Endogenous Money, Output and Prices in India

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Endogenous Money, Output and Prices in India – Simultaneous Equations Model

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I. Introduction

The current literature on endogenous money supply in India described how the issue of endogeneity of money supply was born when RBI relied on credit control on banks in 1970s, but found it ineffective because banks managed to take advantage of loopholes in the definition of deposits or credit, use cash credit, and mobilise non-deposit resources. It also described how, with the acceptance of money multiplier approach the RBI moved toward closer monitoring of reserve requirements, which were also blunt instruments. It further narrated how automatic financing of the budget deficit endogenized the base money though the link was weakened by onset of financial reforms in 1991 but banks demonstrated their ability induced by financial reforms to circumvent controls to satisfy profit motive.

In the above literature

a. endogeneity of money supply is attributed to the lending activities of the banks and
b. the theoretical propositions by and large belong to the Post Keynesian school.

This paper proposes to quantify the macroeconometric relationships among the variables broad money, lending by banks, price, and output in India using simultaneous equations system keeping in view the issue of endogeneity.

II. Literature Review

a. Findings of Rangarajan and Mohanty (1997)

Rangarajan and Mohanty (1997) vividly dealt with endogenous money supply in India relating it to fiscal deficit with the help of open economy model. The goal of their model was to place emphasis on the role of deficit and money in the real economy by bringing out the nexus between money, output and prices. Applying the order condition it was seen that none of the equations had over-identification problem. The model was solved by running deterministic simulation in both static and dynamic framework for the period 1975-76 to 1993-94. The main linkages in the model of Rangarajan and Mohanty (1997) were as follows: Given the availability of borrowed resources from non-monetary and external sources, a part of the deficit was financed by borrowing from RBI. The money stock therefore evolved endogenously through the feedback from reserve money, which varied with the changes in the fiscal deficit. The money stock along with output determined the price level in the economy, which in turn determined the relative prices of exports and imports. To the extent that nominal exchange rate deviated from its full purchasing parity level, given the domestic and world price levels, fiscal deficit financed by money creation led to appreciation of real exchange rate, leading to a rise in imports and decline in the competitiveness of exports. The resulting current account deficit created a financing need and increases the stock of external debt and interest payment, reinforcing the initial deterioration in the current account balance. Another source of transmission could arise from the financial balance of the private sector, which was behaviourally linked to the government deficit. In short they found that money supply was determined by reserve money, and in turn determined the exchange rate.

b. Rath (1999)

Findings of Rath (1999) used Granger-causality framework to identify the relative consistency of the three models with the data at hand: pure portfolio approach, loan demand approach and portfolio loan demand approach. The following were his conclusions: There might exist a paradigm of mixed portfolio-loan model for India. Within the post-Keynesian endogenous money framework, there was a reason to support the structural approach over the accommodative endogeneity approach, since the non-stationarity in the bank loan-reserve ratio and its corresponding time variance would indicate that loans had not grown proportionately over time relative to reserves. Some of the reasons for absence of proportionality could be, among others, the practice of liability management that banks did leading to a situation of growth in lending in excess of the growth of reserves.

c. Dash and Goal (2001)

Dash and Goal (2001) found that the money supply process in India lying between two extreme beliefs of economists: (a) Money supply could be endogenous and (b) Money supply could be controlled.

III. The model in this paper

Endogeneity of reserve money or bank credit means presence of causality from other variables to these variables. A model of endogenous money supply is a variant of causality model. It seems necessary to explore their recent interrelationships especially in the post reform period from 1996-97 to 2002-03 because conclusive data are available till 2003 in the RBI sources as in March 2009. In order to maintain consistency the data on all variables are taken till 2002-03. Quarterly data is taken on gross domestic product (GDP), wholesale price index (WPI) and broad money (M3). From the economic theory of money supply it is known that money supply causes price level and in a less developed country like India where development is credit financed, money supply causes output also. So the following simultaneous equations model is proposed[1]:

$Y = \alpha_0 + \alpha_1 P + \alpha_2 M + u_{1t}$, Y represents GDP, P represents WPI, M represents M3.

$Y = \beta_0 + \beta_1 P + u_{2t}$

Here it is assumed that M is exogenous whereas Y and P are endogenous. The first equation is not identified by the order condition which is a necessary condition of identification whereas the second equation is exactly identified by the order condition as well as the rank condition. The reduced form equations corresponding to the preceding structural equations are

$Y_t = \Pi_0 + \Pi_1 M + w_t$

$P_t = \Pi_2 + \Pi_3 M + v_t$

Here the Πs are the reduced from coefficients and are the non-linear combinations of the structural coefficients where w and v are linear combinations of the structural disturbances u_1 and u_2. Here each reduced form equation contains only one endogenous variable which is the dependent variable and is a function solely of the exogenous variable and the stochastic disturbances. Hence the parameters of the preceding reduced form equations may be estimated by the OLS. These estimates are $\Pi_1^{\#} = \{\sum(Y-Y^*)(M-$

[1] Maddala (1989) has developed a similar model involving three time series variables. p 299

$M^*)\}/\sum(M-M^*)^2$, $\Pi_0^\# = Y^* - \Pi_1^\# M^*$, $\Pi_3^\# = \{\sum(P-P^*)(M-M^*)\}/\sum(M-M^*)^2$, $\Pi_2^\# = P^* - \Pi_3^\# M^*$, Y^* and M^* are respectively mean Y and mean M whereas $\Pi_0^\#$, $\Pi_1^\#$, $\Pi_2^\#$ and $\Pi_3^\#$ are estimates of Π_0, Π_1, Π_2 and Π_3 respectively. The computed values are $\Pi_1^\# = 0.095$ and $\Pi_3^\# = 4$, $\Pi_0^\# = 273864.1644$, $\Pi_2^\# = 101$. Now the following estimates of reduced form coefficients are obtained: $\beta_1^\# = \Pi_3^\#/\Pi_1^\# = 42.1$, $\beta_0 = \Pi_2^\# - \beta_1^\# \Pi_0^\# = 101 - (42.1 \text{ x } 273864.1644) = -11531021.71$. The second equation stands as GDP = -11531021.7 + 42 P. These are the indirect least square estimates. The negative intercept means that without credit finance it is not feasible to obtain positive netput (net output) in the economy.

Here there is an effort to estimate the famous quantity equation M = kPY, where M is money supply, PY is nominal GDP and k is income velocity of money. Here Y is taken at 1993-94 constant P. So Y is divided by the 1993-94 constant P in order to give real Y and then multiplied by P in order to give true nominal Y with a view to making the model in line with macroeconomic theory. Since all the variables have deterministic trend one can first estimate the equation and then test the residuals whether they are stationary. Thus the equation M3 = k GDP is estimated. The estimated equation stands as

M3 = 0.484 GDP

(1.35) $\quad\quad \bar{R}^2 = 0.2348$

Here the residuals are found to have a downtrend, the t value is very poor and the regression coefficient is very week. So first one needs to stationarise the variables. This is done by deducting their means from the respective variables. If the true nominal Y is called TY, the mean of TY called TY* and the mean of M called M*, then TY-TY* can be called 'ty' and M-M* called 'm'. Now regress if m on ty is run without intercept.

The estimated equation is:

m = 7.8 ty

(16.77) $\quad\quad \bar{R}^2 = 0.9$

In order to get back to the original M and TY the means are added with the respective variables in order to give M = 7.8 TY, where M = m + 1187943 and TY = ty + 192024.1. Here the residuals are purely stochastic, i.e. white noise. The economics of the above result lies in the fact that true nominal GDP growth is backed by real GDP growth. Increase in volume of goods and services need be accompanied by increase in the volume of money supply in order to lubricate the exchange processes and facilitate transactions.

Again it is also true that endogenous money supply in form of bank credit increases in the wake of increase in planned output. Further, rise in nominal GDP leads to rise in factor payments which are made by checks or drawing upon the banks. In such a situation banks often need knock the door of the central bank for more reserves so much so that money supply rises. Another explanation can be in the context of exchange rate of rupee vis-à-vis other currencies. When domestic output increases transaction demand for money increases and hence total demand for money increase. This makes rupee appreciate ceteris paribus vis-à-vis other currencies like US dollar or the reference basket of currencies. Too much of such appreciation may create undesirable quantum of foreign exchange outflow. So the central bank might require to increase money supply to the extent sufficient to make the value of rupee reduce to the target level or it has to buy US dollars sufficient in exchange for rupee to make US dollar appreciate vis-à-vis rupee or do both in order to maintain a the desired level of rupee/US dollar rate.

Next the relationship between money, output and prices is examined with the help of partial adjustment model. One should focus here on how output (GDP) responds to commercial bank credit (CBC) and prices (WPI). Here there are certain features of the RBI data to be noted. The monthly CBC data from 1990-1 and 1999-2000, quarterly GDP data at 1993-94 prices from 1996-97 to 2002-03 and the monthly WPI data at 1993-94 prices from 1994 to 2002-03 are taken from the RBI source. In order to bring the data on all the three variables on a uniform footing one should choose monthly data from 1994-95 to 1999-00 for CBC and for WPI and IIP at 1993-94 prices. Following Acharya and Kamaiah (1998) index of industrial production (IIP) is substituted for GDP because IIP data at 1993-94 prices are available1994-5 to 1999-2000 while GDP data are not. The following models are proposed:

$IIP_t = \alpha + \beta\, CBC_t + \delta\, IIP_{t-1} + \upsilon_t$

$IIP_t = \alpha + \gamma\, WPI_t + \delta\, IIP_{t-1} + \upsilon_t$

$IIP_t = \alpha + \beta\, CBC_t + \gamma\, WPI_t + \delta\, IIP_{t-1} + \upsilon_t$

Before estimation one should check the stationarity status of all the variables. It was found that IIP at first difference, and CBC and WPI at second difference are white noise. The observation is verified by Augmented Dickey-Fuller Tests for the variables at their first and second differences with intercept. So the models to be estimated are

$IIP\_2_t = \alpha + \beta\, CBC\_2_t + \delta\, IIP\_2_{t-1} + \upsilon_t$

$IIP\_2_t = \alpha + \delta\, IIP\_2_{t-1} + \gamma\, WPI\_2_t + \upsilon_t$

$IIP\_2_t = \alpha + \beta\, CBC\_2_t + \gamma\, WPI\_2_t + \delta\, IIP\_2_{t-1} + \upsilon_t$

'_2' means at the second difference e.g. IIP_2_t means the value of IIP at the second difference for the period t.

The estimated equations are respectively

$IIP\_2_t = 0.24361 - 0.5354\, IIP\_2_{t-1} - 0.0003\, CBC\_2_t + \upsilon_t$

(0.26859) (-5.2299) (-2.8774) $\bar{R}^2 = 0.52093$

$IIP\_2_t = 0.14919 - 0.6853\, WPI\_2_t - 0.7311\, IIP\_2_{t-1} + \upsilon_t$

(0.15553) (-0.5841) (-6.9623) $\bar{R}^2 = 0.4636$

$IIP\_2_t = 0.23931 - 0.7917\, CBC\_2_t - 0.5706\, WPI\_2_t - 0.0003\, IIP\_2_{t-1}$

(0.26285) (-0.711) (-5.0028) (-2.8886) $\bar{R}^2 = 0.51731$

Now one need examine whether the error terms are white noise. So their graphs are checked. All the errors are found white noise. Here cointegrating vector is not found because of different orders of integration of the level time series data nor is multicollinearity problem detected such as to require application of principal component analysis.

IV. Conclusion

Without credit finance it is not feasible to obtain positive netput (net output) in the economy given the feedback from price to output via money. This result is in line with Dash and Goal (2001). They found that during the credit liberalisation regime the banks were circumventing the RBI control and expanding credit. Again Rangarajan and Arif (1990) found price level to have been determined by money supply also. Again during post liberalisation regime banks got more autonomy in extending credit. It seemed that bank credit had influenced prices, which in turn had influenced output. Thus GDP responded strongly to price.

In the relationship between nominal GDP and broad money the residuals are purely stochastic, i.e. white noise. The economics of the above result lies in the fact that true nominal GDP growth is backed by real GDP growth. Increase in volume of goods and services need be accompanied by increase in the volume of money supply in order to lubricate the exchange processes and facilitate transactions. Again it is also true that endogenous money supply in form of bank credit increases in the wake of increase in planned output. Further, rise in nominal GDP leads to rise in factor payments which are made by checks or drawing upon the banks. In such a situation banks often need knock the door of the central bank for more reserves so much so that money supply rises. Another explanation can be in the context of exchange rate of rupee vis-à-vis other currencies. When domestic output increases transaction demand for money increases and hence total demand for money increase. This makes rupee appreciate ceteris paribus vis-à-vis other currencies like US dollar or the reference basket of currencies. Too much of such appreciation may create undesirable quantum of foreign exchange outflow. So the central bank might require to increase money supply to the extent sufficient to make the value of rupee reduce to the target level or it has to buy US dollars sufficient in exchange for rupee to make US dollar appreciate vis-à-vis rupee or do both in order to maintain a the desired level of rupee/US dollar rate.

From the above equations involving commercial bank credit, industrial output index and wholesale price index one finds that individually commercial bank credit and wholesale price index have strong influences on industrial output. But jointly they do not influence industrial output perhaps because wholesale price index is correlated to commercial bank credit. Thus one can say that because their correlation coefficient between is as high as 0.976, commercial bank credit raises the real cost of production which has an adverse effect on IIP. This goes against Rangarajan and Mohanty (1997).

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