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SAVINGS, COMMODITY MARKET RATIONING AND THE REAL RATE OF INTEREST IN CHINA

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ABSTRACT

This paper uses an intertemporal, disequilibrium framework to analyze the rapid increase in personal savings that has taken place in China since 1979. A theoretical model of savings behavior under rationing is developed, and a specification of a "virtual" price index is derived. The virtual price index is then used to estimate certain savings functions, and is found to explain the data better than official price indices. When savings are allowed to depend on real interest rates, defined in terms of the virtual price index, a negative and significant interest rate effect on consumption is found. Using official prices these results no longer hold.

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1. INTRODUCTION

Developing adequate theories to describe household savings behavior has been a major element in modern economics. In this paper we attempt to develop such a theory for a highly non-market economy, and apply the resulting model to China, a country where private saving has undergone dramatic changes over the past thirty five years. China is of particular interest for a variety of reasons. First, because prior to the reforms carried out in 1979, it represented an extreme example of a repressed economy. Second, because it is now undergoing a series of economic reforms that are quite possibly the most far-reaching ever undertaken by a socialist country; one of the first indicators of the impact of these reforms has come in the dramatic increase in the volume of savings. Finally, because the analysis of private savings allows one to derive an empirical measure of the degree to which markets are repressed in China. Our results also refute the commonly stated notion that in planned economies such as China, consumers are subject to too many regime shifts to exhibit stable behavior characteristics.

A recent article by Chow (1985) demonstrates that it is, indeed,

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possible to estimate stable behavioral relationships in the Chinese economy, in this case a version of the permanent income hypothesis. Chow's article, however, makes an assumption that we wish to avoid, namely, that official price data indeed reflect the costs that people perceive themselves as facing. This is an especially important assumption in a model that attempts to explain savings, since in an economy with significant price controls the official rate of inflation may distort the relative cost of present and future consumption. Our general assertion is that the Chinese consumer finds himself in a world in which goods markets do not, at least temporarily, clear because of government price controls. He has two possible views of the future; in one of these he expects markets to clear when prices eventually adjust, while in the other he expects markets to remain repressed indefinitely. In either of these circumstances the consumer's perception of the future purchasing power of his savings will be different than if he believed that he could satisfy his goods demands at existing official prices.

We demonstrate that ignoring non-market clearing phenomena in China causes false qualitative conclusions to be drawn about savings behavior. We will show, for example, that use of the official rate of inflation series leads one to conclude that there has been a regime shift affecting household savings. Using the measure of repressed inflation that we shall develop, however, we find that there have been no regime shifts. We will also demonstrate that a number of neo-classical theories of savings are supported by our disequilibrium estimates and, perhaps more surprising, that household savings are responsive to real interest rates, if these rates are defined in terms of "virtual", or repressed, inflation rates.

There have been numerous studies of savings behavior in centrally planned economies (CPEs) 1/ with approaches to the problem falling essentially in one of two categories. In the first (e.g., Portes and Winter, 1978; Pickersgill, 1976, 1980), there is no allowance made for the potential disequilibrium - the analysis assumes equilibrium and proceeds as if the CPEs were market oriented economies. This is clearly inappropriate in the presence of substantial repressed inflation, as observed quantities will not be on the consumption demand curve. The estimation is quite simple, however, and may yield reasonable results if the macroeconomic disequilibrium is not "too" pervasive.

The second approach (e.g., Portes and Winter, 1980; Podkaminer, 1982), involves explicit disequilibrium econometric techniques, 2/ which attempt to disentangle supply and demand schedules using a min-condition and discrete switching. The methodology is valid, although difficult to implement, and it requires specification of a supply equation in addition to demand. 3/

This paper presents a third approach, that of "virtual prices."4/ The virtual price level is defined as that which would induce the observed

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1/ Portes (1986) provides a survey of this literature.

2/ The methodology is described in Fair and Jaffee (1972) and in Quandt (1982).

3/ A methodology which does not fit into either approach is that of Howard (1976). See Portes and Winter (1980) for a discussion of the limitations of his approach.

4/ The concept of virtual prices is introduced and analyzed extensively in Neary and Roberts (1980). Feltenstein and Farhadian (1986) uses virtual prices to explain money demand in China, and van Wijnbergen (1985) uses virtual prices to analyze the intertemporal consequences of commodity market rationing.

quantity of consumption (and savings) in the absence of price controls. By specifying the relationship between virtual and official prices, we may use the (unobserved) virtual prices to estimate a demand schedule as if we were in equilibrium. This methodology thus takes the potential disequilibrum into account while maintaining the simplicity and clarity of the first methodology above.

The next section will give a brief overview of certain relevant aspects of recent Chinese economic history, while Section 3 develops a theoretical disequilibrum model suitable for our analysis. Section 4 presents estimation results for a number of standard specifications of savings behavior. Section 5 estimates a neo-classical specification of savings based on real interest rates, while Section 6 is a summary and conclusion.

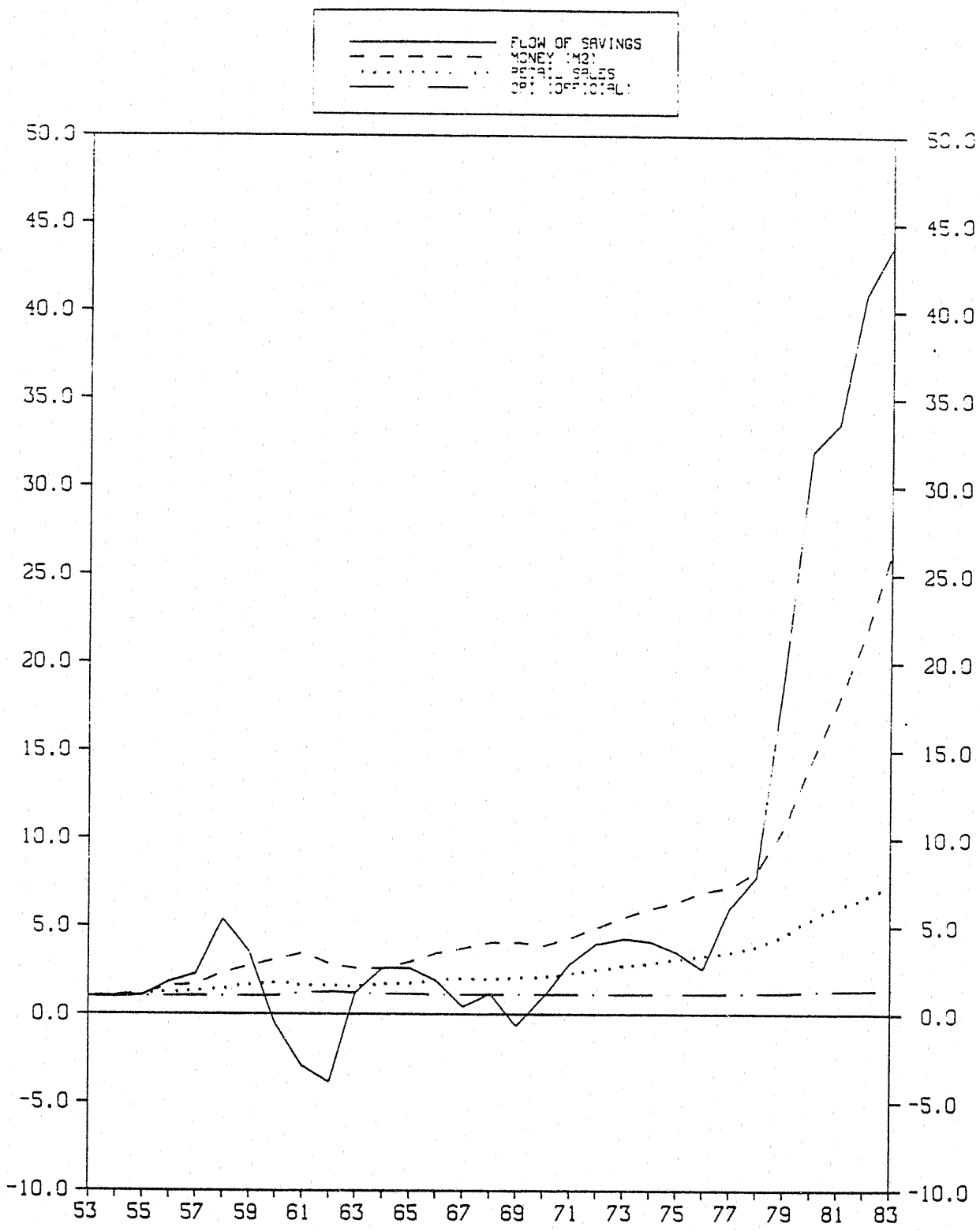
2. INSTITUTIONAL CHANGES AND THE BEHAVIOR OF HOUSEHOLD SAVINGS IN CHINA

As indicated by Chart 1, household savings in China, after being a fairly stable fraction of national income for 25 years, rose sharply following the economic reforms instituted in 1979. These reforms are described in de Wulf (1985a,b) and De Wulf and Goldsborough (1986), while their monetary implications are discussed in Feltenstein and Farhadian (1986), as well as in Chow (1986a) and Portes and Santorum (1986). We will summarize here those aspects of the Chinese economic system, both pre- and post- reform, that are relevant for our analysis.

Prior to 1979, the Chinese system did not view private savings as being a source of investment funds. Rather, lending for investment came from the budget and was interest free. Banks did offer low interest rates on

Chart 1

CHINA - SCALED MACRO VARIABLES



deposits, and used these deposits to make short term loans to enterprises. Households, in turn, received wage payments in currency and although they were free to use their cash balances as they wished, the absence of financial assets forced them to distribute their income between current expenditure and savings deposits. The government, in turn, used a "cash plan" to attempt to determine the quantity of money held by households. It was felt that this quantity of money could have inflationary pressures if it grew too rapidly and was not channelled into savings.

"If social purchasing power much exceeds commodity supplies, then part of the purchasing power will not be realized and will become excess currency circulation on the market which will influence the stability of the market and currency. Of course, if it is the purchasing power of the urban and rural population that is not realized then currency will accumulate in their hands, or in the form of savings deposits." 1/

At various periods, the Chinese authorities have experienced major failures in controlling monetary expansion, with immediate implications for savings behavior. During the period of the Great Leap Forward (1958-59) credit policy became, "Give as many loans as are needed whenever they are needed." 2/ Currency in circulation thus rose by 140 percent between 1957 and 1961. The degree of repressed inflation rose steadily, and by 1961 could no longer be contained, with prices rising 16 percent, or about 8 times the previous average rate of inflation. Consumers responded in a neo-classical fashion by reducing their banks deposits by 50 percent between 1959 and

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1/ Liu (1980), p. 169, quoted in Peebles (1983), p. 86.

2/ Li Chengrui (1981).

1962. A similar situation occurred during the Cultural Revolution, particularly during 1966-69 and 1974-76.

Since 1979, considerable autonomy has been granted to enterprises in wage determination; in addition, they are being permitted to retain profits, which they were previously required to remit to the government. The price system has not, however, been liberalized as rapidly as wages, and the result has been the rapid rise in savings. In addition, banks have been given greater autonomy with respect to interest rates, among other things. "Banks may make use of methods such as extending or refusing loans,...., raising or lowering interest rates, rewarding the good and penalizing the bad." 1/ As an attempt to control the rapid expense in liquidity, and fearing the growing volume of saving deposits was, "a tiger in a cage," the Chinese government in 1982 introduced the sale of Treasury bills to individuals, although the current volume of these sales is still quite low.

We will now develop a model that allows us to predict ex ante the rate of inflation in the virtual price index corresponding to a particular level of market disequilibium. In addition, we will estimate the responsiveness of household savings to interest rates, shedding light on the effectiveness of one aspect of government macroeconomic policy. Finally, our estimates will indicate that Chinese consumers have not responded to market shortages by simply involuntarily saving excess wages, but that anticipation of future market conditions has also played a role.

1/ "Strive to Implement the 1985 Credit Plan," Zhongguo Jinrong (1985).

3. A SIMPLE MODEL OF GOODS MARKET RATIONING AND SAVINGS BEHAVIOR

The purpose of this section is to derive a simple equation describing private savings behavior in the presence of commodity market rationing. In the process we also discuss the measurement of wealth when market prices do not represent the marginal cost of the goods concerned. We first present a simple theoretical analysis of goods market rationing, intertemporal trade and macroeconomic policy. The model is designed with empirical application in mind. We first present a market clearing version of the basic model, and then proceed to introduce commodity market rationing.

3.1 An Equilibrium Model of Price determination and Savings Behavior

Consider a simple two period, one commodity per period world. Since we intend to focus on savings behavior rather than the intertemporal allocation of production through investment, we will assume output to be fixed in each period, at level X in period one and at level x in period 2. 1/ In addition, we will suppose that that the economy is closed. Some of the output goes towards government expenditure. By assumption, the government is never rationed. G (g) is government expenditure in period one (two). We set g equal to zero for notational convenience. 2/

1/ We will use upper case letters for first period variables and lower case letters for second period variables.

2/ Government expenditure plays no important role in our theoretical analysis. It is introduced only as a counterpart to positive net private savings. Alternatively, we could have used an open economy model, allowing for a nonzero current account.

Consumer behavior is summarized through an expenditure function E. E represents the minimum discounted value of current and future expenditure needed to achieve utility level U, given current and future prices:

$$E = E\left(P,\ \delta_N p;\ U\right) \tag{1}$$

P (p) represents the current (future) price level. δ_N is the discount factor:

$$\delta_N = 1/\left(1+i\right)$$

where i is the nominal rate of interest. The derivatives of E with respect to any price give the Hicksian demand function for the corresponding good (cf Dixit and Norman (1980)). Therefore commodity market clearing requires:

$$\begin{aligned} X &= G + E_1\left(P,\ \delta_N p;\ U\right) \\ &= G + E_1\left(1,\ \delta_N p/P;\ U\right) \end{aligned} \tag{2}$$

where E_1 stands for $\partial E/\partial P$, and we have used the fact that the Hicksian demand function is homogenous of degree zero in prices. A similar equation holds for second period goods market clearing, but can be eliminated through Walras' law.

Under the simplifying assumption that there are no first period taxes and no second period government expenditure, the government budget constraint equals:

$$G = \delta t \tag{3}$$

where t is a second period non-distortionary tax and δ the real discount factor, $\delta = p\delta_N/P$. Similarly, the private sector faces a budget constraint:

$$X + \delta x - \delta t = E\left(1, \delta; U\right) \tag{4}$$

The mechanics of intertemporal trade are very simple since the asset choice is limited. Consumers can either hoard commodities, an opportunity which we will have to ignore for lack of relevant data, or deposit any income not spent in time deposit accounts in a bank. We ignore investment, so the only demand for bank loans comes from the government: since it raises no revenue through taxes in period one, it has to fund all its current expenditure through domestic credit to the banking sector. We assume, realistically, that consumers hold no interest bearing government paper other than through the indirect channel we just sketched. We also assume, in accordance with the facts, that consumer loans are negligible. Banks face no reserve requirements and hold no reserves. Therefore the only component of the monetary base is currency held by the public.

For simplicity, we assume in the theoretical analysis that the economy starts out with a stock of monetary base to which nothing is added over time. Consumers' demand for money is derived from a straightforward transaction technology: consumers need to accumulate money balances equal to the exact amount of any purchase before being able to make that purchase (a cash in advance constraint). Therefore money market equilibrium requires:

$$PE_1 = M_1, \; pE_2 = m \tag{5}$$

M (m) is the first (second) period money stock. For convenience we assume M = m, although nothing hinges on that assumption.

The mechanics of the model can be described as follows. Through (5), the money stock determines the price level in each period. Commodity market clearing then requires a nominal interest rate that, in combination with the current and future prices from (5), implies a real rate that makes (2) hold. The commodity market clearing equation (2) in conjunction with the private and public sector budget constraints (3) and (4) imply that in equilibrium, private savings equal public dissaving. This of course reflects our assumptions of no capital accumulation and a closed economy.

3.2 Commodity Market Rationing, Virtual Prices and the Real Rate of Interest

Consider now the possibility of rationing in goods markets. We will only introduce temporary (period one) rationing, but will comment on the intertemporal aspects of permanent rationing later. In China, both prices and interest rates are still to a large extent administratively determined. We will therefore assume that prices and monetary policy are set up in such a way that excess demand results:

$$M/P = E_1\left(1,\delta;\ U\right) > X - G \tag{6}$$

or, when current prices (or real interest rates) are "too" low, there is excess demand for current goods. We can now define a "virtual" real discount factor $\tilde{\delta}$ (or virtual price $\tilde{P}$, where $\tilde{\delta} = \delta_N p/\tilde{P}$), defined as the real discount factor at which consumers would willingly consume the volume of goods available to them at official prices:

$$X - G = E_1 (1, \tilde{\delta}; U) \tag{7}$$

The notion that agents in a repressed economy act as if they face the virtual price level rather than the official price level may be understood in a definitional way and need not be taken literally. Alternatively, we can imagine that rationed consumers really do face certain costs, such as a cost of queuing, which raise the effective price they face above the official price, and $\tilde{P}$ reflects these costs. Of course, virtual prices are not observable; we will therefore derive an approximation formula that expresses $\tilde{P}$ in terms of observable variables. Define, for convenience of notation, R = X-G as the volume of goods available to the public.

Note that

$$M/P - R = E_1 (1, \delta; U) - E_1 (1, \tilde{\delta}; U) \tag{8}$$

or

$$M/(PR) - 1 = (E_1 (1, \delta: U) - E_1 (1, \tilde{\delta}; U))/R \tag{8a}$$

A first order Taylor expansion of (8a) yields:

$$\begin{aligned} M/(PR) - 1 &\approx (\tilde{\delta}E_{12}/R)(\delta - \tilde{\delta})/\tilde{\delta} \\ &= \sigma (\delta - \tilde{\delta})/\tilde{\delta} \end{aligned}$$

where σ is the elasticity of real consumption with respect to the real discount factor (one over one plus the real interest rate). This can be written as an equation in virtual and actual prices, for given nominal interest rates and future prices:

$$(\tilde{P} - P)/P \approx 1/\sigma \left(M/(PR) - 1\right) \tag{9}$$

$\tilde{\delta} = \delta P/\tilde{P}$ gives the link between $\tilde{P}$ and $\tilde{\delta}$. By definition, $E_1 \left(\tilde{P}, \delta_N p; U\right) = X - G$. In our empirical work we use a logarithmic approximation to (9):

$$\log\tilde{P} - \log P \approx 1/\sigma \log\left(M/(PR)\right) \tag{10}$$

Also, the transaction period is not necessarily equal to the calendar year unit over which our data are available. Assume the ratio between the two is fixed and equal to k. k equals the inverse of the income velocity of money.

Equation (10) then becomes:

$$\log \tilde{P} - \log P \approx 1/\sigma\left(\log (M/PR) - \log k\right) \tag{10a}$$

which is the formula actually used in the next two sections.

If we furthermore assume homothetic preferences, we can rewrite the demand function for current goods as:

$$\begin{aligned} E_1 \left(\tilde{P}, \delta_N p; U\right) &= E_1 \left(1, \tilde{\delta}; U\right) \\ &= c \left(\tilde{\delta}\right) E \left(1, \tilde{\delta}; U\right) \end{aligned} \tag{11}$$

where $c[\tilde{\delta}]$ is a share term independent of utility. Now $E \left(\tilde{P}, \delta_N p; U\right)$ equals the discounted value of wealth at virtual prices, something we cannot measure (even if we could measure wealth at actual prices). We know, however, that the intertemporal budget constraint holds at actual, not at virtual prices, since actual transactions take place at posted prices:

$$PR + \delta_N pr = PE_1 \left(\tilde{P}, \delta_N p; U\right) + \delta_N pE_2 \left(\tilde{P}, \delta_N p; U\right)$$

$$= E \left(\tilde{P}, \delta_N p; U\right) + \left(P - \tilde{P}\right)E_1 \left(1, \tilde{\delta}; U\right)$$

or

$$\tilde{P}R + \delta_N pr = E \left(\tilde{P}, \delta_N p; U\right)$$

or

$$R + \left(\delta_N p/\tilde{P}\right) r = E \left(1, \tilde{\delta}; U\right) \tag{12}$$

Combining this with (11) leads to the equation:

$$R = c \left(\tilde{\delta}\right) \left(R + \tilde{\delta}\ r\right) \tag{13a}$$

or, in terms of net discounted future expenditure (savings plus discounted future income),

$$\left(\delta_N/\tilde{P}\right) r = \left(1 - c\left(\tilde{\delta}\right)\right) \left(R + \left(\delta_N p/\tilde{P}\right) r\right) \tag{13b}$$

(13a) and (13b) are the equations underlying the empirical analysis presented in the next two sections. If intertemporal preferences are Cobb-Douglas, $\left(1 - c\left(\tilde{\delta}\right)\right)$ is a constant; section 4 proceeds from that assumption. In section 5, we relax that assumption and estimate functional forms that allow for interest sensitive expenditure shares in wealth.

One further issue cannot be addressed in our two period theoretical model, but needs to be resolved before (13a,b) can be tested against actual data: the issue of how long rationing is expected to last. Clearly nobody expects rationing to last ad infinitum, hence our assumption of period two goods market clearing. Permanent rationing would have no effect on the real interest rate, since it would affect future prices as much as current prices;

the relative price of future goods in terms of current goods would therefore not be affected and neither would savings behavior. But in practical terms, how long is period one? The issue matters for our empirical measure of permanent income $y_p = W/\gamma$ where wealth $W = R + \tilde{\delta}\, r$, and $\gamma = 1/(1-\delta)$.

Consider then a multiperiod world. Assume for simplicity that real income in periods with rationing equals $\tilde{y}$, and in non-rationing periods y. If rationing is expected to last until period T, wealth equals:

$$W = \sum_{i=0}^{T-1} \delta^i \tilde{y} + \sum_{T}^{\infty} \delta^i y \tag{14}$$

This can be written as:

$$\begin{aligned} W &= \sum_{i=0}^{\infty} \delta^i \tilde{y} + \sum_{T}^{\infty} \delta^i (y - \tilde{y}) \\ &= \gamma\tilde{y} + \delta^T \sum_{0}^{\infty} \delta^i (y - \tilde{y}) \\ &= \gamma\tilde{y} + \delta^T \gamma (y - \tilde{y}) \\ &= \gamma \left((1-\delta^T)\tilde{y} + \delta^T y \right) \end{aligned} \tag{15}$$

So if there is no rationing, or rationing is expected to last for a negligible period, $W = \gamma y$; if rationing lasts forever, $W = \gamma\tilde{y}$. In section 4, these two extremes are tested against each other. Note that even if T is small and hence $W \approx \gamma y$, there may still be strong <u>substitution</u> effects; these operate through $\tilde{\delta}$, not through W.

4. VIRTUAL PRICES AND COMMON SAVINGS FUNCTIONS

In this section, we estimate a number of common savings functions under the assumption that consumers respond to virtual prices, and show that this yields superior results to the same functions estimated using official prices. The saving equations in this section are based on the assumption of Cobb-Douglas intertemporal preferences, so that savings will depend on wealth only, not on intertemporal substitution effects.

4.1 Specification of the Empirical Model

The model consists of two equations: a virtual price level equation and a savings equation. The virtual price level is derived in equation (10): 1/

$$\ln \tilde{P} = \ln P + \alpha \ln \left(M/PR\right) \tag{16}$$

where R is real retail sales, M is the stock of money and $\alpha = 1/\sigma$. The specification has a very natural "money chases goods" interpretation. If M and PR increase at the same rate, there is no additional divergence between the official and virtual price levels. When $\alpha = 0$ (the intertemporal substitution elasticity is infinite) the virtual price level collapses to the official price level.

1/ Feltenstein and Farhadian (1986) used a different specification for $\tilde{P}$. In our estimation, the variables P and M/PR were normalized to equal unity in the year 1953. This latter normalization corresponds to the inclusion of the constant k in equation (10a).

We employ several common savings specifications, all involving real per capita disposable income as an explanatory variable for real per capita savings. The virtual price level is used to deflate nominal savings. The following specifications are tested:

$$S/\tilde{P} = b_o + b_1 I^P + b_2 I^t \tag{17}$$

$$S/\tilde{P} = b_o + b_1 (S/\tilde{P})_{-1} + b_2 (I - I_{-1}) \tag{18}$$

$$S/\tilde{P} = b_o + b_1 I + b_2 I_{-1} + b_3 I_{-2} \tag{19}$$

$$S/\tilde{P} = b_o + b_1 I \tag{20}$$

where S is per capita nominal savings and I is per capita real disposable income (divided into permanent and transitory components I^P and I^t). Equation (17) is a permanent income model, equation (18) an asset adjustment model, equation (19) a general distributed lag model, and equation (20) an absolute income model. We define permanent income (I^P) as a 3 year moving average of I, [1] and transitory income (I^t) is defined by $I^t = I - I^P$. It is not our intention to propose any one savings specification appropriate for China; rather, we test a number of common specifications to demonstrate that deflating savings by the virtual price index is more reasonable than deflating by the official price index.

1/ Results will be presented for two definitions of I^P: backward-looking, where $I^P = 1/3\ (I + I_{-1} + I_{-2})$ and forward-looking, where $I^P = 1/3\ (I_{+1} + I + I_{-1})$.

Substituting for $\tilde{P}$ from equation (16), equations (17) to (20) become

$$S/P = \left(\frac{M}{PR}\right)^{\alpha} \left(b_o + b_1 I^P + b_2 I^t\right) \tag{21}$$

$$S/P = \left(\frac{M}{PR}\right)^{\alpha} \left(b_o + b_1\left(\frac{S}{P}\right)_{-1} + b_2\left(I - I_{-1}\right)\right) \tag{22}$$

$$S/P = \left(\frac{M}{PR}\right)^{\alpha} \left(b_o + b_1 I + b_2 I_{-1} + b_3 I_{-2}\right) \tag{23}$$

$$S/P = \left(\frac{M}{PR}\right)^{\alpha} \left(b_o + b_1 I\right) \tag{24}$$

Again, note that when $\alpha = o$, these equations reduce to the usual equations based on the official price level. Hence our hypotheses are nested, with no rationing $(\alpha = 0)$ being a testable restriction. 1/

4.2 The Data

Monetary data are taken from Byrd (1983) and from International Financial Statistics. Income, sales and price data are taken from Chinese Statistical Yearbook (1984). Household savings is taken to be the change in urban and rural savings deposits over the year. As there is no disposable income series, we construct one using retail sales as a proxy for consumption, plus the savings variable. We employ two alternative definitions of real disposable income: one normalized by the official price index, the other by the virtual price index:

1/ The importance of allowing disequilibrium in the maintained hypothesis was stressed by Portes and Winter (1980).

$$I_1 = R + S/P$$

$$I_2 = R + S/\tilde{P}.$$

Retail sales are measured in real units, so in both cases, reported nominal retail sales are normalized by the official price index to obtain R. Regarding the nominal savings component, however, it is less clear which is the more appropriate deflator, and we employ both. As argued in section 3, the choice of deflator should relate to the length of time the rationing is expected to last. Specifically, if rationing is expected to cease after 1 period, I_1 is the appropriate real income definition, and if rationing is expected to last forever, I_2 is the more appropriate definition.

We use a monetary aggregate coresponding to M2, equal to the sum of currency in circulation plus savings deposits. 1/ We take the consumer price index, an average of retail and service price indices, as our official price index. 2/ All data are listed in Appendix A. 3/

4.3 Empirical Results

Equations (21) to (24) were estimated by the nonlinear maximum likelihood technique of Berndt, Hall, Hall and Hausman, on yearly data over the period 1955 to 1983. The model was similarly estimated under the constraint $\alpha = 0$, that is, the official price level is used to deflate nominal savings rather than the virtual price level. The results for the case

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1/ In appendix B, we present selected results using currency in circulation as our definition of money.

2/ Results using the retail price index are similar to these presented here.

3/ For further information on Chinese data, see Chow (1986b).

of one period expected rationing (income normalized by the official price level) are presented in Table 1.

For all savings specifications, estimates for α are highly significant, as is clear from the t-statistics. Indeed a likelihood ratio test decisively rejects the hypothesis $\alpha = 0$ in all specifications, as the X^2 statistics range from 7.4 to 22.8. The .99 value of X_1^2 is 6.63. This in itself is strong evidence in support of our virtual price level specification, since the models are nested and the estimates of α are quite stable across savings specifications. The hypothesis that the highest value of α (1.796) is equal to the lowest value (.729) cannot be rejected (the t-statistic on the difference is 1.84).

Further, in the official price model (i.e., when α is constrained to equal zero), with the exception of the asset adjustment specification, which contains a lagged dependent variable, the Durbin Watson statistic easily rejects the null hypothesis of zero first order serial correlation at a 1 percent confidence level. In the virtual price model, (when α is unconstrained) only the absolute income specification and the forward-looking permanent income specification display serially correlated errors; for the other specifications, zero first order serial correlation cannot be rejected at a 5 percent confidence level. The high degree of serial correlation in the offical price residuals leads one to suspect the existence of a spurious correlation and is, in addition to the highly significant estimate of α, sufficient grounds for rejecting the model.

With regard to the parameter estimates, in all cases savings propensities out of income are much larger in the official price model than in the virtual price model. For example, in the backward-looking permanent income specification, the savings propensities out of transitory and permanent

Table 1

Equation	Period	α	b_o $(x10^{-3})$	b_1	b_2	b_3	LLF	R^2 (H)	DW	$(\alpha = 0)$
a	1955-1983	1.427	-.510	.009	.082		166.7	.9494	1.86	
		(2.99)	(-.71)	(.96)	(2.97)					20.4
		0	-5.767	.081	.209		156.5	.8973	0.87	
			(-7.27)	(8.32)	(4.40)					
b	1955-1982	1.346	-1.519	0.23	.064		153.9	.8931	1.05	
		(2.62)	(-1.44)	(1.64)	(1.63)					11.8
		0	-6.709	.096	.084		148.0	.8355	0.61	
			(-8.19)	11.20)	(.82)					
c	1955-1983	1.796	.103	.560	.034		166.0	.9468	2.32	
		(3.79)	(1.44)	(4.04)	(2.27)				(-1.84)	10.4
		0	.017	.924	.120		160.8	.9237	2.07	
			(.07)	(12.20)	(3.62)				(-0.22)	
d	1955-1983	1.598	-.271	.044	-.002	-.036	168.0	.9536	1.86	
		(3.07)	(-.48)	(2.33)	(-.15)	(-2.69)				22.8
		0	(-5.719	.159	-.024	-.055	156.6	.8977	0.85	
			(-6.96)	(4.23)	(-.39)	(-1.28)				
e	1955-1983	.729	-2.933	.044			157.4	.9039	0.85	
		(2.18)	(-2.21)	(2.47)						7.4
		0	-6.831	.098			153.7	.8754	0.64	
			(-9.68)	(13.77)						

(a) $S/\tilde{P} = b_o + b_1 I^p + b_2 I^t$ where $I^p = \frac{1}{3}\left(I + I_{-1} + I_{-2}\right)$ Permanent Income (Backward-looking)

(b) $S/\tilde{P} = b_o + b_1 I^p + b_2 I^t$ where $I^p = \frac{1}{3}\left(I_{+1} + I + I_{-1}\right)$ Permanent Income (Forward-looking)

(c) $S/\tilde{P} = b_o + b_1\left(S/\tilde{P}\right)_{-1} + b_2\left(I - I_{-1}\right)$ Asset Adjustment

(d) $S/\tilde{P} = b_o + b_1 I + b_2 I_{-1} + b_3 I_{-2}$ General Distributed Lag

(e) $S/\tilde{P} = b_o + b_1 I$ Current income

incomes are, respectively, .082 and .009 in the virtual price model, and .209 and .081 in the official price model. In both models, as we would expect, the propensity to save out of transitory income is much higher than that out of permanent income. However, only in the virtual price model do we fail to reject the theoretically attractive hypothesis that savings out of permanment income is zero.

Next, we show that in the official price level model, the parameter estimates are unstable. We employ a dummy variable which takes a value of unity from 1979-1983, the period of liberalization, and check for a change in slope during this period. In the permanent income model, we check the slope of transitory income. In the asset adjustment model, we check the slope of the change in income. In the distributed lag and current income models, we check the slope of current income. Results are presented in Table 2.

In the virtual price model, only the absolute income specification yields a dummy parameter which is significantly different from zero at 5 percent. In the official price model, however, in four of the five specifications the dummy is significant, indicating a change in the slope during the liberalization period. Further, the inclusion of these slope dummies brings the parameters in the official price specifications closer to those estimated in the virtual price model. In the backward-looking permanent income specification, for example, the coefficient on savings out of transitory income declines from .209 to .148, whereas in the virtual price model the coefficient was estimated to be .082. By no means does adjustment for the regime change eliminate the problems of the official price model; serial correlation is not eliminated and, in two of the specifications, the estimate of alpha is still significant. The result that the virtual price

Table 2

Equation	Period	α	b_0 $(x10^{-3})$	b_1	b_2	b_3	Dummy	LLF	R^2	DW (H)
a	1955-1983	1.234	-.554	.010	.075		.039	168.5	.9552	1.79
		(2.65)	(-.75)	(1.03)	(3.10)		(1.29)			
		0	-4.183	.061	.148		.191	159.9	.9188	0.95
			(-4.41)	(5.23)	(3.01)		(2.57)			
b	1955-1982	1.647	-1.076	.017	.034		.149	155.9	.9077	1.00
		(2.71)	(-1.20)	(1.38)	(.99)		(1.57)			
		0	-6.645	.095	.066		.364	148.3	.8391	0.56
			(-7.99)	(10.87)	(.63)		(0.74)			
c	1955-1983	.989	.144	.588	.040		.061	169.4	.9579	2.25
		(1.63)	(1.39)	(4.31)	(2.08)		(1.26)			(-1.28)
		0	.149	.753	.067		.181	168.0	.9536	2.15
			(.81)	(10.22)	(2.28)		(4.01)			(-.45)
d	1955-1983	.925	-.151	.056	-.008	-.042	.009	171.8	.9644	1.91
		(1.90)	(-.21)	(2.75)	(-.40)	(-2.77)	(1.45)			
		0 -	-1.655	0.95	-.013	-.053	.032	167.6	.9521	1.61
			(-1.71)	(3.27)	(-.31)	(-1.78)	(5.22)			
e	1955-1983	.249	-1.918	.033			.024	163.4	.9364	1.13
		(.80)	(-1.62)	(2.11)			(2.23)			
		0	-2.490	.042			.034	163.0	.9345	1.16
			(-2.40)	(3.30)			(4.84)			

(a) $S/\tilde{P} = b_o + b_1 I^P + b_2 I^t + b_{2d} I^t \text{ DUM}$ where $I^P = \frac{1}{3}\left(I + I_{-1} + I_{-2}\right)$

(b) $S/\tilde{P} = b_o + b_1 I^P + b_2 I^t + b_{2d} I^t \text{ DUM}$ where $I^P = \frac{1}{3}\left(I_{+1} + I + I_{-1}\right)$

(c) $S/\tilde{P} = b_o + b_1 (S/\tilde{P})_{-1} + b_2 (I - I_{-1}) + b_{2d} (I - I_{-1}) \text{ DUM}$

(d) $S/\tilde{P} = b_o + b_1 I + b_2 I_{-1} + b_3 I_{-2} + b_{1d} I \text{ DUM}$

(e) $S/\tilde{P} = b_o + b_1 I + b_{1d} I \text{ DUM}$

model is stable over the same period that the official price model indicates a regime shift is further evidence in favor of the virtual price model.

We now turn to the length of time that rationing is expected to continue. The above results were presented for the case in which rationing is expected to last for a negligible period of time. We similarly estimated the model under the assumption that rationing is expected to last forever: that is, nominal income is deflated by virtual prices. Qualitative results were similar, and we present only the values of the respective log likelihood functions in Table 3.

Table 3. Log Likelihood Values Under Temporary and Permanent Rationing

Equation	Temporary Rationing	Permanent Rationing
Permanent Income (Backward-Looking)	166.7	164.0
Permanent Income (Forward-Looking)	153.9	152.7
Asset Adjustment	166.0	163.0
Distributed Lag	168.0	165.3
Current Income	157.4	156.6

As the two income variables are highly collinear, it is not possible to imbed these in the same model and estimate the expected duration of rationing explicitly. 1/ Nevertheless, in all cases the temporary rationing model leads to a higher likelihood value than does the permanent rationing model, which gives reason to believe that rationing was indeed expected to be temporary.

A final issue concerns our assumption of constant velocity. In appendix B we test for interest sensitivity of the velocity factor k within the context of the model of this section. Interest sensitivity turns out to be insignificant both when we use M2 and when we use a more narrow concept, currency in circulation. This is perhaps not surprising given the absence of alternative assets in China.

It maybe of interest to examine the ratio of virtual to official price indices over time. Chart II therefore plots $\tilde{p}/p$, using α as estimated in table 1, equation (a). We notice that there is a gradual increase in this measure of repressed inflation until 1978, when the economic liberalization began. From this point, $\tilde{p}/p$ rises rapidly, as one might expect. Thus the wedge between virtual and official 190% in 1979, rose to about 600% in 1984.

1/ Ideally one would like to allow consumers to update their expectation on duration of rationing each period, incorporating the new information about rationing in that period. Data availability precludes estimation of such learning models.

5. SAVINGS AND THE REAL RATE OF INTEREST

In this section we move beyond the specifications of section 4 and allow savings to depend on real interest rates in addition to wealth. The real interest rate (ρ) is given by

$$1 + \rho = (1 + i)/(1 + \Pi) = (1 + i)\ P/p = 1/\delta$$

in the market clearing model, or by

$$1 + \tilde{\rho} = (1 + i)\tilde{P}/p = 1/\tilde{\delta} \tag{25}$$

in the rationing model, where variables are defined as in section 3. Rationing this period which is expected to stop next period implies a lower "virtual" inflation rate (as current virtual prices are higher than current official prices) and hence a higher "virtual" real interest rate than would be the case if the current official price level were market clearing. This higher real interest rate induces people to save more in the rationing regime than in the market clearing regime for given values of the official price level and interest rate.

Our empirical specification is derived from equation (13a) in section 2. 1/ Taking a log-linear approximation yields:

$$\ln R = b_o + b_1 \ln(1 + \tilde{\rho}) + b_2 \ln I$$

1/ We use consumption rather than savings in this section as we wish to use the logarithmic specification and the flow of savings was negative for part of the sample.

with I a proxy for permanent income or, equivalently, wealth. Substituting from equations (16) and (25) yields

$$\ln R = b_o + b_1 \ln\left((1 + i)\, P/P_{+1}\right) + b_1\alpha \ln\left(M/PR\right) + b_2 \ln I$$

Finally, allowing for differing responses to permanent and transitory income, and noting that $\ln\left(I^p + I^t\right) = \ln I^p + \ln\left(1 + I^t/I^p\right) \approx \ln I^p + I^t/I^p$, we obtain

$$\ln R = b_o + b_1 \ln\left((1 + i)P/P_{+1}\right) + b_1\alpha \ln\left(M/PR\right) + b_2 \frac{I^t}{I^p} + b_3 \ln I^p \qquad (26)$$

We estimate equation (26) using the same two permanent income specifications as in section 4 above. 1/ As current disposable income is correlated with current consumption, we instrument for this variable using two stage least squares. 2/ We similarly instrument for the unobserved future price. Instruments include all independent variables, a lagged dependent variable, and three additional variables thought to be correlated with income: government expenditure, fixed investment, and GNP in Japan (Japan being China's largest trading partner). Results are presented in Table 4.

1/ We present results only for the backward-looking permanent income specification. Results for the forward-looking specification are similar.

2/ Similarly, we technically should have instrumented for disposable income in section 4 above. However, as our equations in that section are highly nonlinear, in parameters as well as variables, we were not able to carry this out. Further, in this section omitting the instruments leads to only a negligible change in the estimated parameters, indicating that the omission in section 4 would not be expected to affect the qualitative conclusions.

Table 4:

	α	b_o	b_1	b_2	$1-b_3$	LLF	R^2	X^2_3*
a)	.323 (5.72)	.0416 (6.01)	-.207 (-4.67)	.733 (23.42)	0	97.20	.9991	6.83
b)	.172 (1.62)	-.0640 (-.98)	-.193 (-4.45)	.771 (20.22)	.033 (1.62)	99.05	.9992	4.41
c)	0	-.0108 (-1.98)	-.005 (-.07)	.730 (12.33)	0	77.19	.9978	11.92
d)	1.57 (.51)	.0174 (2.71)	-.040 (-.49)	.759 (16.58)	0	87.55	.9983	13.20

Period: 1955-1983

* This tests the hypothesis that the residuals are white noise to three autocorrelation lags.

$X^2_{3,\ .95} = 7.81$

$X^2_{3,\ .99} = 11.34$

a) $b_3 = 1$

b) no restrictions

c) $b_3 = 1;\ \alpha = 0$

d) $b_3 = 1;\ i = 0$

$$\ln R = b_o + b_1 \ln\left((1 + i)P/P_{+1}\right) + b_1\ \alpha\ \ln\left(M/PR\right) + b_2 \frac{I^t}{P_I} + b_3 \ln I^p$$

In row a we make the theoretically plausible assumption that the elasticity of consumption with respect to permanent income is unity. As we see from row b, this assumption is justified - we cannot reject a unitary coefficient on permanent income. We see that the estimate for α in row a is highly significant, although smaller than in section 4. The most striking result, however, is that the estimate of b_1 is negative and significant. That is, consumption declines (savings increases) in response to an increase in real interest rates. Given the difficulty researchers have had in finding a significant savings response to real interest rates in developing countries (see, e.g., Giovannini, 1985), or, for that matter, in developed countries, we take this result to be of some interest.

As in section 4, when α is constrained to equal zero the errors display serial correlation and, in addition, the significance of the real interest rate disappears. Again, the virtual price model far out-performs the official price model.

We also estimate the model omitting the nominal interest rate - that is, b_1 now represents the consumption response to the inverse of the expected inflation rate. The results are presented in row d. In this equation b_1 is seen to be insignificant, indicating that the nominal interest rate is indeed important in explaining consumption behavior.

It might be thought that the correlation between savings and real interest rates need not represent causality. That is, perhaps the government adjusts nominal interest rates to accommodate observed savings patterns. In the context of our model, this would indicate that we have omitted an interest rate determination equation, of which savings would be an argument. We test this possibility by estimating equation (26) while instrumenting for the nominal interest rate. The U.S. T-Bill rate is added to the list of

instruments. This estimation yields results (presented in appendix B) very similar to those of Table 4; in particular, the estimate of b_1 is still negative and significant. This would indicate that real interest rates really do influence savings, and not the converse.

6. SUMMARY AND CONCLUSIONS

China has seen a rapid increase in personal savings since the economic liberalization began 1979. We have attempted to explain this phenomenon in an intertemporal disequilibrium framework, using a virtual price technique. The virtual price level is defined as that price level which would induce the observed level of consumption in the absence of price controls. We first set out a simple theoretical model of savings behavior under rationing which, when combined with a cash in advance constraint, leads to a simple virtual price specification which links the virtual price to observable variables.

We then use the virtual price level to estimate a number of common savings functions. We find that normalizing savings by virtual prices explains savings behavior far better than does normalizing by the official price series. When official prices are used, that is, when equilibrium is imposed, the equations are found to be unstable and to indicate a regime shift during the liberalization. Allowing for disequilibrium by employing virtual prices eliminates this problem.

We next provide a test which lends support to the theory that rationing was perceived to be temporary, suggesting that intertemporal phenomena do play an important role in determining savings behavior. We therefore proceed to include real interest rates as a determinant of

savings. Using virtual prices, we find a negative and significant real interest rate effect on consumption which, despite its intuitive appeal, has only rarely been empirically detected. As before, when we eliminate the virtual prices and assume equilibrium, the results deteriorate and we no longer detect a consumption response to real interest rates. This interest rate response indicates that savings does indeed respond to future market conditions, and is not simply an involuntary residual. Finally, we find that the nominal interest rate has considerable importance in influencing savings behavior, so that macroeconomic policy in China may be more effective than previously thought.

We see two primary directions for future research. First, the model should be extended to include open economy effects, as the balance of payments represents an alternative to savings as an outlet for excess monetary expansion. Finally, the relationship of the virtual price estimation technique to more traditional disequilibrium approaches could usefully be explored.

References

Byrd, William A., 1983, China's Financial System, (Westview Press).

Chinese Statistical Yearbook, 1984, (Beijing).

Chow, Gregory, 1985, "A Model of Chinese National Income Determination," Journal of Political Economy, 93(4), 782-92.

Chow, Gregory, 1986a, "Money and Price Level Determination in China," Econometric Research Program Research Monogram No. 327, Princeton University.

Chow, Gregory, 1986b, "Chinese Statistics," The American Statistician, 40(3) pp. 191-96.

de Wulf, Luc, 1985a, "Economic Reform in China," Finance and Development, December, 19-22.

de Wulf, Luc, 1985b, "Financial Reform in China," Finance and Development, March, 8-11.

de Wulf, Luc, and David Goldsborough, 1986, "The Evolving Role of Monetary Policy in China," IMF Staff Papers, 33, 209-242.

Dixit, A. K. and V. Norman, 1980. Theory of International Trade (Cambridge University Press).

Fair, R. C. and D. M. Jaffee, 1972. "Methods of Estimation for Markets in Disequilibrium", Econometrica, 40, 497-514.

Feltenstein, A., and Z. Farhadian, 1986, "Fiscal Policy, Monetary Targets and the Price Level in a Centrally Planned Economy; An Application to the Case of China", Journal of Money, Credit and Banking, forthcoming.

Giovannini, A., 1985, "Savings and the Real Interest Rate in LDCs," Journal of Development Economics, 18, 197-217.

Howard, D. H., 1976. "The Disequilibrium Model in a Controlled Economy: An Empirical Test of the Barro-Grossman Model," American Economic Review, 66(5) 871-79.

Li Chengrui, 1981, "The Balance of Finance and Credit," Jingji Yanjiu (Economic Research), No. 3, 3-12.

Liu, Hongru, 1980, Problems of Socialist Money and Banking (Peking: China Finance and Economics Publishing House).

Neary, J. P., and K. W. S. Roberts, 1980. "The Theory of Household Behavior under Rationing," European Economic Review, 13, 25-42.

Peebles, Gavin, 1983, "Inflation, Money and Banking in China: In Support of the Purchasing Power Approach," ACES Bulletin, 25(2), 81-103.

Pickersgill, J., 1976, "Soviet Household Saving Behavior", Review of Economics and Statistics", 18, 139-47.

Pickersgill, J., 1980. "Recent Evidence on Soviet Household Saving Behavior," Review of Economics and Statistics, 62, 628-33.

Podkaminer, L. 1982, "Estimates of the Disequilibria in Poland's Consumer Markets 1965-1978," Review of Economics and Statistics, 64, 423-31.

Portes, R., 1986, "The Theory and Measurement of Macroeconomic Disequilibrium in Centrally Planned Economics," Centre for Economic Policy Research Discussion Paper No. 91.

Portes, R., and D. Winter, 1978. "The Demand for Money and for Consumption Goods in Centrally Planned Economies," Review of Economics and Statistics, 60, 8-18.

Portes, R., and D. Winter, 1980. "Disequilibrum Estimates for Consumption Goods Markets in Centrally Planned Economics," Review of Economics Studies, 47, 137-159.

Portes, R. and A. Santorum, 1986, "Money and the Consumption Goods Market in China," unpublished mimeo, University of London.

Quandt, R. 1982, "Econometric Disequilibrium Models," Econometric Review, 1, 1-63.

van Wijnbergen, Sweder, 1985, "Oil Price Shocks, Unemployment, Investment and the Current Account: An Intertemporal Disequilibrium Analysis," Review of Economic Studies, 52(4), 627-45.

Zhongguo, Jinrong (Chinese Finance), 1985, People's Bank of China, January.

Appendix A

All series are in billions of Yuan unless noted.

	(1) Currency in circulation	(2) Savings deposits	(3) Money	(4) Savings	(5) CPI	(6) Population (millions)	(7) Interest (%)	(8) Retail sales	(9) Investment in fixed expen-diture assets	(10) Government	(11) Real GNP Japan (billion 1980 yen)
1953	3.96	1.23	5.19	0.37	121.4	587.96	0.1539	32.88			29077
1954	4.11	1.59	5.70	0.36	123.1	602.66	0.1539	35.61			30776
1955	4.01	1.99	6.00	0.40	123.5	614.65	0.1539	36.40	10.52	26.93	33496
1956	5.70	2.67	8.37	0.68	123.4	628.28	0.1539	42.40	16.08	30.57	35937
1957	5.27	3.52	8.79	0.85	126.6	646.53	0.1539	44.16	15.12	30.42	38614
1958	6.75	5.52	12.27	2.00	125.2	659.94	0.1355	48.12	27.91	40.94	40781
1959	7.49	6.83	14.32	1.31	125.6	672.07	0.0560	55.65	36.80	55.29	44406
1960	9.60	6.63	16.23	-0.20	128.8	662.06	0.0629	59.24	41.66	65.41	50327
1961	12.55	5.54	18.09	-1.09	149.6	658.59	0.0629	53.77	15.61	36.70	57612
1962	10.65	4.11	14.76	-1.43	155.3	672.95	0.0629	54.37	8.73	30.53	61657
1963	8.97	4.57	13.54	0.46	146.1	691.72	0.0629	54.48	11.67	33.96	68109
1964	8.01	5.55	13.56	0.98	140.7	704.99	0.0629	57.27	16.59	39.90	77060
1965	9.07	6.52	15.59	0.97	139.0	725.38	0.0497	59.01	21.69	46.63	68992
1966	10.81	7.23	18.04	0.71	137.3	745.42	0.0403	63.28	25.48	54.16	76325
1967	12.18	7.39	19.57	0.16	136.4	763.68	0.0403	67.91	18.77	44.19	84567
1968	13.40	7.83	21.23	0.44	136.5	785.34	0.0403	64.92	15.16	35.98	95319
1969	13.71	7.59	21.30	-0.24	137.8	806.71	0.0403	69.82	24.69	52.59	107035
1970	12.34	7.95	20.29	0.36	137.8	829.92	0.0403	72.88	36.81	64.94	117591
1971	13.61	9.03	22.64	1.08	137.7	852.29	0.0385	77.69	41.73	73.22	123104
1972	15.08	10.52	25.60	1.49	137.9	871.77	0.0329	85.35	41.28	76.64	134147
1973	16.61	12.12	28.73	1.60	138.0	892.11	0.0329	91.77	43.81	80.93	145977
1974	17.61	13.65	31.26	1.53	138.9	908.59	0.0329	96.74	46.32	79.08	144167

Appendix A (continued)

	(1) Currency in circulation	(2) Savings deposits	(3) Money	(4) Savings	(5) CPI	(6) Population (millions)	(7) Interest (%)	(8) Retail sales	(9) Investment in fixed expen-diture assets	(10) Government	(11) Real GNP Japan (billion 1980 yen)
1975	18.25	14.96	33.21	1.31	139.5	924.20	0.0329	104.64	54.49	82.09	147655
1976	20.36	15.91	36.27	0.95	139.9	937.17	0.0329	109.90	52.39	80.62	155502
1977	19.51	18.16	37.67	2.25	143.7	949.74	0.0329	117.43	54.83	84.35	163752
1978	21.20	21.06	42.26	2.90	144.7	962.59	0.0329	126.49	66.87	111.10	172133
1979	26.77	28.10	54.87	7.04	147.4	975.42	0.0385	147.60	69.94	127.39	181137
1980	34.62	39.95	74.57	11.85	158.5	987.05	0.0516	179.40	74.59	121.27	189787
1981	39.63	52.37	92.00	12.42	162.5	1000.72	0.0554	200.25	66.75	111.50	197462
1982	43.91	67.54	111.45	15.17	165.8	1015.41	0.0582	218.15	84.53	115.33	204059
1983	52.98	83.75	136.73	16.21	169.1	1024.95	0.0591	242.61	95.20	129.25	210903

(1) Source: International Financial Statistics (IFS) and Byrd, p. 138.

(2) Source: IFS and Byrd, p. 157.

(3) Currency in circulation plus savings deposits.

(4) Change in savings deposits.

(5) 1950 = 100. Source: IFS and Chinese Statistical Yearbook (CSY), p. 425.

(6) Source: CSY, p. 81.

(7) Annual rate on one-year term individuals bank deposits. Source: Byrd, p. 154.

(8) Source: CSY, p. 345.

(9) Source: CSY, p. 301.

(10) Source: CSY, p. 417.

(11) Source: IFS.

Appendix B

B.1 Currency Rather than M2 as Definition of M

This appendix contains additional results referred to in the text. We first present selected results using an alternative definition of money, currency in circulation. Table B1 presents the backward-looking permanent income equation of Section 4. Table B2 presents the corresponding equation (including interest rates) of Section 5.

Table B1

$$S/\tilde{P} = b_o + b_1 I^P + b_2 I^t \quad \text{where } I^P = \frac{1}{3}\left(I + I_{-1} + I_{-2}\right)$$

α	b_o	b_1	b_2	LLF	R^2	DW
1.590 (2.06)	-2.396 (-1.83)	.035 (2.03)	.095 (2.63)	160.1	.9202	1.27
0	-5.766 (-7.27)	.081 (8.31)	.290 (4.40)	166.5	.8973	0.87

Period: 1955-1983

Table B2

$$\ln R = b_o + b_1 \ln\left((1 + i)P/P_{+1}\right) + b_1\alpha \ln\left(M/PR\right) + b_2 \frac{I^t}{I^p} + b_3 \ln I^p$$

$$\text{where } I^p = \frac{1}{3}\left(I + I_{-1} + I_{-2}\right)$$

α	b_o	b_1	b_2	$1-b_3$	LLF	R^2	X^2_3
.455 (3.70)	.0358 (3.08)	-.203 (-2.79)	.592 (10.54)	0	85.03	.9982	7.91
0	-.0075 (-1.28)	-.037 (-.51)	.685 (10.34)	0	76.85	.9978	8.55

Period: 1955-1983

We see that results are similar to those using the broader definition of money. In the Cobb-Douglas permanent income equation of Table B1, the estimate of α is significant and the Durbin-Watson statistic is larger than when α is constrained. Similarly, in the interest rate model of Table B2, α is highly significant, and b_1 is negative and significant, confirming the interest sensitivity of savings. As with the model in Table B1, however, the inclusion of virtual prices (allowing α to differ from zero) does not eliminate the problems of serial correlation as readily as it does in the text where we used the broader monetary aggregate. Nevertheless, the basic results seem robust to the choice of monetary aggregate.

B.2 Interest Sensitive Velocity

We now allow the velocity term (1/k) from equation (10a) to depend on interest rates, rather than forcing it to be a constant. We specify

$$\ln \alpha = k_0 - k_1 \ln (1+i)$$

where $k_0 \equiv (\frac{M}{PR})_0 - k_1 \ln (1+i_0)$

which gives

$$\ln \tilde{P} = \ln P + \alpha \ln [\frac{M}{PR} (\frac{PR}{M})_0 (\frac{1+i}{1+i_0})^{k_1}] \qquad \text{(B1)}$$

(B1) corresponds to the formula used in the text for $k_1 = 0$. The normalization described in footnote 1 of p. 16 corresponds to the $(PR/M)_0$ term. The subscript "o" refers to year 1953. A positive value for k indicates that velocity increases with the interest rate.

We use this equation to estimate the backward looking permanent income equation, employing currency in circulation as our money definition as in section B1 of this appendix. As we have assumed that there exist no alternative assets to savings, we would not expect a positive interest elasticity of velocity when we use the broader monetary aggregate as in the text.

Table B3

$$S/\tilde{P} = b_0 + b_1 I^p + b_2 I^t \text{ where } I^p = \frac{1}{3}(I + I_{-1} + I_{-2})$$

$$\ln \tilde{P} = \ln P + \alpha \ln \left[\frac{M}{PR}\left(\frac{PR}{M}\right)_0 \left(\frac{1+i}{1+i_0}\right)^{k_1}\right]$$

k_1	α	b_0	b_1	b_2	LLF	R^2	DW
11.76	1.098	-9.243	.143	.378	165.6	.9461	1.87
(1.71)	(1.98)	(-1.94)	(2.06)	(2.60)			
0	1.590	-2.396	.035	0.95	160.1	.9202	1.27
	(2.06)	(-1.83)	(2.03)	(2.63)			

Period: 1955-1983.

We see that the estimate of k_1 is positive but not significant. The estimate of α is smaller than in the constant velocity ($k_1 = 0$) case, but remains significant. The insignificance of k_1 gives support to our constant velocity assumption.

B.3 Instrumental Variables Applied to Interest Rates

We now present results for the interest rate model in which we instrument for nominal interest rates, and add the U.S. T-bill rate to the instrument list. Results are very similar to those of Table 4 in the text.

Table B4

$$\ln R = b_o + b_1 \ln\left((1 + i)P/P_{+1}\right) + b_1 \alpha \ln \left(M/PR\right) + b_2 \frac{I^t}{I^p} + b_3 \ln I^p$$

$$\text{where } I^p = \frac{1}{3}\left(I + I_{-1} + I_{-2}\right)$$

α	b_o	b_1	b_2	$1-b_3$	LLF	R^2	X^2_3
.343 (4.99)	.040 (5.48)	-.190 (-4.03)	.739 (23.15)	0	97.16	.9991	8.66
0	-.009 (-1.51)	-.011 (-.15)	.696 (9.79)	0	77.03	.9977	8.54

Appendix C

How Does the Model Perform on US Data? 1/

In the paper, we present a model based on the assumption of commodity market rationing. The empirical work reported for China strongly supported that assumption. Of course, there is a strong presumption that there is commodity market rationing in China. One's confidence in the approach employed would obviously increase if the same tests, when applied to the USA, where widespread commodity market rationing is implausible, would in fact reject the assumption of commodity market rationing.

We perform two tests. In the first test, we use exactly the same data definitions as we used in the main body of the text for China. However, the assumption that increases in savings deposits capture a substantial part of private savings, while reasonable for China, clearly makes less sense for a country like the USA. Hence we present a second test where we use the difference between personal disposable income and private consumption as our measure of private savings.2/ The results of both tests are reported below.

In this section we use exactly the same data definitions as used in the China regressions; we run the US equivalents of all the equations reported in Table 1 for China.

1/ The tests performed in this appendix were suggested to us by an anonymous referee.

2/ The data on personal disposable income and private consumption are taken from the Economic Report of the President 1985. All other U.S. data are from IFS.

Table C1

Equation	Period	α	b_0	b_1	b_2	b_3	LLF	R^2	DW (H)
(a)	1959-1984	-1.10 (2.07)	-0.00 (1.27)	0.36 (2.10)	1.42 (4.15)	--	227.5	0.85	1.55
(b)	1959-1983	0.03 (.03)	-0.00 (0.67)	0.18 (1.31)	1.10 (3.19)	--	214.9	0.80	1.32
(c)	1959-1984	0.10 (0.17)	0.00 (2.59)	0.58 (6.05)	0.69 (3.78)	--	229.7	0.87	1.47 (1.20)
(d)	1959-1984	-1.10 (1.84)	-0.00 (1.22)	1.10 (3.81)	-.41 (3.53)	-0.29 (2.62)	227.8	0.85	1.39
(e)	1959-1984	-3.34 (4.31)	-0.00 (2.30)	2.42 (2.44)	--	--	215.1	0.61	1.38

(a) $S/\tilde{P} = b_o + b_1 I^p + b_2 I^t + b_{2d} I^t \text{ DUM}$ where $I^p = \frac{1}{3}\left(I + I_{-1} + I_{-2}\right)$

(b) $S/\tilde{P} = b_o + b_1 I^p + b_2 I^t + b_{2d} I^t \text{ DUM}$ where $I^p = \frac{1}{3}\left(I_{+1} + I + I_{-1}\right)$

(c) $S/\tilde{P} = b_o + b_1 \left(S/\tilde{P}\right)_{-1} + b_2\left(I - I_{-1}\right) + b_{2d}\left(I - I_{-1}\right) \text{ DUM}$

(d) $S/\tilde{P} = b_o + b_1 I + b_2 I_{-1} + b_3 I_{-2} + b_{1d} I \text{ DUM}$

(e) $S/\tilde{P} = b_o + b_1 I + b_{1d} I \text{ DUM}$

The results are unambiguous: every single equation either rejects the hypothesis of α different from zero, or, where it does not do so, α has the wrong sign. The model therefore clearly rejects the rationing hypothesis for the US, at least conditional on the data definitions used. The second set of regressions, reported below, tests the same hypothesis using a better measure of private savings.

Table C2

Equation	Period	α	b_0	b_1	b_2	b_3	LLF	R^2	DW (H)
(a)	1959-1984	.32 (0.58)	-.23 (0.60)	.091 (2.64)	.097 (0.61)	--	-119.3	0.79	0.93
(b)	1959-1983	.53 (1.13)	-.20 (0.67)	.082 (3.07)	.44 (2.13)	--	-112.9	0.82	0.85
(c)	1959-1984	-0.66 (1.57)	0.26 (0.94)	0.90 (12.7)	0.33 (2.42)	--	-113.8	0.86	2.32 (-1.01)
(d)	1959-1984	0.36 (0.65)	-0.23 (0.63)	0.035 (0.31)	0.16 (1.03)	-0.10 (0.91)	-118.6	0.80	1.19
(e)	1959-1984	0.33 (0.69)	-0.22 (0.67)	0.090 (2.97)	--	--	-119.3	0.79	0.94

(a) $S/\tilde{P} = b_o + b_1 I^P + b_2 I^t + b_{2d} I^t \text{ DUM}$ where $I^P = \frac{1}{3}\left(I + I_{-1} + I_{-2}\right)$

(b) $S/\tilde{P} = b_o + b_1 I^P + b_2 I^t + b_{2d} I^t \text{ DUM}$ where $I^P = \frac{1}{3}\left(I_{+1} + I + I_{-1}\right)$

(c) $S/\tilde{P} = b_o + b_1 (S/\tilde{P})_{-1} + b_2 (I - I_{-1}) + b_{2d} (I - I_{-1}) \text{ DUM}$

(d) $S/\tilde{P} = b_o + b_1 I + b_2 I_{-1} + b_3 I_{-2} + b_{1d} I \text{ DUM}$

(e) $S/\tilde{P} = b_o + b_1 I + b_{1d} I \text{ DUM}$

These results are clear also: again α is insignificant, or, where significant, has the wrong sign. These results therefore clearly reject the assumption of commodity market rationing in the US. Of course this is an implausible assumption for the US, hence this outcome should increase the confidence in the approach developed and employed in this paper.

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