Is the Quantity Theory of Money Relevant to China?

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I. Introduction

The quantity theory of money, despite its affinity with monetarism in Western economics, has long been one of the accepted doctrines of the socialist monetary authority. The version of the quantity approach adopted is of course the classical, transactions-based, one rather than the modern, Friedmanite extension which includes considerations on interest rates, assets and wealth, and adaptive expectations, etc. An idealised scenario of using the theory in centrally planned economies (CPEs) is as follows: given the constancy of (or reliable information on) the velocity of monetary circulation (V) and the level of real output (y), the government could then automatically supply the appropriate amount of money (M) to the economy to facilitate transactions and maintain stability in the price level (P). Hence money is endogenous and passive, driven by socialist planning.

This view should be set against the peculiar institutional framework in the CPEs. The pre-reform monetary system in most CPEs was dominated by the "monobank". In the Chinese case, it was the People's Bank of China, which monopolized the roles of central banking and "commercial" banking at the same time.[1] No formal "money market" in the proper sense existed and interest rates were heavily manipulated and generally kept stable irrespective of what happened in the economy. The transactions among enterprises were under the strict supervision of the People's Bank and its affiliates, and they were not allowed to hold but a very small amount of cash. Although a large percentage of the working capital of the enterprises was financed in the form of credit from the Bank under the guidance of the credit plan, the remaining part, plus all fixed capital needed for basic construction and modernization investments, were met by interest-free and non-repayable budgetary grants, for which the Bank acted as the accountant. So the wider definitions of the money supply were

theoretically under the direct scrutiny of the monobank, in accordance with the central plan. The cash circuit was somewhat different. Proceeds of agricultural procurement, wage payments etc. had to be dispersed to the peasants and workers in the form of cash, which the recipients then had considerate freedom in using, various rationing schemes or "shortages" notwithstanding. Hence, cash was viewed as "active money", which required more careful attention [Chai, 1981].

The standard practice in China was to relate the amount of currency in circulation to the volume of retail sales as retail transactions were mediated almost exclusively with cash. A ratio of 1:8 was generally regarded as normal and conducive to price stability while a ratio greater than 1:6 was believed to be inflationary [Shi, 1982; Zhao, 1986]. These criteria were apparently derived from experience and little theoretical justification was given. Seen from this perspective, nevertheless, the task of monetary control for the Chinese "monobank" appeared to be relatively simple, at least in the less complicated circumstances of the pre-reform period. For the monitoring of the deposits of the enterprises, the Bank needed only to act according to the credit plan and carefully scrutinize their movements. As to currency control, given the information on velocity (which might change in accordance with cyclical and seasonal patterns) and the level of relevant output (total of retail goods and services, for example), the Bank could then supply the appropriate amount of new cash to the system to maintain price stability, which some advocates of the "traditional view" of socialist inflation [Wang, 1980] argued meant zero inflation.

If this perspective is appropriate, one would find the quantity theory generally a valid explanatory tool for macroeconomic trends involving the monetary variable in China, leaving aside the questions of exogeneity and causality.[2] Chow [1987] has pioneered an econometric exercise to apply the theory to China, employing the more recently developed techniques of cointegration tests and error-correction modelling on annual data covering the period of 1952-83. He makes it clear that he is more interested in "explaining the price level in China" than establishing a viable money-demand function. In any case, he comes out with the conclusion that the quantity theory provides a "reasonable first approximation" in explaining the demand for money in China [p.325] and that "the price level P can be reasonably explained by the ratio M/y as suggested by the quantity theory" [p.326]. He even finds that a short-run price-determining equation, constructed in the spirit of cointegration (so that it gravitates towards a long-run quantity relation), a satisfactory model for the period up to 1983, as the Chow Test shows no signs of structural breaks before and after the dividing year of 1979, when the economic reform was launched.

In any case, Chow's findings are surprising, even given his emphasis on the price equation. Despite official adherence and some arguments advanced to support the relevance of the classical quantity theory to socialist countries in general [Portes, 1983], there are important counter-arguments which throw serious doubts on this view, particularly on the continued relevance of the theory after the launching of the economic reform, not to mention that of the same short-run dynamic equation. After all, China's socialist experiment since 1949, marked by turbulent events such as the Great Leap Forward, the Cultural Revolution and the Economic Reform of the Eighties, has been characterized by transformations and structural changes which have been more drastic than those witnessed in most CPEs. Given all these marked fluctuations and changes, one would be hard pressed to explain why money has still exhibited stable relations with variables such as output and the price level in any simple manner over the whole era of Chinese socialism. These arguments equally apply even if we restrict ourselves, like what Chow [1987] did, to a consideration of the relation between the narrow definition of money, i.e. currency in circulation, on the one hand and income and prices on the other.

In this paper, we expand on the scope of Chow's investigation and look into the relevance of the classical quantity theory to China more generally.[3] The paper is organized as follows. First, we set out in Sections II and III the theoretical arguments against the relevance of the theory, both before and after the Chinese economic reform. Then in Section IV, we report on the findings of an econometric analysis of the pre-reform situation, which includes integration and cointegration tests on the narrow definitions of money, prices and expenditure, cast in the context of the money demand function and the price equation. The data sets are extended to cover the reform period up to 1988 in Section V, where broader definitions of the variables are also investigated. A test on the structural stability of a short-run price equation is also performed out of curiosity. Some overall comments are offered in Section VI.

II. Pre-reform Considerations

Even leaving aside the problems of structural instability, the idealized view of the official employment of the classical quantity equation has been contested even for the situation under the pre-reform regime, as it assumes that market disequilibrium was not a serious problem, or that it could be neglected in the long-run. Price stability was no doubt a paramount consideration for the planners. However, as Peebles [1983,

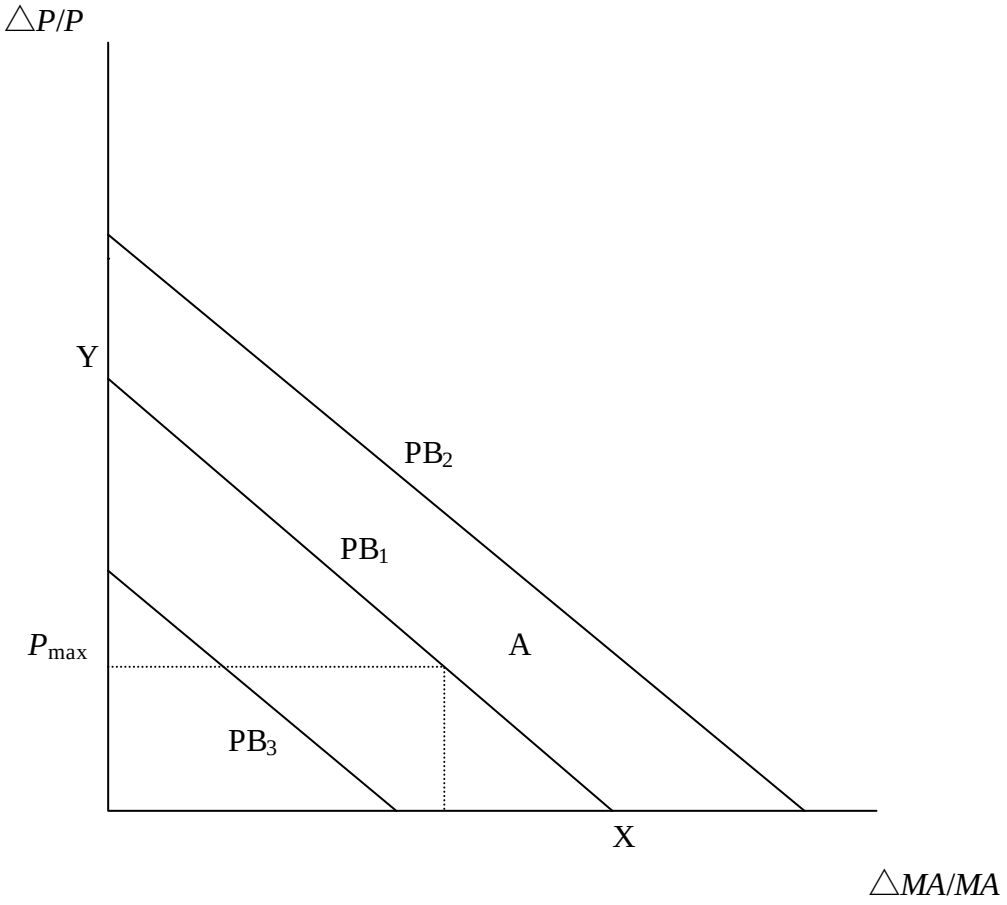
1987] has argued, Chinese planners did have to adjust prices to overcome what he calls "purchasing power imbalances" and 100% stability was either not an objective or not achievable.

In a socialist country, the issue of money is often influenced by a large number of economic and political factors, particularly when the government is responsible for the lion's share of providing the population with purchasing power: wage payments to the city workers, agricultural procurements from farmers and the financing of the operation of the state enterprises etc. Much as the government wants to constrain it, this kind of distribution often has its own logic and cannot be totally compromised for the sake of macroeconomic stability. For example, the nominal amounts of procurement from farmers are very difficult to predict, and refusal to increase purchases in times of bumper harvest might lead to serious political difficulties, particularly in a country like China where farmers constitute the absolute majority of the population. Due to the problems associated with the "soft budget constraint" [Shen, 1986; Kornai, 1980, 1982, 1986], the government also has to cater for the enterprises financially almost whenever they are in trouble. Bankruptcy is extremely rare. These problems are often compounded by those of "taut planning" [Brada and King, 1986] under which planners come up with over-optimistic output targets exceeding the full-employment productive capacity of the economy. When that occurs, the monobank has little choice other than catering for the taut plans automatically. Thus the socialist government's degree of freedom in determining aggregate demand and the size of *M*, in contrast to normal expectations, has actually been much smaller. More specifically, there is a high probability for *M* to overshoot its optimal level, especially as a result of fiscal pressure and in an ex post sense [Niu and Lu, 1987].

The adjustments in prices are somewhat less direct. People's purchasing power will be "eroded", "taken back", but it is more difficult for any party to claim itself to be a direct target of official discrimination. Having said that, it does not mean that the socialist government in the pre-reform regime would resort to price adjustments as an easy way out. That would run against its own ideological commitment and might generate even greater political risks. So some forms of rationing, which have the appeal of being "general" and could be justified morally by resorting to socialist and developmental ideologies, seem inevitable in times of excessive distribution. But given a certain rate of growth of money, and price increases which do not clear the market, rationing would result in involuntary monetary accumulation. The money so accumulated, which the Chinese have referred to, in vivid language, as "tigers in the cage", could not be suppressed forever. They may eventually "re-emerge from the

cage" and make a drastic impact in the goods market. The larger the price increase in the present period is, therefore, the less will the potential risks of money re-emerging be in future periods.

All in all, it seems appropriate to theorize that the socialist government would try its best to keep *M* within targets, but then price adjustments would be used, with some reluctance and as a remedial measure, to do the balancing act. There is however a ceiling on price increases, and rationing may have to be implemented when demand still exceeds supply. An eye must be kept, moreover, on the stock of involuntary monetary accumulation.



The dilemma confronting the monetary authority can be graphically illustrated by figure 1, which is a modified version of figure 3 in Peebles [1987]. $\triangle P/P$ is the rate of price increase and $\triangle MA/MA$ the rate of monetary accumulation. PB1 therefore

represents a trade-off between inflation and involuntary saving. The latter is forced upon the population through rationing when purchasing power exceeds the supply of goods and services. The higher the general price increase, the less would the growth rate of monetary overhang be. Hence the curve is downward-sloping. To completely wipe out the overhang, Y% of inflation rate is called for. On the other hand, if the authority puts top priority on price stability, a zero inflation rate would imply X% of monetary accumulation. Because of a subjective ceiling on tolerable inflation, only AX may in reality be the feasible set of trade-offs. In any case, any monetary accumulation could only be solved in the future by one or several of the following measures: price increases, monetary contraction or above-normal output. Theoretically at least, planners could opt for a permanent state of rationing, if they find it politically and economically feasible to do so.

Note that PB1 is drawn for a given excess supply of money. The curve will shift outwards if the excess is even higher (e.g. to the position of PB2) or inwards (say, to PB3) if it is lower. Obviously, the amount of money in circulation in any particular period will be determined by, among various factors, the monetary overhang (if any), the ex post money supply and the further trade-off that planners are prepared to choose. For example, if distribution of purchasing power was excessive in the past periods and the monetary overhang (as a result of opting for trade-offs involving very small price changes) is regarded as dangerous, the authority may tighten the money supply in this period, thus shifting the PB curve inwards, and regardless of the success or failure of that effort, choose a trade-off with larger price increases. So M/y may fall while P rises, defying the prediction of simple quantity theory. In general, the degree of shortage (rationing) and the ratios M/y and M/P may move in various directions, depending on the history of the past few periods and the general political and economic situation in the present period. Moreover, there is no inherent tendency for market-clearing equilibrium to be achieved. The classical quantity theory, even as a long-run proposition, simply cannot capture the complexity of such a situation.

Chow [1987] admits that because of the existence of price control, "prices may not adjust to monetary forces as they would in a market economy. However, the theory could still provide a good explanation of the general price level if the remaining uncontrolled prices were able to adjust sufficiently." [p.322]. It is not clear what he means by the uncontrolled prices being able to "adjust sufficiently". It may imply the overall matching of supply and demand through secondary markets where prices were uncontrolled. In that case, the proportionality between the money aggregate and the general price level calculated on the basis of a weighted average of

controlled and uncontrolled prices might be maintained. Unfortunately, the relative size of the "free markets" fluctuated rather widely in China [Naughton, 1986, appendix E] and they were always subject to administrative interference, or at least moral suasion. During the Cultural Revolution, for example, the uncontrolled sector was severely limited. Market activities were in many cases forced to go underground and it is doubtful if the "free prices" were able to clear the aggregate market. More generally, Brus and Laski [1985] have presented a formal model arguing that the secondary market may not restore aggregate balance because economic agents would rather join the queue for goods in the controlled sector as they are much cheaper. The probability of being able to acquire desired goods and the possible length of waiting time in the controlled sector have to be balanced with the higher prices that will be charged for purchases in the secondary market. Whether the phenomenon should be characterized as "forced saving" is controversial, as admitted by Brus and Laski. Anyway, the proportionality between M and P will be upset as varying portions of money join the queue or find expressions in free prices during different periods. The largely unpredictable policy of the Chinese government towards rationing and "free markets" over the past decades could only have increased the randomness of the division between queuing and immediate buying.

The wider the definitions of money, prices and expenditure are, the less sustainable the proposition of proportionality will become. Deposits, particularly those by enterprises, came under much stricter control in China, so did the production of intermediate and producer goods. Free markets that had been developed for the latter were also subject to greater interference. Hence, effective supply in those markets was severely hindered. Demand for their output (e.g. iron and steel, cotton, electricity, bicycles and tractors, etc.), however, turned out to be price-inelastic because very few, if any, substitutes existed. So both the supply and demand curves would have been very steep in those markets, and their intersection point might have been outside the feasibility region of economics as well as politics. Producers or agents charging extraordinarily high prices in the secondary markets faced tremendous risks, while demanders (including many farmers who had little access to any form of credit) who could not afford it had to revert to the queue. For state-owned enterprises facing soft budget constraint, moreover, the marginal cost of failing to acquire the required material and producer goods in the uncontrolled sector was anything but significant, particularly in the pre-reform period before 1979. Joining the queue was the natural choice.

III. Reform-related Considerations

For the situation during the reform period, the question of the relevance of the quantity theory becomes more complicated, as the economy undergoes some unprecedented transformations and changes. Since price control has been liberalized to a certain extent, inflation has become more open. So Chow's argument of proportionality between M and P seems to have more weight. However, a great deal of control measures, restrictions and interference still exist and the events from 1988 onwards showed how easily decentralized decision-making power could be recentralized. The expectations of the Chinese population have nevertheless been raised significantly as a result of the reform process and the open-door policy. The problems of the aggravated investment thirst of local units, which have been given greater autonomy, and the "over-matured" consumption patterns of many households and social organizations have been widely reported and discussed. There is therefore little reason to believe that aggregate equilibrium is more likely during the reform than the period before. I have elsewhere [Tsang, 1989] analyzed the aggregate consumption goods market in China using the Burkett [1988] version of the Portes-Winter disequilibrium model. The results show that shortage (excess demand) actually worsened during the economic reform period up to 1987, compared with the second half of the seventies.

The reform has also generated important effects on both the supply and the demand sides of the economy which would have seriously undermined the predictive power of any simple model based on the quantity theory of money [Tsang, 1990]. In the loan-deposit circuit, the monopolization of the People's Bank was ended in 1983 and a system of specialized banks has since been established. These banks have been given more autonomy and incentives in collecting deposits and in lending to enterprises and rural units, increasing the possibility of excessive supply of money. As the reform raises living standard and affects the preferences of the population, their spending and saving patterns are also bound to change. This will affect the stability of the parameters in any formulation of the quantity equation. That stable long-run relations in the forms of money demand function and price equation as suggested by the classical quantity theory have been formed in the first ten years of Chinese economic reform seems to be a highly speculative proposition. That the same relations exist before and after the launching of the reform is even harder to believe.

The most important factor that affects the stability of the parameters in any quantity formulation is the so called "commoditization" (or, in Western terminology,

"monetization") of the economy, which is a direct consequence of the reform. The proportion of direct transfer and allocation of materials, goods and services in the overall economic process has dropped markedly. Most (but by no means all) transactions are now mediated with money. Secondly, the improvement in the national living standard as a result of the economic reform means that the propensity to save may rise. Since currency in hand and deposits with banks and credit co-operatives are the major forms of saving in China, given the still backward state of other financial instruments and markets, the demand for money in all its definitions will probably increase. This factor is reinforced by the change in government policy to rectify the past "Stalinist" tendency of emphasizing accumulation at the expense of consumption. To rally the people to the cause of the economic reform, the government has deliberately carried out measures to raise the income and consumption levels of the population, examples being the large increases in the procurement prices for agricultural produces in the first stage of reform (1979-1984), and the freedom given to enterprises in the cities to raise wages and consumption funds in the second stage which started in late 1984. However, a counter argument may be equally convincing: since consumption has been so repressed in the past and the prospect of the reform being continued is never certain, it may be more advisable for the Chinese to enjoy life "while the good days last". Hence total (voluntary and forced) saving may actually decline in the reform period. The impact on money demand will therefore be much quite uncertain.

Thirdly, the increasing importance of transactions mediated by cash, due to the fact that banking service in China has not been growing as fast as the real economy itself, also implies that the velocity of circulation would fall and demand for money would increase if cash changes hands more slowly than transfer across bank accounts. There are however doubts on this point because cash may actually change hands more quickly than bank transfers, given the reality of an underdeveloped financial system and different forms of administrative interference in China.

The above considerations can be presented more formally. Let us start with the simple quantity equation:

$$M.V = P.T \qquad (1)$$

where M represents the total demand for money, V velocity, P the price level and T the total amount of transactions on goods and services.

A socialist economy under economic reform witnesses a changing degree of monetization, which we denote as *z*, and a varying propensity to save, *S*, which is split between savings in the form of cash, *Sc*, and in the form of deposits, *Sd*. Assume also that because of the relative underdevelopment of financial services compared with the growth of the economy, a rising %, *q*, of transactions is in cash.

We can divide total demand for money into two components: demand for currency, *Mc*, and demand for deposits, *Md*; each with a different velocity, *Vc* and *Vd*.

(i) Demand for Cash

After a portion has been set aside for savings, the amount of currency left must be able to sustain transactions mediated by cash:

$$(Mc - Sc.Mc)Vc = q.z.Y \qquad (2)$$

where *Y* is nominal output, which replaces *P.T* for simplicity. Denoting (1-*Sc*)*Vc* = *Vc'*, we obtain

$$Mc = \frac{1}{Vc'}(q.z.Y) \qquad (3)$$

(ii) Demand for Deposits

Like-wise, the amount of deposits left after a portion has been set aside for saving should be able to sustain transactions mediated by payments through banks:

$$(Md - Sd.Md)Vd = (1-q)z.Y \qquad (4)$$

Let (1-*Sd*)*Vd* = *Vd'*, then

$$Md = \frac{1}{Vd'}(1-q)z.Y \qquad (5)$$

(iii) Total Demand for Money

Aggregating the two types of demand, we obtain:

$$M = Mc + Md = \frac{1}{Vc'}(q.z.Y) + \frac{1}{Vd'}(1-q)z.Y \qquad (6)$$

and letting $V' = \frac{Vc'.Vd'}{Vd'.q + Vc'(1-q)}$,

we have finally the modified quantity equation:

$$M = (1/V')z.Y \qquad (7)$$

It can easily be checked that the partial derivatives of *M* with respect to *z, Sc* and *Sd* are all positive, and the partial derivative of M with respect to q is positive if *Vd* > *Vc*. It is reasonable to assume that *z, Sc, Sd* and *q* have all changed significantly in China since 1979. However, there is little ground to suppose that they have changed almost instantly and then moved onto new and stable magnitudes, given the twists and turns of the reform. Whether *Vd* has been greater than *Vc* is also in doubt. So it is difficult to believe that the quantity theory holds for the reform era and that the same formulation of the theory could provide consistent explanations of money demand or the price level in China over the whole period of 1952-88.

IV. Empirics for the Pre-reform Period

Some of the above analyses and observations can be put to more formal tests within the confines of the classical quantity theory, subject to data availability. Chow's [1987] attempt to apply the theory to China, restricted largely to the question of the determination of the price level, is still admittedly exploratory and there are apparent limitations. First, the implementation procedures of cointegration and error-correction modelling are employed rather selectively without providing specific justifications. For example, Chow has not performed any tests on the degree of integration of the relevant series before the cointegration tests are implemented and the cointegration tests utilize only the DW statistic, which is actually not the one recommended in the paper by Engle and Granger [1987], which he quotes as a support. Second, the structural test on the short-run dynamic price model hinges on the Chow test, using 1979 as the watershed. With regard to China, although 1979 was the year of the formal announcement of the launching of the economic reform,

changes in the monetary system tended to be lagged. Loose monetary policy and inflationary pressure became serious problems only after the launching of the second stage of the reform in the cities in late 1984. Chow's [1987] test for structural continuity between 1952-78 and 1979-83 may therefore suffer from the problem of having too few degrees of freedom for the reform period.

If our reasoning about the historical, institutional and behavioural reality in China is correct, it would mean that the specifications of both the money demand function and the price equation on the basis of the classical identity $MV=Py$ and using observable data would be misleading and inappropriate. Moreover, the reform would generate structural instability for any dynamic equation based on pre-reform specifications. These form our core hypotheses.

Ideally, we should test the relevance of the quantity theory for the pre-reform period and the reform period separately, and then investigate the issue of structural continuity. Such a venture is however constrained by data availability and the problem of degrees of freedom, given the relatively short history of the reform. Quarterly time series for retail prices, for example, started only in 1983 and were presented only on a year-on-year basis. What we can do is therefore to implement tests on the money demand and price equations using annual data for the periods of 1952-78 and 1952-88 instead of looking at the reform period separately. An error-correction model on short-run price dynamics for 1954-88 is also considered and subject to the Chow test on parametric stability, using 1979 as the dividing line. In this section, we first concentrate on the pre-reform period of 1952-78.

a. Money Demand Function

Writing the quantity equation as a money demand function in log form and assuming the constancy of velocity, we have:

$$\ln(M/P) = c + \alpha \ln y \qquad (8)$$

where c is a constant and α a coefficient. The trouble is: if the economy is undergoing significant structural changes and both M and P are used as partial instruments to augment the frequent practice of rationing (which is not observable directly), there is little reason to suggest that $\ln(M/P)$ and $\ln y$ would exhibit any stable long-term relation.

The closest pairing to a quantity-theory view is obviously the relation between demand for real currency balance and retail sales volume. In the case of China, the only other set of published monetary data running continuously from 1952 through the present is that on savings deposits by households in the urban and rural areas [Zhongguo Tongji Nianjian, 1988; State Statistical Bureau, 1989]. Adding that to the currency in circulation forms our *M1* series for the whole period. As an analysis of the relevance of the quantity theory of money to China, we shall first concentrate on the relations between currency and retail sale and pick up later the *M1* and the national income (*y*) series for further tests.

To test our hypothesis of irrelevance empirically, we start by running the following OLS regression on the money demand function for the period 1952-78:

$$\ln(CURR/RPI) = \underset{(0.4832)}{-2.7816} + \underset{(0.0752)}{1.1275}\ln RRSL \qquad (9)$$

$$R^2 = 0.8999$$
$$SSR = 0.6262$$
$$DW = 0.8133$$

where *CURR* represents currency in circulation, *RPI* the general retail price index which is a composite index calculated from a basket of state-regulated and free-market commodities, and *RRSL* retail sales volume, formed by deflating nominal sales by *RPI*.[4] SSR is the sum of squared residuals and figures in parentheses are the standard errors of the regression. Note that the estimate of the coefficient α is above unity at 1.1275--a result which is similar to Chow's [1987, p.325] for the period of 1952-83, where he puts real national income on the right hand side.

For a test on a long-run relation between real money demand and the price level, we use the "cointegration tests" developed recently by Granger [1981] and Engle and Granger [1987]. Chow [1987] applies only one of the several tests suggested (CRDW) to Chinese data. These tests take as a starting point that the series are individually $I(1)$ i.e. integrated of the first order and become $I(0)$ (stationary) after first differencing. Most economic data series in log are $I(0)$ after first differencing and Chow [1987] apparently makes the same assumption. But then we have to be careful about Chinese

data, given the historical and institutional peculiarities. As a first step, we inspect the autocorrelation functions of both ln(*CURR/RPI*) and ln*RRSL* in levels, and then their first-differenced series. The former decline very slowly to zero, showing symptoms of non-stationarity, while the latter do so after one year or immediately. These imply that first differencing is needed to achieve stationarity for the series.

The most widely used formal test on the degree of integration of any time series, say *Xt*, has been the one proposed by Dickey and Fuller [1979, 1981] and Dickey, Bell and Miller [1986]. Essentially, the test, dubbed "Augmented Dickey-Fuller (ADF) Test", or the "standard" testing sequence [Dickey and Pantula, 1987], which should be distinguished from the ADF test on cointegration that we also employ below, involves the following regression:

$$\Delta^i X_t = a + b\Delta^{i-1} X_{t-1} + \sum_{j=1}^{p} c_j \Delta^i X_{t-j} + e_t \qquad (10)$$

where Δi represents the ith differencing of the data (so i=0 means no differencing). The third term, the collection of lags of the same degree of differencing, is added just to ensure that the residuals are devoid of serial correlation. Hence the magnitude of p is judgmental. The relevant test statistic is t_u on $\hat{b}$, which happens to be the normal *t*-statistic computed for OLS regression, but its distribution is not the common one and we have to refer to Fuller [1976, Table 8.5.2]. The null hypothesis is H_0:$Xt \sim I(i)$. It is rejected if t_u is larger than the critical value, i.e. when $\hat{b}$ is significantly different from zero.

However, as Dickey and Pantula [1987] have argued, the ADF test is predicated on the assumption of at most one unit root. So at least the first few tests in the sequence would not be theoretically justified if the series has more than one unit root. From their simulation experiments, they find that the ADF test has a non-trivial bias towards declaring stationarity when in reality second or third differencing is needed. They propose another sequential testing procedure which stands on firmer theoretical ground, if it is suspected that the series X_t needs more than first differencing to achieve stationarity. It involves finding the test statistic $t_{i,n}(k)$, which is the regression *t*-statistic for the coefficient of $(1-B)^{i-1}X_{t-1}$ in the regression of $(1-B)^k X_t$ on $(1-B)^{i-1} X_{t-1}$, $(1-B)^i X_{t-1}$,.....,$(1-B)^{k-1}X_{t-1}$, where B is the back-shift operator, n the number of observations and k the maximum number of unit roots under consideration. The null

hypothesis H_i (of the series having i unit roots) against the alternative hypothesis of H_{i-1} is rejected if $t_{i,n}(k)$ is less than the critical value, given by Fuller [1976, Table 8.5.2]. The procedure starts with the large number of unit roots, $i=k$, under consideration and works downward; that is, i is decreased by one each time the null hypothesis is rejected. Upon acceptance of a null hypothesis, the procedure stops.

For the case of Chinese monetary and related data, it seems prudent to set the maximum, k, at 3. Including the intercept in the OLS regressions, we arrive at the results as reported in Table 1:

Table 1
Dickey-Pantula Test on the Degree of Integration:1952-78

	ln*CURR*	ln*RPI*	ln(*CURR*/*RPI*)	ln*RRSL*	ln(*CURR*/*RRSL*)
$I(3)$					
$t_{3,24}(3)$	-8.08[a]	-4.96[a]	-9.02[a]	-6.36[a]	-6.39[a]
$I(2)$					
$t_{2,24}(3)$	-3.14[a]	-3.89[a]	-3.02[b]	-3.74[b]	-4.01[a]
$I(1)$					
$t_{1,24}(3)$	-1.44	-2.07	-1.35	-0.20	-2.28

Note: [a] significant at 1%; [b] significant at 5%; [c] significant at 10%. Critical values given in Fuller [1976, Table 8.5.2].

The results confirm that all the relevant series are $I(1)$. With that issue settled, we proceed on with the cointegration tests. Engle and Granger [1987] investigate tests for the case of a pair of time series which are both $I(1)$. The following cointegration regression is performed:

$$Y_t = \alpha + \beta X_t + u_t \qquad (11)$$

where α is the intercept and u the error term. The null hypothesis is that Y_t and X_t are "non-cointegrated" while the alternative is that they are cointegrated. So the test is on

the null hypothesis that the system has two unit roots against the alternative that it has only one. They performed Monte Carlo experiments on a sample size of 100 observations, using different test methods. In a first-order system, where the residuals of the cointegration regression are characterized by first-order serial correlation, two procedures stand out: the Durbin-Watson (CRDW) test and the Dickey-Fuller (DF) test. In higher order systems, the Augmented Dickey-Fuller (ADF) test is recommended.

Engle and Yoo [1987] have generalized the results of Engle and Granger [1987] into the multivariate case and provided critical values for the three tests over a variety of sample sizes, including that of just 50 observations. Employing those critical values, we have performed the three tests on cointegration between ln(*CURR*/*RPI*) and ln*RRSL*. The results are reported in Table 2.

Table 2
Cointegration Tests between Real Currency Balance
and Retail Sales Volume: 1952-78

1.	CRDW	0.81[b]
2.	DF	-2.52
3.	ADF	-1.63

Note: CRDW--Cointegration Regression Durban Watson; DF--Dickey-Fuller; ADF--Augmented Dickey-Fuller. [a] significant at 1%; [b] significant at 5%; [c] significant at 10% (according to the critical values simulated by Engle and Yoo [1987, Tables 2, 3 and 4] for 50 observations, assuming that the system is of first order for the CRDW and DF tests and of fourth order in the form of system (33) in Engle and Yoo [1987] for the ADF tests).

It should be noted that Engle and Granger [1987] have expressed reservations about the CRDW test "because the critical value is so sensitive to the particular parameters within the null" [p.268]. The ADF test, on the other hand, is recommended for its comparative power properties despite the fact that efficiency is reduced as more lagged variables may be included than necessary--a result arising from ignorance about the actual lag structure. Such inefficiency will disappear as the

sample becomes large. Engle and Yoo [1987] concur with such a view. Their simulation results show that the critical values for the bivariate CRDW test differ significantly over different sample sizes and orders of the system. "Hence this statistic does not appear to be too useful for testing co-integration." [p.158] The differences between the critical values for the DF test and ADF test for a fourth-order system are relatively small. In practice, the ADF test turns out to be the most popular one [e.g. Osborn et al., 1987].

Keeping these considerations in mind, the data series of real currency balance and real retail sale in the pre-reform period in China did not appear to be cointegrated since they fail both the DF and ADF tests. As prima facie evidence, this fits our theoretical considerations in section 2 that both $\triangle M$ and $\triangle P$ were used in a non-systematic fashion by the government to stabilize the economy under a situation where rationing might be frequently practiced. Hence, the money-demand function in the light of the quantity theory seems to be a non-starter for China, even in the pre-reform period.

b. Price Equation

An alternative formulation of the quantity theory is the price equation. To follow through the required procedures of tests on integration and cointegration, we first regress ln*RPI* on ln(*CURR*/*RRSL*) for the period of 1952-78 and obtain the following results:

$$\ln RPI = \underset{(0.0617)}{0.6591} + \underset{(0.0338)}{0.2794}\ln(CURR/RRSL) \qquad (12)$$

$$R^2 = 0.7317$$
$$SSR = 0.0365$$
$$DW = 0.8015$$

The coefficient estimate on the log of real money is just 0.279, well below unity. The implication is that the velocity is not constant due to various reasons, including possibly rationing, shortages, repressed inflation and the like. But it could also be due to partial adjustments and lags, which do not nullify the quantity theory as a long-run theory. As we have already satisfied ourselves that the relevant series are $I(1)$ by

looking at their autocorrelation functions and on the basis of the results as contained in Tables 1, we then proceed onto the cointegration tests. Table 3 below reports the findings:

Table 3
Cointegration Tests for ln*RPI* and
ln(*CURR*/*RRSL*): 1952-78

1. CRDW	0.80[b]
2. DF	-3.91[b]
3. ADF	-2.53

Note: see Table 2 above.

The retail price index and the ratio of currency to real retail sales show some signs of being cointegrated in the pre-reform period of 1952-78 but the rejection even at 10% level of significance of the null hypothesis on the basis of ADF creates serious doubt. This result again lends credibility to our theoretical presentation in the Section II.

V. Extending into the Reform Period

As discussed above, we should expect that significant structural transformations are taking place under the Chinese economic reform and that the relations between money on the one hand and income and various variables on the other have been undergoing marked changes. Whether the quantity theory holds in such a situation is a moot point, despite Chow's [1987] positive findings. It may therefore be worthwhile to extend the major empirical tests to cover the reform period up to 1988.

a. Integration and Cointegration

The Dickey-Pantula test on the degree of integration of the relevant series for the period 1952-88 are implemented and the findings are reported in Table 4:

Table 4

Dickey-Pantula Test on the Degree of Integration: 1952-88

	ln*CURR*	ln*RPI*	ln(*CURR*/*RPI*)	ln*RRSL*	ln(*CURR*/*RRSL*)
I(3)					
$t_{3,34}(3)$	-8.82[a]	-5.52[a]	-9.90[a]	-7.55[a]	-7.62[a]
I(2)					
$t_{2,34}(3)$	-2.84[c]	-2.12	-3.31[b]	-4.18[a]	-4.05[a]
I(1)					
$t_{1,34}(3)$	1.59	(2.10)	0.99	1.14	0.43

Note: see Table 1.

The results show that while all the other series are *I*(1) when the data are extended to cover the reform period (up to 1988), the series *RPI* turns out to be integrated of the second order, i.e. *I*(2). These findings contrast with those for the pre-reform period where all the relevant series are *I*(1). The a priori explanation is obviously that the liberalization of prices, a key feature of the Chinese economic reform, leads to significant changes in the movements of prices. In any case, they further undermine the relevance of the quantity theory to the Chinese economy.

As ln(*CURR*/*RPI*) and ln*RRSL* are both *I*(1), we can proceed to test for their cointegration. However, for the price equation, ln*RPI* is *I*(2) but ln(*CURR*/*RRSL*) is *I*(1). It is therefore improper to implement the cointegration tests as the theory implies that series of different degrees of integration are non-cointegrated. More practically, we would not expect series of *I*(2) to exhibit any long-run stable relation with series of *I*(1) in the form of the linear combination $Y_t = \alpha + \beta X_t$, which is the mathematical form of the log-linear version of the quantity theory. In any case, we perform the cointegration tests for both the money demand function and the price equation and the results are reported in Table 5.

Table 5
Results of Cointegration Tests for CURR: 1952-88

	CURR/RPI on RRSL	RPI on CURR/RRSL
1. CRDW	0.70[c]	0.99[b]
2. DF	-2.73	-3.79[b]
3. ADF	-1.68	-2.49

Note: see Table 2.

Both equations fail the recommended ADF test and it is doubtful whether the relevant variables are cointegrated. The fact that our integration tests show that *RPI* is *I*(2) and yet both the CRDW and DF tests on its cointegration with *CURR*/*RRSL* come up with apparently affirmative results underpins the fact that we have to be careful about the implementation of the tests of integration and cointegration. Inappropriate conclusions may be drawn if we do not follow through the necessary procedures.

b. Tests on Broader Aggregates

We also perform the cointegration tests wider definitions of money, income and the price level for the period 1952-88 as a supplementary analysis. Negative results are a sufficient condition for rejecting the quantity equation as a long-run theory for China, irrespective of whether the requirements of integration hold. In Table 6, we report the results of the tests where *M*1 is the sum of currency in circulation and household savings deposits in urban and rural areas, *DFLY* the deflator of national income available, and *RY* national income available in real terms.[5] The pairing of variables is deliberate. For the money demand function, we first deflate *M*1 by *RPI* and regress the quotient on *RRSL*. Then we deflate *M*1 by DFLY and regress the result on RY. For the price equation, we regress *RPI* on the ratio of *M*1 to retail sales volume and then the deflator on the ratio of *M*1 to *RY*. No evidence of cointegration in all these wider definitions of money, income and prices is discerned.

Table 6

Results of Cointegration Tests for M1: 1952-88

MODEL	I	II	III	IV
	*M*1/*RPI* on *RRSL*	*M*1/*DFLY* on *RY*	*RPI* on *M*1/*RRSL*	*DFLY* on *M*1/*RY*
1.CRDW	0.48	0.46	0.64	0.45
2.DF	-1.74	-1.95	-1.79	-1.31
3.ADF	-1.54	-1.45	-2.21	-2.73

Note: see Table 2 and text.

c. Structural Stability

Given that the price level and the money-income ratio are not cointegrated, any short-run dynamic price equation that claims to gravitate towards a long-run stable relation would be illegitimate. Chow [1987] constructed a first-order error-correction price equation for China in the spirit of Engle and Granger [1987] and found no sign of structural break between 1954-78 and 1979-83. As a matter of curiosity, we assume that cointegration holds and test the parametric stability of the price equation in the form of Chow's [1987]. Using the residuals of the cointegration regression as the error-correction term, *U*, we, like Chow [1987], find the lagged term of CURR/RRSL insignificant and come up with the following error-correction model for 1954-88:

$$\triangle \ln RPI = \underset{(0.0049)}{0.0031} + \underset{(0.0316)}{0.2092}\triangle \ln(CURR/RRSL) + \underset{(0.1281)}{0.4477}\triangle \ln RPI_{t-1}$$

$$- \underset{(0.1278)}{0.2068} U_{t-1} \qquad (13)$$

$$R^2 = 0.6947$$
$$SSR = 0.0208$$
$$DW = 2.0069$$

We then run the same regression for the periods 1954-78 and 1979-88 and obtain the results as in eqs.(14) and (15) respectively:

$$\triangle \ln RPI = \underset{(0.0041)}{0.0012} + \underset{(0.0267)}{0.1824}\ \triangle \ln(CURR/RRSL) + \underset{(0.1198)}{0.2698}\triangle \ln RPI_{t-1}$$

$$- \underset{(0.1122)}{0.2470} U_{t-1} \qquad (14)$$

$$R^2 = 0.7335$$
$$SSR = 0.0084$$
$$DW = 2.2481$$

$$\triangle \ln RPI = \underset{(0.0262)}{-0.0121} + \underset{(0.1501)}{0.3096}\triangle \ln(CURR/RRSL) + \underset{(0.4686)}{0.7704}\triangle \ln RPI_{t-1}$$

$$- \underset{(0.4244)}{0.3745} U_{t-1} \qquad (15)$$

$$R^2 = 0.5881$$
$$SSR = 0.0083$$
$$DW = 2.3659$$

Using the SSR of the restricted regression of eq.(13) and the pooled SSR of the unrestricted regressions of eqs.(14) and (15), adjusted for the relevant degrees of freedom, we come up with the test statistic of 6.66, which is above the 5% critical F(4,27) value of 2.73. So the null hypothesis of no structural change is rejected. Given our theoretical considerations in the first two sections, this result should not be surprising.

The Chow test is a test of structural break at an identified point where it occurs. Ideally, for the case of China, we would like to test for structural stability without any a priori information, i.e. we are interested not just in the stability of the S-R price model beyond 1979, but also its stability over the whole experience of China's socialist experiment. With regard to this, tests based on recursive residuals developed

by Brown, Durbin and Evans [1975], namely CUSUM and CUSUM of squares tests may be useful. The key problem with these tests in the present context is the existence of the lagged dependent variable, $\triangle \ln RPI_{t-1}$, on the LHS in the dynamic model. As Pagan and Nicholls [1984] and Pesaran, Smith and Yeo [1985] have argued, this undermines the validity of "backward" predictive failure tests to which the CUSUM tests belong. For "forward" tests, a complication centres on the distinction between one-step and multi-step prediction errors. Testing procedures in this area are still being developed [Dufour, 1982].

In our case, since the integration and cointegration tests have not provided us with any firm foundation for the construction of the S-R error-correction models covering the whole period from 1952 to 1988, a venture into such tests is not motivated.

VI. Concluding Remarks

We have set out the theoretical considerations on the irrelevance of the classical quantity theory of money to China despite official adherence and some positive scholarly support. These centre around the institutional reality of the Chinese economy, in particular the imperfect control over aggregate demand and the money supply under taut planning and socialist politics, the employment of price adjustments with reluctance and the possibly frequent existence of rationing and shortage, as well as the structural transformations and fluctuations that the Chinese economy has been undergoing, before and after the economic reform. Empirical tests on integration and cointegration on the long-run propositions of the quantity theory are implemented, and a short-run dynamic price equation constructed in the spirit of error-correction modelling is subject to a structural test despite doubts about its convergence to long-run equilibrium. All the major findings appear to confirm our skepticism.

Footnotes

Remark: This was 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, and folks at Manchester including Chris Birchenall, Denise Osborn, Graham Smith and Zhang Wenda for useful comments and suggestions. The usual disclaimer applies. A first version appeared as a working paper in 1989 at the then Hong Kong Baptist

College. Initially, I submitted it to the JCE, and was turned down by two contrasting referees (an "average" would do me good, I guess). Versions then swam in the ocean of journals, until I gave up (and I, as well as the computer with the ever-changing software, forgot when). Hence I could not remember the exact date for this last version.

1. There were in fact other banks in China even before the reform but they were either directly under the People's Bank (the Bank of China and the Agricultural Bank) or, in the case of the Construction Bank which was officially under the State Treasury, kept its accounts with the People's Bank.

2. The hallmark of the quantity theory is the proportionality between the nominal and the real, if only in the long run; while monetarism is a doctrine based on the theory, plus specific hypotheses of exogeneity and direction of causation.

3. In other words, we are concerned with testing the validity of the official view on the quantity theory rather than Chow's specific results, although as the products of a pioneering attempt worthy of attention we have to refer to them.

4. See Data Appendix.

5. For details, see Data Appendix.

Data Appendix

Most of the data series up to 1987 are extracted or computed from the 1988 edition of Zhongguo Tongji Nianjian (Chinese version of the Statistical Yearbook of China) which will be referred to as SYC below. Provisional figures for all relevant variables in 1988 are adopted from State Statistical Bureau [1989].

The year-end total of currency in circulation (CURR) for 1952-79 can be obtained from Yu [1981] and that for 1980-87 is available in the Almanac of China's Finance and Banking [1988]. Statistics on saving deposits by households in urban and rural areas are taken from the SYC [p.805]. M1 is the sum of the two series.

Nominal retail sales figures are available in SYC [p.684] and the retail price index (RPI) computable from SYC [p.777]. The series of retail sales volume (RRSL)

is derived by deflating the nominal series by RPI.

Real national income available (RY) is obtained by deflating the nominal series [SYC, p.60] with a deflator (DFLY) obtained from nominal national income [SYC, p.51] and its index calculated on the basis of comparable prices [SYC, p.52]. The difference between national income and national income available is explained by the trade balance and statistical discrepancies. The assumption here is that the deflators of the two series are insignificantly different.

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