this difference provokes that the relationship between the interest rate and this two monetary aggregates differ considerably. This is not surprising, since the additional component of the Base money (the reserve balances) provides information about the financial intermediaries. Of course, the central bank does not increase the money supply by dropping money from a helicopter, it does so by interacting with the financial intermediaries, so changes in the reserve balances provide some information about this interaction. When the central bank is implementing an expansive monetary policy, it reduces the cost of funding for the financial intermediaries; these intermediaries respond to the change in the cost of funding by shifting the rate structures of their assets and liabilities, so they can allocate the new resources. This idea reinforces why the Currency issue does not necessarily have a well defined relation with the interest rate, because by the time the extra money is gone from the central bank and from the vaults of the depository institutions an reaches the public, the interest rates already had changed. This is very important for the next section because we need to identify the appropriate measure of money in order to document a liquidity effect, and with this argument, the use of the total reserve balances[5] as the measure of money appears to be very attractive.

M_1 and M_2 show patterns like those of the Base money, not because they have information about reserves, but because they have information of liabilities of the depository institutions. In Guatemala the financial sector is dominated by banks, there does not exist a developed securities market, nor a stock market, so the investment options are very limited in the national financial system. M_1 consists of currency in circulation plus demand deposits and M_2 consists of M_1 plus some other less liquid liabilities (saving and term deposits), so with a banking sector accounting for the 87 percent of the regulated system's assets, there is a close relation between the level of liabilities of the system and the total reserves of the depository institutions; if the liabilities (components of M_1 and M_2) rise, the reserves held in the central bank should too. If the liabilities and reserves move jointly, they would show similar correlations with the interest rate. We are not saying that the arguments presented by Christiano and Eichenbaum (1992) about the inappropriate use of broad aggregates as the measure of money are wrong, maybe for a very complex financial system like the one of the

[5] Graph: 6 shows the correlations between the Total reserve balances and the four interest rates.

US economy these arguments are valid, but for the Guatemalan case, the preponderance of the banks in the financial system and the limited investment options might make it reliable to use broad aggregates as the measure of money and succeed in documenting a liquidity effect.

III. Recursive VAR Model

In section II we obtained information about how different monetary aggregates and different interest rates are related to each other and how they interact. Even though this information is valuable, the correlations cannot provide information about the monetary policy disturbances and their implications. That is why in the present section we go further in our analysis of the liquidity effect, formulating a recursive VAR model.

The economy evolves in the model according to:

$$\mathrm{A}\,\vec{X}_t = C(L)\,\vec{X}_{t-1} + \vec{\varepsilon}_t \qquad (1)$$

Where X_t is a vector of variables that summarize the state of the economy. We are mindful that the policy makers take in consideration some measures that might be termed indicator variables. Some of this variables may be not directly controllable, but taken together they should suggest at least the likely course of overall economic activity, affecting in that way, the decision making. We consider a five-variable VAR consisting of a measure of liquidity (M), interest rate (i), inflation (π), exchange rate (ex) and output (y). A is a constant matrix that summarizes the manner in which the contemporaneous values of X_t are related to each other. $C(L)$ is a polynomial matrix in positive powers of the lag operator L. The structural disturbances of the economy are summarized by the i.i.d. random variable ε_t.

A reduced-form VAR representation of the structural model can be obtained pre-multiplying (1) by A^{-1}:

$$\vec{X}_t = B(L)\,\vec{X}_{t-1} + \vec{v}_t \qquad (2)$$

Where:

$$B(L) = A^{-1}C(L) \qquad (3)$$

$$\varepsilon_t = A\nu_t \qquad (4)$$

The covariance matrix for the reduced-form residuals ν_t is related to that of the structural disturbances ε_t in the relation:

$$E\varepsilon_t\varepsilon_t^{'} = A\,E[\nu_t\nu_t{'}]\,A^{'} = D \qquad (6)$$

D is specified as a diagonal matrix, because the structural disturbances are assumed to originate from independent sources.

It is possible to estimate this reduced form of the VAR, but without imposing restrictions to identify matrix A, it's obvious that the statistical innovations to X_t (the ν_t´s) need not be the same as the structural disturbances ε_t. In order to resolve this problem, restrictions must be imposed to identify the matrix A. The most common type of restrictions in the existing liquidity effect literature affects the contemporaneous nature of feedback among the elements of X_t; this is done by adopting a particular Wold causal interpretation of the data, assuming that the matrix A is lower triangular when the variables in X_t are ordered according to their causal priority. With this assumptions, there is a unique A which satisfies (5) for a given covariance matrix D.

This Wold ordering determines how the monetary disturbances are identified. For example, consider the next ordering for X_t: [M, i, π, ex, y]. By placing M first in the ordering we are assuming that innovations in the measure of money are attributed solely to the actions of the monetary authority, they are not affected by the contemporaneous value of the interest rates, the inflation rate or any other variable. Consider now the ordering of Xt: [ex, M, i, π, y]; this ordering implies that the unanticipated change in the monetary policy is measured by the portion of the reduced-form innovation in M that is orthogonal to the statistical innovation in *ex*. From this perspective we are assuming that the contemporaneous portion of the central bank's feedback rule for setting the money growth involves *ex*, but not other contemporaneous variables. In our study, we use 6 different orderings[6] to see whether the results are robust to different orderings (different Wold causal ordering).

IV. VAR Results

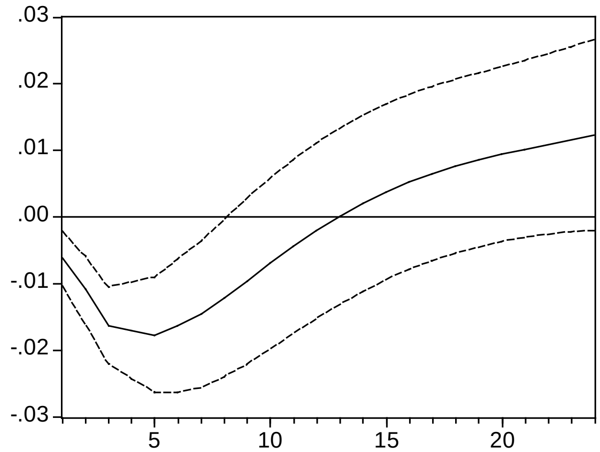
We begin this section presenting the results of the impulse-response analysis. As in the dynamic correlations exercise, we used the following interest rates: Repos, Omos28, Financial liabilities, and Interbank deposits; and the following measures of money: Total reserves, Currency issue, Base money, M1, M2. For the exchange rate, we used the market average exchange rate, for inflation we used the Consumer Price Index and, as the measure of production, we used the Economic Activity Monthly Index (IMAE). All variables[7] were logged and we used a 12-month growth rate[8] and the lag selection for the variables was made finding the minimum value of the Schwarz Criteria; the sample period is 1996.1 - 2002.12.

Consider first the findings when the **Base Money** is used as the measure of money and the Financial liabilities rate is the interest rate; *M* is placed first in the ordering. We found a strong liquidity effect, with a negative contemporaneous response of the Financial liabilities interest rate (-0.6218%) to a one standard deviation shock in the Base Money. It shows a 11 months persistence; this is suggested by the punctual estimator (7 months by the ±2 S.D. confidence interval).

[6] These orderings can be seen on Appendix 2
[7] Appendix 1 contains the names and description used in the econometric software.
[8] Stability and stationarity analyses can be found in Appendix 3

Figure: 3

Response of INTOBFIN to Cholesky
One S.D. INTBASE Innovation

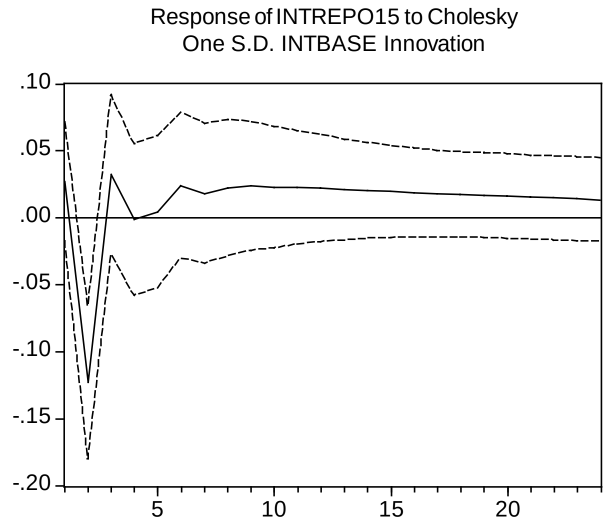


Impulse response of the Financial liabilities interest rate
from a five-variable VAR; using ordering # 1

Considering the confidence interval, output increases with a 5-month lag and does so for 10 months. The punctual estimator indicates that output has no contemporaneous reaction to a shock in money, it rises only after two months, and does so over the 24 month horizon. Inflation and exchange rate devaluation have no statistically significant reaction. This results are robust in the 6 different orderings adopted. The impulse-respond graphics for the six orderings can be found in Graphs 7 trough 12.

Doing this exercise again, but using the Repo rate instead of the Financial liabilities interest rate, we found a much more short-lived liquidity effect. In this case there is no contemporaneous negative response of the Repo rate to a shock in the base money. But the Repo rate is consistently negative for the second month after the shock, no matter what ordering we adopt. Nevertheless by the third month it becomes higher than its pre-shock level. The output rises after 4 months of the money shock and does it for 7 months. The exchange rate rises for two months with statistical significance and the inflation does not show a significant response. (see Graph: 13)

Figure: 4



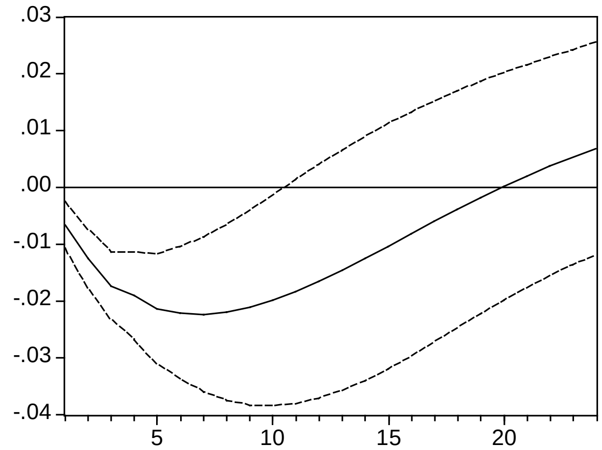
Impulse response of the Repo interest rate from a five-variable VAR; using ordering # 1

When we run the VAR model using the Base Money and the Interbank Deposits interest rates a liquidity effect is observed viewing the point estimator but it is statistically not significant. The same situation applies when the Omos28 rate is used. Notwithstanding the poor statistical significance of this results, it is interesting that at least with the point estimator we found a liquidity effect for all the orderings using any of these two interest rates.

Using $\mathbf{M_1}$ as the measure of money and the Financial liabilities interest rate, again we found a strong and persistent negative response of the interest rate to a shock in money. It has a contemporaneous response of -0.6624% and this negative behavior continues for ten months with statistical significance, the point estimator shows a 20 months persistence. The other variables included in the VAR did not show a significant response. These results are not sensitive to the ordering of the variables (Graphs 14 through 19).

Figure: 5

Response of INTOBFIN to Cholesky
One S.D. INTM1 Innovation

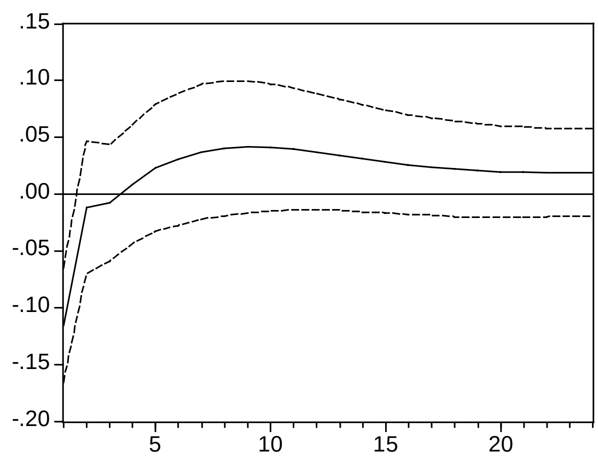


Impulse response of the Financial liabilities interest rate
from a five-variable VAR; using Ordering # 1

When Repo rate is used instead of the Financial liabilities rate, one S.D. shock to M_1 produces a strong contemporaneous negative response of the Repo rate but it lasts only one month, the output rises for almost 12 months after the money shock.

Figure: 6

Response of INTREPO15 to Cholesky
One S.D. INTM1 Innovation



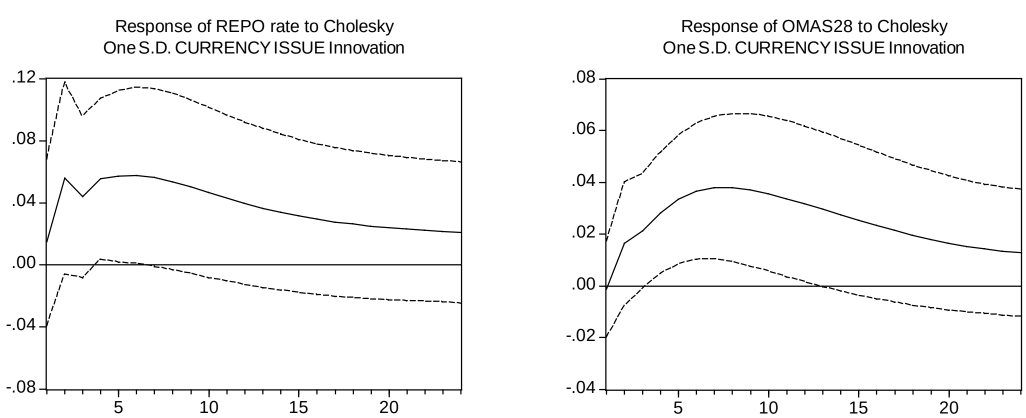
Impulse response of the Repo interest rate from a
five-variable VAR; using ordering # 1

When we use M_2 as the measure of money, we found quite similar results to those obtained using M_1 as the measure of money; i.e., a strong and persistent liquidity effect when the interest rate used is the Financial liabilities rate, and we find a very short-lived liquidity effect when the Repo rate is used. The responses of the Interbank deposits rate and the Omos28 rate are negative but not statistically significant. All this results are robust to different orderings.

Consider now the use of **Total Reserves** as the measure of money. If the interest rate in the VAR is the Repo rate, a shock of one standard deviation to the Total Reserves drives down the interest rate for about 2 months. The other VAR variables do not show a statistically significant response, except for the inflation, which with a lag shows a decline from its pre-shock level. When the interest rate used is the Financial liabilities rate, it shows a negative but not statistically significant response.

At this point the strongest evidence that we have found against the liquidity effect hypothesis is: statistically non significant **negative** responses of the interest rate to shocks in money. But when the **Currency issue** is used as the measure of money, we find a positive respond of the interest rate to innovations in money. This results are observed when the Repo rate and the Omos28 rate are used.

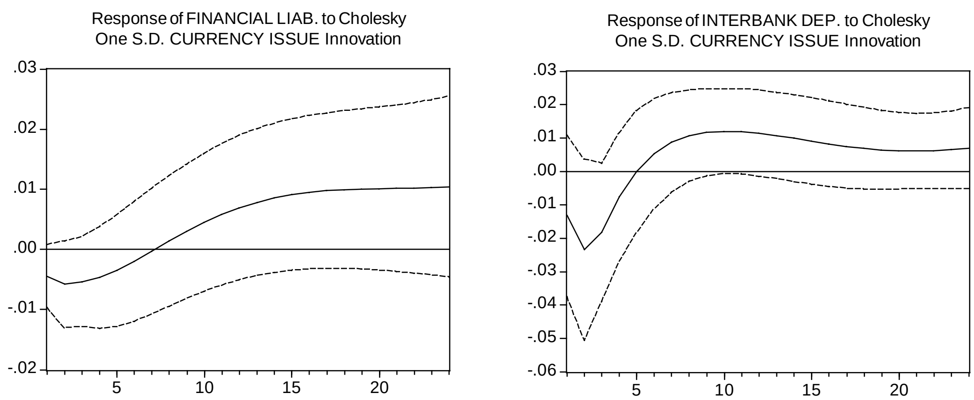
Figure: 7



Impulse-response from a five-variable VAR; using ordering # 1

The responses of the Interbank deposits rate and the Financial liabilities rate to a shock in the Monetary Issue are negative but they are not statistically significant.

Figure: 8



Impulse-response from a five-variable VAR; using ordering # 1

V. Concluding Remarks

The findings of section IV are in consonance with those suggestions of the dynamic correlations of section II. We found strong evidence supporting the existence of the liquidity effect in Guatemala. We were not expecting to find a liquidity effect with every measure of money and every interest rate. As shown by the dynamic correlations, different monetary aggregates interact in very different ways with the interest rates. Our findings suggest that when a monetary aggregate that has some information about the behavior of the financial institutions is used as the measure of money, and the monetary policy disturbances are identified of its statistical innovations, a strong liquidity effect can be found, if in addition a well behaved interest rate is used. From the dynamic correlations we knew that the Total Reserves, Base Money, M_1 and M_2 had information about the financial institutions so we were expecting to find strong evidence of the liquidity effect using this measures of money, and indeed we did, using the Financial liabilities interest rate. This Financial liabilities rate is a well behaved interest rate that could reflect the liquidity level of the financial system, we are not saying by any means that this interest rate is the policy relevant interest rate. When the Repo rate was used with these this measures of money, it shows a short-lived liquidity effect, but these results could be affected by the high volatility of this interest rate as explained on section II. With the Total Reserves we did not find strong evidence for the liquidity effect (as we did using the Base Money, M_1 and M_2) maybe because it is the liquidity measure closer to the monetary authority actions so, although it has information about the financial institutions, it must be related to a well behaved short-term interest rate, indeed we found a short-lived liquidity effect using the Repo rate, but these were not our best results because of the high volatility of the Repo rate. The counterintuitive results observed using the Currency issue as the measure of money do not affect our conclusions because, as it was explained in section II, currency represents 90% of the Monetary Issue, therefore, it does not have to show a certain expected relation with the interest rate.

Our findings using M_1 and M_2 as measures of money, may be different to the findings for the US economy. These results may seem to be puzzling, because it has been argued that the secular change in velocity brought about by financial innovation and other factors are further barriers to use money growth rates alone as a measure of the direction of policy. But it must be understood that the Guatemalan financial system is totally different to the US financial system and it is dramatically less complex. We hope that reviewing the definitions of money (Appendix 1) jointly with the explanations given in section II will help readers to assimilate our findings.

This paper is the first attempt to study the empirical operation of the liquidity effect in Guatemala, so an extensive investigation agenda has been opened. We believe it would be worthwhile to extend the present analysis by using alternative variables for prices and production, doing sample sensitive tests and employing different identification restrictions.

VI. References

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Appendix 1: Interest Rates & Money Definitions

Money

Excess reserves: Is defined as the Total reserve balances held by the banks minus the Required reserves.

Total reserve: Is defined as Total reserve balances held by depository institutions. (used as **INTENCOM** in the econometric software).

Currency issue: Consists of currency in circulation plus vaulted cash held by depository institutions (used as **INTEMI** in the econometric software).

Base money: Consists of currency outside the central bank -including the vaulted cash held by depository institutions- and required and excess reserve balances held at the central bank (used as **INTBASE** in the econometric software).

M_1: Consists of currency in circulation outside the central bank and depository institutions plus demand deposits (used as **INTM1** in the econometric software).

M_2: Consists of M_1 plus saving and term deposits (used as **INTM2** in the econometric software).

Interest Rates

Repos: Is the interest rate applied on repo operations with a 8 to 15 day maturity horizon (used as **REPO15** in the econometric software).

Omos28: Is the interest rate applied in the Open Market Operations done by the central bank with a maturity of 28 days (used as **OMAS28** in the econometric software).

Financial liabilities: Is the interest rate of the bonds issued by chartered banks (used as **INTOBFIN** in the econometric software).

Interbank deposits: Is the interest rate applied in the interbank deposits (used as **INTDEPIN** in the econometric software).

In the econometric software:

The foreign exchange rate: **INTPROM**
Inflation: **INTINFLA**
Production: **INTX11**

Appendix 2: Wold Orderings Adopted

Wold Orderings Adopted

1	2	3	4	5	6
Money	Interest rate	Inflation	Exchange rate	Production	Production
Interest rate	Money	Money	Money	Money	Inflation
Inflation	Inflation	Interest rate	Interest rate	Interest rate	Exchange rate
Exchange rate	Exchange rate	Exchange rate	Inflation	Inflation	Money
Production	Production	Production	Production	Exchange rate	Interest rate

Appendix 3: Stability and Stationarity Analysis

An economic time series is said to be stationary if it appears to be the realization of a data generating process that has a constant mean and constant auto-covariance over time. This implies that there are no trends or shifts in the mean or in the auto-covariances, or specific seasonal patterns. This definition can be applied for systems like the VAR(2) processes that we are working with. We also know that a stable VAR(*p*) process is also stationary, the stability condition is referred to as *stationarity condition* in the time series literature[9]. We verify the stationary condition and confirm that our VAR models are stable and thus stationary. A VAR(1) process is stable if all the eigenvalues of its coefficient matrix have modulus less than 1. Any VAR(*p*) process can be written in a VAR(1) form:

$$x_t = \nu + A_n x_{t-1} + U_t$$

defined as:

$$x_t := \begin{bmatrix} y_t \\ y_{t-1} \\ \vdots \\ y_{t-p+1} \end{bmatrix}, \quad \nu := \begin{bmatrix} \nu \\ 0 \\ \vdots \\ 0 \end{bmatrix}, \quad A_n := \begin{bmatrix} A_1 & A_2 & \cdots & A_{p-1} & A_p \\ I_k & 0 & \cdots & 0 & 0 \\ 0 & I_k & & 0 & 0 \\ \vdots & & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & I_k & 0 \end{bmatrix}$$

If all eigenvalues of A_n have modulus less than 1, the VAR(*p*) process is stable. (thus stationary).

[9] See authors like Lütkepohl (1993) and Hamilton (1994) for demonstrations.

We also test for individual stationarity of the series running the Augmented Dickey Fuller test, finding that our series are not stationary in levels nor in first differences using annual growth rates data. Some econometricians may suggest to do more transformations of the data, but we consider that this only will obscure the economic interpretation of the results, besides, knowing that our VARs attain the stationary condition makes valid our impulse-response analysis.

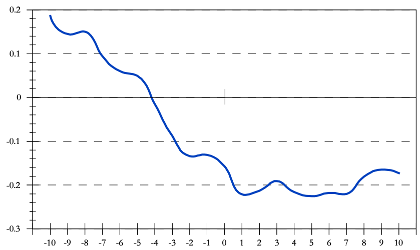
AUGMENTED DICKEY FULLER TEST
5% significance

Series	ADF in	Lags	ADF Statistic	5%value	SBC
INTX11	levels	1	-1.933289	-2.8967	-8.366498
INTX11	first difference	1	-6.28383	-2.8972	-8.306545
INTINFLA	levels	1	-2.517512	-2.8967	-7.434848
INTINFLA	first difference	1	-7.783337	-2.8972	-7.39819
INTPROM	levels	1	-1.166121	-2.8967	-7.27463
INTPROM	first difference	2	-3.252647	-2.8976	-7.278121
INTREPO15	levels	2	-1.801439	-2.8972	0.229988
INTREPO15	first difference	1	-10.59496	-2.8972	0.217017
INTOMAS28	levels	5	-2.846509	-2.8986	-1.682959
INTOMAS28	first difference	1	-7.382463	-2.8972	-1.624388
INTDEPIN	levels	1	-2.741764	-2.8967	-1.209128
INTDEPIN	first difference	1	-8.796057	-2.8972	-1.141769
INTOBFIN	levels	4	-2.824011	-2.8981	-4.587402
INTOBFIN	first difference	1	-3.540622	-2.8972	-4.590884
INTEMI	levels	1	-2.177271	-2.8967	-5.86248
INTEMI	first difference	1	-6.682464	-2.8972	-5.791362
INTRESCOM	levels	2	-3.248661	-2.8972	-2.636081
INTBASE	levels	1	-2.362424	-2.8967	-4.652791
INTBASE	first difference	1	-8.286935	-2.8972	-4.591441
INTM1	levels	2	-2.2653	-2.8972	-5.391152
INTM1	first difference	1	-5.599333	-2.8972	-5.380888
INTM2	levels	1	-1.553233	-2.8967	-6.229542
INTM2	first difference	1	-6.487673	-2.8972	-6.197338

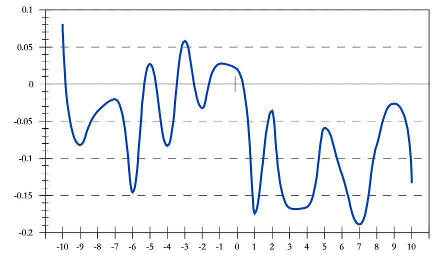
GRAPH 1:
Correlation: **Interest Rate (t) – Excess Reserves (M_{t-k})**

K = -10,...,10 HP filtered data; Period: 1995.1 – 2002.12

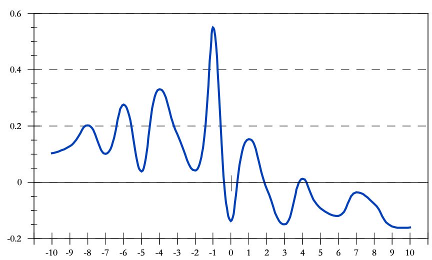
Financial liabilities rate (t) - Excess cash Reserves(M_{t-k})



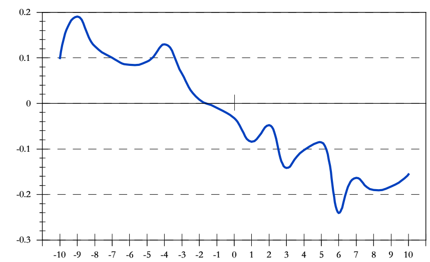
Interbank deposits rate (t) - Excess cash Reserves (M_{t-k})



Repos rate (t) - Excess cash Reserves (M_{t-k})



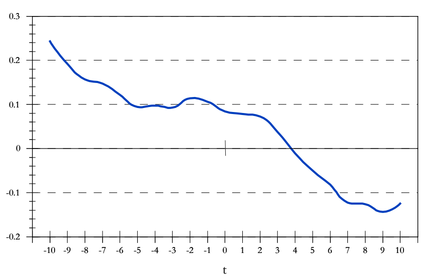
Omos 28 (t) - Excess cash Reserves (M_{t-k})



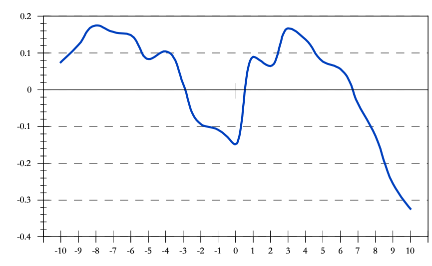
GRAPH 2:
Correlation: **Interest Rate (t) – Currency Issue (M_{t-k})**

K = -10,...,10 HP filtered data ; Period: 1995.1 – 2002.12

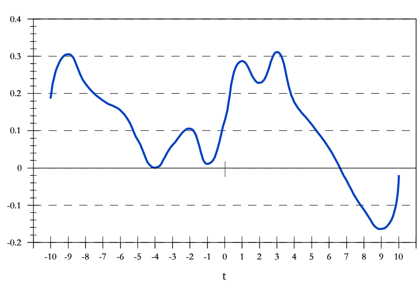
Financial liabilities rate (t) - Monetary Issue (M_{t-k})



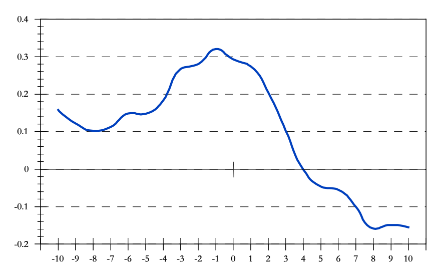
Interbank deposits rate (t) - Monetary Issue (M_{t-k})



Repos rate (t) - Monetary Issue (M_{t-k})



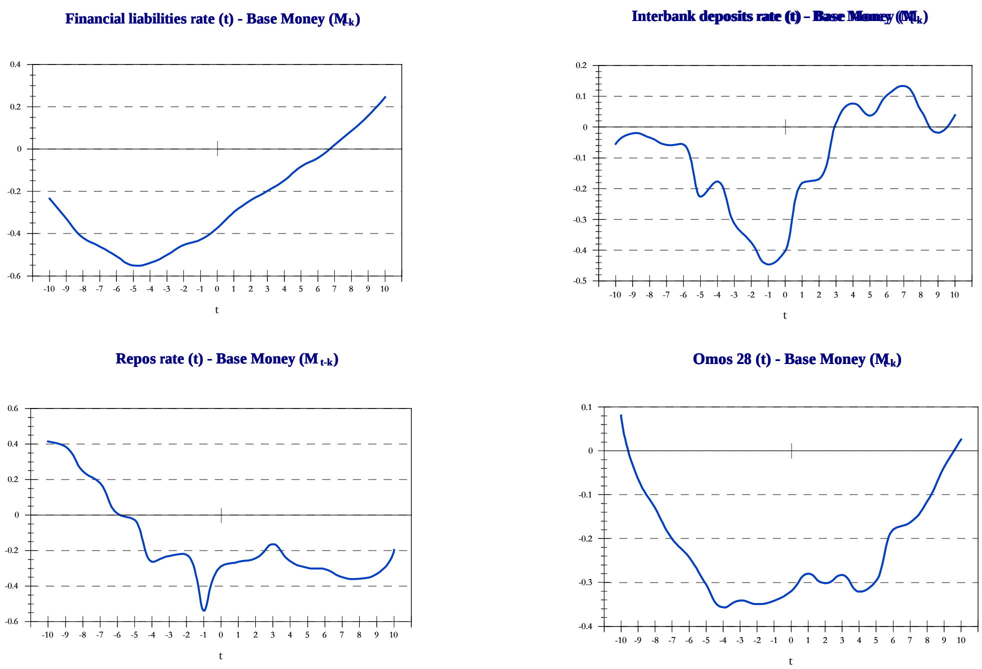
Omos 28 (t) - Monetary Issue (M_{t-k})



GRAPH 3:

Correlation: **Interest Rate (t) – Base Money (M_{t-k})**

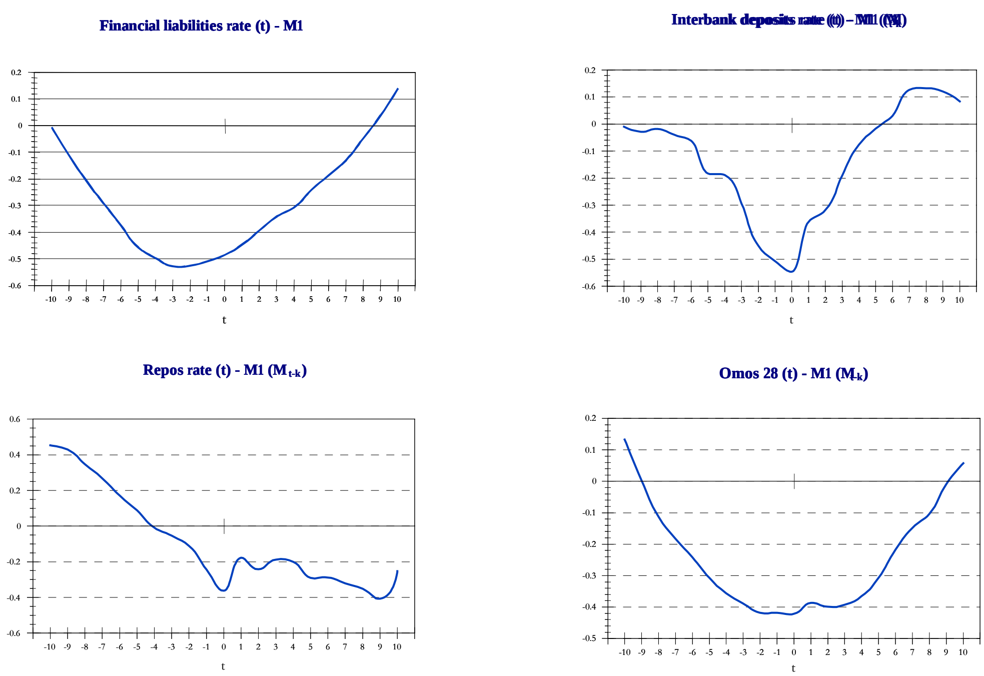
K = -10,...,10 HP filtered data ; Period: 1995.1 – 2002.12



GRAPH 4:

Correlation: **Interest Rate (t) – M1 (M_{t-k})**

K = -10,...,10 HP filtered data ; Period: 1995.1 – 2002.12

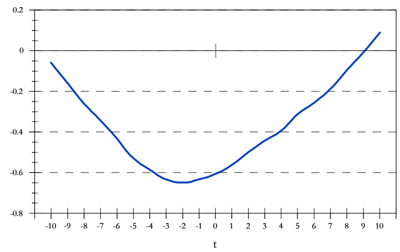


GRAPH 5:

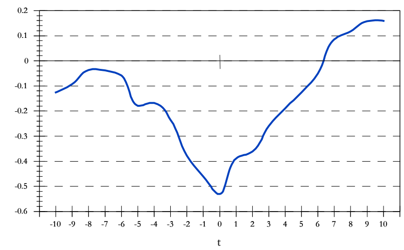
Correlation: **Interest Rate (t) – M_2 (M_{t-k})**

K = -10,...,10 HP filtered data ; Period: 1995.1 – 2002.12

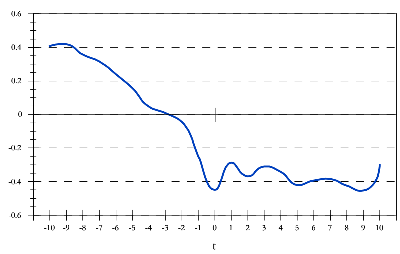
Financial liabilities rate (t) - M2 (M_{t-k})



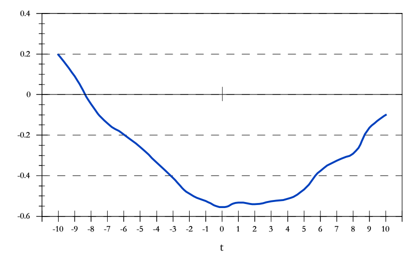
Interbank deposits rate (t) - M2 (M_{t-k})



Repos rate (t) - M2 (M_{t-k})



Omos 28 (t) - M2 (M_{t-k})



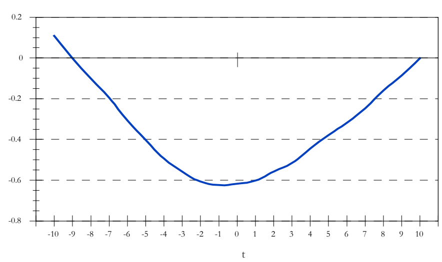
GRAPH 6

Correlation: **Interest Rate (t) - Total Reserves (M_{t-k})**

K = -10,...,10 HP filtered data ; Period: 1995.1 – 2002.12

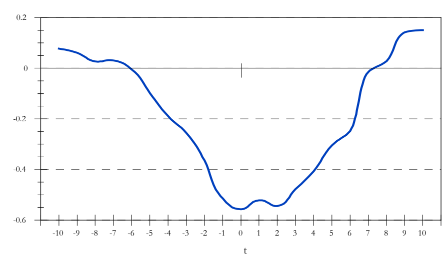
Financial Liabilities Rate (t) - Total Reserves (M_{t-k})

K = -10,...,10 HP filtered data
1995.1 - 2002.12



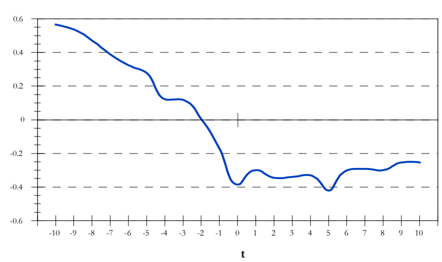
Interbank Deposits Rate (t) - Total Reserves (M_{t-k})

K = -10,...,10 HP filtered data
1995.1 - 2002.12



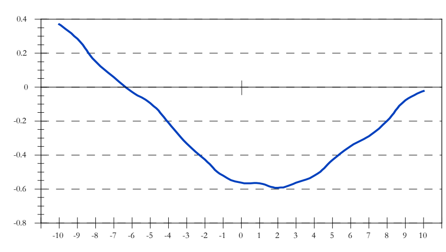
Repos rate (t) - Total Reserves (M_{t-k})

K = -10,...,10 HP filtered data
1995.1 - 2002.12



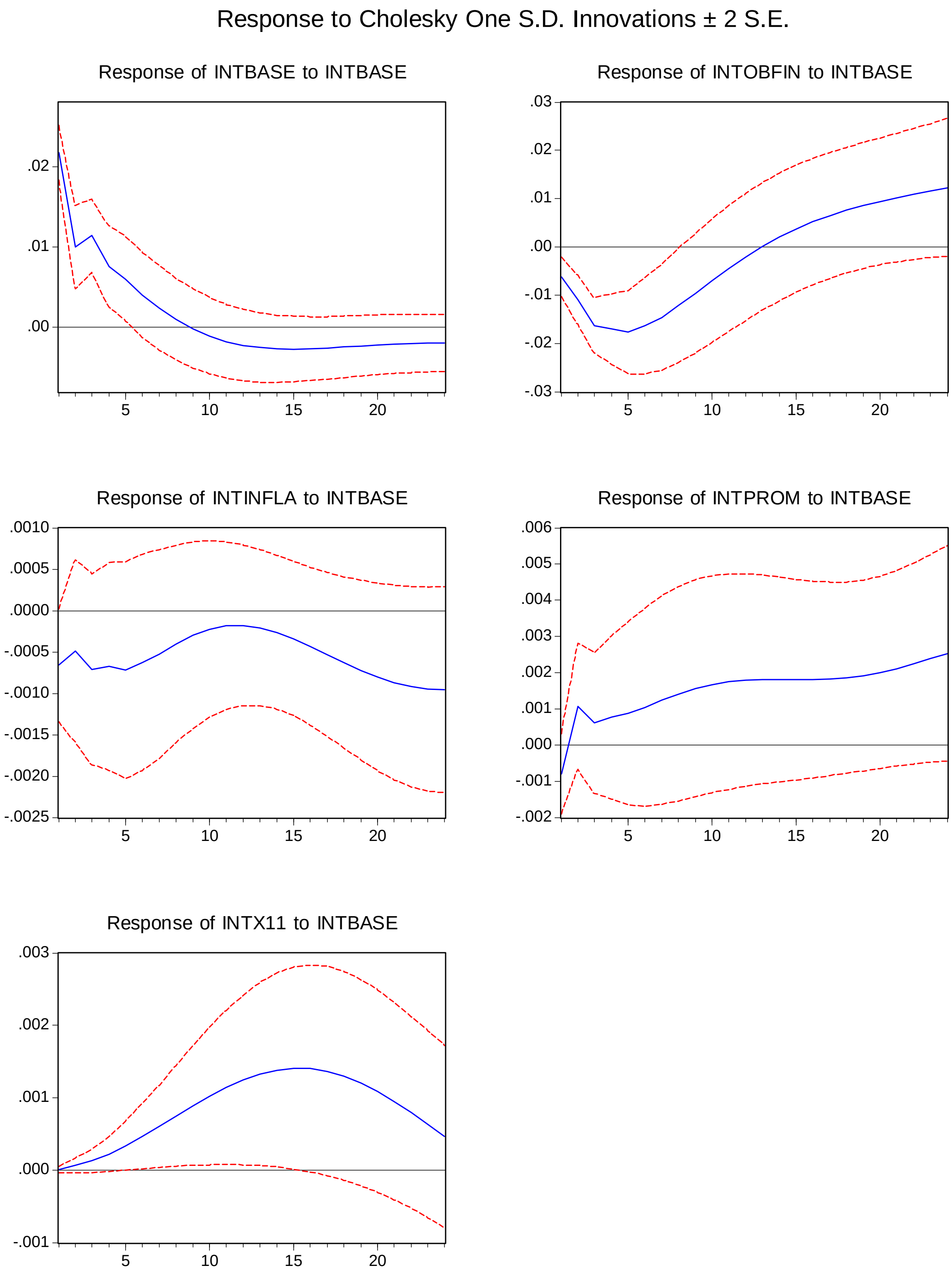
Omos 28 (t) - Total Reserves (M_{t-k})

K = -10,...,10 HP filtered data
1995.1 - 2002.12



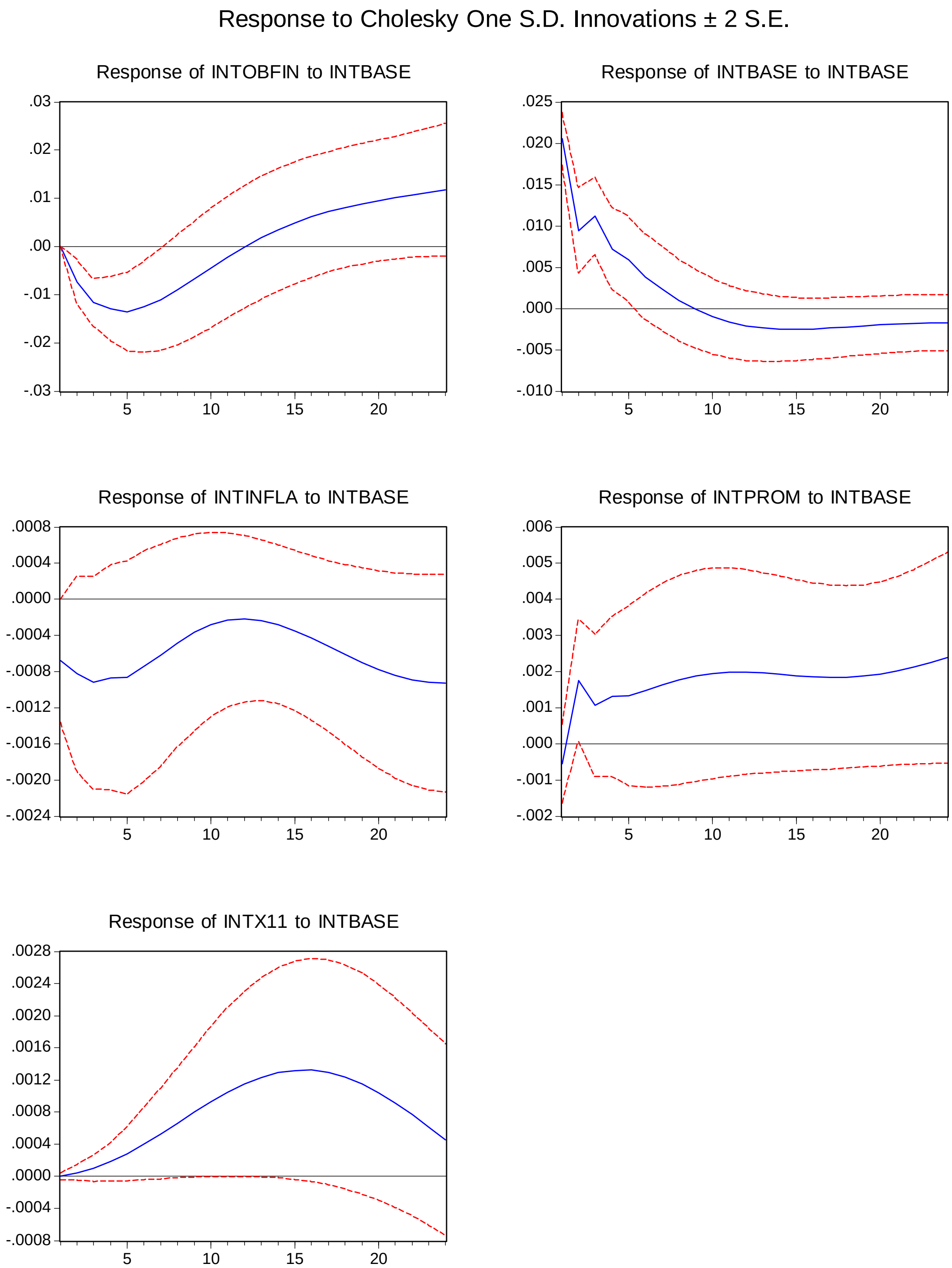
GRAPH 7: Base Money – Financial liabilities

First Ordering: [M, i, π, ex, y]



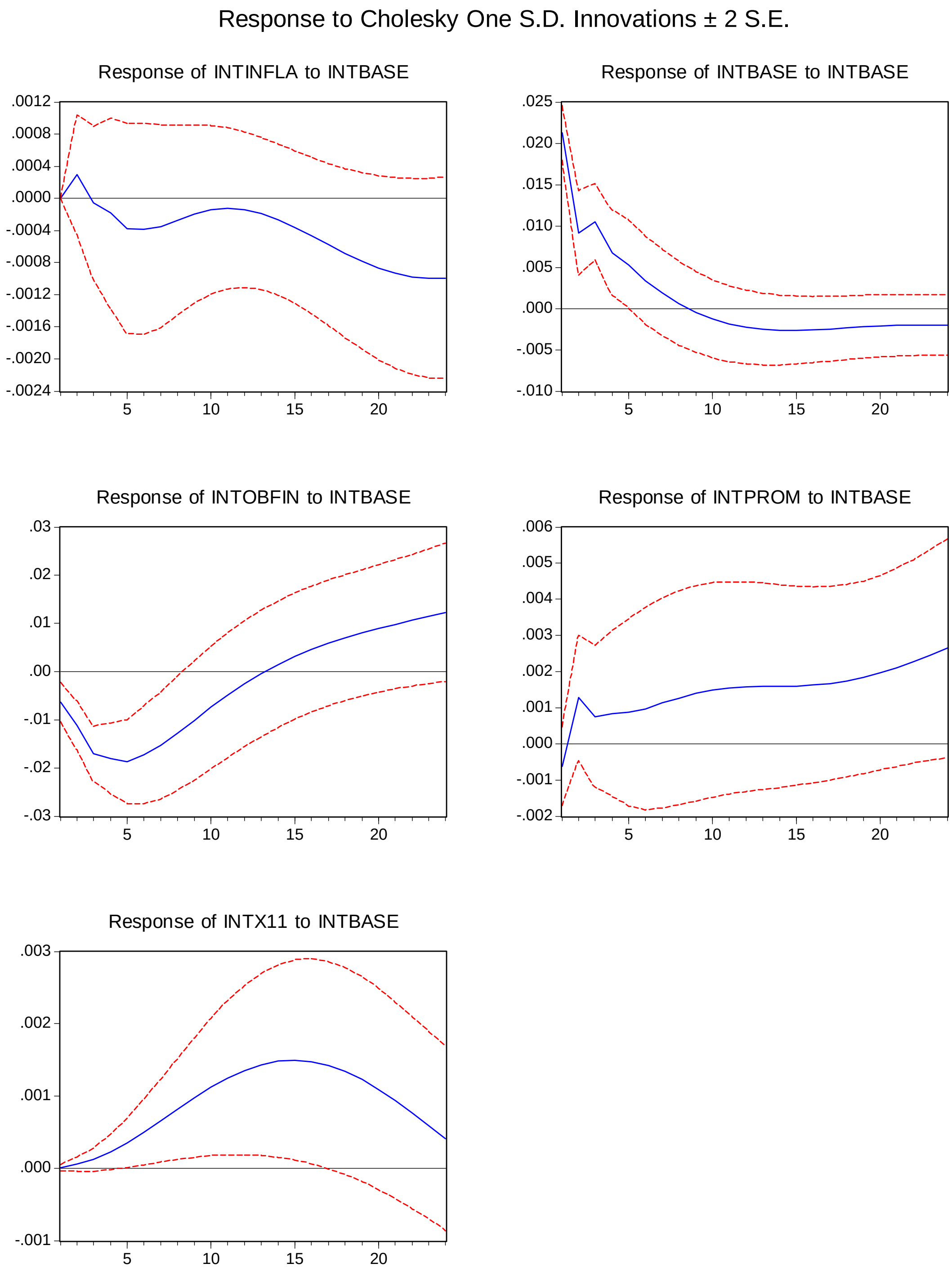
GRAPH 8: Base Money – Financial liabilities

Second Ordering: [i, M, π, ex, y]



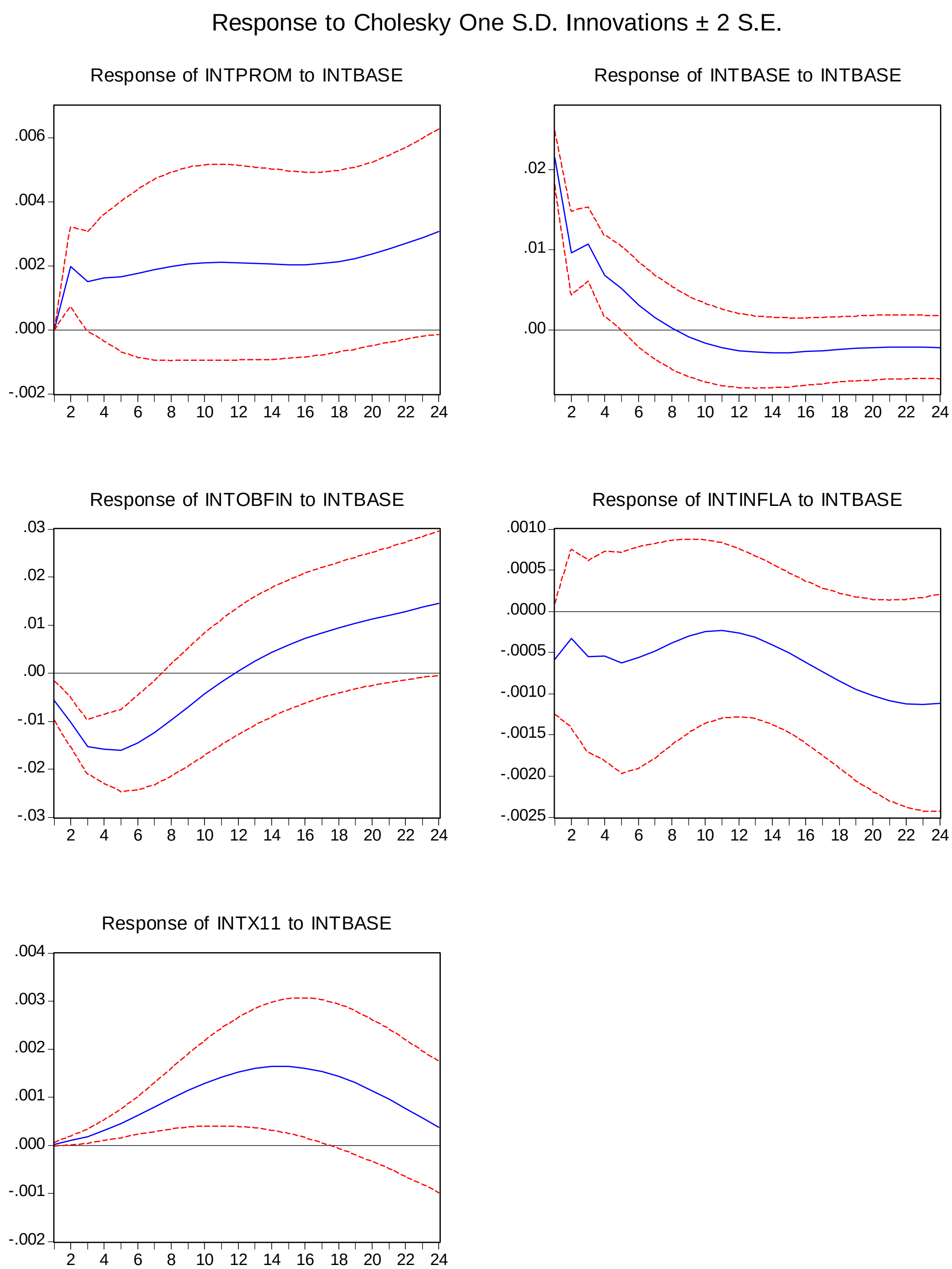
GRAPH 9: Base Money – Financial liabilities

Third Ordering: [π, M, i, ex, y]



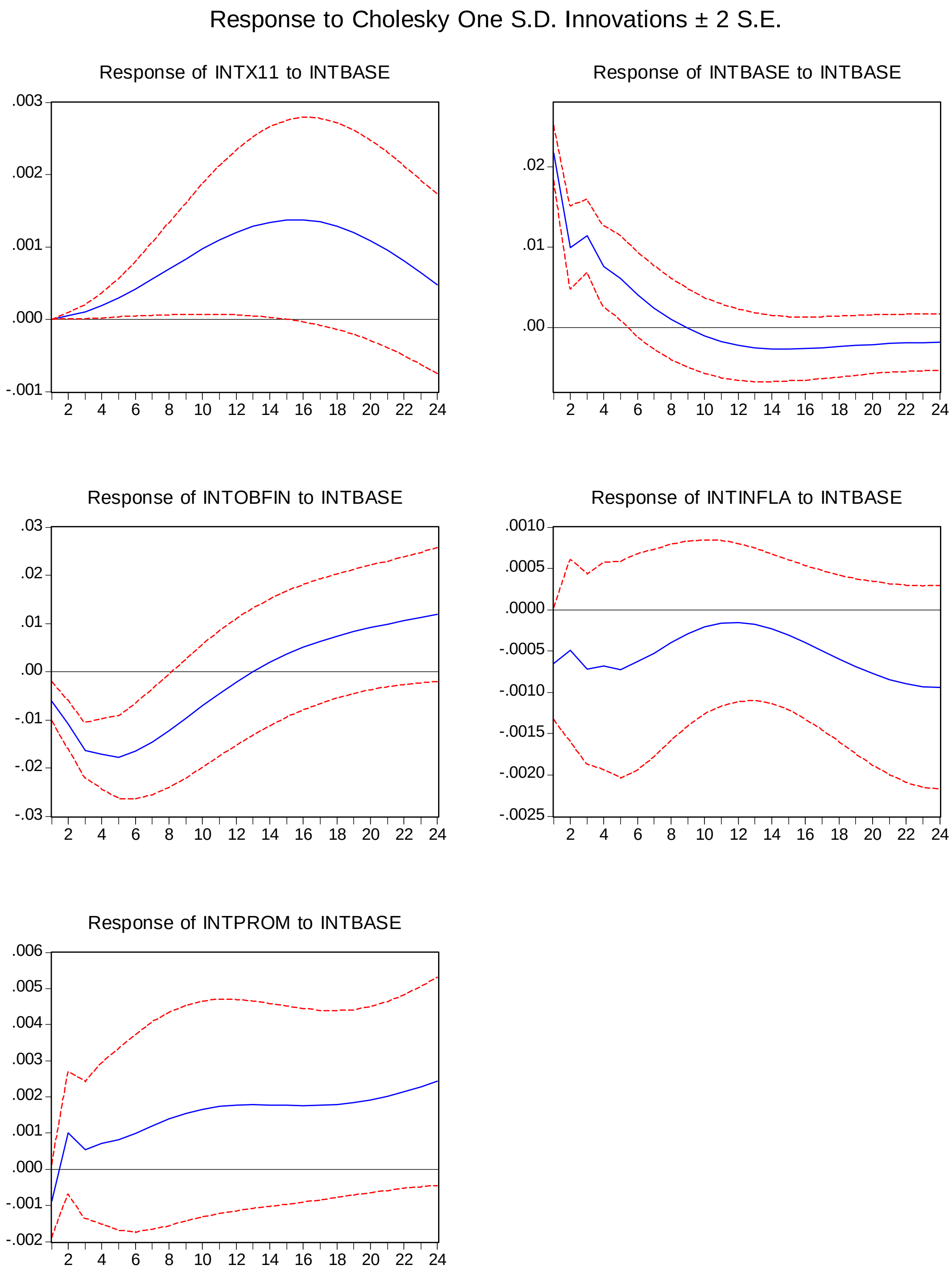
GRAPH 10: Base Money – Financial liabilities

Forth Ordering: [*ex*, *M*, *i*, *π*, *y*]



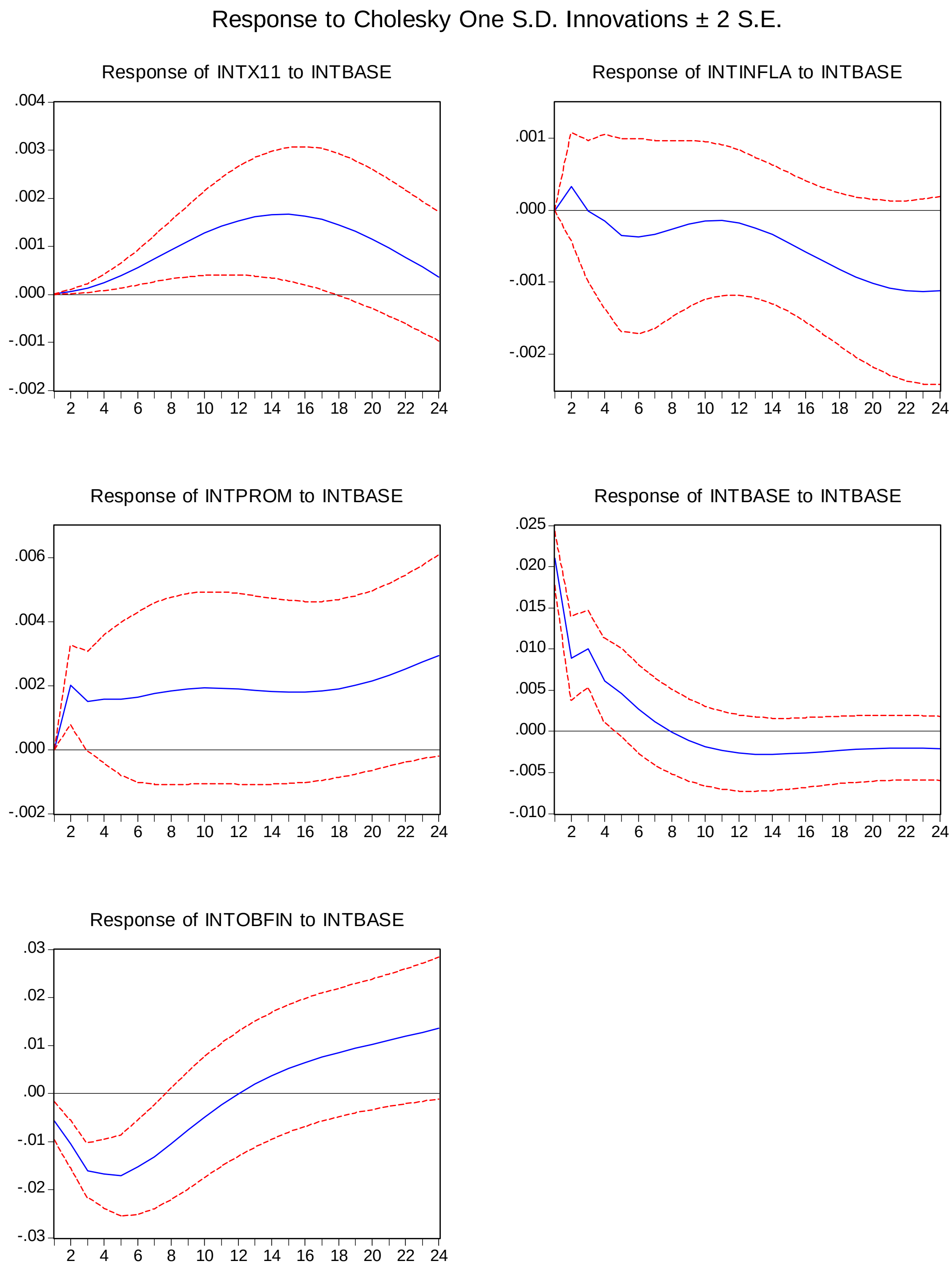
GRAPH 11: Base Money – Financial liabilities

Fifth Ordering: [*y*, *M*, *i*, *π*, *ex*]



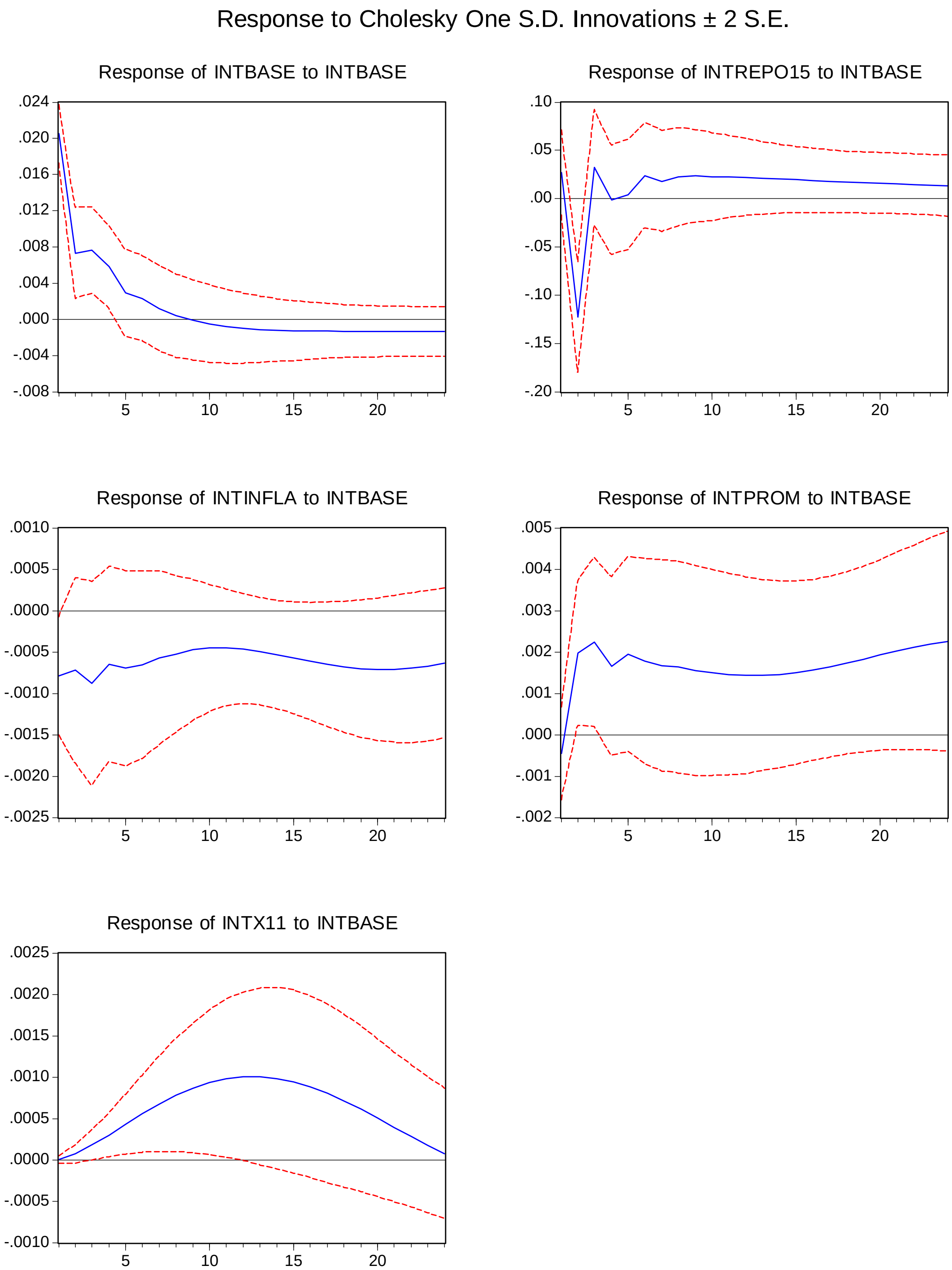
GRAPH 12: Base Money – Financial liabilities

Sixth Ordering: [y, π, ex, M, i]



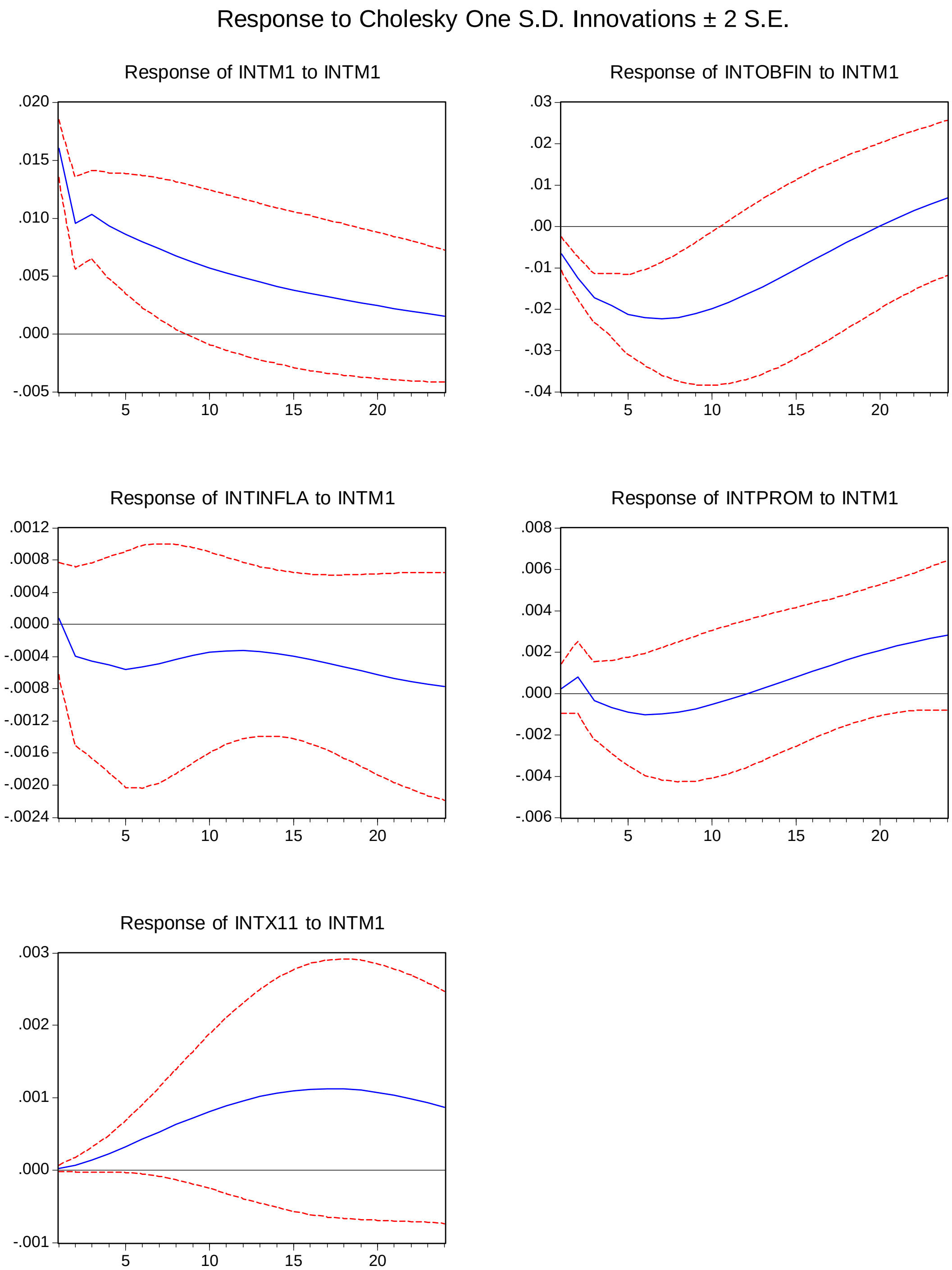
GRAPH 13: Base Money – Repo rate

First Ordering: [M, i, π, ex, y]



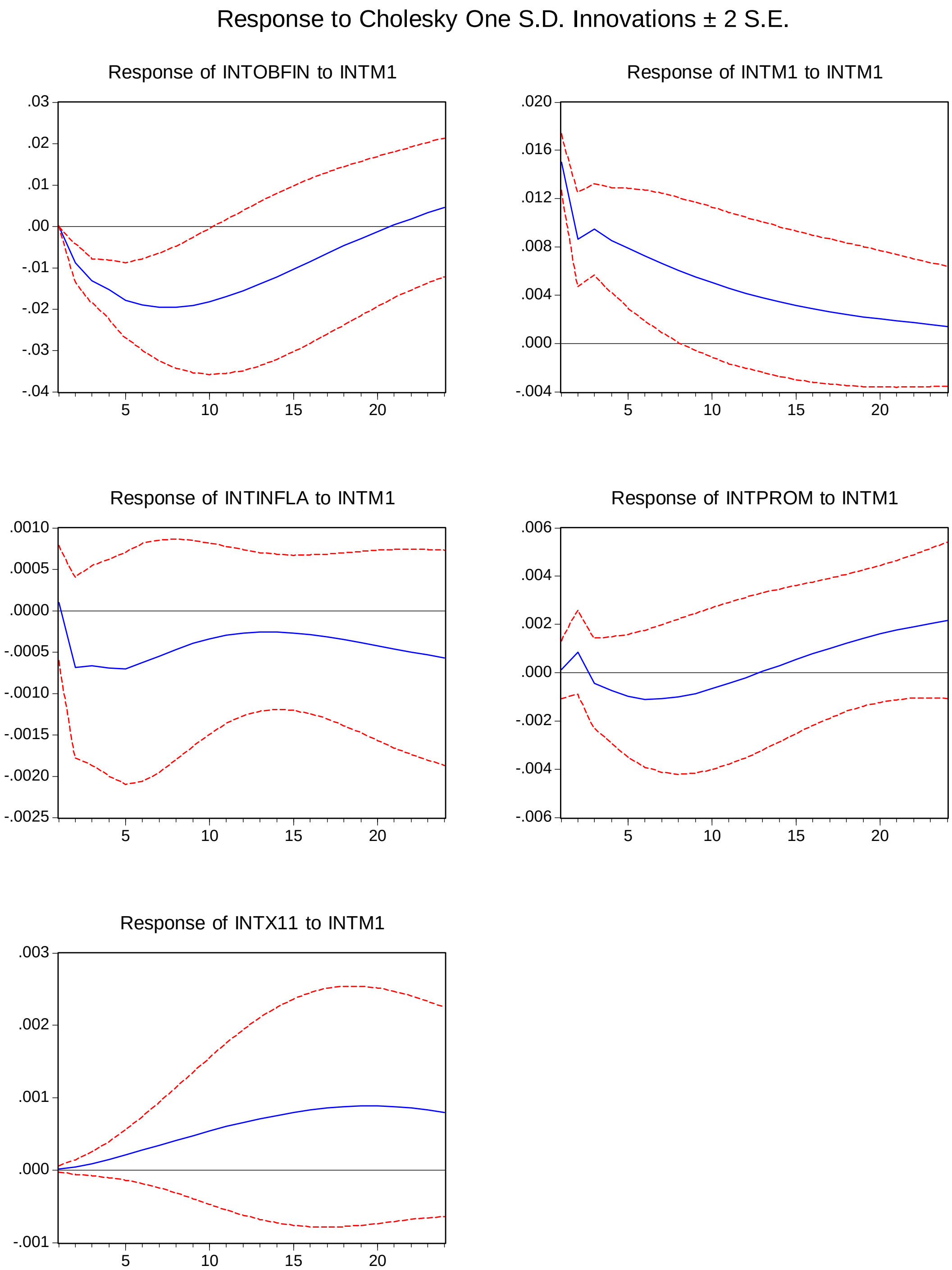
GRAPH 14: M_1 – Financial liabilities

First Ordering: [M, i, π, ex, y]



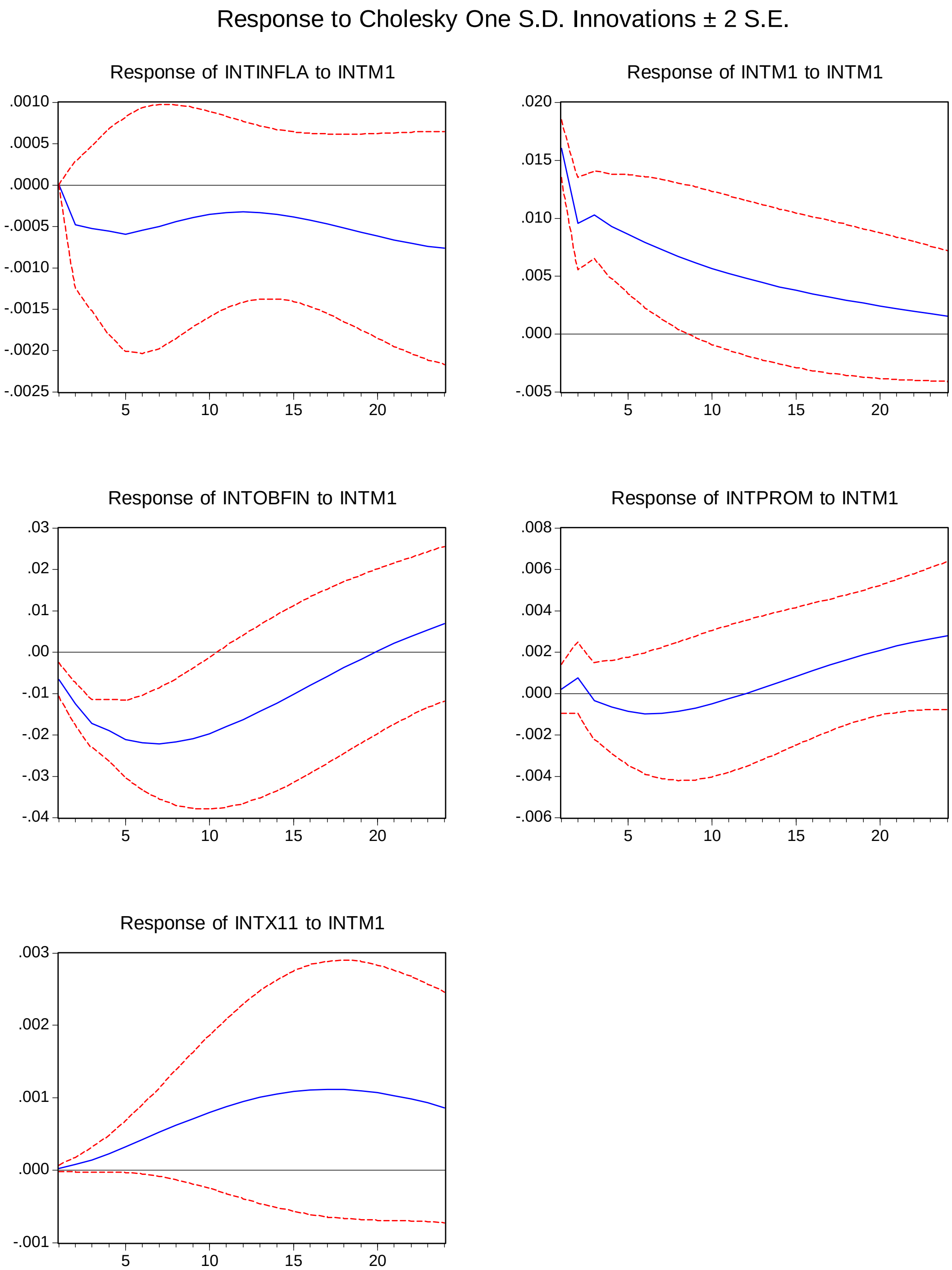
GRAPH 15: M_1 – Financial liabilities

Second Ordering: [i, M, π, ex, y]



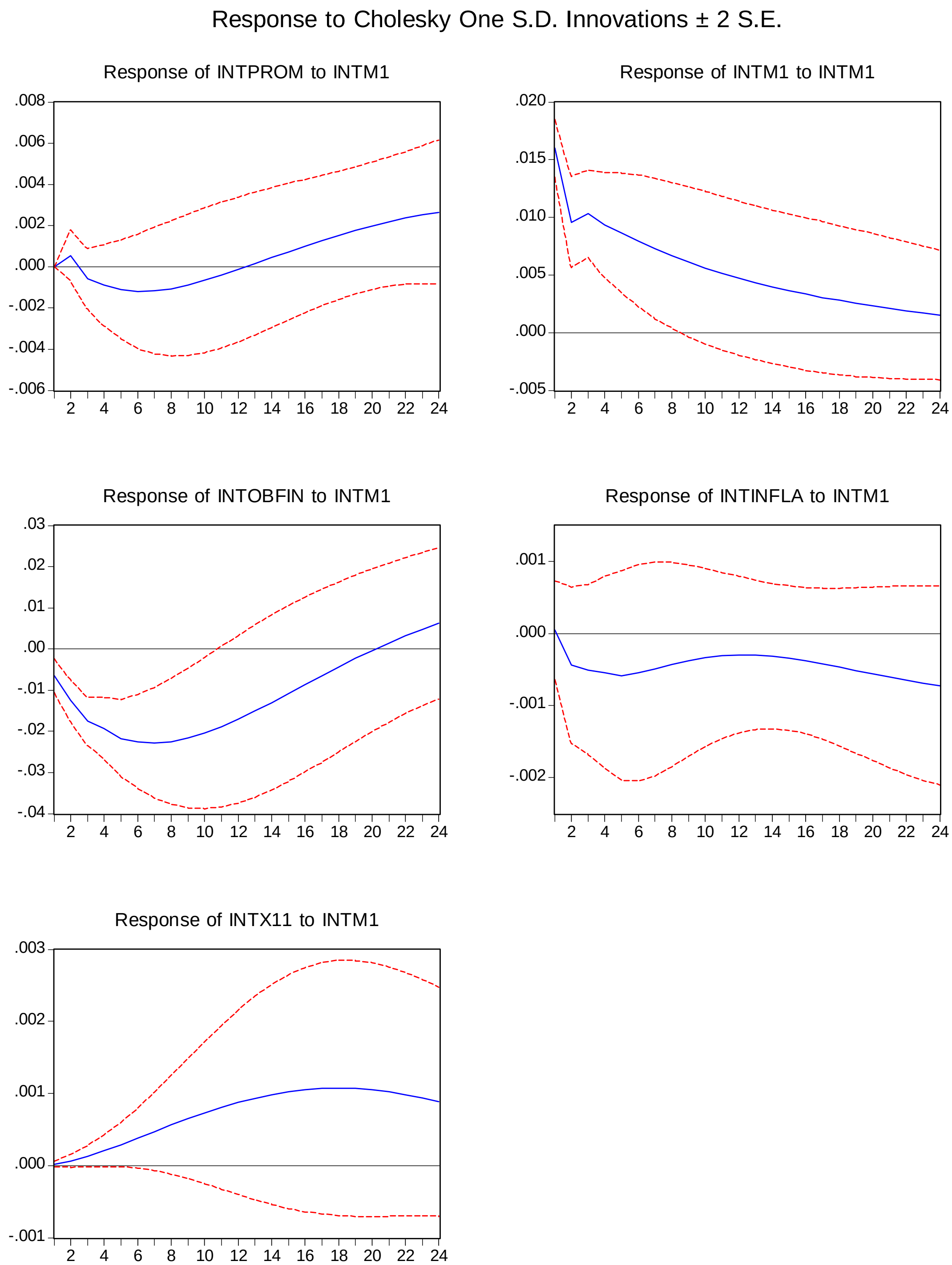
GRAPH 16: M_1 – Financial liabilities

Third Ordering: [π, M, i, ex, y]



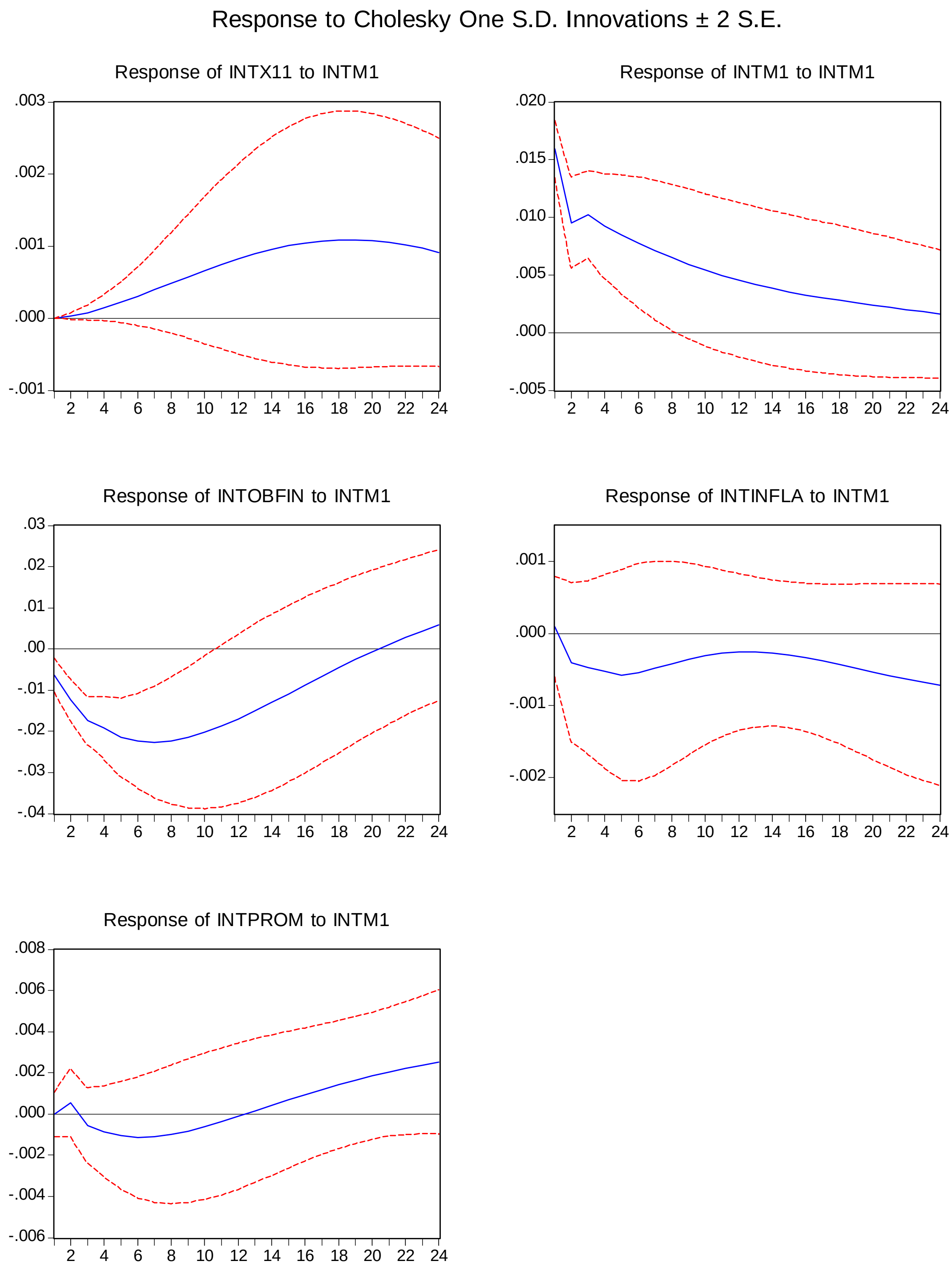
GRAPH 17: M_1 – Financial liabilities

Forth Ordering: [ex, M, i, π, y]



GRAPH 18: M_1 – Financial liabilities

Fifth Ordering: [y, M, i, π, ex]



GRAPH 19: M_1 – Financial liabilities

Sixth Ordering: [y, π, ex, M, i]