Lancaster University Management School
Working Paper
2000/009

Oiling the wheels: credit and monetary neutrality in Saudi Arabia

N Taher, Mohammed Salisu and P N Snowden

The Department of Economics
Lancaster University Management School
Lancaster LA1 4YX
UK

Oiling the wheels: credit and monetary neutrality in Saudi Arabia

N. Taher, M. Salisu and P.N. Snowden•
Department of Economics, Lancaster University Management School,
Lancaster LA1 4YX United Kingdom.

• The authors wish to thank Ibrahim Alghelaiqah for helpful suggestions during the preparation of this study. He bears no responsibility for the final outcome.

Introduction:

David Hume's price-specie-flow mechanism in which the quantity of money was equated with the demand to hold it through the international redistribution of bullion provided a foundation for the monetary approach to the balance of payments in the late 1960s (Johnson, 1972, pp.229-30). While retaining Hume's original insight the new approach de-emphasised the role of relative goods market price adjustments in the achievement of monetary equilibrium. Instead, the focus was placed on the direct influence of the net excess demand for money on the balance of payments 'below the line' (*ibid.*).

The present study returns to this monetary mechanism in a modern context chosen both for its approximation to the institutional conditions originally supposed, and to examine its likely operation in developing economies characterised by a high degree of commodity export dependence. Saudi Arabia's oil export specialisation and essentially complete dependence on imported supplies would seem to limit the role of relative goods price adjustments in the achievement of monetary equilibrium. Moreover, under a rigidly pegged exchange rate regime, the implied exogeneity of the influences normally thought to determine the demand to hold nominal money suggests that supply disturbances might readily generate (transitory) imbalances in the money market. In application to a commodity exporting economy, however, the source of these imbalances and their connection with balance of payments disequilibria might be expected to differ significantly from the account emphasised both in Hume's original exposition and in its later revival.

The more recent literature, in particular, highlighted the consequences for subsequent movements in the balance of payments of domestic (fiduciary) monetary issue. In the present case of oil revenue dependence, such disturbances are at least as likely to be initiated externally and to be introduced into the domestic economy through the financing of government expenditures. To test the monetary adjustment mechanism in Saudi Arabia, therefore, account must be taken of fluctuating oil revenues and a structural vector autoregression (SVAR) model is developed below to this end.

Under the proposed sequence of disturbances, and in conflict with the classical presumption, it is suggested that the induced monetary adjustments have proved not to be neutral for the real economy. Indeed, with associated evidence on the determination of bank credit allocation, some insight into the failure of the Kingdom to diversify its economic base in the years since 1979 is suggested. Before proceeding to an exposition of the SVAR model, balance sheet data of the Saudi Arabian Monetary Agency (SAMA) are reviewed briefly below to highlight the distinctive features of the monetary framework under consideration.

1. Monetary sector developments since 1980

The summary data in Table 1 confirm that SAMA is atypical in international central banking terms. Foreign assets account for almost all of the institution’s balance sheet total although, according to the Agency’s annual reports, the proportion of these that was clearly liquid (currencies and deposits with banks abroad) represented not more than half in the three years 1996 to 1998 (SAMA, 1997 and 1998). Neglecting the small official valuation of gold holdings, ‘investments in foreign securities’ accounted for the remainder.

Table 1: SAMA balance sheet data and 'narrow' income velocity
(Billions of Riyals or per cent)

Government deposits held with SAMA accounted for three-quarters of foreign assets after the second oil price 'shock' in 1981. A sharp decline following 1985 was to lead in 1990[1] to a ratio of only a little over ten per cent before stabilising at approximately 20-22% after 1992. As foreign reserves (and government deposits) declined during the 1980s, the fifth column of Table 1 indicates that the fraction of foreign assets 'financed' by the monetary base increased, eventually approaching one third by 1995. Taken together, these two liabilities were to account for only one half of SAMA's foreign exchange holdings during the mid- to late 1990s. A single large item (other miscellaneous liabilities) appears in the published reports to furnish most of the remainder and, presumably, reflects various forms of external official borrowing in the post Gulf conflict period.

While base money has grown in significance within SAMA's liability structure, the third column of Table 1 confirms that it is increasingly a circulating medium with a declining fraction held in the form of commercial bank reserve assets. Summing 'active' currency with commercial bank demand deposits (M1), the measure in the final column of the table suggests that the (non-oil) income velocity of circulation has tended to decline over the full period. The corresponding rise in the narrow money to income ratio reflects the use in deflation of two price indices, with the official consumer price index applied to nominal money consistently implying a lower rate of inflation than the deflator for non-oil income. Using unadjusted

[1] Gulf War hostilities began in the third quarter of 1990

(nominal) figures, the ratio has remained approximately stable with an average value of 2.33 over the years reported in the table.

The extent to which this behaviour of narrow money reflects the operation of the 'classical' monetary adjustment mechanism in a resource dependent economy is examined through application of the SVAR framework.

2 SVAR representation of the Saudi monetary sector

Structural VAR models are perhaps the most important modern development in the empirical testing of traditional monetary propositions. Their great appeal in examining the monetary policy transmission mechanism, for instance, is their ability to identify the impact of policy without the need for a complete structural model of the economy (Rudebusch, 1996). Recent empirical investigations have therefore become heavily dependent on SVARs (eg. Sims, 1992, Christiano *et.al.*, 1994, Ramaswamy and Slok, 1998, Sirivedhin,1998 and Wong, 2000).

The proposed structural model contains five variables in the following order: the income terms of trade (ToT), the Saudi riyal interest rate (i), real non-oil GDP (Rnoy, based on its own deflator), the narrow money multiplier (mm1) and the real monetary base (RMo, using the CPI deflator). This ordering broadly reflects a theoretical perspective in which the demand to hold money (ultimately) determines the observed supply, and which also recognises the probable comparative importance of different disturbances. In the latter connection, and reflecting contemporary practice, the order begins with the variables assumed to be the most exogenous and ends with the most endogenous (Bacchetta and Ballabriga, 2000).

The priority accorded in the ordering to the income terms of trade reflects its assumed exogeneity, at least from the viewpoint of the Saudi monetary sector. While the Riyal interest rate (on time deposits) would be a suitable opportunity cost variable in a narrow money demand function, its 'high' ordering also reflects its exogeneity under a rigid currency peg with unimpeded international flows. This position must, of course, be qualified by the likely connection (through the level of world demand) between international interest rates and the Saudi income terms of trade. Although this introduces some ambiguity into their proposed ordering, the two external sources of disturbance would each be expected to influence the behaviour of domestic real and monetary aggregates (Kiel 1993, Ahmed and Murthy, 1994, and Conway *et al*., 1998).

It is assumed that the first of the domestic variables to be affected will be non-oil GDP. This position reflects the influence both of (revenue-induced) fluctuations in government expenditure programmes and of interest rate movements on non-oil sector activity. It also acknowledges the presumed importance of the latter in determining the demand for transactions balances. Having thus incorporated some of its potential demand determinants, narrow money supply appears in the ordering through its decomposition into the implied monetary multiplier and (CPI-deflated) money base. Autonomous portfolio decisions by banks, or changing cash preferences of the public, might entail multiplier changes that are unconnected with movements in overall money demand. Allowing for these disturbances the real base, as the last variable in the ordering, is seen as offsetting money supply and demand disturbances through the balance of payments (Guerra *et. al*., 1998).

A triangular structure for the model is therefore proposed with a long run causal ordering reflected in the following solution form:

$$\Delta \mathrm{ToT}_t = \eta_t$$

$$\Delta \mathrm{i}_t = a\, \Delta \mathrm{ToT}_t + \psi_t$$

$$\Delta \mathrm{Rnoy}_t = b\, \Delta \mathrm{ToT}_t + c\, \Delta \mathrm{i}_t + \varphi_t$$

$$\Delta \mathrm{mm1} = d\, \Delta \mathrm{ToT}_t + e\, \Delta \mathrm{i}_t + f\, \Delta \mathrm{Rnoy}_t + \varepsilon_t$$

$$\Delta \mathrm{RMo} = g\, \Delta \mathrm{ToT}_t + h\, \Delta \mathrm{i}_t + l\, \Delta \mathrm{Rnoy}_t + z\, \Delta \mathrm{mm1}_t + \nu_t \qquad (1)$$

where Δ represents the first difference operator with all variables in logarithms, and η_t, ψ_t, φ_t, ε_t, ν_t represent orthogonal shocks.

According to this ordering the income terms of trade are affected in the long run only by their own innovations (η_t). While these may have lasting effects on interest rates, interest rate shocks (ψ_t) are defined to have none on the income terms of trade. Both terms of trade and interest rate shocks exert a lasting (one way) influence on real non-oil GDP with these three sources of disturbance then influencing the money multiplier. While the latter's own shocks (ε_t) will influence the real base, monetary neutrality is implied in the hypothesised lack of long-run effect of the last two variables on the real economy.

The SVAR in equation (1) is not estimated directly but is derived from the parameters of a set of empirical VAR relationships. Subject to the data meeting certain statistical requirements the structural system may be derived from the VAR coefficients provided that a sufficient number of restrictions are imposed. With five variables 25 restrictions are needed, 15 being available through simple normalisation. The remaining ten are obtained through the Blanchard and Quah (1989) identification scheme which constrains the long run multiplier matrix to be lower diagonal as reflected in the form of equation (1). Appendix A provides a more detailed explanation of the role of these restrictions in permitting a unique identification of the SVAR system used for simulation purposes. As has been recognised elsewhere, an especially useful aspect of the Blanchard and Quah technique is that it provides a unique, and economically meaningful, decomposition of the time series into temporary and permanent components (Giannini, 1992). For these inferences to be valid, however, certain restrictions must be seen to apply to the data themselves.

3 Data description

All the data used in the empirical estimation are quarterly, seasonally unadjusted, time series for the period 1978:1-1998:1 (80 observations) and are converted into logarithms. Although not reported in the results, dummies were included to capture seasonal variations in the variables, and the impact of the Gulf War (1 for 1990:3 to 1991:3, 0 otherwise). The income terms of trade (ToT), measured as the crude petroleum revenue index divided by the import price index, is calculated from *International Financial Statistics* (IMF, various issues). Domestic interest rates (i) are the 3-month offshore Saudi riyal deposit rate obtained for pre-1987 values from the National Commercial Bank, and subsequently from the *Money and Banking Statistics* of SAMA. The money supply multiplier (mm1) and the monetary base (RMo) are drawn from the latter source, as is the Saudi consumer price index used for deflation. Non-oil GDP data (with deflator) are supplied on an annual basis in the Agency's *Annual Reports.* Since quarterly non-oil GDP data are not reported these values are interpolations from quarterly import data on the basis of the high (annual) correlation between the two series.

An initial requirement of the data for SVAR application is that they must satisfy the time series property of stationarity (eg. Enders, 1995). Computed Augmented Dickey Fuller (ADF) statistics for all five variables in levels indicated that they were integrated of order one [I(1)] at the 5 per cent level of significance. First differencing of the data was sufficient to achieve stationarity on the same criterion. Having established that all the data series in levels were I(1), it was then necessary to test for the possibility of cointegration between the variables. Such a relationship would undermine the assumption, shown in the appendix to be necessary for identification of the SVAR, that there are as many (mutually orthogonal) shocks to the system as endogenous variables.

In view of the theoretical position that money supply should adjust to demand in the Saudi context, a cointegrating relationship might have been expected between the variables chosen. Despite this consideration, however, the results for Johansen's (1991) technique reported in Table 2 suggest that the null hypothesis of no cointegration cannot be rejected at both the 5 and 10 per cent levels. While this finding suggests that some influences on money demand may have been omitted, the effect of the two diverging price deflators on the money-income relationship was noted in Table 1. The insensitivity of the CPI deflator to broader price trends was confirmed in a re-estimation of the SVAR system using nominal rather than CPI-deflated base money. Although the evidence against cointegration was slightly stronger in this case, the simulation results were almost identical to those reported. A minor advantage of the present specification is that those for the behaviour of base money are more readily interpreted as reflecting a change in terms of a specific consumption basket.

Table 2: Cointegration LR test based on maximal eigenvalue of the stochastic matrix

Turning to the lag structure for estimation of the SVAR, two information criteria were used to determine the lag length (AIC; Akaike (1973)), and the Schwarz information Criterion (Schwarz (1978)).[2] On the basis of the minimisation of both criteria, the number of lags in the system was set at eight. The results are presented in Table 3. Ljung-Box Q statistics (Ljung and Box, 1978) confirm the lack of serially correlated residuals at the 5% level of significance.

Table 3: Criteria for selecting the lag length

[2] Using respectively the simple formulae:

$$AIC = \log|\Sigma| + \frac{2k}{T}, \quad SC = \log|\Sigma| + \frac{k \log T}{T}$$

where, $|\Sigma|$ is the determinant of the variance covariance matrix of the VAR residuals, k is the number of parameters in the model, T is the number of observations.

4. SVAR simulation results

Once estimated, the SVAR structure may be used for both variance decomposition and impulse response analysis. Variance decomposition analysis provides evidence on the relative contribution of the different sources of shock to the forecast error variance for each variable in the SVAR system. Although the neutrality restriction imposes a ranking of the variables by the degree of their long-run exogeneity, the variance decompositions also offer some check on this assumption over shorter time periods. The direction of the influences identified is then ascertained graphically through impulse response analysis. The long run implications of the latter are then discussed under the imposed neutrality restriction.

4.1 Variance decomposition analysis

The variance decomposition results are presented for periods of up to ten quarters in Table 4:

Table 4: Variance decompositions of variables at different horizons

Evidence on the relative degree of exogeneity of the variables is contained in the diagonal columns which report the proportion of the error variance for each attributable to its own past innovations. Although qualified support is provided for the hypothesised long run ordering, interest rates appear to be more, rather than less, exogenous than the income terms of trade. With over 70% of the interest rate forecast error accounted for by its own disturbances, the theoretical presumption that this variable is determined externally under a pegged exchange rate is strongly supported.

The somewhat less clear result for the income terms of trade reflects an apparent (and implausible) lagged influence on that variable of the components of M1. Further investigation of the data suggests that this result reflects two factors. Although measured as the ratio of oil revenues to import prices, the income terms of trade appear to strengthen when import prices are rising: import prices ‘Granger cause’ oil revenues over the period under study. The general failure of the CPI to reflect these externally induced price increases and, presumably, the true cost of living then suggests that transactions balances would rise before oil revenues. This would not imply a long run relationship and later sections of the table appear to confirm the *a priori* position that the two money supply components are strongly and immediately influenced by fluctuations in the terms of trade.

By contrast, the relationship between the terms of trade and the interest rate remains ambiguous. Each appears to have some influence on the other over the ten quarters horizon and Granger causality tests were inconclusive. Inversion of the order of these variables in the SVAR was found to produce two changes in the pattern of the variance decompositions. The influence of the terms of trade on non-oil income became stronger at the expense of the interest rate effect on the same variable. The interest rate in turn had a somewhat stronger effect on the money base. Since neither of these changes is crucial to the main findings, the priority accorded to the terms of trade reflects the assumption that oil market disturbances are unlikely to be closely connected with short-term interest rate levels in the long run.

The hypothesised ordering is supported for the remaining ‘internal’ variables. Real non-oil income, the multiplier and the base thus provide the appropriate ranking of these variables according to variance explained by their own past behaviour. Subject to the *caveat* arising from the imposed ordering of the two external variables, non-oil income appears to be influenced more by interest rate disturbances than by those arising through the terms of trade. While the unimportance of the latter is striking it is equally clear that the terms of trade have a marked impact both on the multiplier and on the base up to a two-year horizon. The (tentative) evidence, contrary to the *a priori* ordering, that the multiplier exhibits somewhat more influence on non-oil income than applies in the other direction appears less difficult to interpret as a comparatively short run effect than as a long term one. On this assumption, the long run impact on the level of each variable arising from a disturbance in one of the others will be clarified by reference to the impulse response functions.

4.2. Impulse Response Functions

With reference to the perspective developed earlier, the impulse response functions mapped in Figures B1 to B4 are best summarised in reverse order (see Appendix B). They portray the development over time of the full impact of a one standard deviation shock to each variable on the *level* of the others. The dashed lines indicate the lower and upper bounds corresponding to the 5 per cent level of significance as reported in connection with the variance decomposition analysis.

Holding constant the first three variables a shock to the monetary multiplier has a negative impact on the real money base, as would be expected for an (implied) unchanged demand to hold narrow money. Similarly a positive shock to real non-oil GDP, and therefore to money demand, increases both the multiplier and the level of the monetary base (Figure B3). The effect of a positive (eg. foreign) shock to interest rates is to produce a long run negative effect on real incomes and, consistent with the previous result, a decline in both the multiplier and the base (Figure B2). The positive impact on interest rates of a shock to the income terms of trade is displayed clearly in Figure B1 and, with reference to the previous figure, confirms the expectation that improved terms of trade alone would have a positive influence on the long run income level. In this simulation, the combined effect of an improvement in the terms of trade is both to raise the multiplier and to *reduce* the base. Moreover, comparison of the same two figures suggests that the positive impact on the multiplier of the improvement is comparatively large: a noteworthy result in view of the apparently small effect on non-oil incomes. In general, and again by reference to the hypothesised monetary adjustment mechanism, the unanticipated aspect of these simulations is the apparently systematic part taken in overall monetary adjustment by the multiplier. Before interpreting the results, however, an assessment of the comparative importance of the developments reported is required. Accordingly, Table 5 reports the accumulated impulse responses reflected in the terminal values of the traces in Figures B1 to B4:

Table 5: Accumulated impulse responses out of ∞ steps

The diagonals of the table are the magnitudes of a permanent, one standard deviation, shock to the variables. With the data entered as first differences of logarithms they may therefore be regarded as measuring a proportional change in its level in each case. The extent of the consistency of these magnitudes with the hypothesised monetary adjustment mechanism under a pegged exchange rate may be indicated by the following calculations. With the variables to its left initially held constant, the penultimate column suggests that a 2.8% permanent rise in the multiplier gives rise to a 0.7% fall in the base. The inverse relationship, although not the implied net increase in real M1, would be expected for an autonomous change in the multiplier under given money demand conditions. The sustained rise in real money may, in turn, be consistent with an underestimation of actual price rises by the CPI deflator.

Since real non-oil incomes are calculated with their own deflator, this explanation strengthens the inference from the middle column that the income elasticity of demand for money balances could be less than unity. Division of the sum of the values for the induced responses of the multiplier and the base by the 2.9% increase in real income suggests an elasticity of 0.8. As confidence intervals for this calculation are not readily determined, however, and recalling the declining income velocity reported in Table 1, the estimate may not be inconsistent with a ‘true’ value of approximately unity. By applying the estimated elasticity (0.8) to the small (0.9%) fall in income associated with an interest rate shock a negligible (-0.06%) interest elasticity of demand for narrow balances is suggested. This finding is not, of course, surprising in the present context and, when the two elasticities calculated so far are applied to the values in the final (first) column, it is equally unsurprising that a permanent change in the terms of trade has no *independent* effect on narrow money demand.

With this tentative support for the monetary mechanism, the measured impact of different shocks to the money multiplier (rather than to real M1 as a whole) is of some interest. In particular, when the same calculations are applied to the multiplier alone, it appears that a permanent (15.3%) shock to the terms of trade is independently responsible for a (3%) rise in the multiplier. This variation then accounts for the apparent decline in the base in view of the earlier finding that the terms of trade exert no overall effect on the demand to hold narrow money. Recognising that the calculations are based on long run simulated adjustments it is of importance in explaining the effect of oil income changes on the base that the multiplier is apparently permanently affected. An interpretation of this finding will be developed by reference to the behaviour of the assets side of commercial bank balance sheets in relation to the influences examined thus far.

5 Money, credit and liquidity

Variations in the money multiplier derive conventionally from changes in the cash and reserve ratios, respectively, of the public and the banks. Examination in these terms of the Saudi data reveals that the dominant source of fluctuations in the period up to 1986 was bank reserve to deposit ratios as substantial excess reserves were run down. While the public's cash to deposit ratio was also influential, it was in the subsequent period that this was to become the major cause of multiplier fluctuations. With bank reserves having reached comparatively low levels in the later years, it appears that one source of long term sensitivity of the multiplier to the terms of trade needs to be sought in their effects on the cash holdings of the public. It should be added that this ratio (to demand deposits) approached 60% from substantially higher values in the earlier years of the study.

For consistency with the observed positive association between the multiplier and the terms of trade, it would be necessary to observe a negative relationship between the latter and the public's cash ratio. Recalling that this is unrelated to a change in the level of non-oil GDP, an improvement in the terms of trade will nevertheless imply a rise in disposable incomes through internal transfer payments. While their immediate expenditure on (say) imported goods should not influence observed money holdings, an *anticipation* of higher disposable incomes could do so with additional import demand being financed through a decline in cash balances. Similarly, a fall in the terms of trade, by signalling a decline in oil related receipts, could lead to a reduction in import expenditures and an accumulation of cash balances. While this explanation may be plausible in the context of a major change in oil revenues in either direction it would seem less probable that the public would modify their expenditure plans against terms of trade fluctuations on a continuous basis.

An alternative interpretation would be that the public's demand for immediate liquidity (cash) rises with a fall in the terms of trade and *vice versa*. This explanation is consistent with Saudi narrative accounts to the effect that private sector liquidity is indeed squeezed when oil revenues decline. Not only are government expenditure flows quite sensitive to revenue changes but reports claim that rates at which payments are settled tend to fluctuate with the health of public finances (Al-Dukheil, 1995, Saudi British Bank 1999). If the need for liquidity is influenced by oil income through these means, it might also be expected that commercial bank lending to the private sector would exhibit similar behaviour. After confirming that the (logarithm) of real bank lending to the private sector and the (logarithm of the) public's ratio of cash to deposits were I(1) variables the following cointegrating regressions were run using the variables already defined.

Table 6a: Cointegration LR test based on maximal eigenvalue of the stochastic matrix

Table 6b: Estimated long-run elasticities for LRLps and Lc using the Johansen procedure

The results for the cash ratio (Table 6b, right column) appear to be consistent with the normal expectation in relation to real incomes, with the negative coefficient implying that higher incomes are associated with a disproportionate rise in transactions that may be financed by cheque. It is also clear that the terms of trade have a lasting negative relationship to the cash ratio. While these results may reasonably be interpreted as reflecting influences on the relative demand to hold cash, those involving real bank lending to the private sector could reflect either an (unconstrained) loan demand function or a (rationed) loan supply relation. The same signs could be rationalised for the alternative hypotheses, although narrative accounts of bank behaviour that draw attention to their reluctance to lend widely in the private sector may be consistent with quantity rationing (Bakor, 1999).

It appears that only well-established concerns with regular incomes from government contracts can rely on credit facilities. If this view is accepted, the results could be interpreted as involving a demand function for loans by such 'eligible' enterprises and the same negative relationship to the terms of trade is again evident, together with a highly income elastic response of credit flows. In practice it is likely that the results also reflect supply-side influences since the negative relationship between real lending and the terms of trade is consistent with an acknowledged SAMA policy orientation. Attempts are made to curtail bank liquidity when oil induced government expenditures increase and threaten to raise the rate of local inflation (Saudi British Bank, *op.cit*). It is similarly explicitly recognised that falling official sector expenditures deprive the private sector of liquidity and thus require a more relaxed stance on the part of the Agency (*ibid*).

The finding that an improvement in the terms of trade tends (*ceteris paribus*) to reduce the monetary base appears to reflect, through their consequences for the money multiplier, developments in the broader liquidity needs of the economy. The endogenous behaviour of the multiplier appears, moreover, to reflect long run rather than transitory behaviour. In summary, both cash and bank borrowing offer liquidity services and it is these needs that rise when oil revenues decline. The relevance of the findings in the context of the monetary model will be discussed in conclusion.

6 Conclusions

The objective of this study has been to re-examine the traditional monetary adjustment mechanism in the context of a primary exporting economy operating with a pegged exchange rate. Although the context is somewhat singular, Saudi Arabia represents a stark case of these characteristics with the added element of unrestricted international capital flows. The traditional view that the money supply must adjust to the demand to hold it appears fully appropriate in this context. While these considerations suggest that the country's experience may have wider applicability a key distinction has been emphasised in the form of the unusual structure of central bank (SAMA) assets that serve as 'backing' for the monetary base.

Through its holdings of accumulated foreign assets on behalf of the authorities, the Agency is distinguished from most other cases by having external liquidity considerably in excess of that required fully to support the domestic monetary base. SAMA might therefore be regarded as a well-funded currency board and the modest (multiplier induced) changes in the monetary base to which attention has been drawn here are unlikely in themselves to be of policy interest. Nevertheless, the interpretation offered above might be argued to be of relevance to the country and, especially, to others lacking the Kingdom's external assets but in which government spending is similarly dependent on export revenues.

Despite the reasonable correspondence between our results and those that the monetary perspective would have predicted, the residual behaviour of the monetary base has been influenced by apparently systematic variations in the simple monetary multiplier. The interpretation offered for these fluctuations suggests a useful insight into the monetary adjustment mechanism. Rising external revenues induce public expenditures that enhance credit and liquidity flows to the private sector. While import expenditures rise strongly in consequence, the endogenous decline in liquidity when government spending is eventually cut back equally helps to explain the curtailment of import spending as revenues weaken. From the balance of payments perspective this represents an element of automatic adjustment that will help to preserve foreign reserves.

From a broader developmental perspective, however, it appears less likely that the mechanism will be helpful. Reference has been made in the Saudi case to the restricted range of eligible private sector borrowers and to their apparently high income elasticity of loan demand. In addition to this influence borrowers also appear to seek credit for liquidity support and, if such needs decline with improved terms of trade, the following calculation is of some interest. The long run impulse responses gathered in the first column of Table 5 provide estimates of the eventual consequences for non-oil income (and interest rates) of a 15.3% improvement in the terms of trade. If these values are fed into the (cointegrating) real loans relationship reported in Table 6 the decline in the liquidity (terms of trade linked) need for credit of these borrowers is almost exactly balanced by their enhanced (income related) demand. Real private sector credit following a substantial improvement in the terms of trade is therefore unchanged when associated developments are taken into account. To some degree it is possible that this represents a switch from the credit financing of working capital to fixed capital and durable goods expenditures.

For borrowers without ready access to bank credit, such liquidity requirements must be self-financed and it is especially likely in these cases that a (public spending induced) decline in private liquidity as oil revenues weaken will curtail some investment expenditures. While these inferences cannot be confirmed without much more detailed information than is at present available, especially with respect to commercial bank lending activities, they suggest that a public expenditure pattern that varies with export revenues may have negative consequences for private sector development. The strikingly small (ultimate) impact of a substantial terms of trade improvement on real non-oil incomes, as suggested in Table 5, may have part of its explanation in these financial sector considerations and would constitute a development case for the stabilisation of public expenditures.

Appendix A:

Long run neutrality restrictions and the identification of structural vector autoregression models.

A structural vector autoregression (SVAR) may be interpreted as the reduced form of a structural model in which the endogenous variables are represented in a set of equations as functions of their own lagged values and exogenous disturbances. In a five variable system with *p* lags for instance, the A terms represent 5x5 coefficient matrices while the error, ε_t, and y terms each 5x1:

$$A_0 y_t = A_1 y_{t-1} + A_2 y_{t-2} + ----+ A_p y_{t-p} + \varepsilon_t \qquad (1)$$

This model may also be stated as:

$$A(L) y_t = \varepsilon_t \;\; where \; A(L) = A_0 - \textstyle\sum_{k=1}^{p} A_k L_k \qquad (2)$$

The moving average representation of the same model would be:

$$y_t = C(L)\varepsilon_t \;\; where \; C(L) = A(L)^{-1} \qquad (3)$$

A reduced form version of equation (1) suitable for estimation is:

$$y_t = \Phi_1 y_{t-1} + \Phi_2 y_{t-2} + ------+ \Phi_p y_{t-p} + e_t \qquad (4)$$

Comparison with equation (1) implies (provided that the y terms are stationary and that $\Phi(L)$ is invertible):

$$\Phi(L) = A_0^{-1} A(L) \;\; and \;\; e_t = A_0^{-1}\varepsilon_t$$

These last results suggest that the estimated coefficients (Φ), together with the variance covariance matrix ($e_t e_t^{'}$) could only be sufficient to identify the structural coefficients and shocks hypothesised in equation (1) if restrictions equivalent to the dimension of the matrix A_0 could be imposed (5x5=25 in the present case). For comparison with equation (2), the estimated equation (4) could be represented as:

$$\Phi(L)y_t = e_t$$

For later reference it may be noted that:

$\Phi(1) = [\mathrm{I} - \Phi_1 - \Phi_2 - - - - - - \Phi_p] =$ the inverse of the reduced form dynamic multipliers.

To achieve identification of the model in equation (1) reference may be made to its moving average representation in equation (3) and its relationship to that implied by the estimated equation (4). Multiplying equation (3) by $C_0^{-1}C_0$:

$$\begin{aligned} &y_t = C(L)C_0^{-1}C_0\varepsilon_t \;\; or \;\; D(L)e_t \\ &where \;\; D(L) = C(L)C_0^{-1} \;\; and \;\; e_t = C_0\varepsilon_t \end{aligned} \tag{5}$$

This is the equivalent comparison to that reported for equation (4) above, and both D(L) and e_t are known from the inversion of that estimated equation. Equation (5) implies that:

$$Ee_t e_t^{'} = \Sigma = C_0\varepsilon_1\varepsilon_1^{'}C_0^{'} = C_0\Omega C_0^{'} \tag{6}$$

and that $D(1) = C(1)C_0^{-1}$ with, from estimation,

$$D(1) = [\mathrm{I} - \Phi_1 - \Phi_2 - - - - - - \Phi_p]^{-1}$$

The following matrix is known: $D(1)\sum D(1)^{'}$. Using the information in equation (6) it is equal to:

$$C(1)C_0^{-1}C_0\Omega C_0^{'}C_0^{-1^{'}}C(1)^{'} = C(1)\Omega C(1)' \qquad (7)$$

In general, the assumption that the variance covariance matrix of shocks is diagonal (the shocks are orthogonal) provides {n(n-1)}/2 constraints. Amounting to ten in the five variable case, fifteen further restrictions must be imposed. A further n (= 5) restrictions represent normalisations in the form, either, of setting the diagonals of the Ω matrix equal to unity (the shock variances), or, of setting the diagonals of the C(1) matrix at unity. The latter option is chosen in the present application.

For the final restriction, the assumption that the model is characterised by the long run neutrality of (say) money implies that the matrix of long run multipliers contained in the model (C(1)) is lower triangular. In general, this provides the final 10 (or {n(n-1)}/2) restrictions. With these restrictions, C(1) and Ω are defined from the Choleski decomposition in equation (7). Using C(1), $C_0 = D(1)^{-1}C(1)$ and, finally, from equation (5) $D(L)C_0=C(L)$. These are the sought coefficients for the structural model in equations (1) and (3) above and are used in the reported impulse response and variance decomposition analyses.

Appendix B: Impulse responses

Figure 1: Responses to the terms of trade

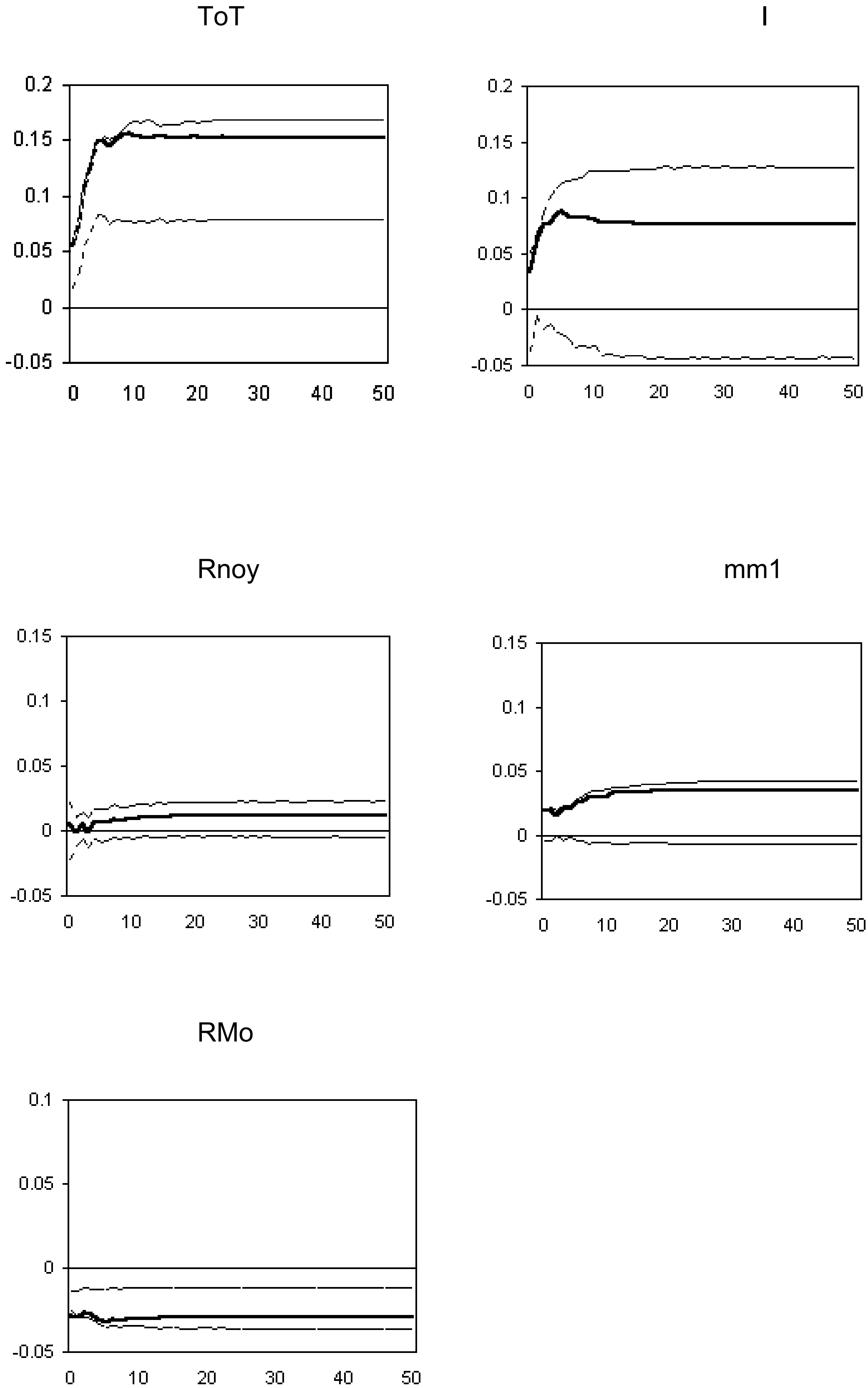


Figure 2:Responses to the interest rate

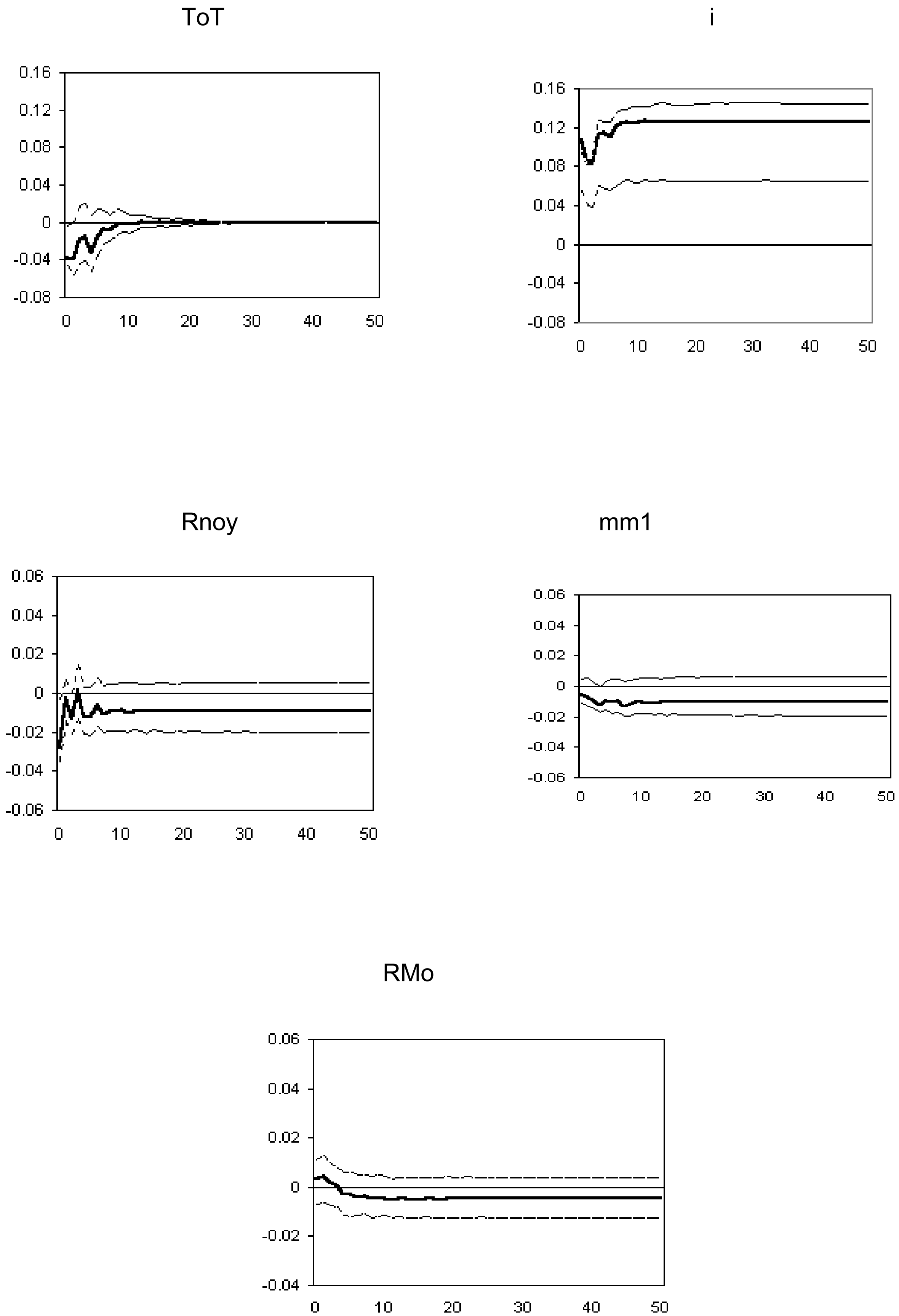


Figure 3: Responses to real non-oil GDP

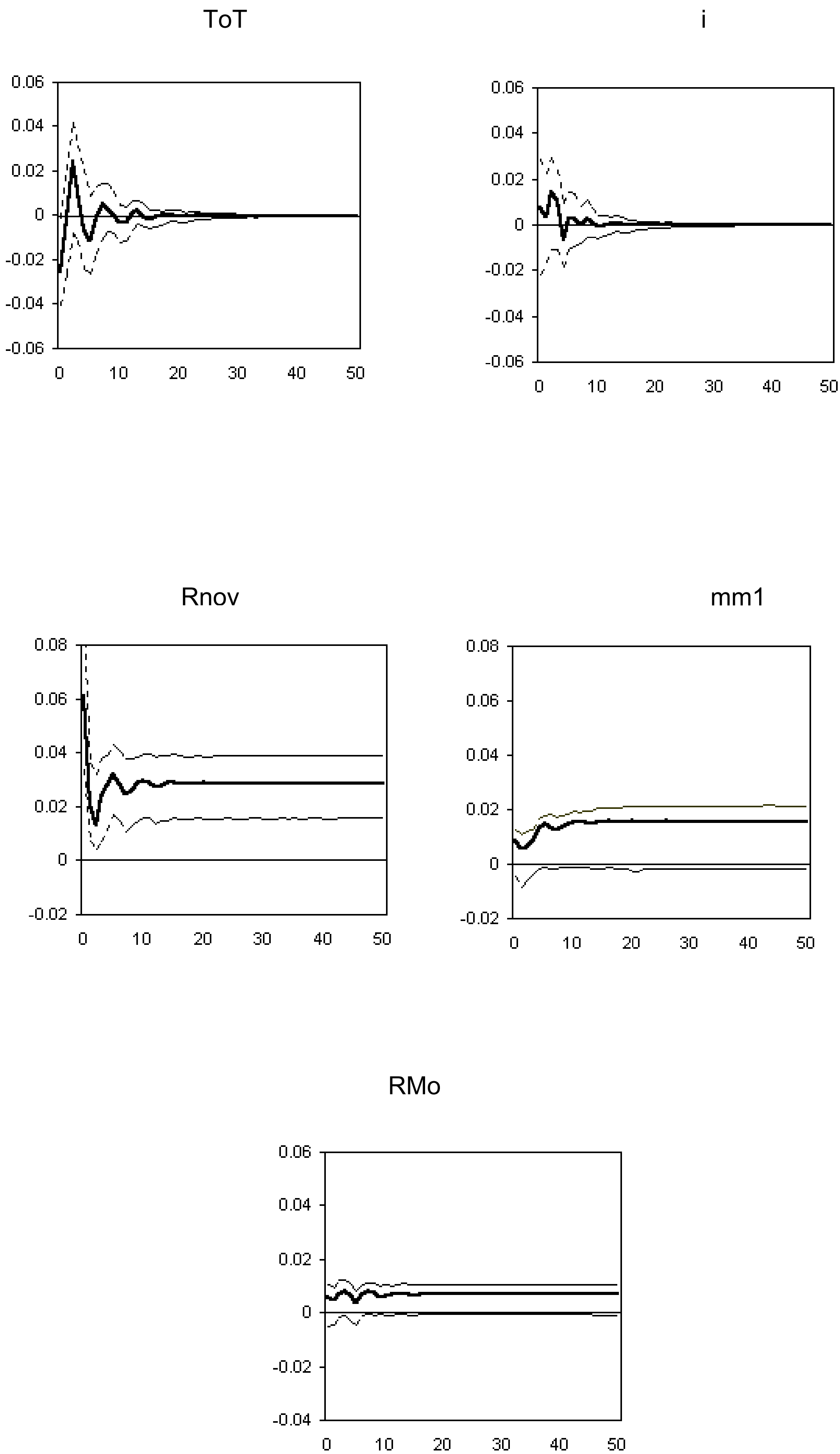
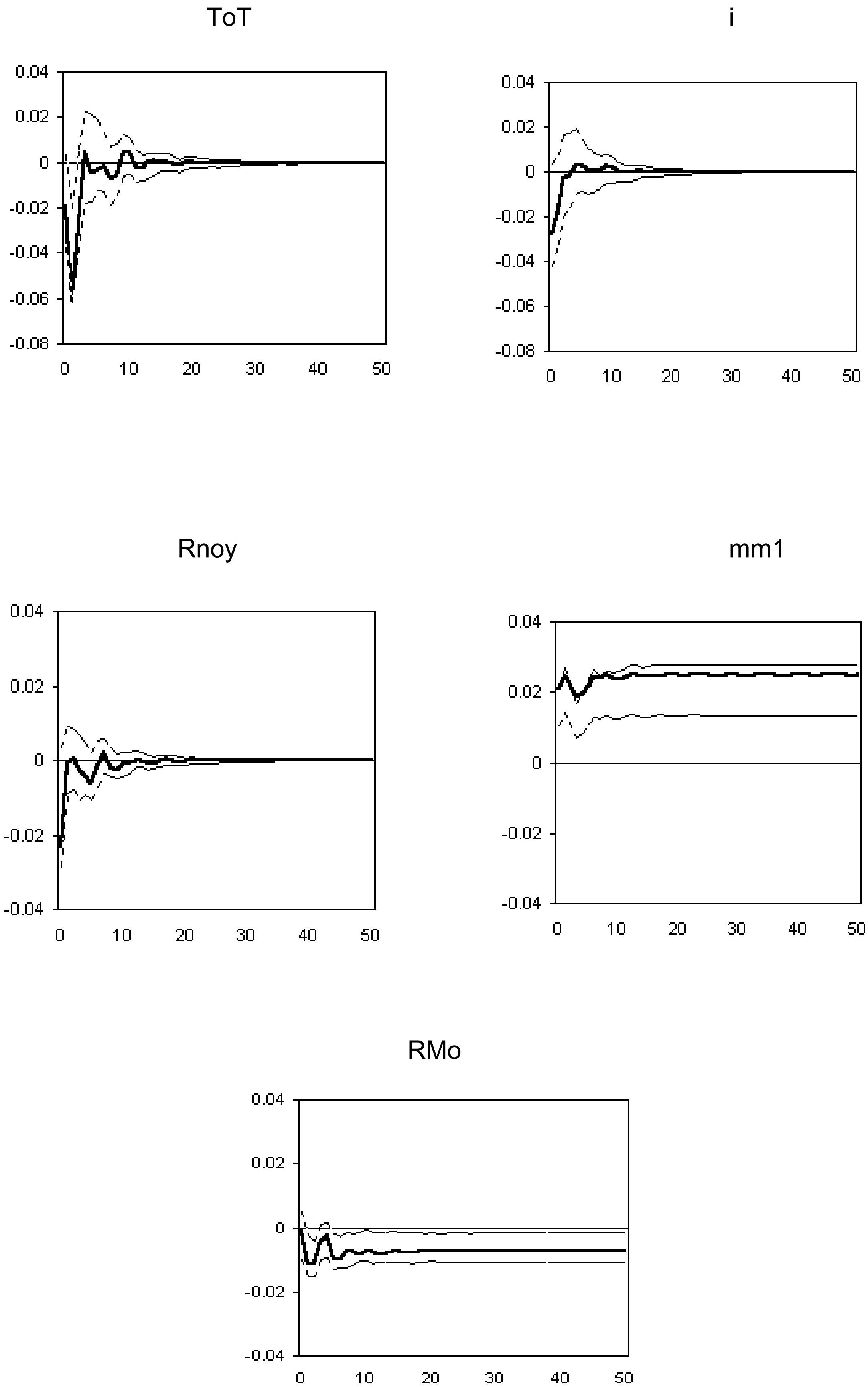


Figure 4: Responses to the money multiplier



References

Ahmed, S. and Murthy, R. (1994) 'Money, output and business cycles in a small open economy' *Canadian Journal of Economics* (Vol. 27, No.4, pp. 982-93).

Akaike, H (1973) 'Information theory and an extension of the maximum likelihood principle', in (Eds.) B. Petrov and F. Csake *Second International Symposium of Information Theory*, Budapest.

Al Dukheil, A. (1995) *The Banking System and its Performance in Saudi Arabia* (London, Saqi).

Bacchetta, P. and Ballabriga, F. (2000) 'The impact of monetary policy on banks' balance sheets: some international evidence', *Applied Financial Economics*, (Vol.10, pp. 15-26).

Bakor, N. (1999) 'Commercial banks and their effects on the Saudi economy over the period 1970-97' *Saudi Economic Association Working Paper* (May, in Arabic).

Blanchard, O. and Quah, D. (1989) 'The dynamic effects of aggregate demand and supply disturbances', *American Economic Review* (Vol. 79, pp. 655-73).

Christiano, L., Echenbaum, M. and Evans, C. (1994). 'Identification and the effects of monetary policy shocks', *Federal Reserve Bank of Chicago Working Paper* (WP-94-7).

Conway, P., Drew, A., Hunt, B. and Scott, A. (1998). 'Exchange rate effects and inflation targeting in a small open economy: a stochastic analysis using FPS', in *Topics in Monetary Policy Modeling* (Conference papers, Vol. 6, Bank of International Settlements, Basle).

Enders, W. (1995). *Applied Econometric Time Series,* (New York, John Wiley & Sons, Inc).

Giannini, C. (1992). *Topics in Structural VAR Econometrics*, (Springer-Verlag)

Guerra, J., Rodriguez, C. and Sanchez, G. (1998) 'The monetary policy transmission mechanism in Venezuela' in *The Transmission of Monetary Policy in Emerging Market Economies*, (BIS, Policy Papers, No. 3, Basle, pp. 223-46).

Johansen, S. (1991) 'Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models', *Econometrica*, (Vol. 59, pp. 1551-80).

Johnson, H.G. (1972) ‘The monetary approach to balance of payments theory’ in his *Further Essays in Monetary Economics* (London, Allen and Unwin)

Kiel, J. (1993) ‘Output, money and the terms of trade’, *Kredit & Kapital*, (Vol. 26, No.1, pp. 22-38).

Ljung, G. and Box, G. (1978) ‘On a measure of lack to fit in time series models’, *Biometrika*, (Vol. 66, pp. 66-72).

Ramaswamy, R. and Slok, T. (1998) ‘The real effects of monetary policy in the European Union: what are the differences?’ *IMF Staff Papers*, (Vol. 45, No. 2, pp. 374-96).

Rudebusch, G. (1996) ‘Do measures of monetary policy in VARs make sense?’ *Banca D’Italia Working Paper* (No. 269, May).

SAMA (1997, 1998) *Annual Reports* (Riyadh, Saudi Arabian Monetary Agency)

Saudi British Bank, (1999) *Financial and Economic Developments in Saudi Arabia: A Hundred Years* (Riyadh, in Arabic)

Schwarz, G. (1978) ‘Estimating the dimension of a model’ *Annals of Statistics*, (Vol. 6, pp. 461-64)

Sims, C. (1992) ‘Interpreting the microeconomic time series facts’, *European Economic Review*, (Vol. 36, pp. 975-1011)

Sirivedhin, T. (1998) ‘Financial reform and the monetary transmission mechanism: the case of Thailand’, in *The Transmission of Monetary Policy in Emerging Market Economies*, (BIS Policy Papers No. 3, pp. 195-222, Basle.

Wong, K. (2000) ‘Variability in the effects of monetary policy on economic activity’, *Journal of Money, Credit, and Banking*, (Vol. 32, No. 2, pp. 179-98).

Table 1: SAMA balance sheet data and 'narrow' income velocity
(Billions of Riyals or per cent)

	Foreign Assets	Monetary Base	*Outside Deposit Banks*	Govt. Deposits	Base % of Foreign Assets	Income Velocity
1978	197.99	43.40	*19.18*	112.02	21.92	3.05
1979	206.11	38.72	*23.71*	109.01	18.79	2.86
1980	288.52	34.46	*25.68*	182.86	11.94	2.82
1981	431.85	39.20	*29.49*	321.01	9.08	2.64
1982	472.93	44.65	*34.44*	332.73	9.44	2.49
1983	437.98	43.73	*35.42*	303.35	9.98	2.50
1984	392.21	43.00	*35.11*	258.81	10.96	2.64
1985	319.53	42.12	*35.77*	232.34	13.18	2.55
1986	276.17	45.83	*38.81*	118.51	16.59	2.29
1987	256.54	46.34	*38.84*	55.01	18.06	2.26
1988	232.81	43.44	*35.95*	44.64	18.66	2.22
1989	226.64	41.83	*33.88*	26.82	18.46	2.36
1990	212.22	52.48	*44.78*	22.32	24.73	2.26
1991	208.95	54.53	*44.62*	30.45	26.10	1.98
1992	214.89	53.89	*43.77*	41.97	25.08	1.96
1993	193.08	53.79	*42.62*	42.48	27.86	1.97
1994	185.56	56.23	*44.97*	35.53	30.30	1.98
1995	174.04	54.93	*43.89*	34.63	31.56	1.95
1996	196.07	54.15	*43.04*	45.52	27.62	1.93
1997	219.03	58.24	*45.82*	48.51	26.59	1.98

Source: International Financial Statistics (IMF)

Table 2: Cointegration LR test based on maximal eigenvalue of the stochastic matrix

List of variables included in the cointegrating vector LToT LI LRNOY Lmm1 LRMo List of I(0) variables included in the VAR DWAR S1 S2 S3				
Null	**Alternative**	**Statistics**	**95% critical Value**	**90% critical Value**
r = 0	r = 1	22.4780	29.9500	27.5700
r ≤ 1	r = 2	17.0643	23.9200	21.5800
r ≤ 2	r = 3	9.3291	17.6800	15.5700
r ≤ 3	r = 4	3.6642	11.0300	9.2800

Table 3: Criteria for selecting the lag length

Model Criteria	**Number of lags**		
	7	8	9
AIC	399.26	395.09*	401.32
SC	188.62	159.55*	169.53

* Denotes the model selection by each criterion.

Table 4: Variance decompositions of variables at different horizons

Forecast Error in	Quarters	Proportions of forecast error variance, quarters ahead, accounted for by innovations in				
		ToT	**i**	**Rnoy**	**mm1**	**RMo**
ToT	**0**	0.508 (0.15, 0.71)	0.129 (0.0, 0.48)	0.059 (0.0, 0.38)	0.034 (0.0, 0.44)	0.271 (0.0, 0.53)
	1	0.462 (0.15, 0.67)	0.094 (0.0, 0.36)	0.082 (0.0, 0.43)	0.139 (0.02, 0.35)	0.222 (0.02, 0.45)
	2	0.457 (0.16, 0.63)	0.095 (0.01, 0.32)	0.096 (0.01, 0.41)	0.165 (0.04, 0.41)	0.187 (0.02, 0.40)
	4	0.455 (0.17, 0.57)	0.094 (0.01, 0.30)	0.097 (0.03, 0.34)	0.183 (0.05, 0.36)	0.171 (0.07, 0.40)
	6	0.453 (0.18, 0.54)	0.107 (0.03, 0.31)	0.102 (0.05, 0.31)	0.177 (0.05, 0.34)	0.161 (0.11, 0.38)
	8	0.451 (0.18. 0.49)	0.106 (0.03, 0.32)	0.104 (0.05, 0.30)	0.179 (0.06, 0.35)	0.160 (0.11, 0.39)
	10	0.451 (0.18, 0.54)	0.106 (0.03, 0.32)	0.104 (0.05, 0.31)	0.179 (0.06, 0.34)	0.160 (0.11, 0.38)
i	**0**	0.078 (0.0, 0.58)	0.800 (0.25, 0.93)	0.003 (0.0, 0.25)	0.055 (0.0, 0.22)	0.063 (0.0, 0.38)
	1	0.112 (0.02, 0.56)	0.749 (0.23, 0.87)	0.005 (0.0, 0.23)	0.056 (0.0, 0.35)	0.077 (0.0, 0.31)
	2	0.125 (0.02, 0.51)	0.723 (0.22, 0.82)	0.011 (0.0, 0.23)	0.065 (0.0, 0.36)	0.076 (0.0, 0.30)
	4	0.118 (0.04, 0.47)	0.716 (0.24, 0.78)	0.027 (0.01, 0.23)	0.062 (0.01, 0.33)	0.077 (0.01, 0.27)
	6	0.117 (0.05, 0.46)	0.710 (0.24, 0.74)	0.031 (0.02, 0.22)	0.061 (0.02, 0.34)	0.081 (0.02, 0.27)
	8	0.117 (0.04, 0.45)	0.708 (0.23, 0.73)	0.033 (0.02, 0.22)	0.060 (0.02, 0.31)	0.082 (0.02, 0.27)
	10	0.117 (0.04, 0.45)	0.708 (0.23, 0.73)	0.033 (0.02, 0.21)	0.060 (0.02, 0.31)	0.082 (0.02, 0.27)
Rnoy	**0**	0.005 (0.0, 0.27)	0.149 (0.0, 0.45)	0.721 (0.22, 0.94)	0.107 (0.0, 0.35)	0.017 (0.0, 0.18)
	1	0.009 (0.0, 0.31)	0.176 (0.0, 0.48)	0.666 (0.21, 0.88)	0.135 (0.0, 0.40)	0.014 (0.0, 0.23)
	2	0.015 (0.0, 0.30)	0.185 (0.01, 0.48)	0.654 (024, 0.82)	0.131 (0.0, 0.39)	0.015 (0.0, 0.23)
	4	0.025 (0.0, 0.29)	0.207 (0.03, 0.43)	0.592 (0.23, 0.74)	0.116 (0.01, 0.34)	0.057 (0.01, 0.25)
	6	0.025 (0.01, 0.29)	0.209 (0.04, 0.40)	0.588 (0.24, 0.74)	0.118 (0.01, 0.33)	0.059 (0.02, 0.25)
	8	0.026 (0.01, 0.29)	0.208 (0.05, 0.41)	0.583 (0.24, 0.72)	0.120 (0.02, 0.32)	0.063 (0.02, 0.25)
	10	0.026 (0.01, 0.29)	0.208 (0.05, 0.41)	0.583 (0.24, 0.72)	0.120 (0.02, 0.32)	0.063 (0.02, 0.25)

Table 4 Continued

Forecast Error in	Quarters	Proportions of forecast error variance, quarters ahead, accounted for by innovations in				
		ToT	**i**	**Rnoy**	**mm1**	**RMo**
Mm1	**0**	0.338 (0.10, 0.68)	0.032 (0.0, 0.34)	0.073 (0.0, 0.34)	0.456 (0.20, 0.79)	0.101 (0.0, 0.29)
	1	0.317 (0.10, 0.62)	0.031 (0.0, 0.32)	0.075 (0.0, 0.30)	0.449 (0.23, 0.73)	0.128 (0.0, 0.34)
	2	0.320 (0.12, 0.58)	0.036 (0.0, 0.32)	0.073 (0.01, 0.37)	0.447 (0.23, 0.69)	0.124 (0.02, 0.32)
	4	0.297 (0.14, 0.51)	0.047 (0.03, 0.29)	0.084 (0.02, 0.34)	0.419 (0.20, 0.59)	0.153 (0.02, 0.32)
	6	0.300 (0.16, 0.50)	0.046 (0.03, 0.28)	0.083 (0.03, 0.32)	0.413 (0.23, 0.58)	0.158 (0.03, 0.32)
	8	0.300 (0.17, 0.48)	0.055 (0.04, 0.29)	0.082 (0.03, 0.32)	0.400 (0.23, 0.55)	0.163 (0.03, 0.31)
	10	0.300 (0.17, 0.48)	0.055 (0.04, 0.29)	0.082 (0.03, 0.31)	0400 (0.23, 0.54)	0.163 (0.03, 0.32)
Rmo	**0**	0.669 (0.16, 0.82)	0.008 (0.0, 0.38)	0.030 (0.0, 0.17)	0.001 (0.0, 0.27)	0.292 (0.13, 0.70)
	1	0.612 (0.18, 0.75)	0.008 (0.0, 0.31)	0.028 (0.0, 0.20)	0.083 (0.01, 0.29)	0.267 (0.14, 0.58)
	2	0.604 (0.17, 0.72)	0.013 (0.0, 0.32)	0.032 (0.0, 0.21)	0.082 (0.01, 0.30)	0.269 (0.15, 0.59)
	4	0.556 (0.20, 0.67)	0.021 (0.01, 0.30)	0.033 (0.01, 0.22)	0.109 (0.02, 0.32)	0.281 (0.16, 0.51)
	6	0.528 (0.21, 0.61)	0.022 (0.01, 0.28)	0.044 (0.02, 0.24)	0.136 (0.03, 0.31)	0.270 (0.16, 0.49)
	8	0.517 (0.22, 0.61)	0.023 (0.02, 0.29)	0.047 (0.02, 0.25)	0.140 (0.03, 0.31)	0.273 (0.17, 0.49)
	10	0.517 (0.22, 0.61)	0.023 (0.02, 0.29)	0.047 (0.02, 0.25)	0.140 (0.03, 0.31)	0.273 (0.17, 0.49)

Table 5: Accumulated impulse responses out of ∞ steps

Response of	ToT	i	Rnoy	Mm1	RMo
ToT	0.153	0.000	0.000	0.000	0.000
I	0.077	0.125	0.000	0.000	0.000
Rnoy	0.011	-0.009	0.029	0.000	0.000
Mm1	0.034	-0.010	0.016	0.028	0.000
Rmo	-0.029	-0.005	0.007	-0.007	0.016

Table 6a: Cointegration LR test based on maximal eigenvalue of the stochastic matrix

List of variables included in the cointegrating vector:
LRLps (or Lc) LRnoy Li LtoT
List of I(0) variables included in the VAR:
DWAR S1 S2 S3

Null	Alternative	Statistic (LRLps)	Statistic (LRLc)	95% critical Value	90% critical Value
r = 0	r = 1	53.3853	63.0631	28.2700	21.5800
r ≤ 1	r = 2	19.0420	12.9002	22.0400	19.8600
r ≤ 2	r = 3	9.0989	6.8740	15.8700	13.8100
r ≤ 3	r = 4	2.1353	0.5364	9.1600	7.5300

Table 6b: Estimated long-run elasticities for LRLps and Lc using the Johansen procedure*

Independent variables	LRLps	Lc
Cons	-6.1848 (4.626)	8.227 (10.313)
Lrnoy	2.7182 (9.061)	- 1.8408 (11.321)
Li	-1.7773 (1.955)	- 0.7881 (6.532)
LtoT	- 0.1906 (2.078)	- 0.2612 (8.7334)
Method	VAR (Coint)	VAR (coint)

Notes: Estimated with intercept, seasonal dummies and the Gulf war dummy, (1978q1-1998q1). Eight lags were chosen on the basis of the Akaike criterion. Figures in parentheses are t ratios. Critical values are 2 and 2.3 at the five percent and one percent levels respectively.