MONEY AND PRICE LEVEL DETERMINATION

IN CHINA

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INTRODUCTION

The most crucial component of economic reform in China in the second half of the 1980's is price reform. In the important Decision of the Central Committee of the Communist Party of China on Reform of the Economic Structure, adopted on October 20, 1984, price reform was stated as a key component (see China Daily, October 22, 1984, pp. 9-10). Its crucial role in achieving the other components, especially allowing more autonomy to state enterprises, was explicitly pointed out in the Decision: "The prices of many commodities reflect neither their value nor the relation of supply to demand. This irrational price system has to be reformed. Otherwise it will be impossible to assess correctly the performance of enterprises, . . . As the decision-making power of enterprises grows, pricing will be increasingly important in regulating their production and operation." In the deliberations in 1986 of the leading members of the State Commission for Restructuring the Economic System and of the People's Bank who are responsible for designing concrete steps of reform to implement the October 1984 Decision, price reform was also recognized to be most fundamental (see Chow, 1986b). A serious concern among Chinese economic officials in carrying out price reform, by decontrolling prices or adjusting them toward market equilibrium levels, is the possible effect on inflation.

Ever since the late 1940's when hyperinflation caused by the excessive printing of money created an economic disorder partly responsible for the collapse of the Nationalist government, Chinese economic officials in both

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the mainland and Taiwan have considered inflation a serious problem. They recognize that government budget deficits may lead to increases in money supply which may in turn lead to inflation. The possible effect of an increase in money supply on inflation became an important issue for the Chinese economic reform officials in 1985 when currency in circulation had actually increased by about 50 percent from the end of 1983 to the end of 1984, mainly as a result of the policy to allow individual banks the discretion to extend credit without having established a mechanism of monetary control by the central bank. The main purpose of this paper is to study the effect of money supply on the price level in China. This topic is not only of theoretical interest in economics, but is of relevance to the choice of different options in carrying out price reforms. To the extent that inflation is found to be a monetary phenomenon, there should be less concern over possible inflationary effects of decontrolling or adjusting prices of selected individual commodities. At the same time, to the extent that upward movements of prices of selected consumer goods require, for political reasons, and assuming downward price rigidity, certain adjustments in money wages which may lead to an increase in money supply, the inflationary effect of the policy can be quantitatively evaluated.

In section 1, I discuss the theoretical issues in applying the quantity theory of money to explaining the price level in the Chinese institutional setting. In section 2, long-run relations based on the quantity theory will be empirically established using Chinese annual data from 1952 to 1983. In section 3, equations explaining short-run price changes from year to year will be estimated and tested. In section 4, for comparison purposes, analogous equations for the long-run and the short-run will be estimated using data of the United States from 1922 to 1953. The similarity of results

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between the two countries are noteworthy. In section 5, additional issues concerning short-run price determination will be addressed, including the possible direct effect of aggregate wage on the price level, a possible structural change after the economic reform began in 1979, and the use of the short-run model for forecasting inflation.

1. THEORETICAL AND INSTITUTIONAL ISSUES

Economists have suggested that the quantity theory of money may provide a crude explanation of the price level. It is of interest to ascertain how well this theory can explain the price level in China from 1952 to 1983, and to compare the results with those obtained for the United States using similar data three decades earlier. To do so, it is necessary to specify the theory more precisely and discuss its relevance in the Chinese setting.

The quantity theory of money is based on the quantity equation

$$Mv = Py \qquad (1)$$

where M is the stock of money, P is the price level, y is national income in real terms, and v is income velocity. The quantity eqution (1) can be interpreted merely as an identity which defines the velocity v as the ratio of national income Py in money terms to the stock of money M. If so interpreted, it cannot serve as an explanation of P. However, if v is nearly constant through time and if changes in y are largely independent of changes in M, and these are big ifs, then a change in M will lead to a proportional change in P. The quantity theory of money is derived from equation (1) on the condition that these two presuppositions are roughly valid. Under this condition, the theory provides an explanation for the price level P.

There are many reasons why the constancy of v is at best a rough approximation to reality. A wellknown one is the Keynesian argument that when prices are rigid an increase in M will lead to a downward movement in the rate of interest and a reduction in v, rather than a rise in P. How good is the assumption of the constancy of v? This question has been answered both theoretically and empirically mainly by reinterpreting (1) as a demand equation for money:

$$\frac{M}{P} = ky \tag{2}$$

where $k = v^{-1}$. If the demand for real money balances, M/P is approximately proportional to real income y, or if (2) is a good approximation to reality, k or its inverse v can be treated as a constant approximately. Theoretically, it is known that the demand for M/P depends also on the rate of interest, and that the income elasticity of demand for money does not have to be unity as (2) implies. These two considerations aside, it is still worthwhile to observe how well equation (2) fits the data.

However, assuming that equation (2) fits the data reasonably well by some standard, one cannot thereby conclude that an increase in M, given y, will lead to a proportional increase in P. Imagine that the data for M and y satisfy the relation M = ky, or

$$\log M = \log k + \log y$$

and that log P is generated as an independent, identically distributed random variable ε. We have

$$\log (M/P) = \log k + \log y - \varepsilon$$

A regression of log (M/P) on log y may yield a coefficient of unity and

possibly a high R^2, supporting the hypothesis (2) and yet changes in M do not affect changes in P. Hence by studying the demand for real money balance through equation (2), one learns little about how money supply affects the price level. Nevertheless, the demand for money is itself a subject of interest.

To apply the quantity theory of money to explain the price level P, we rewrite (1) as

$$P = v(M/y) \qquad (3)$$

If v were close to being constant, regressing logP on log(M/P) would yield a coefficient of unity and a good fit. If v itself is negatively associated with (M/y), changes in P will be less than proportional to changes in (M/y). As long as an increase in (M/y) is not completely offset by a proportional reduction in v, it will have a positive effect on P. The question of how good the assumption of a constant v is should be answered differently depending on the variable one wishes to explain. A constant k may be satisfactory when equation (2) is used to explain M/P. A constant v may be more or less satisfactory when equation (3) is used to explain P. A more relevant question for the purpose of this paper is how well the theoretical framework suggested by (3) can explain the price level P in China. We will try to answer this question in section 2, and study the short-run dynamics of changes in P in section 3. Before proceeding, let us consider briefly the institutional setting of China and examine whether the theoretical framework above is applicable.

Three sets of issues have to be addressed when the quantity theory is applied to explain a general price index in China. First, prices of many producer and consumer goods have been controlled. Therefore these 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. Second, the quantity theory assumes that all income flows are associated with money payments. As in a less developed economy, some agricultural products in China are a part of national income but do not go through market transactions. Furthermore, as in a centrally planned economy, many producer goods are paid for by transfers of funds to and from bank accounts held by state enterprises. Bank deposits of state enterprises are often earmarked for specific purposes and cannot be used to finance general purchases. If these deposits are excluded from our definition of money supply, certain flows of producer goods will be excluded from both sides of the quantity equation. The theory may be applicable if we confine ourselves to expenditure flows paid by consumers provided that the variables M, P and y are defined accordingly. Third, related to the choice of variables is the accuracy of Chinese official statistics which will be used to test the theory. The quality of these data has been subject to question by scholars. I have discussed this issue in Chow (1986a). It suffices to point out here that these data have been found reasonable when used to estimate simple economic relationships, including those reported in Chow (1985a, pp. 123, 129, 165-166, and 263, and 1985b). By using these data to test economic hypotheses as in this paper, one learns more about their quality.

Bearing in mind that the stock of money M has to be defined consistently with the output y being purchased at an average price level P, I have decided to confine my attention to retail purchases by consumers. The main price index to be explained is a general index of retail price. The relevant stock of money is currency in circulation. In China consumers do not use checks

and demand deposits by consumers are nonexistent. However, saving deposits exist and could be included in the definition of money. Concerning the output variable y, one may choose to include only those products that are related to final purchases by consumers and to exclude producer goods purchased by state enterprises. I have decided to use a more comprehensive measure of output, namely, national income available as reported in Chinese official statistics. This measure will be appropriate if it is highly correlated with final purchases by consumers. It is interesting to find out how well such a measure which is usually employed in testing the quantity theory can perform in the Chinese context, realizing that the measures of P and M are more narrowly defined. To employ a more narrowly defined measure of y would make the theory less powerful because such a measure itself has to be explained.

2. LONG-RUN EXPLANATIONS OF THE PRICE LEVEL

The general index of retail prices is one of the five price indices regularly published in the Statistical Yearbook of China. In the 1981 edition of the Yearbook (pp. 519-520), the following explanations are given:

> In China there are several ways in pricing commodities, including list prices of the state-owned commercial departments and the free markets (fair trade), the negotiated price and the purchasing price of the surplus farm and sideline products. Therefore, apart from the indexes of the list price, it is important to compile the general retail price index and the general index of the cost of living of the workers and staff members, both of which include the list retail price and the negotiated retail price and the retail price in free market, as well as general purchasing price indexes for farm and sideline products that include the list purchasing price, negotiated purchasing price and the purchasing price of surplus farm and sideline products. The actual value of sales and purchases based on different prices is taken as the weights for calculating the general indexes.

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(1) The index of the list retail price is calculated by the formula of weighted arithmetic mean. The weights used are adjusted annually based on the data on actual retail sales. The markets and items of commodities selected for calculation have been on the increase. At present more than 140 cities and 230 county towns are selected as the basic units for data collection; 450 items of commodities in the cities and 400 in the county towns are included in the calculation. The price of a standard commodity from each item of products is adopted in the calculation.

Almost identical explanations are found in the 1984 edition (pp. 569-579) and the 1985 edition (p. 672). This is the main price index to be studied. Annual data are available, presumably referring to the middle of the year or to an average within the year.

The stock of money is measured by currency in circulation reported in a table on "bank credit receipts and payments" of the Statistical Yearbook. The data are for the end of each year, although for our purpose the unavailable mid-year figures would be more appropriate. The chosen measure of output is national income available. In Chinese official statistics, it is the sum of consumption and capital accumulation, government expenditures being included in either of the two. Some service items are excluded from Chinese national income figures. "National income available" differs from "national income" by including imports minus exports and a statistical discrepancy. To obtain a measure of national income available in real terms, I have deflated it by an implicit deflator which is the ratio of national income in current prices to national income in constant prices (the last two series being found on pp. 29 and 30 respectively of Statistical Yearbook of China, 1984).

Annual data from 1952 to 1983 on the general index of retail price P, currency in circulation M, national income available in real terms y and in nominal terms Y are given in Table 1. In this section, we will examine how

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well the quantity theory of money can provide a framework for explaining the demand for money and the level of retail prices in China, without regard to the short-run dynamics of annual changes. To get some preliminary idea about the possible constancy of income velocity v in the context of the demand for money, I have exhibited the ratio $k = v^{-1}$ of M to Y in the last column of Table 1. Observe that the ratio k changes somewhat from year to year, with large increases occurring in 1960 and 1961 and falling to about normal levels in 1964, smaller but still significant increases in 1967 and 1968, and taking higher values in the 1980's than before. The large increases in k during the political-economic crises of 1960-1961 and 1967-1968 may be attributed to the reductions in national income in the denominator. The higher values in the 1980's may signify the effect of economic reforms leading to an increase in the demand for money. In spite of these changes in velocity, can the quantity theory provide a crude explanation of the demand for money and of the price level?

To investigate the demand for money, we take natural logarithms of both sides of equation (2) and explain ln(M/P) by lny in the following regression using annual data from 1952 to 1983:

$$\ln (M/P) = - 3.927 + 1.162 \ln y \qquad \begin{aligned} R^2 &= .9083 \\ s &= .1971 \\ DW &= .7847 \end{aligned} \qquad (4)$$
$$(.492) \quad (.067)$$

where the standard errors of the regression coefficients are put in parentheses, s stands for the standard error of the regression and DW for the Durbin-Watson statistic. This demand for money equation appears reasonably good except for the facts that the coefficient of ln y, or the income elasticity of demand for money, is larger than unity, contradicting the quantity theory, and that the Durbin-Watson statistic is low, signifying

TABLE 1

PRICE LEVEL AND ITS DETERMINANTS

Year	Index of Retail Price	Currency-in Circulation (100,000 yuan)	Real National Income Available (100,000 1952-yuan)	Nominal National Income Available (100,000 yuan)	Ratio M/Y	Total Wage (100,000 yuan)
	P	M	y	Y	k	W
1952	1.118	38.55	607.0	607.0	.0635	68.78
1953	1.156	39.60	688.5	727.0	.0545	90.15
1954	1.183	41.19	726.5	765.0	.0538	99.79
1955	1.195	40.13	773.9	807.0	.0497	110.44
1956	1.195	57.03	868.2	888.0	.0642	161.56
1957	1.213	52.80	928.0	935.0	.0565	188.44
1958	1.216	67.59	1098.7	1117.0	.0605	200.62
1959	1.227	74.98	1241.0	1274.0	.0589	262.73
1960	1.265	96.10	1215.6	1264.0	.0760	300.82
1961	1.470	125.67	838.7	1013.0	.1241	289.87
1962	1.526	106.66	791.0	948.0	.1125	265.32
1963	1.436	89.76	893.6	1047.0	.0857	265.22
1964	1.383	80.26	1009.6	1184.0	.0678	281.59
1965	1.346	90.82	1129.7	1347.0	.0674	295.49
1966	1.342	108.25	1316.8	1535.0	.0705	305.48
1967	1.332	121.97	1212.2	1428.0	.0854	313.57
1968	1.333	134.12	1175.4	1409.0	.0952	317.72
1969	1.318	137.29	1338.6	1537.0	.0893	328.61
1970	1.315	123.56	1690.7	1876.0	.0659	342.78
1971	1.305	136.23	1795.4	2008.0	.0678	367.42
1972	1.302	151.02	1836.1	2052.0	.0736	412.43
1973	1.310	166.33	2010.8	2252.0	.0739	428.91
1974	1.317	176.36	2041.3	2291.0	.0770	450.62
1975	1.319	182.70	2218.8	2451.0	.0745	469.47
1976	1.323	203.82	2202.5	2424.0	.0841	490.14
1977	1.350	195.37	2313.4	2573.0	.0759	514.95
1978	1.359	212.27	2638.3	2975.0	.0714	570.09
1979	1.386	267.71	2861.2	3356.0	.0798	651.62
1980	1.469	346.20	3037.0	3686.0	.0939	776.93
1981	1.504	396.34	3144.8	3887.0	.1020	818.76
1982	1.533	439.12	3448.1	4256.0	.1032	879.79
1983	1.556	529.78	3812.8	4731.0	.1120	931.51

positive serial correlation in the residuals. Both of these characteristics have been found in demand for money equations estimated using data for the United States (see equation (4A) of section 4). A simple way to account for the positive serial correlation in the residuals is to assume that lny explains only the equilibrium level of ln(M/P), and that the actual change in ln(M/P) is only a fraction of the difference between this equilibrium level and the actual level, leading to the equation, for 1953-1983:

$$\ln(M/P)_t = -1.322 + .3504 \ln y + .7409 \ln(M/P)_{t-1} \qquad \begin{array}{l} R^2 = .9749 \\ s = .1024 \\ DW = 2.101 \end{array} \qquad (5)$$
$$(.394)\ (.0966) \qquad (.0813)$$

The positive serial correlation in the residuals is eliminated in equation (5) as seen from the Durbin-Watson statistic. For our purpose, it is important to note that the quantity theory as formulated in equation (2) provides a reasonable first approximation in explaining the demand for money in China.

To find out how well the price level can be explained, we take logarithms of both sides of (3) and regress ln p on ln(M/y) using annual data from 1952 to 1983, obtaining

$$\ln P = .9445 + .2687 \ln(M/y) \qquad \begin{array}{l} R^2 = .8217 \\ s = .0363 \\ DW = 1.003 \end{array} \qquad (6)$$
$$(.0567)\ (.0229)$$

Equation (6) shows that the ratio M/y does provide a good explanation of the price level P, as the quantity theory predicts. The t statistic for the coefficient of ln(M/y) is .2687/.0229 or 11.76, and the R^2 is fairly high. However, the coefficient of ln(M/y) is only .2687 and very much below unity, contradicting the quantity theory. The conclusion is that although the ratio

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M/y can explain the price level P fairly well, changes in M/y lead to less than proportional changes in P. This can happen if v is negatively associated with M/y so that when M/y increases, its effect is partly absorbed by the reduction in v and only partly reflected in an increase in P. A second shortcoming of equation (6) is the low Durbin-Watson statistic, a subject to be studied in section 3. Before concluding this section, we will check whether the variables M and y should enter equation (6) separately or as a ratio as implied by the quantity theory. Regressing lnP on lnM and lny separately yields

$$\ln P = .6219 + .2388 \ln M - .2046 \ln y \qquad \begin{array}{l} R^2 = .8566 \\ s = .0331 \\ DW = .9546 \end{array} \qquad (7)$$
$$ (.1320) \ (.0237) \qquad (.0319)$$

The coefficient of lny turns out to be approximately equal to the negative of the coefficient of lnM. To test the null hypothesis that the coefficient of lny indeed equals the negative of the coefficient of lnM, we compare the sum of squared residuals of the restricted regression (6), or .039577, with the corresponding sum of the unrestricted regression (7), or .031834. The ratio of their difference .007743 to the latter sum is only .2432, far from being significant as a statistic from the $F(1,29)$ distribution and supporting the hypothesis that $\ln(M/y)$ is an appropriate variable to use in explaining lnP.

3. SHORT-RUN DYNAMICS OF PRICE CHANGES

In equations (6) and (7) we have found that the price level P can be reasonably explained by the ratio M/y as suggested by the quantity theory, although velocity is not constant, resulting in less than proportional changes in P. It is often easier to explain the levels of economic variables than their changes. How well can the theoretical frameqork of equation (6)

explain annual changes in lnP? To answer this question two common approaches
are taken. The first is to introduce the lagged dependent variable lnP_{t-1} in
equation (7), as we did in equation (5), and use the resulting equation to
explain ΔlnP by subtracting lnP_{t-1} on both sides. The second is to take the
first difference of equation (6) and try to explain ΔlnP by $\Delta ln(M/y)$,
allowing for more complicated lag structures.

Pursuing the first approach we find

$$\Delta lnP = .5167 + .1491 \ ln(M/y) - .5054 \ lnP_{t-1}$$
$$(.0656) \ (.0201) \qquad (.0708)$$

$$R^2 = .6824 \qquad (8)$$
$$s = .0199$$
$$DW = 1.341$$

The coefficient of lnP_{t-1} is significant. To use equation (8) for explaining
the level lnP rather than the difference ΔlnP, the coefficient of lnP_{t-1}
would be (1 - .5054) or .4946, and R^2 would be higher. Although (8) is an
improvement over (7), it still leaves a positive serial correlation in the
residuals as seen in the Durbin-Watson statistic.

To pursue the second approach, we attempt to explain ΔlnP by $\Delta ln(M/y)$.
Using the simplest lag structure, we find

$$\Delta lnP = .00747 + .1266 \ \Delta ln(M/y)$$
$$(.00461) \ (.0252)$$

$$R^2 = .4647 \qquad (9)$$
$$s = .0254$$
$$DW = 1.723$$

The result shows that $\Delta ln(M/y)$ is a significant variable in explaining ΔlnP.
R^2 is lower in equation (9) than in equation (8), but the Durbin-Watson
statistic shows less positive serial correlation in the residuals. To
establish a more satisfactory lag structure, we employ the modelling
techniques of error correction and cointegration. Engle and Granger (1987)
provide an exposition of these techniques. I will review briefly the
essential ideas before applying them to the Chinese data.

Suppose that one is interested in establishing a dynamic relationship between the first differences Δy_t and Δx_t of two economic variables and that the levels y_t and x_t of these variables are believed to satisfy certain stable relationship in the long run. In our problem, we may believe that the levels of the variables $\ln P$ and $\ln(M/y)$ satisfy certain long-run equilibrium relationship as estimated by equation (6), and we are interested in constructing a dynamic model for $\Delta \ln P$ and $\Delta \ln(M/y)$. If one were not concerned with the long-run relationship, one might choose the model

$$\Delta y_t = \beta \Delta x_t + \varepsilon_t \tag{10}$$

However, if the ε_t are independent and identically distributed, model (10) implies a non-stationary relationship between the levels y_t and x_t. To convert (10) to a relation between the levels, we apply the identity

$$y_t = \sum_{s=1}^{t} \Delta y_s + y_0 \tag{11}$$

and substitute the right-hand side of (10) for Δy_s, yielding

$$y_t = \sum_{s=1}^{t} (\beta \Delta x_s + \varepsilon_s) - y_0 = \beta \sum_{s=1}^{t} \Delta x_s + \sum_{s=1}^{t} \varepsilon_s + y_0$$

$$= \beta x_t + y_0 - \beta x_0 + \sum_{s=1}^{t} \varepsilon_s \tag{12}$$

The residual $\sum_{s=1}^{t} \varepsilon_s$ in the regression of y_t on x_t is not only serially correlated but has a variance increasing linearly with time.

To allow for a stable long-run relationship $y_t = \alpha x_t$ between y_t and x_t in a model explaining Δy_t by Δx_t, one may introduce an error correction mechanism by using the lagged deviation $(y_{t-1} - \alpha x_{t-1})$ from the long-run relationship as an additional variable in (10), yielding

$$\Delta y_t = \beta \Delta x_t - \gamma(y_{t-1} - \alpha x_{t-1}) + \varepsilon_t \qquad (13)$$

The rationale is that if in the last period y_{t-1} is above its long-run equilibrium level αx_{t-1}, the change in y_t during the current period should be smaller, and vice versa. The error correction model (13) has two desirable characteristics. It is stationary. The long-run change in y_t associated with a permanent unit change in x_t is α. Both can be easily shown by converting (13) into an equation in the levels of the variables:

$$y_t = (1 - \gamma)y_{t-1} + \beta x_t - (\beta - \alpha\gamma)x_{t-1} + \varepsilon_t \qquad (14)$$

When $0 < \gamma < 1$, the coefficient $(1 - \gamma)$ is smaller than one, giving a stationary model for y_t. The long-run relation between y and x is given by

$$[1 - (1 - \gamma)]y = [\beta - (\beta - \alpha\gamma)]x \qquad (15)$$

which is obtained by collecting all the coefficients of the y and x variables while ignoring the time subscripts. From (15), we have $y = \alpha x$, which is the long-run relationship.

These two desirable characteristics remain when the error correction term $\gamma(y_{t-1} - \alpha x_{t-1})$ is added to a more complicated distributed lag relation between Δy_t and Δx_t than (10), such as

$$\Delta y_t = \beta_1 \Delta x_t + \beta_2 \Delta x_{t-1} + \beta_3 \Delta y_{t-1} + \varepsilon_t \qquad (16)$$

An error correction model is a special case of a dynamic model for the first differences of variables in which the variables are "cointegrated," i.e., the levels of the variables (obtained by integrating the differences) satisfy certain long-run relation or relations.

To construct an error correction model to explain $\Delta\ln P$ by $\Delta\ln(M/y)$, we allow the short-run dynamics to be as complicated as in equation (16) and add an error correction term. The error correction term can be estimated as the difference between $\ln P_{t-1}$ and the regression of $\ln P_{t-1}$ on $\ln(M/y)_{t-1}$, i.e., as the lagged residuals u_{t-1} in the regression equation (6). Using annual data from 1954 to 1983, this model is estimated to be

$$\Delta\ln P = \underset{(.00380)}{.00445} + \underset{(.0217)}{.1364} \Delta\ln(M/y) + \underset{(.0328)}{.0267} \Delta\ln(M/y)_{-1} \qquad \begin{array}{l} R^2 = .7247 \\ s = .0195 \\ DW = 1.895 \end{array} \qquad (17)$$

$$+ \underset{(.1447)}{.1415} \Delta\ln P_{-1} - \underset{(.1478)}{.3086}\, u_{t-1}$$

The coefficient $-.3086$ of the error correction term has the correct sign and is statistically significant. The residuals of the regression do not show a significantly positive serial correlation. The lag structure, however, is more complicated than necessary in that both the coefficients of $\Delta\ln(M/y)_{-1}$ and of $\Delta\ln P_{-1}$ are not significant. If the weakest variable $\Delta\ln(M/y)_{-1}$ is dropped, the result is

$$\Delta\ln P = \underset{(.00376)}{.00422} + \underset{(.0201)}{.1430} \Delta\ln(M/y) + \underset{(.1098)}{.2176} \Delta\ln P_{-1} \qquad \begin{array}{l} R^2 = .7174 \\ s = .0193 \\ DW = 2.068 \end{array} \qquad (18)$$

$$- \underset{(.1209)}{.3771}\, u_{t-1}$$

Equation (18) is a satisfactory error correction model. All the three coefficients have the right signs and are statistically significant. The Durbin-Watson statistic indicates the lack of positive serial correlation in the residual. The equation explains about 72 percent of the variance of $\Delta\ln P$. Engle and Granger (1987) suggest seven tests of the null hypothesis

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that a long-run relation between the levels of the variables do _not_ exist.
One such test is to examine the DW statistic of the regression (6) and accept
the null hypothesis if it is close to zero. Since the DW statistic is as
high as 1.003, we reject the null hypothesis and conclude that a long-run
relation between lnP and ln(M/y) does exist, as suggested by the quantity
theory. The short-run dynamic relation between lnP and ln(M/y) is satis-
factorily given by equation (18).

4. COMPARABLE ANALYSES OF U.S. DATA

It is interesting to find out how well the statistical models of
sections 2 and 3 can explain a comparable set of data for the United States.
To do so I have selected a sample of annual data of the same length from 1922
to 1953, used in my study of the demand for money (1966), and estimated
equations analogous to (4), (5), (6), (7), (8), (9), (17) and (18). The
selection of this sample period is somewhat arbitrary. The period includes
the Great Depression and World War II, providing variations in the data
comparable to those occurring after the Great Leap Forward movement in
China. Our main purpose is to see whether the explanatory power of the
theoretical framework is different and how different. For the U.S.
equations, P is a price index of consumer expenditures, M is currency and
demand deposits adjusted in the middle of the year, and y is net national
product deflated by the above consumer price index, as referenced in Chow
(1966, pp. 128-129). For ease of comparison, the equations are given the
same numbers as before, except with an A added.

The demand for money equation corresponding to (4) is

$$\ln (M/P) = - 3.912 + 1.241 \ln y \qquad \begin{array}{l} R^2 = .9216 \\ s = .1428 \\ DW = .4070 \end{array} \qquad (4A)$$
$$ (.801) \quad (.066)$$

After adding the lagged dependent variable, it becomes

$$\ln(M/P) = -.5942 + .1908 \ln y + .8487 \ln(M/P)_{-1} \qquad \begin{array}{l} R^2 = .9856 \\ s = .0616 \\ DW = 1.141 \end{array} \qquad (5A)$$
$$ (.4570) \ (.0954) \qquad (.0735)$$

The similarities between these equations and (4) and (5) are striking. (5A) is slightly less satisfactory than (5) in having a smaller t ratio for ln y and a lower DW statistic.

The equations explaining lnP corresponding to (6) and (7) are

$$\ln P = .4699 + .6334 \ln(M/y) \qquad \begin{array}{l} R^2 = .7324 \\ s = .1239 \\ DW = .2381 \end{array} \qquad (6A)$$
$$ (1031) \quad (.0699)$$

$$\ln P = -.7472 + .5385 \ln M - .4493 \ln y \qquad \begin{array}{l} R^2 = .7376 \\ s = .1248 \\ DW = .1806 \end{array} \qquad (7A)$$
$$ (1.6106) \ (.1437) \qquad (.2531)$$

To test whether the coefficient of lny equals the negative of the coefficient of lnM, we compare the sum of squared residuals of (6A) .46026 with the sum for (7A) .45134. Their difference divided by the latter sum is .0198, not at all significant as an $F(1, 29)$ statistic and supporting equation (6A). However, the DW statistics of (6A) is very low, requiring further modelling of the dynamics of $\Delta \ln P$ as in (8) and (9).

The corresponding results from the U.S. data are

$$\Delta \ln P = .1632 + .1450 \ln(M/y) - .1313 \ln P_{-1} \qquad \begin{aligned} R^2 &= .2950 \\ s &= .0457 \\ DW &= .9079 \end{aligned} \qquad (8A)$$
$$ (.0443) \ (.0442) \qquad (.0632)$$

$$\Delta \ln P = .0116 + .1773 \ \Delta \ln(M/y) \qquad \begin{aligned} R^2 &= .0563 \\ s &= .0520 \\ DW &= .8414 \end{aligned} \qquad (9A)$$
$$ (.0097) \ (.1347)$$

Both equations are not as good as the corresponding equations for China, in terms of the lower t statistics for the coefficients of $\ln(M/y)$ and $\Delta \ln(M/y)$, higher standard errors of the regression and less satisfactory DW statistics.

Attempts to construct a suitable error correction model using the residuals u_t from (6A) have produced

$$\Delta \ln P = .0038 - .0322 \ \Delta \ln(M/y) + .0072 \ \Delta \ln(M/y)_{-1} \qquad \begin{aligned} R^2 &= .5814 \\ s &= .0371 \\ DW &= 1.506 \end{aligned} \qquad (17A)$$
$$ (.0073) \ (.1144) \qquad (.1144)$$

$$+ .6886 \ \Delta \ln P_{-1} - .1578 \ u_{t-1}$$
$$ (.1398) \qquad (.0622)$$

$$\Delta \ln P = .0034 + .6758 \ \Delta \ln P_{-1} - .1575 \ u_{t-1} \qquad \begin{aligned} R^2 &= .5836 \\ s &= .0358 \\ DW &= 1.564 \end{aligned} \qquad (18A)$$
$$ (.0068) \ (.1242) \qquad (.0548)$$

For explaining $\Delta \ln P$ in (17A), neither $\Delta \ln(M/y)$ nor $\Delta \ln(M/y)_{-1}$ are significant. After dropping both terms, we are left with $\Delta \ln P_{-1}$ and the error correction term u_{t-1} in (18A), both being significant. The long-run effect of $\ln(M/y)$ on $\ln P$ implicit in (18A) is still given by the coefficient .6334 of equation (6A). Equation (18A) is of the form

$$\Delta y_t = \beta \Delta y_{t-1} - \gamma(y_{t-1} - \alpha x_{t-1})$$

and can be rewritten as

$$y_t - (1 + \beta - \gamma)y_{t-1} + \beta y_{t-2} = \gamma \alpha x_{t-1} \qquad (19)$$

which implies a long-run relationship $\gamma y = \gamma \alpha x$ or $y = \alpha x$.

By (19) we see that (18A) amounts to explaining $\ln P_t$ or $\Delta \ln P_t$ by $\ln P_{t-1}$, $\ln P_{t-2}$ and $\ln(M/y)_{t-1}$. By adding the variables $\ln(M/y)_t$ and $\ln(M/y)_{t-2}$ in the regression of $\Delta \ln P_t$ on the above variables, we have found them to be very insignificant, with t ratios of $-.097$ and $.083$ respectively. Dropping these variables, the regression becomes

$$
\begin{aligned}
\Delta \ln P = \ &.0990 + .4803\ \ln P_{-1} - .6357\ \ln P_{-2} && R^2 = .5900 \qquad (18B)\\
&(.0430)\ (.1496) \qquad\quad (.1405) && s\ = .0362\\
& && DW = 1.538\\[6pt]
&+ .1135\ \ln(M/y)_{-1}\\
&\ \ (.0412)
\end{aligned}
$$

Note that (18A) and (18B) are less satisfactory than equation (18) for China in having lower R^2's, larger standard errors of the regression, and DW statistics further away from 2. The DW statistic of (6A) is low, failing to reject the null hypothesis that a stable long-run relation between $\ln P$ and $\ln(M/y)$ does not exist.

In summary, we have found $\ln(M/y)$ to be a significant variable in explaining $\ln P$ in both China and the United States, but the short-run dynamics is harder to model and the long-run relationship may be less stable for the United States.

5. ADDITIONAL ISSUES

Two additional issues are addressed in this section. First, does total wage affect the price level? Second, does our equation (18) remain stable

after the economic reforms from 1979 on and how well does it forecast for 1984? To answer the first question, a wage variable W is constructed as the sum of total wage of state enterprises (Statistical Yearbook of China, 1984, p. 458) and total wage of collective enterprises. The latter equals the number of staff and workers in collectives (Yearbook 1984, p. 110) times their average wage rate, which is assumed to be the average wage rate in state enterprises divided by 1.2752. 1.2752 is the ratio prevailing in 1978 (Yearbook 1984, p. 455). Data for W are also given in Table 1. Adding lnW in equation (6) gives

$$\ln P = .5297 + .2010 \ln(M/y) + .0430 \ln W \qquad \begin{aligned} R^2 &= .8786 \\ s &= .0305 \\ DW &= .9543 \end{aligned} \qquad (20)$$
$$ (.1221) \ (.0266) \qquad\quad (.0117)$$

The coefficient of lnW is statistically significant, but the effect is small, having an elasticity of only .043. If $\ln W_t$ and $\ln W_{t-1}$ are added to equation (18), their coefficients have t statistics of .309 and -.164 and the coefficients of the other three variables are hardly affected. It can be concluded that the effect of money supply on the price level is much more important than that of the wage bill, and that equation (18) remains valid in ignoring the possible effects of total wage.

To see whether equation (18) is subject to a structural change after 1979, we perform the standard F test by dividing the data into two periods, the first from 1954 to 1978 and the second from 1979 to 1983. The sum of squared residuals of the two separate regressions is .008217 with 30-8 or 22 degrees of freedom. The sum of squared residuals of the pooled regression (18) is .009731 with 30-4 or 26 degrees of freedom. The test statistic is the ratio of (.009731 - .008217)/4 to .008217/22, or 1.013, much smaller than the 10% right-tail critical value 2.22 for the $F(4, 22)$ distribution. We

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thus accept the null hypothesis that the four coefficients of equation (18) did not change after 1979.

If equation (18) remains valid after the economic reforms began in 1979, it can be used to forecast the retail price index P. The first post-sample year 1984 provides a good opportunity for observing how well equation (18) can forecast since there was a rapid increase in the amount of currency in circulation M from 529.78 hundred-thousand yuan at the end of 1983 to 792.11 at the end of 1984, while the index of real national income increased by a much smaller percentage of 13.9 (see Statistical Yearbook of China 1985, p. 34). To perform the forecasting experiment for 1984, we rewrite equation (18) as an equation explaining $\ln P$ by $\ln P_{-1}$, $\ln P_{-2}$, $\ln(M/y)$ and $\ln(M/y)_{-1}$:

$$\ln P = .360428 + .840422 \ln P_{-1} - .217564 \ln P_{-2}$$
$$+ .143004 \ln(M/y) - .0416556 \ln(M/y)_{-1} \tag{21}$$

Data for P_{-1}, P_{-2} and $(M/y)_{-1}$ are given in Table 1. M is 792.11; y is 4342.79, or 13.9 percent higher than the 1983 figure given in Table 1. Using these data, equation (21) yields a forecast of .477928 for $\ln P$ or 1.6127 for P in 1984. The actual value of P in 1984 is 1.600 (see Yearbook 1985, p. 530). The error in forecasting $\ln P$ is -.0079, even smaller than the standard error of regression .0193 for equation (18). Hence equation (18) stands up very well when it is used to forecast the retail price index in 1984.

In this paper I have found that the quantity theory of money provides a useful first approximation to explaining the index of retail prices in China. The ratio of money supply to real output is an important variable in explaining the price level, as the quantity theory implies. The elasticity of price with respect to this ratio is smaller than unity,

however, suggesting that velocity is not constant. The assumption of constant velocity may be more or less reasonable, depending on whether one wishes to explain the demand for money or the price level. The success in one case does not carry over to the other. The theoretical framework is somewhat more successful in explaining the Chinese data from 1952 to 1983 than the United States data from 1922 to 1953. The model for short-run changes in log price is better, and the stability of a long-run relation between the price level and the money-output ratio is better established for China. Total wage is found to assert little or no additional effect on price. The model for price change is stable after 1979, and forecasts well in 1984.

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