IMF WORKING PAPER

WP/90/42

INTERNATIONAL MONETARY FUND

Asian Department

Economic Reform and the Demand for Money in China *

Prepared by David Burton and Jiming Ha

Authorized for Distribution by
Gyorgy Szapary

April 1990

Abstract

Error correction models of the demand for a range of monetary aggregates in China are estimated with quarterly data for the period 1983-88. The estimated models fit the data reasonably well and appear to be relatively stable. Money demand is found to be sensitive to changes in expected inflation. In the case of currency, demand increases in the short term in response to an increase in expected inflation even though there is a fall in demand in the long run. A "cash-in-advance" explanation for this response pattern is suggested. It is also argued that the estimation results taken as a whole provide indirect evidence against the existence of substantial repressed inflation in China during the sample period.

JEL Classification Number
223

* Mr. Ha was a summer intern in the Asian Department. The authors are grateful for comments from Charles Adams and Gyorgy Szapary, and for discussions with Jeroen Kremers.

Contents

I. Introduction

The economic reforms introduced in China since 1978 have greatly increased the role of monetary policy in macroeconomic management. 1/ Prior to the reforms, the banking system played a passive role, supplying credit to support the output targets contained in the central plan. Over the past 12 years, however, decision making has been decentralized and central planning scaled back. As the importance of market mechanisms has grown, the financial system has played an increasing part in allocating resources in the economy, and the monetary authorities have been given a correspondingly greater responsibility for controlling aggregate demand. 2/ The expansion in the role of monetary policy as an instrument for macroeconomic management has added to the potential importance of monetary aggregates as intermediate targets and indicators of policy. For a monetary aggregate to be useful in formulating and monitoring monetary policy, it is, of course, necessary that the demand for it be a stable function of a small number of macroeconomic variables. With this in mind, the present paper attempts to estimate the demand for a range of monetary aggregates on the basis of quarterly data from the post-reform period.

An important issue in considering money demand in China concerns whether there is significant repressed inflation in the economy--that is, whether agents are forced to hold substantially more real money balances than they would like to--because goods are rationed at fixed prices. 3/ Some observers have suggested that the decline in the income velocity of money during the 1980s (Chart 1) reflects such a phenomenon, and there is some econometric evidence that supports this view--see Section III. The prevalence of forced saving would clearly have important implications for attempts to estimate money demand, since real balances would be largely determined by the nominal money supply and official pricing policy rather than by notional demand, as is usually assumed.

It is easy to understand how repressed inflation could arise in a full command economy in which nearly all prices are fixed by the government and black markets are effectively banned. In China, however, prices have been substantially liberalized, and during the sample period

---

1/ The evolution of the role of monetary policy in China is described in De Wulf and Goldsbrough (1986). For an overview of economic reforms in China, see Perkins (1988), Harding (1987), and Riskin (1987).

2/ The financial system has been substantially restructured to help it fulfill its expanded responsibilities. In particular, a central bank was established and a range of new banks and nonbank financial institutions has emerged.

3/ For an analysis of repressed inflation see Barro and Grossman (1974).

perhaps only about one half of transactions took place at prices that were set administratively. In particular, for many commodities China operates a two-track price system under which quota production is distributed at state-set prices while production above quota is sold at market prices. In addition, the prices of a number of commodities have been fully liberalized, although the prices of the entire output of some products remain regulated. It therefore seems possible that incipient increases in real balances above their desired level were largely eliminated through their impact on those prices that were market determined. Indeed, it appears from casual observation that market prices, and also the price level as a whole, are strongly influenced by movements in the money supply. The decline in real money balances during 1988 as inflation picked up sharply is also striking (Chart 2). 1/ While this paper does not attempt to estimate directly the importance of repressed inflation, the extent to which it is possible to identify a well-determined money demand function without explicit allowance for forced financial saving can be viewed as providing indirect evidence on the question. It has to be borne in mind, however, that under a partially liberalized system a demand-for-money relationship may exist even though the price level is less than the level that would emerge if prices were fully liberalized. 2/

A number of features of China's economic system have a bearing on the choice of monetary aggregates to be estimated. Traditionally, currency in circulation was the main monetary aggregate monitored by the authorities, largely because it constituted the only available medium of exchange. While the reforms have increased the attention paid to broader aggregates, cash still has a special role as a medium of exchange as checkable deposits have yet to be introduced. Partly for this reason, and also because of the attention still paid to developments in currency by policymakers, the paper estimates the demand for currency as well as for broader aggregates. 3/ A second consideration is that even though enterprises have been given greater independence and responsibility for their financial performance under the reforms, many continue to face soft budget constraints. 4/ This makes them potentially less sensitive than households to the costs and

---

1/ Real money balances also declined in early 1985 as inflation increased.

2/ The scope for repressed inflation with partial price liberalization is considered in Burton (1990).

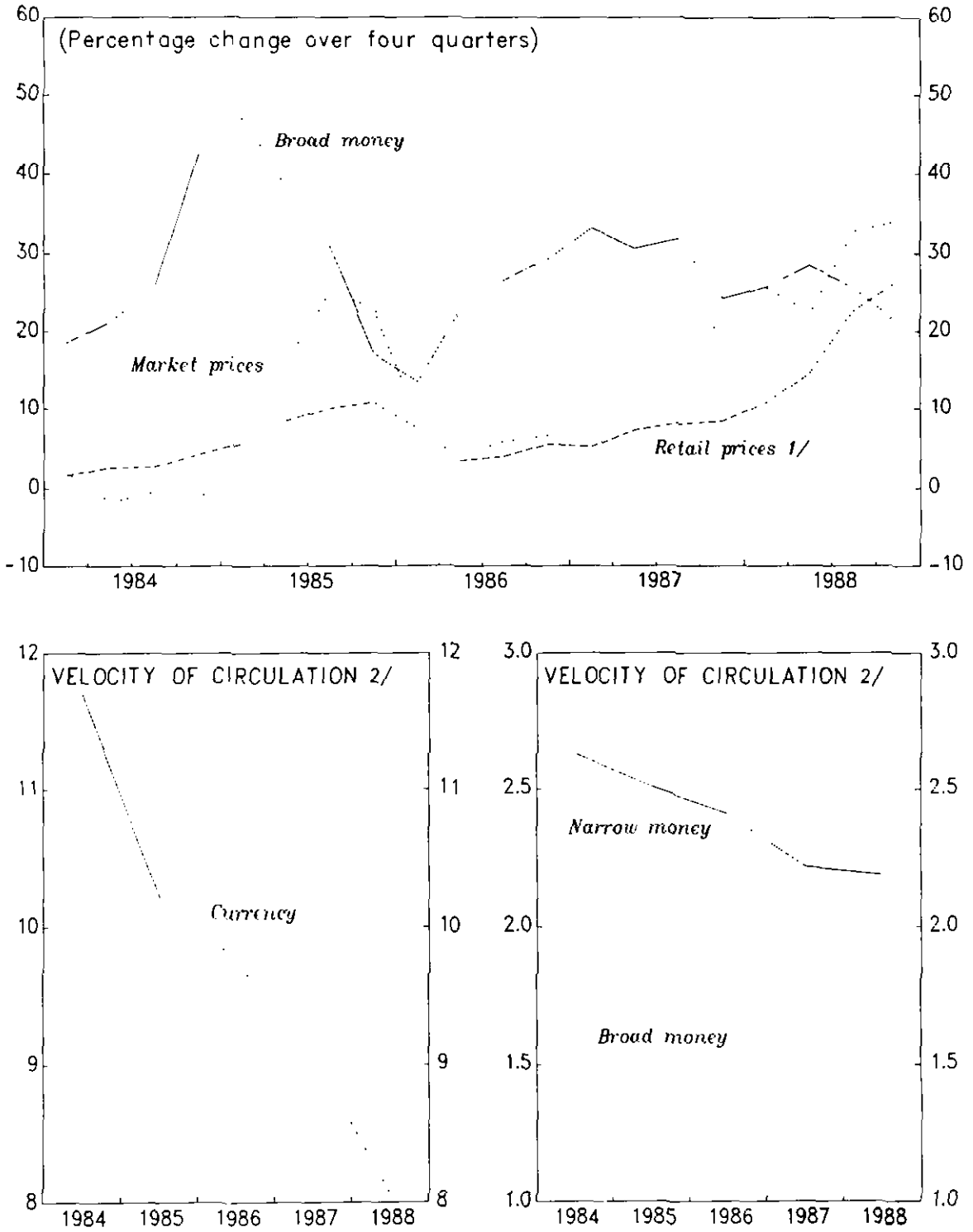
3/ Each year, the authorities establish a cash plan that sets a target for the increase in currency in circulation.

4/ Access to budgetary subsidies, the ability to negotiate taxes as profits and the ready availability of cheap credit all contribute to the softness of enterprise budget constraints.

CHART 1

CHINA

MONEY, INFLATION, AND VELOCITY, 1984-88



Source: Data provided by the Chinese authorities.

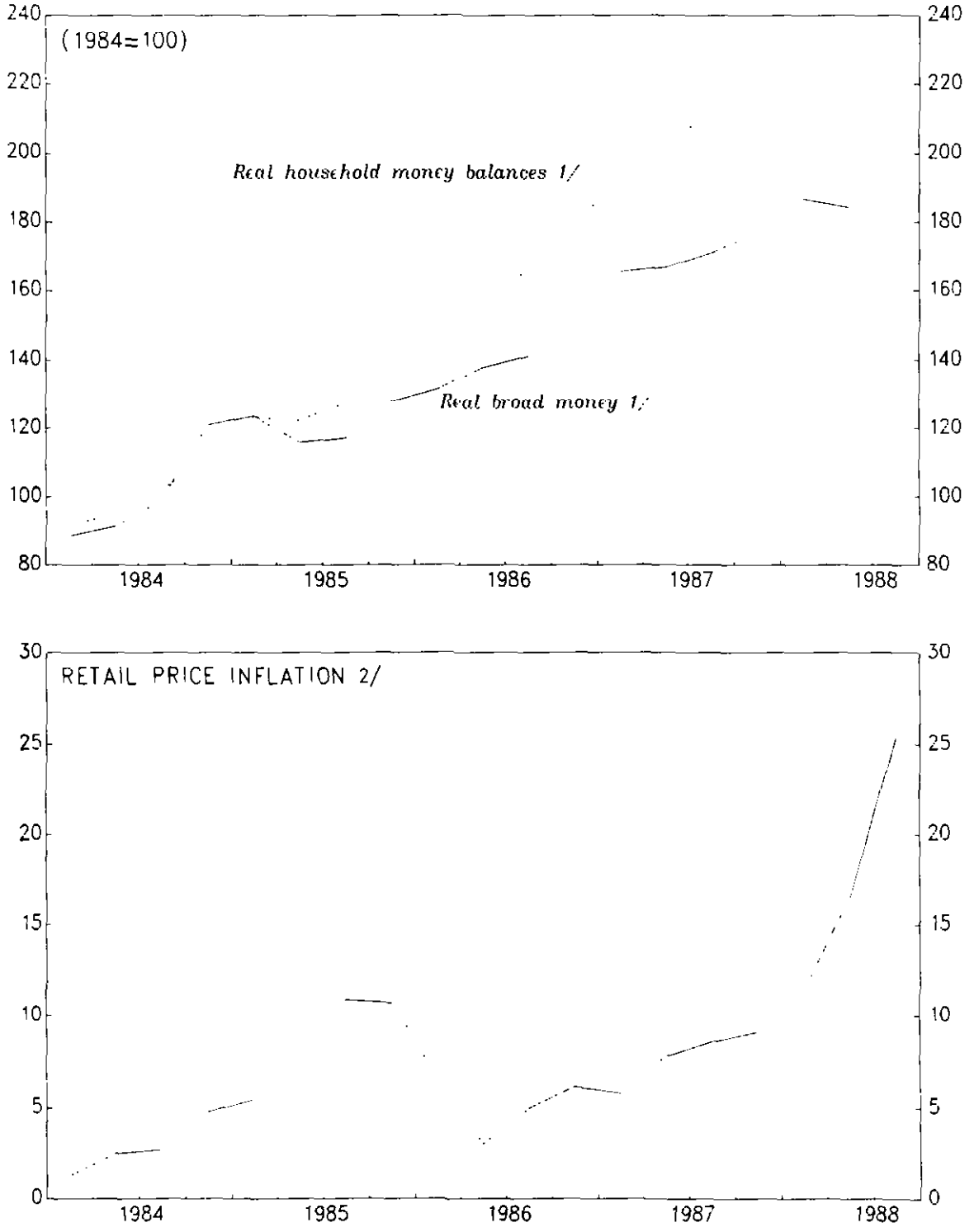
1/ General retail price index

2/ Gross national product divided by annual average money balances.

CHART 2

CHINA

MONEY BALANCES AND INFLATION, 1984-88



Sources: People's Bank of China; and staff estimates.
1/ Deflated by the general retail price index.
2/ Twelve-month rate of increase in the general retail price index.

returns of holding money. 1/ With this possibility in mind, demand functions of the money balances of enterprises and of households were estimated separately.

The remainder of this paper is organized as follows: Section II reviews the literature on money demand in China; the methodology employed is discussed in Section III; Section IV reports the results of the estimation of the demand for various monetary aggregates; and concluding comments are presented in Section V.

II. Review of the Literature

Recent studies of the demand for money in China, which include papers by Chow (1987), Feltenstein and Ha (1988), and Portes and Santorum (1987), reach different conclusions about the significance of repressed inflation and also about the dynamics of adjustment to long-run equilibrium. Chow estimates a simple partial adjustment model of the demand for money in which long-run demand depends only on national income (the simple quantity theory), using annual data for the period 1952-83 and with currency as the monetary aggregate. He found that this formulation provides "a reasonable first approximation" to explaining money demand in China. 2/ Money demand models for two aggregates, currency and currency plus household savings deposits, were estimated by Portes and Santorum with similar annual data to that employed by Chow. Their results suggest that currency behaved in a manner more consistent with conventional (real) partial adjustment models than the broader aggregate for which a more general lag structure could not be rejected. Portes and Santorum also argue that, at least for their sample period, disequilibrium in the goods market needs to be taken explicitly into account (see below).

Feltenstein and Ha, using quarterly data for part of the post reform period, also present results that suggest that repressed inflation is important in understanding money demand in China. They estimate a modified partial adjustment model in which the demand for real money balances (and expected inflation) is assumed to be based not on the observed price level, but on the price level that would prevail

---

1/ However, as noted by De Wulf and Goldsbrough (1986), the growth of individually owned and small collective enterprises has begun to blur the distinction between individual and enterprise money holdings.

2/ Chow's results with a sample dominated by data from the pre-reform period suggest that the ability to estimate a well-determined money demand equation may not be a powerful test of the presence of repressed inflation. Chow also estimated an error correction model for the inflation rate, where the long-run form is based on the simple quantity theory of money, which was regarded as providing a satisfactory explanation of inflation dynamics.

in the absence of price controls--the so-called virtual price level. The latter, in turn, is hypothesized to be a function of the observed price level and the ratio of currency to retail sales (the inverse of velocity). In the estimated model, the coefficient on the ratio of currency to retail sales was significantly different from zero, suggesting that repressed inflation was a factor affecting the demand for money. The difficulty with this approach, however, is the circularity involved in using velocity itself to explain the behavior of the demand for money.

There is also a literature on household savings behavior in China that overlaps substantially with the studies on money demand mentioned above. It includes papers by Feltenstein, Lebow and van Wijnbergen (1986), Qian (1988) and Portes and Santorum (1987). 1/ These studies, like those on money demand, differ in their conclusions about the extent of forced saving. Qian is unable to reject the hypothesis that the high savings rate in the post-reform period is the result of a shift in economic structure and/or household behavior, and hence is inclined to the view that it may not represent an increasing amount of repressed inflation. Feltenstein, Lebow and van Wijnbergen, on the other hand, using an approach similar to that of Feltenstein and Ha, conclude that unless repressed inflation is directly taken into account, false conclusions about savings behavior will be drawn. 2/ Portes and Santorum estimate the explicit disequilibrium consumption model with annual data. They find that, since 1954, there have been both periods of generalized excess demand and excess supply, and, in particular, that the period 1980-83 was characterized by excess demand. Unfortunately, their sample period ends in 1983, about the time that substantial price liberalization was undertaken, and their results, therefore, have little to say about the potential for and extent of repressed inflation during 1983-88, the period covered by this paper.

1/ These papers all employ annual data that cover only part of the post-reform period. In the first two papers, household savings is defined as the change in real household money balances. With this definition of saving, the basic Keynesian savings functions estimated are equivalent to the standard partial adjustment model in which the coefficient on lagged real balances is constrained to unity.

2/ In connection with this finding, it may be worth noting that although Feltenstein, Lebow, and van Wijnbergen assume that the velocity of circulation of money is constant in the absence of repressed inflation, the savings models they estimate imply that, even in the absence of repressed inflation, velocity would not be constant.

III. Methodology

In estimating the demand for money, we have followed an approach based on methodology closely associated with David Hendry. 1/ As applied in this paper, it has two distinctive features. The first is that, unlike in previous work on money demand in China, the data are used to determine the structure of the dynamic model through a process of testing down from general to specific formulations. This approach seems appropriate since theory provides little guide to the short-run dynamics of money demand. The second feature is that the dynamic model is estimated in "error correction" form. Such a formulation has the advantage that it helps to avoid the spurious regressions problem that can arise in estimating models with nonstationary variables and also serves to reduce multicollinearity in right-hand side variables.

The implementation of this approach first involves testing down from a general autoregressive distributed lag model of the form,

$$M_t = \alpha_0 + \sum_{i=0}^{n} \beta_i Y_{t-i} + \sum_{i=0}^{n} \gamma_i Z_{t-i} + \sum_{i=1}^{n} \delta_i M_{t-1} + v_t \qquad (1)$$

where M is the log of real money balances, Y is the log of a scale variable, and Z is an opportunity cost variable (or vector), through the sequential deletion of insignificant lags on the basis of F tests. 2/ The resulting dynamic model may then be rewritten in error correction form. For example, if the tested-down model is given by

$$M_t = \alpha_0 + \beta_0 Y_t + \beta_1 Y_{t-1} + \gamma_0 Z_t + \gamma_1 Z_{t-1} + \delta_1 M_{t-1} + v_t \qquad (2)$$

this may be reformulated as

$$\Delta M_t = \alpha_0 - (1-\delta_1)\left[M_{t-1} - \frac{(\beta_0 + \beta_1)}{(1-\delta_1)} Y_{t-1} - \frac{(\gamma_0 + \gamma_1)}{(1-\delta_1)} Z_{t-1}\right] + \beta_0 \Delta Y_t + \gamma_0 \Delta Z_t + v_t \qquad (3)$$

1/ This methodology is described in Hendry and Richard (1982) and C.L. Gilbert (1986). For discussions of its application to the demand for money see Cuthbertson (1985) and Ericsson (1986).

2/ The underlying long-run model in which real money demand depends on income (or wealth) and the opportunity cost variable can be derived from simple transactions demand or portfolio balance approaches to money demand, and also from overlapping generations models (see Laidler (1985) and Blanchard and Fischer (1989)).

The term in square brackets is the deviation of real balances in period t-1 from their long-run equilibrium value; the coefficient $(1 - \delta_1)$ captures the responsiveness of real balances to such deviations, and must be positive (i.e. $\delta_1 < 1$) for stability. The coefficients β_0 and γ_0 represent the immediate effect on real balances of changes in income and opportunity cost, respectively. 1/ The final step in the process is to estimate (3) using the deviations from long-run real balances calculated from the tested-down lag model as the error correction variable in square brackets. 2/

While it can be argued that this approach is no less ad hoc than estimation of the traditional partial adjustment model, it nevertheless has the clear advantage that it allows for a much broader range of dynamic behavior. 3/ Indeed, the partial adjustment model is nested within the error correction model, and the restrictions implied can be tested. For instance, the error correction model (3) can be rewritten as

$$\Delta M_t = (1-\delta_1)(M_t^* - M_{t-1}) - \beta_1 \Delta Y_t - \gamma_1 \Delta Z_t + v_t \qquad (4)$$

where M^* can be calculated from the estimated long-run model. It follows that the partial adjustment model implies the restriction $\beta_1 = \gamma_1 = 0$.

IV. Data

Money demand models are estimated for six monetary aggregates: currency in circulation, household money balances, enterprise money balances, total deposits, narrow money, and broad money. All equations are estimated with quarterly data for the period 1983 Q1 to 1988 Q3. Household money balances are defined as currency plus time and savings

---

1/ Estimation of the error correction model allows the dynamic relationship to be investigated without the spurious regressions problem being incurred, provided the variables in the long-run model are co-integrated. In fact, the presence of equilibriating feedback in a model such as (3) is a test of cointegration--see Granger (1986). It may be noted, however, that if variables are cointegrated, estimation of models on levels of nonstationary variables will yield, for at least some parameters, consistent estimates with the standard asymptotic distributions--see Stock and Watson (1988).

2/ An alternative approach is to use residuals from the estimated long-run model. The results were broadly the same as those reported in the paper when this procedure was used.

3/ Error correction models, like the adjustment model, can be derived in a framework in which there are costs of adjustment and agents minimize a quadratic loss function--see Gilbert (1986).

deposits. 1/ Since data on household currency holdings are available only annually, this component of quarterly household money was derived from total currency on the basis of the annual average proportion of total currency held by households. In deriving a series for enterprise money (currency plus deposits), the currency component was calculated using the same procedure. Narrow money comprises currency, household and enterprise sight deposits, and the sight deposits of quasi government institutions. Broad money is defined as narrow money plus household time and savings deposits.

The scale variable in most of the estimated models is a quarterly real national income series constructed from annual data (see Appendix I). However, a quarterly series for industrial production was used as the scale variable in the estimation of enterprise money demand. A third scale variable, household cash income, was also used in the estimation of one model of household money demand. 2/ For broader monetary aggregates, it would have been desirable to include a broad definition of wealth in the estimated equations (broad money accounts for the bulk of financial wealth), but the needed data are not available.

Although interest rates were used more actively during 1988 and early 1989 than in the past, they were more or less constant for the bulk of the sample period. For this reason, various measures of inflation were the only opportunity cost/rate of return variables included in estimated equations.

The price data employed in the study relate to general retail prices (a weighted average of controlled, regulated, and market prices) and to market prices. The only available series for both variables are in the form of 12-month percentage changes, however, and price indices were constructed by assuming that the price level increased smoothly during a base year (1982) in line with the twelve month growth rate for December of that year.

Given the small number of observations, formal tests for the order of integration of the time series involved were not conducted. However, inspection of plots of real balances (for each aggregate), real income and inflation suggested that the first differences of their logs were stationary.

1/ For all aggregates, only deposits with specialized and universal banks and rural credit cooperatives are included. Deposits with urban credit cooperatives and trust investment companies, data for which are not available on a quarterly basis for much of the sample period, are not included.

2/ This was constructed from monthly household survey data on cash incomes of rural and urban households.

V. Empirical Results 1/

In applying the methodology described in the previous section, the autoregressive lag model for each aggregate was estimated initially with four lags for all variables. A general finding was that the inflation rate of the general retail price index performed better than the inflation rate of market prices as a proxy for inflation expectations, and hence only models with general retail price inflation included are reported. 2/

1. Household money balances

The estimated error correction model for household money balances is

$$\Delta M = \underset{(0.10)}{-\ 0.001} \underset{(3.82)}{-\ 0.781\ \hat{u}_{t-1}} \underset{(3.99)}{+\ 0.910\ \Delta Y_t} \underset{(5.57)}{-\ 1.583\ \Delta \pi^{*}_{t}} \underset{(3.85)}{-\ 0.114\ D}$$

$R^2 = 0.74$
$AR\ (4, 11)^{4}_{1} = 0.53\ (3.36)$
$NORM\ (2)^{1} = 0.82\ (5.99)$
$HET\ (1, 18) = 1.50\ (4.41)$
$PREF\ (12, 13) = 0.09\ (8.74)$

$\hat{C} = 0.026$
$AR\ (1, 14)^{1}_{1} = 0.08\ (4.60)$
$ARCH\ (2)^{1} = 0.54\ (5.99)$
$CHOW\ (4, 11) = 0.37\ (3.36)$

where $\hat{u}_{t-1}$ is the deviation of real household balances from long-run equilibrium calculated from the tested-down version of the general lag model. 3/ The (expected) inflation term, π^{*}, is the average of current (quarterly) inflation, inflation lagged one period and inflation lagged four periods; 4/ Y is the log of real national income; 5/ and D is a

---

1/ The results of the estimation of models for broad and narrow money are reported in Annex I.

2/ It might have been expected, instead, that the demand for money would have been more strongly influenced by the expected inflation rate of market prices, since, in substituting from money into commodities, it is those goods readily available on free markets, rather than goods rationed at state-set prices, that are most relevant. However, adjustments to state-set prices have become more frequent in recent years, and hence expectations about future changes in them would also have an important influence on the perceived opportunity cost of holding money.

3/ Similar results were obtained using the residual from the direct estimation of the long-run model.

4/ This formulation was indicated by the general lag model.

5/ If real national income is replaced by household cash income, which grows more slowly than real national income (possibly owing to an increasing amount of under-reporting of incomes in the household survey), the coefficient is not significant. This indicates that household money balances, household cash income, and the inflation variable are not cointegrated.

dummy variable for the second quarter of 1985, a period when monetary growth was sharply reduced primarily through the tightening of direct credit controls.

The estimated equation satisfies the diagnostic tests, including a Chow test for parameter stability and a Chow predictive failure test (with the sample split at the second quarter of 1985 for both tests). 1/ The coefficient on the error correction term, $\hat{u}_{t-1}$, is significant at the 1 percent level, which provides evidence that real balances, real income, and inflation are cointegrated. The underlying equilibrium relationship from which $\hat{u}$ is derived implies that the long-run income elasticity is close to 2 (Table 1), indicating an increasing role for money in the economy as the reforms progressed during the sample period; 2/ income elasticities greater than one are obviously not sustainable in the very long run. 3/ The long-run coefficient on the inflation variable (whose dimensions are percent per quarter) indicates that a 1 percentage point increase in the annual inflation rate would reduce real household money balances by about one half percentage point.

Turning to the dynamics of household money demand, the results imply that a 1 percent increase in national income initially raises real household balances by just under 1 percent, while a 1 percentage point increase in Π (at an annual rate) lowers real balances on impact by 0.4 percent. 4/ The remaining adjustment to the long-run equilibrium appears to occur rapidly, with almost 80 percent of the deviation between actual and equilibrium money balances (lagged one quarter) eliminated in a quarter. 5/ A final point with regard to the dynamic

---

1/ The tests are described in Appendix II. For the Chow tests, the break point was chosen because it coincided (approximately) with the implementation of a substantial price liberalization and enterprise reform.

2/ Monetization was not tested directly because a reasonable proxy variable that would capture the extent to which transactions were conducted in the monetary economy was not available.

3/ It is not unusual, however, to find income elasticities greater than one in developing countries.

4/ A 1 percentage point increase in actual inflation in a quarter (at an annual rate) would have only one third the impact on real balances.

5/ If the first difference of real income or inflation has a nonzero mean, the model in general does not converge to its long-run equilibrium unless certain parameter restrictions are imposed (see Currie (1981)). Instead, the model converges to some constant distance from long-run equilibrium. The problem, which applies even more severely to the partial adjustment model, arises because the long-run equilibrium to which the model converges is specified in terms of the current levels of explanatory variables even though they may exhibit trend growth. For an approach in which the future path of the explanatory variables is explicitly taken into account, see Cuthbertson and Taylor (1987).

Table 1. China: Money Demand--Estimated Long-Run Coefficients 1/

	Log of scale variable 2/	Inflation variable 3/
Household money	1.97	-2.06
Enterprise money	1.48	-5.32
Currency in circulation	1.66	-1.01
Savings deposits	1.69	-4.70
Narrow money	1.34	-2.38
Broad money	1.53	-3.67

1/ The coefficients are calculated from the estimated autoregressive lag models for each monetary aggregate.

2/ The scale variable is industrial production in the case of enterprise money and national income for all other aggregates.

3/ For all aggregates, the reported coefficient captures the effect of a permanent increase in quarterly general retail price inflation (in percent per quarter).

structure is that the restrictions implied by the partial adjustment model are decisively rejected when the error correction model is estimated in a form similar to equation (4).

2. Enterprise money

The estimated error correction model for enterprise money is

$$\Delta M = \underset{(0.67)}{0.10} - \underset{(4.70)}{0.335}\ \hat{u}_{t-1} + \underset{(3.37)}{1.438}\ \Delta Y^{*}_{t} - \underset{(2.92)}{0.553}\ \Delta\Delta Y^{*}_{t} - \underset{(4.74)}{1.467}\ \Delta\Pi_{t}$$

$$- \underset{(3.27)}{0.098}\ D + \underset{(6.36)}{0.189}\ D_1 + \underset{(6.19)}{0.128}\ D_2$$

$R^2 = 0.929$		$\hat{\sigma} = 0.025$	
AR $(4,13)_4$	= 0.77 (3.18)	AR $(1,16)_1$	= 0.08 (4.49)
Norm $(2)_1$	= 1.16 (5.99)	ARCH $(2)_1$	= 2.64 (5.99)
HET (1, 23)	= 0.59 (4.28)	CHOW (6, 13)	= 0.64 (2.92)
PRE (13, 6)	= 0.21 (3.56)		

The inflation term, Π, is the current inflation rate of the general retail price index (the general lag model indicated that longer lags did not influence enterprise money demand); and Y is the log of industrial production. The model also includes a fourth quarter seasonal dummy (D_1) and a dummy variable for the fourth quarter of 1984 (D_2), in addition to the dummy variable for the second quarter of 1985 discussed earlier. The dummy variable D_2 is included because there was a surge in credit in late 1984 that resulted in a sharp, but temporary, rise in enterprise real money balances. 1/

With regard to the dynamics of the model, the presence of the accelerator term, $\Delta\Delta Y$, implies that the impact effect of a change in income is smaller when income growth is rising. The role of current inflation rather than the lag structure found relevant for household money demand suggests either that the inflation expectations of enterprises react faster to changes in inflation than those of households, or that enterprise money demand responds sooner to changes in expected inflation. The latter is perhaps the more likely explanation since enterprise money balances consist almost entirely of currency and sight deposits, whereas a substantial proportion of household money consists of time deposits for which there are penalties for early withdrawal. It is also interesting to note that the long-run effect of a change in inflation on enterprise money balances is substantially larger than for households. At the same time, the speed of response to deviations from long-run real balances (38 percent per quarter) is

---

1/ The surge in credit was partly the result of a rumor that credit allocations in 1985 would be based on credit extended in 1984, combined with reforms that increased the autonomy of enterprises.

substantially slower than in the case of household money balances. To the extent that enterprise money demand is determined largely by transactions requirements, an adjustment that is faster than for households might have been expected.

Finally, the restrictions imposed by the partial adjustment model on the error correction equation were tested and rejected at the 1 percent level.

3. Currency in circulation

The estimated model for currency has a more complex dynamic structure than the models for the other aggregates. The fitted equation is

$$\Delta M_t = \underset{(0.15)}{0.002} - \underset{(2.71)}{0.639}\ \hat{u}_{t-1} + \underset{(4.28)}{1.176}\ \Delta Y_t + \underset{(2.15)}{2.438}\ \Delta\dot{\Pi}_{t-1}$$

$$- \underset{(2.78)}{2.161}\ \Delta\dot{\Pi}_{t-2} + \underset{(2.92)}{0.140}\ D_1$$

$R^2 = 0.81$ $\qquad \hat{G} = 0.043$

$AR\ (4, 10)^4_1 = 1.00\ (3.48)$ $\qquad AR\ (1, 14)^1_1 = 0.00\ (4.60)$

$NORM\ (2) = 0.19\ (5.99)$ $\qquad ARCH\ (2) = 0.21\ (5.99)$

$HET\ (1) = 0.168\ (4.41)$ $\qquad CHOW\ (5, 11) = 1.44$

$PRE\ (13, 3) = 0.60\ (8.73)$

where $\dot{\Pi}$ is a three quarter average of general retail price inflation. The model implies that real currency holdings at first rise in response to an increase in inflation, before declining in later periods to less than their initial value. 1/ The subsequent reduction in demand is brought about both through the error correction term (adjustment is quite rapid), and also through the term, $\dot{\Pi}_{t-2}$. 2/

The dynamic response of the demand for currency to changes in inflation indicated by the model has an intuitively plausible, "cash-in-advance", interpretation in the Chinese context. When inflation rises with nominal interest rates held unchanged, the long-run objective of agents is to shift from both currency and deposits into consumer durables and other storable commodities. However, as noted earlier, there are no checking accounts in China and the availability of some goods has been subject to uncertainty. In these circumstances, it seems

---

1/ Currency is less responsive in the long run to change in expected inflation than other aggregates.

2/ Similar results were obtained in a model in which the two inflation terms were quarterly inflation lagged one period and lagged four periods, with the former variable entering with a positive coefficient and the second term with a negative coefficient.

likely that agents would need to increase their cash holdings initially to put themselves in a position to purchase goods when they became available. This response pattern was particularly apparent during mid-1988 when currency holdings rose sharply as a result of large withdrawals from savings deposits, whose real return had become substantially negative with rising inflation.

It seems unlikely, however, that the relationship between currency demand and inflation is symmetric. If inflation falls, the long-run real demand for both currency and deposits would increase, but there would seem to be little reason for currency holdings to be reduced in the short term as agents attempt to shift from real goods to various forms of money. 1/ The properties of the estimated model probably reflect the fact that inflation was rising for most of the sample period.

As in the case of household and enterprise money balances, the restrictions implied by the partial adjustment model are rejected.

4. Savings and time deposits

Given the different dynamic behavior of currency to household and enterprise money, a model for total deposits (defined as broad money minus currency) was also estimated. The fitted error correction model

$$\Delta M = \underset{(0.89)}{-0.001} \underset{(4.25)}{-0.480}\ \hat{u}_{t-1} \underset{(5.37)}{+0.803}\ \Delta Y_t \underset{(6.27)}{-0.992}\ \Delta\Pi_t$$

$$\underset{(2.11)}{-0.431}\ \Delta\Delta\Pi_t \underset{(2.82)}{-0.057}\ D \underset{(5.51)}{+0.112}\ D1$$

$R^2 = 0.90$ $\quad\quad$ $\hat{G} = 0.018$

$AR\ (4, 12)^4_1$	= 1.228	$AR\ (1, 15)^1_1$	= 2.52 (4.54)
NORM (2)	= 0.80 (5.99)	ARCH (2)	= 2.35 (5.99)
HET (1, 21)	= 0.10 (4.32)	CHOW (5, 12)	= 0.99 (3.11)
PRE (12, 5)	= 0.37 (4.68)		

is similar to those for enterprise and household money, although it differs in that it includes an acceleration term in inflation. The underlying long-run model indicates a greater responsiveness to inflation than either household or enterprise money. It seems likely that this reflects the relatively low estimated inflation elasticity of the currency component of the latter two aggregates. The restrictions implied by the partial adjustment model are rejected at the 1 percent level.

1/ It is possible that agents would initially increase holdings of interest-earning deposits at the expense of cash.

VI. Concluding Observations

The results presented above suggest the existence, for a range of monetary aggregates, of relatively stable demand relationships that might be helpful in guiding monetary policy. The extent of the testing for stability, however, was limited by the small number of observations. It is noteworthy that, for most aggregates, the standard real partial adjustment model is decisively rejected, indicating that a more complex dynamic structure is required to characterize the data adequately. In all cases, the long-run income elasticity is greater than unity, which probably reflects monetization of the economy under the reforms as the coordination of economic activity has increasingly taken place through markets.

A possible alternative explanation of the high income elasticities is that a rising degree of repressed inflation has been correlated with real income growth. However, another feature of the results is that real balances appear to be sensitive to expected inflation as proxied by the inflation rate of the general retail price index. This suggests that agents are able to adjust the level of their real balances to changes in opportunity costs, and hence tends to undermine the argument that a substantial amount of money holdings is involuntary. 1/ At the same time, the question of how expectations were formed remains murky, as the lag pattern on the inflation variable differed across equations. Indeed, the lag patterns probably reflected a combination of expectation formation and the dynamics of adjustment of money demand to changes in expectations.

A particular finding is that an increase in inflation raises the real demand for currency on impact, although it lowers currency demand in the long run; for all other aggregates the impact effect is negative. The dynamics of currency demand probably reflect the absence of checking accounts and the uncertainties about the availability of some consumer goods. In these circumstances, to reduce money holdings (currency and deposits) by increasing purchases of commodities, it is likely that agents initially would need to increase their cash holdings so as to be in a position to purchase goods when they become available. It is also likely that this effect is not symmetric; there is no obvious reason why cash holdings should fall in the short-run when the opportunity cost of holding money declines. The dynamic properties of the estimated model probably reflect the fact that inflation was rising for most of the sample period. The estimation of a model in which an asymetric response is allowed for might make an interesting research project.

1/ As noted earlier, however, the sensitivity of money demand to expected inflation does not rule out the possibility that under a partially liberalized price system, the price level is lower than if prices were fully liberalized.

Although the estimated models passed a limited range of stability tests, the nature of money demand in China is likely to evolve as the economic system, particularly the financial sector, develops. For instance, the introduction of checking accounts would be likely to affect the dynamics of the demand for currency. In addition, the dynamic structure of the models almost certainly reflects a combination of both the dynamics of adjustment to long-run equilibrium and the structure of expectations formation mechanisms; the latter are likely to evolve if the processes generating the variables in question change (the Lucas critique). It should also be remembered that many of the series employed were constructed, and the results obtained may reflect, to some extent, the idiosyncrasies of the data.

An issue that remains to be addressed is the impact of changes in interest rates on the demand for various aggregates; expected inflation is the only opportunity cost variable in the estimated equations because of the very limited variability of interest rates during the sample period. It is likely that a reduction in deposit interest rates would have a similar effect on the demand for deposits to that of an increase in inflation. The consequences for the demand for currency in the present circumstances, however, would probably be more complex. In particular, the long-run demand for currency would be likely to rise, but possibly by less than the short-run increase, as agents temporarily increased their currency holdings as a transitional stage in the substitution from deposits into commodities. The response of currency to an increase in deposit rates, however, would be unlikely to involve a larger short-run than long-run decline in demand, and hence might not be symmetric. Since interest rate policy in China has become more active over the past two years, it may soon be possible to investigate this question empirically.

Results for Broad and Narrow Money

This annex reports the results of estimation of models for the demand for broad and narrow money. While the results reported in the main text suggest that the demand for components of these two aggregates differs to some degree, it nevertheless proved possible to estimate reasonably well-fitting models for broad and narrow money.

The estimated error correction model for broad money is

$$\Delta M_t = \underset{(1.07)}{0.012} - \underset{(2.23)}{0.346}\ \hat{u}_{t-1} + \underset{(2.64)}{0.839}\ \Delta Y_t - \underset{(1.50)}{0.2011}\ \Delta\Delta Y_t$$

$$- \underset{(4.22)}{1.380}\ \Delta\Pi^{*}_t - \underset{(3.70)}{0.096}\ D + \underset{(3.52)}{1.506}\ D_1$$

$R^2 = 0.8254$ $\quad \dot{C}^2 = 0.0251$

AR (4, 10)$^4_1$ = 0.25 (3.48) $\quad$ AR (1, 15)$^1_1$ = 0.93 (4.54)

NORM (2)^1 = 0.56 (5.99) $\quad$ ARCH (2)^1 = 5.67 (5.99)

HET (1, 19) = 0.96 (4.38) $\quad$ CHOW (5, 10) = 1.46 (3.33)

PRE (12, 3) = 0.30 (8.74)

The inflation variable is the same as in the model for household money balances, namely an average of the current, one-period, and four-period lagged inflation rates. Dummy variables for 1984 Q4 and 1985 Q2 are also included. 1/ The restrictions implied by the partial adjustment model could not be rejected at the 5 percent level, although they were rejected at the 10 percent level.

Turning to narrow money, the estimated error correction model is

$$\Delta M = \underset{(0.47)}{0.006} - \underset{(2.92)}{0.548}\ \hat{u}_{t-1} + \underset{(3.44)}{1.211}\ \Delta Y_t - \underset{(2.37)}{0.333}\ \Delta\Delta Y_t$$

$$- \underset{(3.21)}{1.14}\ \Delta\Pi^{*}_t - \underset{(3.85)}{0.105}\ D + \underset{(4.47)}{0.138}\ D_1$$

$R^2 = 0.8849$ $\quad \dot{C} = 0.0248$

AR (4, 10)$^4_1$ = 0.32 (3.48) $\quad$ AR (1, 13) = 0.04 (4.67)

NORM (2)^1 = 0.12 (5.99) $\quad$ ARCH (2) = 1.13 (5.99)

HET (1, 19) = 0.69 (4.38) $\quad$ CHOW (5, 11) = 1.74 (3.20)

PRE (13, 3) = 0.38 (8.76)

It contains the same explanatory variables as for broad money and satisfies all the diagnostic tests. The restrictions imposed by the partial adjustment model were rejected at the 5 percent significance level.

1/ The exclusion of the dummy variables has little effect on the estimated coefficients, although it does sharply reduce the R^2.

APPENDIX I

Construction of Quarterly National Income Series

This appendix describes the construction of the quarterly series for national income. Annual national income data were broken down into three components: (1) agriculture; (2) commerce; and (3) industry, construction, and transportation. Each of these three components was then deflated by the corresponding annual national income deflator.

The next step was to interpolate quarterly data corresponding to the annual observations for each of the three components on the basis of the seasonal pattern for the corresponding year for related series for which quarterly data were available. For the agricultural component of national income, the variable used was quarterly real rural household income (nominal income deflated by the general retail price index). In the case of the industry, construction, and transportation component, the seasonal pattern in the quarterly data on industrial production was employed to generate the quarterly national income series. Thirdly, for the commerce component, quarterly data were generated using the real value of retail sales (the general retail price index was again used as the deflator.

The final step was to recombine the calculated quarterly components of national income.

APPENDIX II

Test Statistics

This appendix provides brief descriptions of the diagnostic tests reported in the paper. In the text, the reported statistic is followed (in brackets) by its 5 percent critical value.

1. $\hat{G}$ = standard error of the regression.

2. AR $(p,n-k-p)F$ = F version of Godfrey's test for residual serial correlation from lags 1 to p (Godfrey 1978a, 1978b).

3. NORM (2) = Lagrange multiplier version of Jarque-Bera's test for the normality of regression residuals (Bera and Jarque (1980).

4. HET (1,n-2) = F Test for heteroscedasticity associated with squares of the explanatory variables (see White (1980)). It is computed by regressing the squared residuals on the squares of the original regressors.

5. ARCH (p) = Lagrange multiplier test for p^{th} order autoregressive-conditional heteroscedasticity (see Engle (1982)).

6. CHOW (.,.) = Chow test for the stability of regression coefficients (Chow (1960)).

7. PRE (.,.) = F version of a test for predictive failure (Chow's second test; see Chow (1960)).

References

Barro, R.J. and H.I. Grossman, "Suppressed Inflation and the Supply Multiplier," Review of Economic Studies, Vol. 41 (1974), pp. 97-104.

Bera, A.K. and C.M. Jarque, "Efficient Tests for Normality, Homoscedasticity, and Serial Independence of Regression Residuals," Economic Letters, Vol. 6 (1980), pp. 295-99.

_____, "An Efficient Large-Sample Test for Nomality of Observations and Regression Residuals," Australian National University Working Papers in Economics, No. 40 (1981), Canberra.

Blanchard, Olivier, and Stanley Fischer, "Lectures on Macroeconomics," (Cambridge, Mass.: MIT Press, 1989).

Burton, David, "Two-Track Pricing and Repressed Inflation in China", (unpublished; Washington: International Monetary Fund, 1990).

Chow, G.C., "Tests of Equality Between Sets of Coefficients in Two Linear Regressions," Econometrica, Vol. 28 (1960), pp. 591-605.

_____, "Money and Price Level Determination in China," Journal of Comparative Economics, Vol. 11 (1987), pp. 319-33.

Currie, D., "Some Long-Run Features of Dynamic Time Series Models," Economic Journal, Vol. 91 (1981), pp. 704-15.

Cuthbertson, Keith, "The Supply and Demand for Money" (New York: Basil Blackwell, 1985).

_____, and Mark P. Taylor, "The Demand for Money: A Dynamic Rational Expectations Model," The Economic Journal, Vol. 97 (Conference 1987), pp. 65-76.

De Wulf, Luc, and David Goldsbrough, "The Evolving Role of Monetary Policy in China," Staff Papers, International Monetary Fund (Washington), Vol. 33, No. 2 (June 1986), pp. 209-42.

Engle, R.F., "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom," Econometrica, Vol. 50 (1982), pp. 987-1008.

Ericsson, Neil R., "Some Issues in Modeling the Demand for Money," (1986), unpublished manuscript.

Feltenstein, Andrew, and Jiming Ha, "Measurement of Repressed Inflation in China: The Lack of Coordination Between Monetary and Price Controls," (1988), unpublished manuscript.

_____, D. Lebow, and Sweder van Wijnbergen, "Savings, Commodity Market Rationing and the Real Rate of Interest in China," World Bank, CPD Discussion Paper No. 1986-27 (1986).

Gilbert, Christopher L., Practitioner's Corner, Professor Hendry's Econometric Methodology, "Econometric Modelling with Cointegrated Variables: An Overview," Oxford Bulletin of Economics and Statistics, Volume 48, (August 1986), p. 283.

Godfrey, L.G., "Testing Against General Autoregressive and Moving Average Error Models when the Regressors Include Lagged Dependent Variables," Econometrica, Vol. 46 (1978a), pp. 1293-1302.

_____, "Testing for Higher Order Serial Correlation in Regression Equations when the Regressors Include Lagged Dependent Variables," Econometrica, Vol. 46 (1978b), pp. 1303-10.

Granger, C.W., Developments in the Study of Cointegrated Economic Variables, "Econometric Modelling with Cointegrated Variables: An Overview," Oxford Bulletin of Economics and Statistics, Volume 48 (August 1986), p. 213.

Harding, Harry, China's Second Revolution: Reform After Mao (Washington: The Brookings Institution, 1987).

Hendry, David F., "Econometric Modelling with Cointegrated Variables: An Overview," Oxford Bulletin of Economics and Statistics, Vol. 48, (August 1986), p. 201.

_____, and Jean-François Richard, "On the Formulation of Empirical Models in Dynamic Econometrics", Journal of Econometrics, Vol. 20 (1982), pp. 3-33.

Laidler, David, The Demand for Money, (New York: Harper and Row, 1985).

Perkins, Dwight H., "Reforming China's Economic System," Journal of Economic Literature (June 1988), pp. 601-45.

Portes R., and A. Santorum, "Money and the Consumption Goods Market in China," Journal of Comparative Economics, Vol. 11 (1987), pp. 354-71.

Qian, Yingyi, "Urban and Rural Household Saving in China," Staff Papers, International Monetary Fund (Washington), Vol. 35 (December 1988), pp. 592-627.

Riskin, Carl, China's Political Economy: The Quest for Development Since 1949 (Oxford University Press, 1987).

Stock, James H., and Mark W. Watson, "Variable Trends in Economic Time Series," Journal of Economic Perspectives, Vol. 2 (Summer 1988), pp. 147-74.

Szapary, Gyorgy, "Monetary Policy and System Reforms in China," (unpublished; Washington: International Monetary Fund, 1989).

White, Halbert, "A Heteroscedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroscedasticity," Econometrica, Vol. 48 (July 1980), pp. 817-38.