THE ENDOGENEITY OF THE MONEY SUPPLY IN CHINA: AN EMPIRICAL TEST

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May 1991

Abstract

In this paper, the endogeneity of the money supply in China is tested using the techniques of vector autoregression (VAR). The framework of the money supply formation table of China, rather than dubious approaches such as the quantity theory or intuitive sourcing, is employed to determine the variables to be included in the VAR system. Rigourous tests of the robustness of the causality models as well as detailed variance decomposition exercises are carried out. A test of the continuity of the models over the break of 1979, when the economic reform was launched, is also performed. The findings provide sufficient *prima facie* evidence that monetary passivity prevailed in China up to 1988, confirming the conventional wisdom in the macroeconomics of centrally planned economies.

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I. Introduction

Monetary economics has not been given much attention in the traditional discourse about the operations of centrally planned economies (CPEs). The conventional wisdom is of course that money is endogenous in CPEs. For a start, the official view until rather recently was that since planning over the real sector predominates, the circuit of money and funding can almost be perfectly controlled or at least passively driven. So it is planned changes in output and price adjustments that give rise to changes in the money supply, not the other way round. Many scholars are of course sceptical of such simplistic assumption of planners' omnipotence. Nevertheless, given the prevalence of various forms of barter, rationing, non-monetary incomes and transfers, and administrative interference, most would be contented with the idea that money is endogenous in CPEs. To put it metaphorically, trying to affect macroeconomic movements through the control of the money supply is just like "pushing a piece of string". They come to the same conclusion as the CPE planners, although for very different or even opposing reasons.

Again such a mixture of conventional wisdom, Chen (1989) implements empirical tests on China for the period 1951-1985 which produce results that run counter to it. He chooses macroeconomic variables somewhat intuitively in his Bayesian vector autoregressive (BVAR) tests of causality and come up with findings that indicate a role of money in China which is more active than that conventionally conceived. Bidirectional (feedback) causality is found to exist between currency on the one hand, and nominal income, the budget deficit and the trade deficit on the other, while one-way causality runs from currency to total inflation. Two-way causality is also found to exist between broader money M2 and nominal income although M2 is unidirectionally caused by the budget deficit and the trade deficit.

In this paper, I will report on an experiment with another set of empirical tests, whose results, in contrast to Chen's (1989), confirm much more clearly the assumption of endogeneity of money in China. Two major features in my empirical tests stand out. First, I keep myself within the framework of the money supply formation table of China,

rather than dubious theories (for China) such as the quantity theory or intuitive sourcing. Second, I have chosen to implement the technique of vector autoregression (VAR), rather than the BVARs of Chen's (as the choice of VARs versus BVARs in causality analysis and forecasting is still a subject of controversy). I have also carried out rigourous tests of the robustness of the causality models as well as detailed variance decomposition exercises, which Chen (1989) has neglected. I like to think that my results command a higher credibility than Chen's. In any case, the different findings may hopefully provide foundations for further research.

In section II, I will set out the institutional framework of the monetary system in the pre-reform and the reform periods and contrast the official version of idealized monetary control with the reality of a monetary system under tremendous pressure at the macro as well as the micro levels. An accounting framework for money formation is then set up. In Section III, the endogeneity of the money supply will be tested empirically using the techniques of VAR. A test of the continuity of the models over the break of 1979 is also performed.

II. China's Monetary System

The official view in China has been that the balance within the monetary system should be achieved and made in line with the aggregate balance of the whole economy (Chen, 1981). Given the scrutiny over non-cash transactions in the pre-reform mono-banking system and careful monitoring of the movements in cash transactions (Chai, 1981), the targetting and controlling of the monetary aggregates should also be relatively straight-forward exercises. In practice, nevertheless, the control of the monetary authority over both the non-cash and the cash circuits was seriously undermined by two sets of factors. The first set of factors was macroeconomic in nature and arose from the subjugation of monetary policies to over-ambitious (or over-contractionary) national investment plans and fiscal and trade policies, and the fluctuating purchase volumes of agricultural output (which was largely unpredictable and very much at the mercy of weather). While the former aspect was related to the well-known phenomenon of "taut planning" (Brada and King (1986)), the latter was linked to the policy of the Chinese government to provide enough incentives to the farmers, who represented over 80% of the total population, to continue production. So, even in the case of a bumper harvest, the government would still guarantee to purchase the output and tolerate eventually unconsumable inventories. These purchases would put pressure on the Bank to issue more money (in effect, cash).

The second set of factors was largely microeconomic in nature and centred around the problem of the "soft budget constraint" (Kornai (1980), (1986)). The behaviour of the enterprises was theoretically under the strict scrutiny of the planning authority and the Bank. In reality, however, the control could not be perfect and the passivity of the enterprises turned out ironically to be their "strength". Given their lack of autonomy and the distortions in the economy, their losses were almost automatically taken care of and little penalty would be imposed. In drawing up the plans, the planners had to depend on the information, submissions and requests put forth by the enterprises. There the leeway for the enterprises and the local authorities to manipulate was much larger. Given their financial dependency and the various distortions in the economy, as well as the fact that they were usually evaluated on the basis of physical and quantitative criteria, the temptation for them to exaggerate their resource needs and to over-expand was great. After all, they did not have to face the consequence directly even if their actions led to "losses". The tendency for enterprises to hoard and to self-aggrandize (in the form of over-investment) was well observed in all CPEs and China has been no exception. When enterprises failed to repay loans, the Bank, unlike its counterparts in the West, could however not resort to measures such as seizure of collaterals and assets or forced bankruptcy to recoup at least some funds. It might even be under pressure to extend more credit and issue more money as inter-enterprise debts generate extra needs in working capital. Only when the whole economy had become so overheated that the government decided on a major clamp down would the Bank be authorized to write off debts and accounts and clear up the financial mess by administrative means.

The economic reform launched in 1979 might theoretically have activated the role of money in the Chinese economy as the major objective of the reform has been to transform the economic system from one dominated by barter and administrative transfer to a "commodity economy guided by planning". Money is supposed to play an active intermediating function of facilitating transactions among units which have been given more decision making power. The banking system has been significantly revamped and credit has replaced bureaucratic allocation as the major source of funds for most enterprises (Tsang, 1990). One clear indication is the ratio of total loans extended by banks and rural credit cooperatives to national income, which rose from 68.1% at the end of 1980 to 97.4% at the end of 1988. Table 1 below gives a summary of the changes in the patterns of the "credit receipts and payments" of the banking system in the reform period up to 1988.

Table 1

National Bank Credit Receipts and Payments
Year-end, 1978, 1979 and 1988

Units: Rmb 100 million

	1978	1979	1988
All Receipts		2162.60	11541.25
Domestic deposits	1134.56	1339.04	7425.62
Enterprise deposits	368.43	468.91	2936.58
Budgetary deposits	187.35	148.68	270.88
Capital construction deposits		109.63	130.30
Deposits of government agencies and organizations	159.83	184.88	392.67
Urban savings deposits	154.91	202.56	2659.16
Rural savings deposits	154.41	203.71	669.55
Other deposits			496.78
Bonds			75.55
Deposits of international monetary institutions			148.63
Currency in circulation		267.71	2134.03
Funds of banks		421.87	1073.81
Current balance of profit and loss accounts of banks		49.24	123.12
Others		84.74	560.49

	1978	1979	1988
All payments		2162.60	11541.25
Loans	1849.96	2039.63	10551.33
Loans to industrial productive enterprises	351.51	363.09	2085.09

	1978	1979	1988
Loans to industrial supply and marketing enterprises and material supply departments	215.55	242.12	520.96
Commercial loans	1117.65	1232.25	4100.61
Equipment loans, long term and short term		7.92	1559.23
Loans to building and construction enterprises			494.71
Loans to collective and individual industrial and commercial units in urban areas	49.77	57.51	656.21
Loans to agricultural units	115.48	136.74	814.21
Other loans			320.31
Gold		12.16	12.04
Foreign exchange		20.58	158.44
Assets in international monetary institutions			187.05
Claims on the Government		90.23	576.46
Others			55.93

Note: Under the Chinese statistical system, the balance sheet of the national banking system embodied the items of the People's Bank. In contrast to the figures for 1978 and 1979, the figures for 1988 included those of the Construction Bank, the Bank of Communications and the banking arm of China International Trust and Investment Corporation (CITIC), reflecting the expansion in China's banking system.

Sources: Statistical Yearbook of China, 1984, p.422; Almanac of China's Banking and Finance (Chinese version), 1988, pp.58-59; Zhongguo Tongji Nianjian, 1989, p.679.

The term "credit receipts and payments" (an official translation) is a misnomer as it suggests that the table is a statement of fund flows. In fact, the table is like a balance sheet and gives the stock figures of the items reported. As can be seen, total receipts or payments increased by more than 400% between 1979 and 1988, with an average annual growth rate of over 20%. The real achievement of the financial reform cannot of

course be judged on quantitative indications alone. If the major objective is to increase the efficiency of fund utilization and the effectiveness of macroeconomic control, the results so far have not been very encouraging. Tsang (1990) has documented the evidence of ineffectiveness of the monetary reform in China. Besides the difficulties of estimating the demand for money, which affects seriously the ability of the People's Bank to set monetary targets, another set of problems troubling the People's Bank during the economic reform has been its own ability to ensure that any targets be achieved. Due to various institutional and policy factors, that ability has been manifestly low.

Firstly, even after acquiring the status of a central bank, the People's Bank of China still lacked the autonomy of its western counterparts in carrying out an independent and consistent monetary policy. It has still been under constant pressures from the state treasury and other ministries to cater for their expansionary ambitions. Secondly, many of the determinants of money supply in the course of the economic reform were as before beyond the control of the central bank. Take the issuance of currency as an example. Table 2, which is the equivalent of the money supply formation tables regularly compiled in the West, presents a quantitative analysis of the "proximate determinants" of the change in the amount of currency in circulation in 1980-88, using the same aggregate statistics of national bank credit receipts and payments as presented in Table 1. To start with, the items in Table 1 (T1) can be represented as an identity equation:

$$CURR+DEPO+CAPB+ELSE(L)=LOAN+FOD+RES+IMBAL+ELSE(A) \quad (1)$$

With some minor modifications, the left-hand-side (LHS) variables of eq.(1) correspond to those items in the "All Receipts" (AR) portion of TB1 while the right-hand-side (RHS) entries are equivalent to those in the "All payments" (AP) portion of TB1. More specifically, CURR in eq.(1) represents "Currency in circulation" in AR in TB1, DEPO the amount of "Domestic deposits" after "Budgetary deposits" have been taken out, CAPB "Funds of banks" plus "Current balance of profit and loss accounts of banks", ELSE(L) "Bonds" and "Others". On the right-hand side (RHS) of eq.(1), LOAN corresponds to "Loans" in the AP portion of TB1, FOD the net amount of subtracting "Budgetary deposits" (an AR item in TB1) from the AP item "Claims on the Government", RES "Gold" plus "Foreign Exchange", and IMBAL the net amount arrived by subtracting "Deposits of international monetary institutions"--an AR item--from "Assets in international monetary institutions".

Rearranging terms I arrive at eq.(2):

$$CURR=(LOAN-DEPO)+FOD+RES+IMBAL-CAPB-(ELSE(L)-ELSE(A)) \quad (2)$$

The time dimension can then be introduced into eq.(2) and by simplifying the notation I obtain:

$$dCURR=d(LOAN-DEPO)+dFOD+dRES+dIMBAL-dCAPB-d(ELSE) \quad (3)$$

where the operator $d(Y) = Y_t - Y_{t-1}$ and ELSE = (ELSE(L)-ELSE(A)). Eq.(3) is an identity equation which can be used to construct simple money supply formation tables from which the "determinants"[1] of the amount of currency in circulation can be statistically compiled (Tsang, 1990).

Among these factors, the People's Bank would find it particularly difficult to control or influence the ones that are related to the fiscal position of the government (FOD) and, because of the fast expansion of external economic relations during the reform period, the balance of payments (RES and IMBAL) as well. Moreover, the effects of the fiscal and trade balances on the monetary aggregate were in the same direction. In China, a fiscal deficit was typically associated with a trade surplus (or a reduction in trade deficit) and both might lead to a rise in the money supply. A fiscal surplus, on the other hand, normally co-exists with a trade deficit, and both would reduce the size of the money supply. This phenomenon has been common among socialist countries which emphasized external trade. The main reason is that because of the lack of flexibility in prices and the exchange rate, government subsidy has become the major tool to improve the trade balance, particularly when a country such as China has been having "absolute disadvantage" in nearly all lines of products vis-à-vis the advanced industrial countries, with which she has been most eager to establishing trade relationship. We have previously given an analysis of this aspect of the Chinese experience in 1979-86 (Woo and Tsang, 1988). I have also made use of a simple money supply formation table to illustrate intuitively the dependence of the narrow definition of money supply on these factors that the Chinese central bank has found it difficult to control (Tsang, 1990).

III. Factors Affecting the Money Supply: Empirical Tests

The analysis of the last section points to a rather passive role on the part of the

People's Bank in both the pre-reform and the reform periods. The money supply was more a consequence of factors such as the expansionary activities of the central authorities and local units, the fiscal position of the government and the balance of payments of the country etc. than their cause. Under such a situation, if these activities and positions upset the aggregate balance of the economy, it would be difficult for the People's Bank to pursue an independent policy to rectify them and to restore economy-wide balance. Under most circumstances, it would just be reflecting inter-system distortions and aggregate imbalance in the economy.

This view can be put to rigourous empirical test. One relevant test would be that of causality between the money supply and factors which might have caused it or have been caused by it. Bivariate causality tests based on Granger's (1969) conception have been very popular with econometricians and various versions have been developed.[2] However, they suffer from the fact that only two variables could be considered despite Granger's original multivariate formulation. The vector autoregressive (VAR) technique popularized by Sims (1980; 1982) overcomes this drawback. I have therefore adopted such a test in determining the direction of causality between the money supply and other relevant variables in China.

The procedure I used is as follows. Suppose I have the following system:

$$Y_t = C_t + AY_t + e_t \qquad (4)$$

where Y_t is a vector of variables the causal relationships among which I want to investigate, C_t a vector of constants, A a square matrix of coefficients, and e_t a vector of zero mean white noise uncorrelated with each other in the period under investigation. A is actually composed of $\phi_{ij}(L) = \sum_{m}^{nij} \phi_{ij,m} L^m$, where n_{ij} is the degree of the $\phi_{ij}(L)$ polynomial while L is the lag operator such that $L^j Y_t = Y_{t-j}$. Granger (1980) states that the jth variable is a prima facie cause of the ith variable if and only if $\phi_{ij}(L) \neq 0$, and the ith variable is a prima facie cause of the jth variable if and only if $\phi_{ji}(L) \neq 0$. If the ith variable is a prima facie cause of the jth variable and the jth variable is a prima facie cause of the ith variable, then a prima facie feedback relationship between the ith and the jth variables exists. Furthermore, following Hsiao (1982), if the jth variable prima facie causes the kth variable and if the kth variable prima facie causes the ith variable, then I can say that the jth variable prima facie causes the ith variable indirectly.

To determine the lag length of each $\phi_{ij}(L)$ polynomial, I adopt the sequential

procedure of Hsiao's (1979, 1981). A series of step-wise regressions is performed and the length that minimizes a function involving the residual sum of squares is chosen. Several functional forms have been developed by econometricians, including the Akaike information criterion (Akaike, 1970) which makes use of the measurement of the final prediction error (FPE) and the Schwarz criterion (Schwarz, 1978). These criteria usually impose a penalty on the number of parameters. The Schwarz criterion, in comparison, puts heavier penalty on additional parameters and so will always choose a model which is no larger than that chosen using Akaike's information criterion. Given our relatively small data set, this is a great advantage since it gives us more degrees of freedom for estimation of the final model. Hence the Schwarz criterion is used. It involves minimizing the following function:

$$SS = (RSS + K(\log T)\sigma^2)/T \qquad (5)$$

where SS stands for the "Schwarz statistic" and RSS is the residual sum of squares of the regression, K the number of regressors, T the number of observations, and σ^2 the standard error of the estimate squared.

The stepwise procedure is performed as follows. Suppose I start with the variable Y1. It is first regressed on its own lag:

$$Y_{1,t} = f_{10} + \sum_{m=1}^{v} f_{11,m} Y_{1,t-m} + e_t \qquad (6)$$

where the lag length m is varied from 1 to a maximum of v. The length m11 that minimizes the SS is then chosen. Then the following regressions are run:

$$Y_{1,t} = f_{10} + \sum_{i=1}^{m11} f_{11,i} Y_{1,t-i} + \sum_{m=1}^{v} f_{1j,m} Y_{1,t-m} + e_t, \quad j = 2,3,..k \qquad (7)$$

where k is the total number of variables (Y's) the causality among which I am considering. To choose among the (k-1) variables the one to be included, I use the specific gravity criterion of Caines, Keng and Sethi (1981) under which the jth variable is included if: (1) it shows the highest specific gravity (in our case, the smallest SS); and (2) the SS obtaining from regressing eq.(7) is smaller than that from eq.(6). The optimal lag length, m1j, is in the meantime determined. If condition (2) is not fulfilled, then none of the (k-1) variables "Granger causes" Y1 and none is added to eq.(6). If the

jth variable with the optimal lag length is included, I then go to the trivariate equation by using the same stepwise approach to choose among the remaining (k-2) variables and the process will go on until either condition (2) is violated or all the k variables are exhausted.

The above procedure enables us to define the equation of causation on the variables Y1. Equations of the other variables will be similarly defined with each Y becoming the endogenous variable in turn. Finally, a near-VAR system represented by eq.(4) is defined.[3] It can be estimated by either Zellner's (1962) seemingly unrelated regression (SUR) technique or the maximum likelihood method. I decided to use the former method. After the system has been estimated, various tests of robustness can then be performed.

a. Currency in Circulation

Although the VAR technique is sometimes referred to as "atheoretical econometrics", it does require a theoretical perspective on the list of relevant variables to be included in the system. I start by looking at the narrow definition of money in China--the amount of currency in circulation (CURR). From our discussions above, the relevant variables involved in the determination of CURR in China seem to include at least the fiscal balance of the government (FBAL), the trade balance (TBAL), and a proxy representing the expansionary activities of the central authorities and local units which the People's Bank found it difficult to control. Taking into account the problem of unquenched "investment thirst", a suitable proxy appears to be the series of net accumulation as a component of national income available (CCON).

Students of the Chinese economy have also emphasized the importance of agricultural output and procurement in affecting the money supply (Naughton, 1986) and some, like Song (1989), even argue that the money supply is endogenous because the amounts of output and procurement are unpredictable and the monetary authority simply has to accept what the weather dictates. Hence as an alternative I can replace CCON by the amount of agricultural procurement (AGBU) in another VAR system. I will call the first system with CCON Model I and the second with AGBU Model II in this section.[4]

Ideally, I should estimate the model for the pre-reform and the reform periods separately. Unfortunately, the annual data series are too short, creating serious problems with regard to degrees of freedom, particularly when I have to estimate so many

parameters in the context of a VAR system. Quarterly data series for CURR and TBAL are available for most of the reform years, but not for the period before the reform. Moreover, quarterly data for CCON, FBAL and AGBU are not available even for the reform years. Hence I had to confine myself to annual models covering both the pre-reform and the reform periods.

Using the stepwise approach, I came up with the preliminary specifications for Model I over the years of 1954-88. The Granger causality test requires stationarity on the part of the series to be considered. On the basis of the Dickey-Pantula (1987) Test, I had to first-difference FBAL and TBAL and first-difference both CCON and CURR in logarithms in order to turn these series into stationary series.[5]

The specifications established in the stepwise procedure were the results of single-equation regressions which did not take into account inter-equation correlations. Hence after the whole model had been estimated by the SUR method, I proceeded to carry out a set of likelihood ratio (LR) tests of its robustness. First each of the non-zero off-diagonal polynomials was subjected to the test. The small sample test statistic (Sims, 1980) is given by

$$LR = (T-c)(\ln|\Sigma r| - \ln|\Sigma u|) \qquad (8)$$

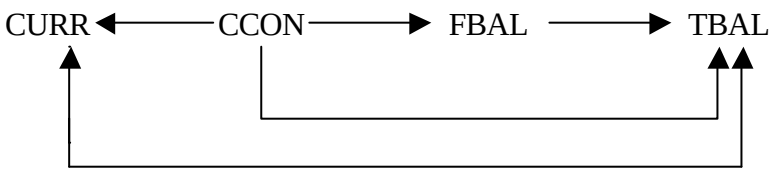
where T is the number of observations, c is the total number of restrictions divided by the number of equations (one in this case), Σr and Σu are the estimated covariance matrix from the restricted and unrestricted models respectively, while $|\ |$ denotes the determinant of the matrix. This test statistic, with c as the "multiplier correction" that improves the small sample properties of the test, is asymptotically distributed as x2 with degrees of freedom equal to the number of restrictions, just as in the case of the normal LR statistic (i.e. $T(\ln|\Sigma r| - \ln|\Sigma u|)$.

Second, the off-diagonal zero polynomials, each set to lag 1, were included one by one in the model and tested for their non-significance. Third, an underfitting test of the model was implemented under which all non-zero polynomials (with at least 2 lags) were reduced by 1 lag. Fourth, all non-zero polynomials (with less than 6 lags) were increased by 1 lag and an overfitting test was carried out. The purpose of the underfitting and overfitting tests was to ensure convergence to the lag specifications from both sides. Compared with the specifications based on the stepwise procedure, only minor changes had to be made. The final version of Model I and its causal implications are presented in Table 2 and Figure 1 respectively.

Table 2
Vector Autoregressive System of Model I

$$\begin{bmatrix} CURR \\ CCON \\ FBAL \\ TBAL \end{bmatrix} = \begin{bmatrix} f_{10} \\ f_{20} \\ f_{30} \\ f_{40} \end{bmatrix} + \begin{bmatrix} f_{11}(1) & f_{12}(2) & 0 & f_{14}(6) \\ 0 & f_{22}(2) & 0 & 0 \\ 0 & f_{32}(1) & f_{33}(2) & 0 \\ f_{41}(2) & f_{42}(1) & f_{43}(6) & f_{44}(2) \end{bmatrix} \begin{bmatrix} CURR \\ CCON \\ FBAL \\ TBAL \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \\ e_{4t} \end{bmatrix}$$

Figure 1
Causal Implications of Model I



Sims (1980, 1982) has shown that the strength of Granger causal relations can be measured from the variance decomposition of an estimated VAR system. It could also be regarded as a test of robustness akin to the LR test, albeit with more revealed information. It is well known that the results of variance decomposition are sensitive to the ordering of the variables in the model (Spencer, 1989). Since I had used the specific gravity criterion in the specification of the equations, the same order was used in the process of variance decomposition. Even those variables not selected in the sequential procedure were included in the order of their "Schwarz statistic". The h-steps used were one-year, two-year and five-year ahead. Table 3 reports the results for Model I.

Table 3
Decomposition of Forecast Error Variance of Model I

Unit: %

Variance of	Steps Ahead	Explained by			
		CURR	CCON	FBAL	TBAL
CURR	1	100.00	0.00	0.00	0.00
	2	87.61	4.39	0.00	8.00
	5	22.24	21.12	8.02	48.62
CCON	1	0.00	100.00	0.00	0.00
	2	0.00	100.00	0.00	0.00
	5	0.00	100.00	0.00	0.00
FBAL	1	0.00	0.00	100.00	0.00
	2	0.00	95.54	4.46	0.00
	5	0.00	95.56	4.44	0.00
TBAL	1	0.00	0.00	0.00	100.00
	2	93.01	4.58	2.36	0.05
	5	95.53	2.46	1.88	0.13

The results of variance decomposition are consistent with those of the sequential procedure and the LR test. Taking everything together, CURR is prima facie caused by CCON and TBAL directly and by FBAL indirectly (through TBAL), but it is also a prima facie cause of TBAL. In other words, there is a feedback relationship between CURR and TBAL. The causal relationship from CURR to TBAL is very strong. As can be seen in Table 3, in a 5- year-ahead forecast, CURR accounts for 95.53% of the forecast error variance (FEV) of TBAL while TBAL explains only 48.62% of that of CURR. Although FBAL is not considered a direct prima facie cause of CURR in the sequential procedure, it accounts for 8.02% of the FEV of the latter in the 5-year-ahead

forecast. I expected CCON to be a cause of FBAL. This is conspicuously confirmed in the test results: the former explains nearly 96% of the FEV of the latter in both the two-year-ahead and the five-year-ahead forecasts. That TBAL is prima facie caused by all the three other variables is also in line with the general understanding of external trade serving a residual function of balancing the economy in a typical CPE.

The results for Model II are presented in Table 4, Figure 2 and Table 5. To obtain the required stationary series, I had to first difference AGBU in logarithms.

Table 4
The Vector Autoregressive System of Model II

$$\begin{bmatrix} CURR \\ AGBU \\ FBAL \\ TBAL \end{bmatrix} = \begin{bmatrix} f_{10} \\ f_{20} \\ f_{30} \\ f_{40} \end{bmatrix} + \begin{bmatrix} f_{11}(1) & f_{12}(2) & 0 & f_{14}(6) \\ 0 & f_{22}(3) & 0 & 0 \\ 0 & 0 & f_{33}(2) & 0 \\ 0 & f_{42}(4) & f_{43}(6) & f_{44}(2) \end{bmatrix} \begin{bmatrix} CURR \\ AGBU \\ FBAL \\ TBAL \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \\ e_{4t} \end{bmatrix}$$

Figure 2
Causal Implications of Models II

Here the passivity of the money supply in China is borne out more clearly than in Model I. CURR is prima facie caused by AGBU and TBAL directly and by FBAL indirectly, but it is not a notable cause of any other variable. Like the results in Model I, FBAL accounts for 2.59% of the FEV of CURR in a time horizon of five years although it does not come out as a direct cause in the stepwise regressions and the LR tests. Innovations in the autonomous expenditure variable (AGBU here) again explain

100% of its own FEV, suggesting that it is exogenous in the specified model. The causality running from it to CURR and TBAL is very strong. However, it is not seen to be a direct or indirect cause of FBAL, which also comes out as exogenous.

Table 5

Decomposition of Forecast Error Variance of Model II

Unit: %

Variance of	Steps Ahead	Explained by			
		CURR	AGBU	FBAL	TBAL
CURR	1	100.00	0.00	0.00	0.00
	2	81.99	2.17	0.00	15.84
	5	10.71	53.21	2.59	33.49
AGBU	1	0.00	100.00	0.00	0.00
	2	0.00	100.00	0.00	0.00
	5	0.00	100.00	0.00	0.00
FBAL	1	0.00	0.00	100.00	0.00
	2	0.00	0.00	100.00	0.00
	5	0.00	0.00	100.00	0.00
TBAL	1	0.00	0.00	0.00	100.00
	2	0.00	86.27	10.31	3.42
	5	0.15	86.27	10.31	3.42

b. A Broader Definition of Money: M1

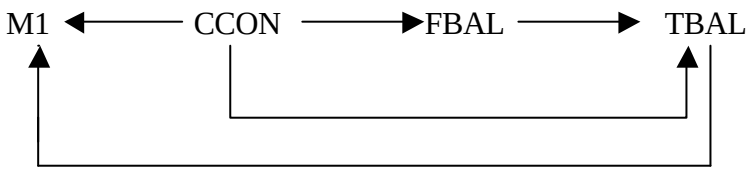
We also carried out similar causality tests on M1 (currency in circulation plus urban and rural savings deposits)--the only published series of broader money supply

covering the period of 1954-88. Here I will refer to the model with CC0N as Model III and that with AGBU as Model IV. The results for Model III are presented in Table 6, Figure 3 and Table 7.

Table 6
The Vector Autoregressive System of Model III

$$\begin{bmatrix} M1 \\ CCON \\ FBAL \\ TBAL \end{bmatrix} = \begin{bmatrix} f_{10} \\ f_{20} \\ f_{30} \\ f_{40} \end{bmatrix} + \begin{bmatrix} f_{11}(6) & f_{12}(1) & 0 & f_{14}(6) \\ 0 & f_{22}(2) & 0 & 0 \\ 0 & f_{32}(1) & f_{33}(2) & 0 \\ 0 & f_{42}(4) & f_{43}(6) & f_{44}(2) \end{bmatrix} \begin{bmatrix} M1 \\ CCON \\ FBAL \\ TBAL \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \\ e_{4t} \end{bmatrix}$$

Figure 3
Causal Implications of Model III



The hypothesis of monetary passivity is again verified. Similar to the results of Models I and II, the monetary variable is caused by CCON and TBAL directly and by FBAL indirectly. Unlike in Model I, M1 is not a prima facie cause of any variable and no feedback relationship between M1 and TBAL is detected. CCON is however seen to be exogenous and a cause of FBAL, just as in Model I.

Table 7

Decomposition of Forecast Error Variance of Model III

Unit: %

Variance of	Steps Ahead	Explained by			
		M1	CCON	FBAL	TBAL
M1	1	100.00	0.00	0.00	0.00
	2	33.92	51.15	0.00	14.93
	5	7.10	22.90	1.61	68.39
CCON	1	0.00	100.00	0.00	0.00
	2	0.00	100.00	0.00	0.00
	5	0.00	100.00	0.00	0.00
FBAL	1	0.00	0.00	100.00	0.00
	2	0.00	99.59	0.41	0.00
	5	0.00	99.59	0.41	0.00
TBAL	1	0.00	0.00	0.00	100.00
	2	0.00	97.04	2.09	0.87
	5	0.00	97.04	2.09	0.87

The results for Model IV are presented in Table 8, Figure 4 and Table 9.

Table 8

The Vector Autoregressive System of Model IV

$$\begin{bmatrix} M1 \\ AGBU \\ FBAL \\ TBAL \end{bmatrix} = \begin{bmatrix} f_{10} \\ f_{20} \\ f_{30} \\ f_{40} \end{bmatrix} + \begin{bmatrix} f_{11}(6) & f_{12}(1) & 0 & f_{14}(6) \\ 0 & f_{22}(3) & 0 & 0 \\ 0 & 0 & f_{33}(2) & 0 \\ 0 & f_{42}(4) & f_{43}(6) & f_{44}(2) \end{bmatrix} \begin{bmatrix} M1 \\ ABGU \\ FBAL \\ TBAL \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \\ e_{4t} \end{bmatrix}$$

Figure 4

Causal Implications of Model IV

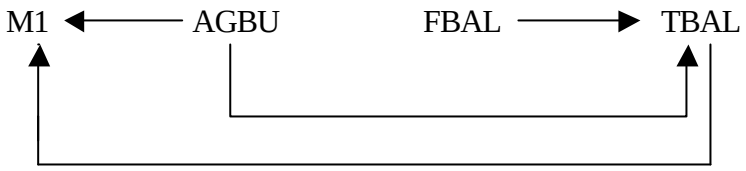


Table 9

Decomposition of Forecast Error Variance of Model IV

Unit: %

Variance of	Steps Ahead	Explained by			
		M1	AGBU	FBAL	TBAL
M1	1	100.00	0.00	0.00	0.00
	2	32.10	45.44	0.00	22.46
	5	16.86	14.95	1.04	67.15
AGBU	1	0.00	100.00	0.00	0.00
	2	0.00	100.00	0.00	0.00
	5	0.00	100.00	0.00	0.00
FBAL	1	0.00	0.00	100.00	0.00
	2	0.00	0.00	100.00	0.00
	5	0.00	0.00	100.00	0.00
TBAL	1	0.00	0.00	0.00	100.00
	2	0.00	88.77	5.98	5.25
	5	0.00	88.77	5.98	5.25

Here the passivity of the money supply is also borne out, in a fashion similar to Model II. The monetary variable M1 is prima facie caused by AGBU and TBAL directly and FBAL indirectly but it is not a direct or indirect cause of any other variable.

Both AGBU and FBAL come out as exogenous.

c. Stability of the Models Over Time

Although, as mentioned, separate models for the pre-reform and the reform periods are not viable because of data limitations, one would be interested in knowing whether the above near-VAR systems are stable over the launching of the reform in 1979. I followed the method of sample-split tests used by Sims (1980). First I estimated the models for the period of 1954-88. Then I re-estimated the models after adding to the data series on the right-hand-side of the equations a set of dummies for the years of 1979-88. The latter formed the set of "unrestricted regressions". The covariance matrices of residuals of the two sets of regressions were then used in a likelihood ratio test along the line of eq.(8) above. The results for the tests of all the four models are presented in Table 10.

Table 10

Tests for Model Stability using 1979 as the Splitting Year

Model	Test Statistic
I	$\chi^2(40)=5.85$
II	$\chi^2(40)=20.44$
III	$\chi^2(40)=10.15$
IV	$\chi^2(40)=11.03$

Note: The critical value at the 10% significance level is 51.81.

The null hypothesis is that of structural stability and will be rejected if the likelihood ratio is greater than the critical value. As it turns out, the likelihood ratio is far below the critical value at the 10% significance level and the null hypothesis cannot be rejected in all the four models. The results would change only marginally even if I abandon the small sample correction adopted by Sims (1980), which aims at rectifying

the bias toward the rejection of the null hypothesis, and use the normal LR test statistic (i.e. $T(\ln|\Sigma r| - \ln|\Sigma u|)$. It appears therefore that I do not have to worry about the structural stability of the VAR models across the reform break. There is sufficient prima facie evidence for us to conclude that monetary passivity prevailed in China up to 1988.

NOTES

1. It goes almost without saying that the "determinants" are not determinants per se as these explanatory variables may be correlated with each other in various ways. So the following analysis should only be regarded as a first approximation, just as formation tables like this are normally used. Results of formal causality tests will be reported in Section 3.

2. These versions include the direct Granger approach, Sims' approach and the Haugh-Pierce approach. See Tsang (1986) for an example of applying these tests.

3. It is called a near-VAR system because there are zeroes in the A matrix. So it is not "complete".

4. For details on the series used, see the Data Appendix.

5. The use of different filters in VAR econometrics is still a subject of controversy. Non-uniform filters are frequently used in practice (e.g. Doan, Litterman and Sims, 1984; Chowdhury, Fackler and McMillin, 1986; Bohara, Bradley and McNown, 1987). However, one has to be careful in the choice of the filters. Nelson and Plosser (1982) and Nelson and Kang (1984) demonstrate the importance of distinguishing between difference stationary processes and trend stationary processes. The first paper shows that macroeconomic time series are often better represented as the former than the latter. Geweke (1982; 1984) also provides rationalization for using non-uniform filters for related time series in a VAR context, when difference stationarity is assumed. Hence I have kept to the use of differencing filters for the VAR exercises although detrending could achieve stationarity for series such as FBAL and TBAL.

DATA APPENDIX

Most of the data series have been extracted or computed from the 1989 edition of

Zhongguo Tongji Nianjian (Chinese version of the Statistical Yearbook of China) which will be referred to as ZTN below. Other supplementary sources of data and derived series have also been used.

The year-end total of currency in circulation (CURR) for 1952-79 can be obtained from Yu (1981) and is reported in Naughton (1986). The same statistics for 1980-87 are taken from the Almanac of China's Finance and Banking (1988, pp.54-55). The figures for 1988 is available in ZTN (p.679). Statistics on saving deposits by households in urban and rural areas have been taken from the ZTN (p.725). M1 is the sum of the two series. Data on net accumulation as a component of national income available (CCON) have been extracted from ZTN (p.36), on purchases by state-owned commercial departments of farm and sideline products (AGBU) from ZTN (p.617), on the fiscal balance of the central government (FBAL) from ZTN (p.657), and on the trade balance in RMB (TBAL) from ZTN (p.633).

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**** This is a modified version of a part of my Ph.D. thesis, Problems of Monetary Control in China (University of Manchester, 1990). I wish to thank my supervisor Michael Artis, my external examiner Wojtek Charemza, Robin Bladen-Hovell, and Daniel W.W. Cheung for comments and suggestions. The usual disclaimer applies. It also appeared as a working paper in the BRC Papers Series (CS91008) of the School of Business of the Hong Kong Baptist College (later University).***