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## GENERAL & APPLIED ECONOMICS | RESEARCH ARTICLE

# The determinants of money demand in China

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**Abstract:** Money demand and its stability have a great impact on the economy of a country. Because China's financial and monetary system has been in reform, there are many uncertainties in money demand. Especially, China's money demand has its own particularity. This paper studies the determinants of China's money demand through building a linear econometric model and SVAR model. The empirical results show that China's money demand is mainly decided by income, interest rate and expected inflation rate. However, other factors, such as financial innovation, government debt, capital mobility and currency substitution, play a relatively small role, mainly because China's financial and monetary system has been under reform. The regression results of sample data from different periods show that money demand in China is unstable, indicating that China's macro-economy has certain risks. This finding suggests that China should adopt prudent financial and monetary policies to cope with the uncertainty of money demand in the future.

**Subjects:** Demand for Money; Money and Economy; Monetary Policy

**Keywords:** money demand; money demand determinants; monetary policy

### 1. Introduction

In the standard money demand model, money demand is determined by real income, interest rate and expected inflation rate. However, because China has been in market-oriented reform since the late 1970s, China's money demand has a special problem at this stage. A key point is how to capture the staged characteristic of macro-variables related to money demand. Another key point

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### PUBLIC INTEREST STATEMENT

Money demand, as one of the important macro-economic variables, has a great impact on the economy of a country. In particular, because China has been in the process of market-oriented reform and opening up since the late 1970s, China's money demand has its own particularity. This paper attempts to investigate and test the relationship between China's money demand and its determinants. At the same time, the data of different periods are used to test the stability of money demand. The empirical results show that China's money demand is mainly determined by real income, interest rate and expected inflation rate. However, other factors, such as financial innovation, government debt, capital mobility and currency substitution, play a relatively small role, mainly because China's financial and monetary system has been under reform. The regression results of sample data from different periods show that money demand in China is unstable.

is how to resolve the unstable problem of money demand in China. The purpose of this study is to present a theoretical deliberation on money demand in China.

First of all, the paper studies the determinants of money demand in China combining with the reality of China, in order to test whether it is consistent with the prediction of the theory. Especially, this paper tries to build an extended monetary demand decision model which accords with the actual situation of China to reflect the special reality of China on the basis of usual standard money demand model. For example, in addition to income, interest rate and expected inflation rate, the paper also considers the impact of government deficits, expected exchange rate and international capital flows on money demand. However, financial innovation and currency substitution have not been added to the model because of the difficulty of measurement and statistical insignificance. At the same time, this paper employs the ECM model to capture short-term dynamic relationship between money demand and its determinants.

Because China is in the market-oriented reform, China's money demand has inevitably its own characteristics. Does the impulse response relationship exist in mutual interaction between money demand and other economic variables? Are there significant differences in the impulse response of different factors? These issues will help us to understand the basic nature of money demand in China, thereby helping the government to formulate money policy and make reasonable money adjustment. The paper will use an SVAR model to systematically analyze these problems.

Financial reform has an important impact on money demand. Especially, it will affect the stability of a country's currency demand. With regard to this, the paper tests whether there are structural differences in China's money demand in different periods using relevant data from different periods. At the same time, the paper further investigates and discusses the impact of marketization, internationalization, e-commerce and macroeconomic policies on money demand.

The remainder of the paper is organized as follows: Section 2 reviews the related literatures. Section 3 provides a general overview of financial reform, economic monetization and money demand for China. Section 4 briefly describes the method and model and the characteristic of data. Section 5 reports the empirical results. Section 6 employs the SVAR model to do a comprehensive analysis. Discussion and policy implication are presented in Section 7. The final section is the conclusion.

## 2. Literature review

With the constantly advancing of China's market-oriented economic reforms, money is playing a more and more important role in China's economic and social life. Therefore, how to scientifically estimate and appraise China's money demand is becoming a hot topic for economic researchers in China. However, there are only few papers to probe into this problem. As a pioneer researcher, Chow (1987) estimated simple money demand function in China derived from quantity theory with China's annual macro data from 1952 to 1983 and concluded that the quantity theory provided a reasonable approximation in explaining the demand for money in China.

After Chow's pioneer work, other economists investigated China's money demand with different methods, respectively. Portes and Santorum (1987), Feltenstein and Farhadian (1987) and Blejer et al. (1991) aimed at estimating short-run dynamic equations. However, such a dynamic specification is based on the presumption that there is a long-run equilibrium relationship between dependent variable and explanatory variables. If the presumption does not exist, the short-run dynamic equations of the given specification will be misdirected.

Hafer and Kutan (1994) tried to resolve the fundamental issue of whether there exists a long-run equilibrium money demand relation between nominal money balances, real income, prices and

interest rates with China's data by means of cointegration test. The results revealed that there was a long-run equilibrium relationship between money demand balance and its arguments.

All studies mentioned above gained some useful outcomes. However, Yu and Tsui (2000) thought that there were still some issues in the above-mentioned studies. Because conventional simple-sum approach, implicitly assuming that the various components of monetary assets are a perfect substitution, was applied to the measure of money aggregates, it was possible to result in a statistical error. Actually, the assumption of perfect substitution between various components of money aggregates is inexistence in practice, especially under the circumstances of the development of numerous financial innovations and new financial instruments in China's banking sector during the period of rapid economic transition.

Furthermore, the simple-sum approach is not consistent with the well-established methodology of measuring other important macroeconomic variables such as GDP and CPI, too. Therefore, Yu and Tsui (2000) adopt the Barnett (1980) and Anderson, Jones, and Nesmith (1997)'s methodology to construct a new monetary services index (MSI) that is appropriate for its transition economy for China and used the newly constructed MSI substituting for the simple-sum money aggregates to establish China's money demand functions. Their studies found that the new index and its money demand function contained more useful information and better reflected China's financial development during the period of rapid economic transition.

Compared to other investigations, methodologically speaking, Yu and Tsui (2000) did a significant work. However, their studies have not still completely resolved the problem of the monetary aggregate measure during the period of rapid economic transition in China. Actually, the main difficulty to estimate and appraise China's money demand functions is how to obtain effective basic statistical data of money and other macro-variables reflecting the real financial and economic change in China. In fact, it is currently difficult to resolve the problem completely due to financial and economic transition (Dou, 2011).

Other research literatures discussed the problem of China's money demand from different angles, for example, long-run money demand and inflation in China (Chen, 1997), China's money demand with disaggregate approach (Xu, 1998), demand for money in China 1987–2004 with a non-linear modeling approach (Austin, Ward, & Dalziel, 2007), the stability of money demand (Boughton, 1981; Baharumshah, Mohd, & Masih, 2009), financial reforms and money demand (Kumar, 2011), the behavior of money demand in the Chinese hyperinflation (Zhao, 2017) and so forth. These studies have all made some meaningful outcomes.

### **3. The impact of China's financial reform on money demand**

#### **3.1. China's financial reform**

China's market-oriented economic and financial reforms since the late 1970s have brought about significant structural change. Before the reforms, independent central bank and its monetary policies actually did not exist, and currency in circulation was used mainly for transactions between the state and the household sectors of the economy. The economic and financial reforms emphasized the effects of the independent central bank and its monetary policies on the economy.

The People's Bank of China (Chinese central bank) was created in 1984 with its own monetary policy instruments. Its main task is to control the aggregate volume of credit in the economy and to realize the state's macroeconomic target. Meanwhile, a new competitive commercial bank system has been also gradually established since 1984. Financial reforms not only accelerate economic monetization and raise financial transaction level and efficiency but also introduce many new financial instruments and services, resulting in financial innovations and other financial

changes. A potential implication of these financial changes is the increased importance of monetary aggregates in policy decisions (Austin et al., 2007).

### **3.2. Financial innovation and money demand**

Since the financial reforms of the late 1970s, many of financial innovations have taken place in the corporate, the household and the financial sectors of China including pure technological progress in transactions and policy changes such as regulation or deregulation. These financial innovations inevitably result in a change in money demand. First, financial innovations alter the structure and quality of the transaction, precaution and speculation demand for money. Because many new financial instruments and services inevitably bring about new financial transaction manners, it will change the motivation of which people possess money. In addition, because many of new financial instruments have high liquidity as well as considerable expected income, under such circumstance, both the transaction and the speculation motivation for money are becoming more and more illegibility. Especially, these can bring about a change in the interest elasticity of money demand.

With regard to the change in the interest elasticity of money demand, there are different viewpoints. Gurley and Shaw (1960) thought that financial innovation can bring about an increase in the interest elasticity of money demand. However, Marty (1961) argued that financial innovation actually reduced rather than raised the interest elasticity of money demand. There is not still make a coherent conclusion so far.

Financial innovations bring about the effect change of every variables determining money demand including basic variable, scale variable, opportunity cost variable and other variables in money demand function, too. Usually, all analysts, including those of the Keynesian and Monetarist School, agree that the scale variable (the income or the wealth variable) is the most important in money demand functions. However, the appearance of new financial instruments gives prominence to the effect of opportunity costs and other variables. Because new financial instruments play down switch costs between money and other assets, the opportunity costs and other variables become important determinant factors in the choice of the combination structure of money and other assets. The status and effect change of all variables in money demand determinants inevitably influence the structure, property and run rule of money demand. Such effects of financial innovations on demand for money are comprehensive and profound. With the appearance of electronic money and other modern financial transaction inter-medium, these effects will become more and more far-reaching (Gurley & Shaw, 1960; Marty, 1961; Silber, 1983; Cesarano, 1990).

This paper considers establishing an extended model introducing a new variable reflecting financial innovations to a conventional money demand function for China to capture the effects of financial innovations (Kabir & Mangla, 1988; Simpson and Porter, 1980).

### **3.3. Currency substitution and money demand**

The hypothesis of currency substitution was firstly advanced by Girton and Roper (1981). It notes that there is mutual substitution between different currencies, for example, the substitution of foreign money for domestic money. Under the condition of the present-day open economy, the currency substitution has become a familiar phenomenon in people's socio-economic activities. To gain a maximum benefit, multinational firms, investment corporations and households usually carry on productive activities at home and abroad, namely taking to the productive activities of the internationalization and globalization. These productive activities require the maintenance of monetary balances denominated in more than one currency to make optimization choice between different currencies. This can result in an increase in foreign currency operations.

The growing importance of foreign currency operations will certainly make disturbances on the demand for domestic money balances (McKinnon, 1982; Viren, 1990). Generally, economic agents can arbitrage interest rate differentials and fluctuations in currency rates. However, the role of the

interest rate differentials (foreign interest rate) mainly signals general capital mobility rather than currency substitution, and only the fluctuations in currency rates (exchange rate expectations) can signal the currency substitution. Thus, it seems better to test the currency substitution hypothesis with exchange rate expectation variable (Cuddington, 1983; Fasano-Filho, 1986; Marquez, 1987).

With the reform and development of China's financial market, currency substitution has actually appeared in China though so far it takes place only in a finite scope (Jin, 2018). It is very likely to affect money demand function in China and will become greater and greater. Therefore, this paper tries to capture the effects of currency substitution on money demand for China in estimating money demand function.

### **3.4. Deficits and money demand**

In recent years, for the sake of promoting economic development, almost all governments have made large budget deficits. The large budget deficits will certainly affect macroeconomic variables, which has become a concerned issue in economic research. In particular, how government deficits affect money demand is becoming an interesting topic. However, different models often make contrary conclusions due to different views on the net wealth effect. Both the Neoclassical and Keynesian models implied that money demand was influenced by government debt. By contraries, the Ricardian model suggested that money demand was not affected by government debt. The reason is that, as the government debt is not viewed as net wealth, so money demand will not increase. The Gulley's study also indicated that no evidence is found to support a positive relationship between government debt and money demand (Gulley, 1994).

Actually, the relationship between real money balances and government debt does not rely on net wealth effect. According to cash-in-advance model, the issuance of government debt would increase transactions and thereby money demand (Rodriguez, 1990). Moreover, recent works on the liquidity effects suggested that an open market operation increased real money holdings (Grossman and Weiss, 1983; Rotemberg, 1984; Lucas, 1990; Christiano, 1991).

A positive relationship between government debt and money demand was previously noted by Butkiewicz (1979) and Deravi, Hegji, and Moberly (1990). Tanner and Devereux (1993) made an improved method based on the former studies and got the same conclusion. Since the reform and open, the Chinese government has always possessed large budget deficits. Owing to economic transition and information asymmetry, economic adjustment to monetization in China is always lagged. Therefore, theoretically speaking, the large budget deficits would certainly exhibit a great effect on money demand.

### **3.5. Capital flows and money demand**

Under the circumstances of the open economy, the external influences of international capital flows on money demand must be considered. Actually, some literatures for discussing the stability of money demand in developing countries have concluded that there were the potential effects of capital flows on money demand (Arize, Darrat, & Meyer, 1990). Moreover, some economists, for example, Mundell (1963), McNown and Wallace (1992), Arango and Nadiri (1981), Bahmani-Oskooee and Pourheydari (1990) and Bahmani-Oskooee, Martin, and Niroomand (1998), conjectured that money demand likely depended upon exchange rate in addition to the so-called standard variables. This indirectly indicates that there exists a relation between money demand and capital flows affected by both exchange rate and interest rate, too.

Since the reform and open, the volume of the in-flow and the out-flow capitals into China via international trade and investment including direct and indirect investments is becoming greater and greater. These capitals have really made considerable great effects on China's economy and finance and thereby undoubtedly made great effects on money demand in

China, too. Actually, the question of money demand function stability for China is directly related to the inflows and the outflows of capitals. This has been practically testified by the inflation of the 1980s and the early and the mid-1990s of China.

At present, because empirical research regarding the effects of capital flows on money demand for China seems to be less, this paper tries to investigate the issue. To capture the potential effects of capital flows, the model concerned includes the sum variable of the exchange rate and the foreign interest rate to measure capital mobility (Arize et al., 1990).

#### 4. Methodology and model

Generally, money demand is usually formulated in terms of three important determinants, that is, income or wealth, interest rate and expected price change. This model formulated is usually called as standard money demand function. However, the consideration in Section 3 suggests that, instead of the standard money demand function, the paper should derive augmented money demand function which takes into account the determinants of financial innovations, deficits, capital mobility and currency substitution. Therefore, the final estimating specification in this paper takes simply the following form.

$$M/P = f(Y, I, \pi^e, B, E^e, FIE) \tag{1}$$

As some variables are able to make negative values, so linear function should be expressed and Equation (1) can be rewritten as,

$$(M/P)_t = a_0 + a_1 Y_t + a_2 I_t + a_3 \pi_t^e + a_4 B_t + a_5 E_t^e + a_6 FIE_t + u_t \tag{2}$$

where  $M/P$  denotes the desired real money balances,  $M$  is the nominal money balances,  $P$  is the consumer price index,  $Y$  is the real income,  $\pi^e$  is the expected inflation rate,  $I$  is the interest rate,  $B$  is the government debt,  $E^e$  is the expected exchange rate,  $FIE$  is the measure of capital mobility defined as the sum ( $I^*+E^e$ ) of the expected exchange rate ( $E^e$ ) and the foreign interest rate ( $I^*$ ) and  $u$  is the white noise series.

The income ( $Y$ ), the expected inflation ( $\pi$ ) and the interest rate ( $I$ ) are three important elementary determinants in a standard money demand function. In theory, money demand is an incremental function of real income as usual budget condition dictates, and it is the most important variable in money demand function. The expected inflation ( $\pi^e$ ) is inversely related to money demand as it reflects the expected return on physical assets. As for present-day China, it should be the second most important determinant in money demand function next to the income, as the expected change in price has been always greatly substantial since the 1980s and has thereby an important effect on economy and money demand. The variable  $B$  has a positive effect on money demand, as an increase in government debt can give rise to more financial transaction demand for money. Interest rate variable ( $I$ ) predicts negative effects on demand for money, as the higher interest rate means more costs holding money. The variables  $E^e$  and  $FIE$  predict negative effects on money demand, respectively, as people usually prefer foreign currencies or financial assets rather than domestic money or assets when they rise in an open economy.

In order to better study the relationship between variables, this paper gives here another short-term equation to measure the short-term determinants of monetary demand as follows:

$$\begin{aligned} \Delta(M/P)_t = & \delta_0 \delta_1 \Delta Y_t + \delta_2 \Delta I_t + \delta_3 \Delta \pi_t^e + \delta_4 \Delta B_t + \delta_5 \Delta E_t^e + \delta_6 \Delta FIE_t \\ & + \delta_7 (M/P - Y - I - \pi^e - B - E^e - FIE)_{t-1} - \delta_8 Y_{t-1} - \delta_9 I_{t-1} + \delta_{10} \pi_{t-1}^e - \delta_{11} B_{t-1} \\ & - \delta_{12} E_{t-1}^e - \delta_{13} FIE_{t-1} + \varepsilon_t \end{aligned} \tag{3}$$

where  $\Delta$  represents difference,  $\delta_i (i = 0, 1, 2, \dots, 13)$  is the estimated parameters and  $\varepsilon$  is the white noise series.

The purpose of this note is to estimate Equation (2) using China’s yearly data for the period 1996–2016, which is the period of single market economy.  $M$  is measured in broad money  $M_2$ , including narrow money  $M_1$  (cash and current saving accounts) and quasi-money.  $P$  is consumer price index (base 1978 = 100).  $Y$  is measured by GDP at constant prices, and  $\pi^e$  is measured by the previous period of inflation rate.  $B$  is nominal government debt that has still a relation to base money reaction function for China (Tanner & Devereux, 1993).  $E^e$  is measured by the previous period exchange rate (domestic currency per U.S. dollar).  $FIE$  is measured by the sum of the US interest rate ( $I^*$ ) and the previous period exchange rate ( $E_{t-1}$ ). The data for  $I^*$  are derived from the World Bank, and other data are taken from China’s statistics bulletin of the National Bureau of Statistics.

## 5. Empirical results

### 5.1. Related tests

Because of time-series properties of the data, as a preliminary step, the stationarity of all the variables in Equation (2) is tested here, respectively. The results of unit root tests of augmented Dickey–Fuller (ADF) for the stationarity are reported in Table 1. The results suggest that all variables are non-stationary on level but stationary on difference, and thereby, they are all one-order integrated variables. Moreover, the maximum likelihood method suggested by Johansen and Juselius (1991) is employed to investigate the potential co-integration relationship between  $M/P$ ,  $Y$ ,  $I$ ,  $\pi^e$ ,  $B$ ,  $E^e$  and  $FIE$ .

Table 2 displays the results based on the maximum likelihood procedure with the maximum lag of 1 and the test assumption of linear deterministic trend in the data. The test results indicate that there exist at least five co-integration vectors between  $M/P$ ,  $Y$ ,  $I$ ,  $\pi^e$ ,  $B$ ,  $E^e$  and  $FIE$ . Consequently, Equation (2) may be estimated by the OLS (Zuo & Park, 2011).

The paper assumes that income ( $Y$ ), interest rate ( $I$ ), expected inflation ( $\pi^e$ ), government debt ( $B$ ), expected exchange rate ( $E^e$ ) and capital mobility ( $FIE$ ) have important impacts on money demand ( $M/P$ ). Granger causality tests indicate that there is mutual Granger causality between income ( $Y$ ) and money demand ( $M/P$ ) (Wang, Zheng, & Zhu, 2014), between expected inflation ( $\pi^e$ )

**Table 1. Unit root tests**

Variable	Test type	ADF	Results
$(M/P)$	(0, c, 1)	2.9962	Nonstationary
$\Delta(M/P)$	(t, c, 1)	-3.5189*	Stationary
$Y$	(t, c, 1)	1.0641	Nonstationary
$\Delta Y$	(0, c, 7)	-2.4573*	Stationary
$I$	(0, c, 1)	-0.0569	Nonstationary
$\Delta I$	(0, c, 1)	-20.705***	Stationary
$\pi^e$	(t, c, 1)	-2.6904	Nonstationary
$\Delta \pi^e$	(0, c, 1)	-7.9487***	Stationary
$B$	(t, c, 1)	-2.2375	Nonstationary
$\square B$	(0, c, 3)	-3.1226**	Stationary
$E^e$	(0, c, 1)	-1.8592	Nonstationary
$\Delta E^e$	(0, c, 8)	-3.9196**	Stationary
$FIE$	(t, c, 1)	-2.1979	Nonstationary
$\Delta FIE$	(t, c, 7)	-33.026***	Stationary

Notes: ADF denotes Augmented Dickey–Fuller test. \*, \*\* and \*\*\* indicate that the variable is statistically significant at the 10%, 5% and 1% levels, respectively. In the (t, c, l) of test type, t, c and l stand for Trend, Intercept and Lagged differences, respectively.  $\Delta$  stands for the first-order difference.

**Table 2. Johansen's cointegration test for  $M/P$ ,  $Y$ ,  $I$ ,  $\pi^e$ ,  $B$ ,  $E^e$  and  $FIE$**

Hypothesized no. of CE(s)	Eigenvalue	Likelihood rate	5% Critical value	1% Critical value
$\rho = 0^{**}$	0.999708	365.6441	109.99	119.80
$\rho \leq 1^{**}$	0.991122	202.8790	82.49	90.45
$\rho \leq 2^{**}$	0.884291	108.3964	59.46	66.52
$\rho \leq 3^{**}$	0.748885	65.26298	39.89	45.58
$\rho \leq 4^{**}$	0.692419	37.62612	24.31	29.75
$\rho \leq 5^*$	0.401491	14.04582	12.53	16.31
$\rho \leq 6$	0.172195	3.779543	3.84	6.51

Notes: The cointegration tests are conducted by the maximum likelihood procedure with a maximum lag of 0 and a test assumption of linear deterministic trend in the data.  $^{**}$  denotes rejection of the hypothesis at 5% (1%) significance level.

and money demand ( $M/P$ ), between expected exchange rate ( $E^e$ ) and money demand ( $M/P$ ) and between capital mobility ( $FIE$ ) and money demand ( $M/P$ ), respectively. Interest rate ( $I$ ) is the Granger cause of  $M/P$ , but  $M/P$  is not the Granger cause of  $I$ .  $B$  is not the Granger cause of  $M/P$ , but  $M/P$  is the Granger cause of  $B$  (see Table 3).

### 5.2. The interpretation of empirical results

The estimation results for Equation (2) are reported in Table 4. To begin with, China's standard money demand function is estimated, and the result is reported in Equation (1) of Table 4. All the estimated coefficients correspond to their hypothesized theoretical values. The  $t$  value of every explaining variable indicates that all the estimated coefficients are statistically significant. The  $F$ -statistic value of 1348.41 implies that all explaining variables jointly explain the dependent variable  $M/P$ . The  $R^2$  value of 0.99 suggests that Equation (1) has a very good explanatory power. The study results fully demonstrate that China's monetary demand conduct has reached or is close to normal levels with great change in financial markets and economic conditions in China.

For the reason of comparison, the paper gradually adds to other variables, for example, the government debt  $B$ , the expected exchange rate  $E^e$  and the capital mobility measure  $FIE$ . The government debt  $B$  variable is first added, and estimation results are shown in Equation (2) of Table 4. One of the interesting findings is that government debt does not certainly affect money demand in China. This is consistent with the results of the Granger causality test.

**Table 3. Pairwise Granger causality tests**

Null hypothesis	Obs.	F-statistic	Prob.
$Y$ does not Granger cause $M/P$	16	5.20988	0.04709
$M/P$ does not Granger cause $Y$		21.4247	0.00217
$I$ does not Granger cause $M/P$	16	5.77095	0.03854
$M/P$ does not Granger cause $I$		1.66426	0.29488
$\pi^e$ does not Granger cause $M/P$	19	3.01951	0.08124
$M/P$ does not Granger cause $\pi^e$		3.68546	0.05178
$B$ does not Granger cause $M/P$	16	2.76304	0.14448
$M/P$ does not Granger cause $B$		4.05096	0.07544
$E^e$ does not Granger cause $M/P$	18	3.50514	0.05301
$M/P$ does not Granger cause $E^e$		3.58036	0.05025
$FIE$ does not Granger cause $M/P$	19	4.95379	0.02361
$M/P$ does not Granger cause $FIE$		7.95531	0.00492

It can be found that, although the  $F$ -statistic value of 2210.45 and the  $R^2$  value of 0.99 imply that Equation (2) has a good explanatory power, there are errors in the signs of the variable  $Y$  and  $FIE$ , and the effect of  $Y$  on  $M/P$  is also statistically insignificant. The reason may be that there is serious multicollinearity between  $Y$  and  $B$ . Another reason might be data measurement error or too little data.

Based on Equation (2) in Table 4, the variable  $E^e$  is further added, and Equation (3) is given (see Equation (3) in Table 4). Although the variable  $E^e$  has itself correct sign and statistically significant effect on the dependent variable  $M/P$ , the signs of  $Y$  and  $I$  coefficients are wrong and the effect of  $Y$  on  $M/P$  is also statistically insignificant. The reason may be that the change in the RMB exchange rate has been all time limited in a narrow band since 1994 and could not thereby offer any useful information in regression. Furthermore, the effect of currency substitution can be partly absorbed into capital mobility with the ceaseless accretion of international capital flows in China. As can be seen that augmented money demand equation (Equation (3)) does not perform very well.

Finally, the variable  $FIE$  is added to Equation (3) to yield Equation (4) in Table 4. It can be found that, in addition to wrong signs in  $Y$ ,  $I$  and  $E^e$ , the effect of  $FIE$  on  $M/P$  is also statistically insignificant, indicating that the measure of capital mobility ( $FIE$ ) is not of crucial importance for China's money demand. Furthermore, the separate inclusion of foreign interest rate ( $I^*$ ) and expected exchange rate ( $E^e$ ) to test their unequal effects is found empirically failure, as they display error signs or statistical insignificance. The reason is likely that change in expected exchange rate has been very small and could not offer any useful information in regression since 1994. In addition, capital items are at present still strictly controlled in China. Therefore, the foreign interest rate could not completely reflect capital mobility.

As discussed earlier, financial innovation has an important effect on money demand. However, because it includes very complicated contents, for example, introduction to new

**Table 4. The OLS estimation results of money demand function**

Variable	Eq. 1	Eq. 2	Eq. 3	Eq. 4
Const.	1151.198 (3.42***)	-3963.857 (3.29**)	-2874.087 (2.33**)	-4562.213 (2.11**)
$Y$	0.004061 (37.64***)	-0.000862 (0.77)	-0.001509 (1.38)	-0.002212 (1.67)
$I$	-162.0770 (3.31***)	622.1359 (3.37***)	602.9495 (3.58***)	786.6032 (3.07***)
$\pi^e$	-5027.313 (2.65**)	-24749.34 (5.22***)	-26446.94 (5.99***)	-30952.09 (4.78**)
$B$		0.046556 (4.32***)	0.048146 (4.88***)	0.056783 (4.32***)
$E^e$			-1.084193 (1.95**)	25.97883 (0.91)
$FIE$				-26.32337 (0.95)
$R^2$	0.99	0.99	0.99	0.99
$F$	1348.41	2210.45	2124.66	1757.87
$D.W.$	1.68	1.27	1.27	1.65

Notes: All equations were run using the OLS technique. The numbers in parentheses below the estimated coefficients indicate  $t$ -values.  $R^2$  = coefficient of determination;  $F$ =  $F$ -statistic;  $D.W.$  = Durbin-Watson statistic; other symbols are defined in the text. \*, \*\* and \*\*\* indicate statistical significance at the 10%, 5% and 1% levels, respectively.

financial instruments, transaction technological innovation and policy change such as regulation or deregulation, how rightly to measure it has become a controversial problem. Kabir and Mangla (1988) introduced a ratchet and a dummy variable to capture the effects of innovation, respectively. Arrau and Gregorio (1993) modeled financial innovation as an unobservable shock that has permanent effects on money demand introducing seasonal dummy in regression. As many of new financial instruments, transaction technologies and policy change such as regulation or deregulation have been gradually introduced and quickly developed in China since 1994, so this paper tries to introduce to a dummy variable to capture the effects of financial innovation but fails. The reason may be that China has not always made significant progress in financial innovation since 1996. Moreover, the function of financial innovation may be reflected in the role of scale variable.

### 5.3. ECM model estimation

Due to limited data and possible serious multicollinearity problem, simple error correction model is here employed instead of Equation (3) to estimate, and the following equation is obtained:

$$\Delta(M/P)_t = 0.004249 \Delta Y_t - 20.102214 \Delta I_t - 1284.209 \Delta \pi_t^e - 0.550765 ECM_{t-1} \quad (4)$$

(13.69)                      (1.86)                      (2.08)                      (1.92)

$$R^2 = 0.76, D.W. = 1.7125, F = 16.57$$

It can be found from Equation (4) that explanatory variables  $y$ ,  $I$ , and  $\pi^e$  have statistically significant effects on explained variable ( $M/P$ ) in the short term. The error correction term  $ECM_{t-1}$  has a significant effect on explained variable ( $M/P$ ), indicating that the short-term dynamic change of money demand has a tendency to deviate from the long-term equilibrium. The negative coefficient of error correction term  $ECM_{t-1}$  shows that there is a tendency for short-term money demand to exceed the long-term monetary demand. Therefore, it is necessary to effectively regulate money demand (Kumar & Rao, 2012).

Compared with long-term money demand model, the impact of interest rate ( $I$ ) and expected inflation ( $\pi^e$ ) on money demand has become smaller (Jiang, Chang, & Li, 2015), but income ( $Y$ ) has a greater impact in the short term. This is because China's economy in the current stage has not fully realized marketization. In particular, the government's management in the issuance and circulation of currency is relatively strict. Therefore, the level of interest rate marketization is very low. In fact, China's interest rates have in the long term been tightly regulated. In recent years, despite the deregulation of interest rates, interest rates have still not realized marketization. This will inevitably have a greater impact on the short-term money demand.

## 6. SVAR model analysis

### 6.1. Model

Let  $m_t$  represents the growth rate of real money demand ( $M/P$ ),  $y_t$  is the growth rate of real GDP,  $i_t$  is the growth rate of real interest rate and  $\pi_t^e$  is the growth rate of real inflation. Not considering constant term, standard SVAR model may be written as,

$$\Gamma_0 Z_t = \sum_{i=1}^l \Gamma_i Z_{t-i} + \varepsilon_t \quad (5)$$

where  $Z_t = [m_t, y_t, i_t, \pi_t^e]$ ,  $\Gamma_0$  and  $\Gamma_i$  are the  $4 \times 4$  impact matrices, respectively,  $l$  is the lag length and  $\varepsilon_t$  is the  $4 \times 1$  vector of white noise.

In order to make the model exactly identified, this paper assumes that  $\Gamma_0$  is the lower triangular matrix with main diagonal element 1 so that the SVAR model becomes a recursive model. At the

same time, assume that the impulse vectors ( $\varepsilon_t$ ) are independent of each other (Bachmann & Sims, 2012). Thus, the SVAR model can be expressed as,

$$\begin{pmatrix} 1 & 0 & 0 & 0 \\ \gamma_{21} & 1 & 0 & 0 \\ \gamma_{31} & \gamma_{32} & 1 & 0 \\ \gamma_{41} & \gamma_{42} & \gamma_{43} & 1 \end{pmatrix} \begin{bmatrix} m_t \\ y_t \\ i_t \\ \pi_t^e \end{bmatrix} = \sum_{i=1}^l \Gamma_i \begin{bmatrix} m_{t-i} \\ y_{t-i} \\ i_{t-i} \\ \pi_{t-i}^e \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{bmatrix} \quad (6)$$

The SVAR model (6) can be converted into a reduced VAR model as follows:

$$\begin{bmatrix} m_t \\ y_t \\ i_t \\ \pi_t^e \end{bmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 \\ \gamma_{21} & 1 & 0 & 0 \\ \gamma_{31} & \gamma_{32} & 1 & 0 \\ \gamma_{41} & \gamma_{42} & \gamma_{43} & 1 \end{pmatrix}^{-1} \sum_{i=1}^l \Gamma_i \begin{bmatrix} m_{t-i} \\ y_{t-i} \\ i_{t-i} \\ \pi_{t-i}^e \end{bmatrix} + \begin{pmatrix} 1 & 0 & 0 & 0 \\ \gamma_{21} & 1 & 0 & 0 \\ \gamma_{31} & \gamma_{32} & 1 & 0 \\ \gamma_{41} & \gamma_{42} & \gamma_{43} & 1 \end{pmatrix}^{-1} \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{bmatrix} \quad (7)$$

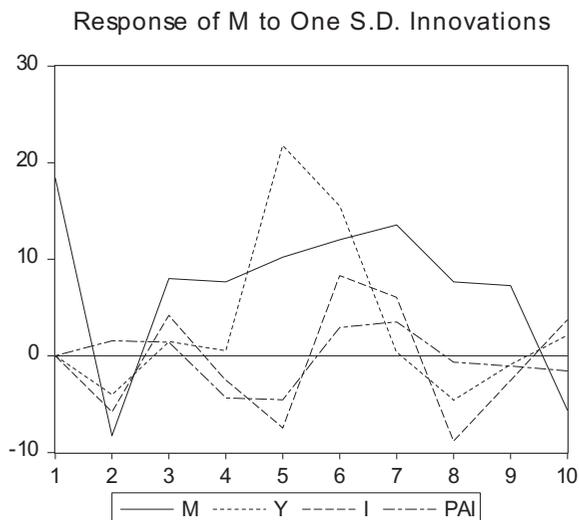
The main purpose of this paper is to use model (7) to discuss, given the impulses of  $y_t$ ,  $i_t$  and  $\pi_t^e$ , respectively, the impulse response functions of  $m_t$  and their own response functions caused by the impulse of  $y_t$ ,  $i_t$  and  $\pi_t^e$  and to capture the impact effects (Zhang & Sun, 2017).

### 6.2. Impulse response analysis

The author is interested in comparing the effects of different factors ( $y$ ,  $i$  and  $\pi^e$ ) on money demand ( $m$ ). As shown in Figure 1, the effect of income ( $y$ ) on the demand for money ( $m$ ) is greatest, especially in the fifth period, reaching the peak. However, the impact began to become smaller after the first to fourth and the seventh period. This result is consistent with the reality of Chinese currency operation and management. Overall, the current demand for money in China is still dominated by transaction demand for money, so the impact of the change in income on money demand is often larger. In addition, because of the more stringent macroeconomic and monetary regulation in China, change in money demand caused by the income fluctuation will decline rapidly after reaching a peak and has significant cyclicity.

The change in money demand caused by interest rate fluctuations shows significant cyclicity. In the first four periods, it is showing staggered changes. However, the period of staggered change begins to become longer after the fourth period, but the magnitude of the fluctuation is increasing (see Figure 1). This is closely related to gradually relaxing with China's interest rate control, which makes more impacts on money demand. It is foreseeable that it will be more closely related to money demand with the gradual realization of marketization of interest rates.

Figure 1. Impulse response function.



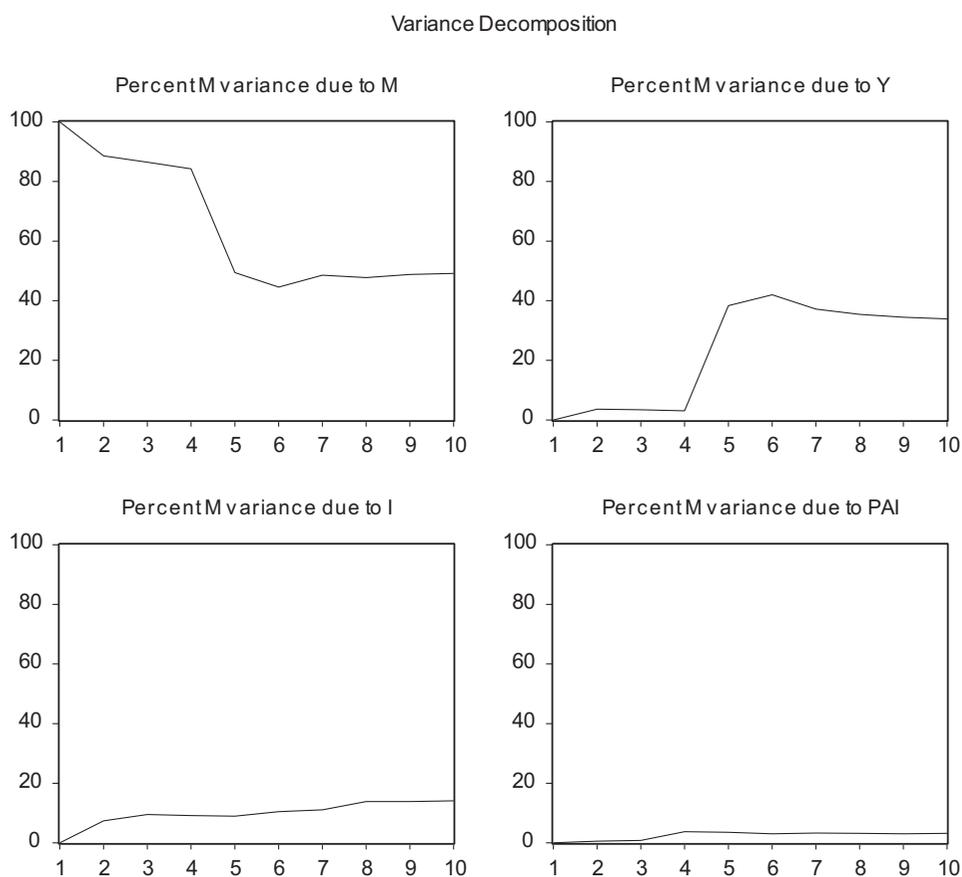
The impact of the change in inflation ( $\pi$ ) on money demand is relatively modest. In the first to the eighth period, the change in money demand caused by the change in inflation ( $\pi$ ) has obvious cyclicity, and the frequency and magnitude of the change are relatively stable. The effect appears to be insignificant after the eighth period (see Figure 1). The reason may be that China's inflation has been controlled in a small range in recent years. Moreover, the growth in domestic demand has been shown in recent years, so the impact on the money demand is relatively small.

An interesting phenomenon is that the impulse effects of the change in money demand on its own are not only large but also have a longer duration. It can be seen from Figure 1 that the impulse response of the money demand has a large reversal in the first to the third phases, continues to be in a higher level after the third phase and a larger decline until the ninth period. The effects do not have synchronization periodicity with other factors. This shows that China's money demand has a significant inertia, which has an important reference value for the formulation and implementation of China's monetary policy.

### 6.3. Decomposition of variance

Decomposition of variance tells us what factors more contribute to impulse response. As shown in Figure 2, the variance of money demand itself is always the biggest. Although the first to fifth period has a quick decline, it remains basically unchanged after the fifth period. The variance of money demand ( $m$ ) due to income ( $y$ ) has been small and smooth, but it suddenly becomes larger after the fourth period and remains stable thereafter. The variance of money demand ( $m$ ) due to the interest rate ( $i$ ) has been relatively small and basically stable. The variance of money demand ( $m$ ) due to inflation ( $\pi$ ) has been minimal and basically stable (Liu & Huang, 2016).

Figure 2. Decomposition of variance graphic.



## 7. Discussion

### 7.1. The stability of money demand

Although China has implemented single market-oriented monetary system including single exchange rate and foreign exchange system since 1994, China's financial system is still imperfect and needs more reform and improvement, which has led to instability in China's currency demand. Data for 1994–2008 have been used to estimate Equation (2), but the standard money demand equation has not obtained. Instead, an extended monetary demand equation excluding domestic interest rates was obtained (Dou, 2011).

One interesting finding is that the interest rate has not a statistically significant impact on money demand using 1994–2008 data to estimate Equation (2) but has a significant impact on monetary demand using 1996–2016 data to estimate Equation (2) again. This may be related to the gradual relaxation of interest rate control and a gradual transition to marketization in China during this period.

Another interesting finding is that government deficits, currency substitution (reflected in  $E^{e+r^f}$ ) and financial innovation (reflected in  $D$ ) have, respectively, significant impact on money demand using 1994–2008 data to estimate Equation (2), but their impacts on monetary demand are not significant using 1996–2016 data to estimate Equation (2) again. It may be related to the selection of data and the existence of measurement errors or uncoordinated or limited reform in China in recent years.

Different results from different data show that China's money demand is still unstable at least in an earlier period. China's money demand instability suggests that China's economy may have some problems and risks. The first is irrational and unstable financial structure and financial market system, which will seriously restrict the development of market economy in China. The second is the higher costs but the lower efficiency of financing, which will significantly reduce the efficiency and quality of economic development. These problems may lead to the risks of macroeconomic imbalance (Lucas & Nicolini, 2015).

### 7.2. Marketization and money demand

Interest rate marketization has a great impact on money demand, as it directly affects investment and consumption, which has an impact on money demand. However, for a long time, China has imposed tighter control on interest rates, especially in the early days of reform and opening up. In recent years, China's control of interest rates has begun to relax, allowing financial institutions to float on the basis of the benchmark interest rate. With the increase in interest rate marketization, the impact of interest rates on money demand will be more and more (Ben-Salha & Jaidi, 2014).

However, China prefers to control the total amount of money supply, as it is in line with China's management tradition. More importantly, China has made a lot of experience in controlling the total amount of money. In this case, the impact of interest rates on money demand is relatively weak. This is why China's currency demand does not have a serious deviation from real economic needs, although China's interest rates have not been market oriented. However, with an increase in the level of interest rate marketization, the phenomenon of Chinese financial repression will gradually disappear, and the potentials of money demand will be fully released by then.

### 7.3. Internationalization and money demand

The research in this paper shows that the impact of international capital flows on money demand is not significant. This is mainly because China's control on international capital flows is relatively strict, and the inflows of international capitals mainly take the form of foreign direct investment, and its impact on money demand is reflected in investment and consumption. At the same time, a large part of the outflows of international capitals takes a concealed form, so they do not directly affect money demand (Kang, Ratti, & Vespignani, 2016).

However, in the long run, China's money demand will also have important links with international economy and capitals with China's economic growth and the increasing internationalization of the RMB. Especially with the launch of China's "the belt and the road initiative", the influence of international factors on China's money demand will be more and more important (Zavyalova, 2017). Chinese economic and financial reform must pay attention to this factor in the future.

#### **7.4. E-commerce and money demand**

The emerging of e-commerce completely changes traditional business behavior in recent years. E-commerce enables consumers to shop online, including online transactions between merchants and online electronic payments. It is a new type of business operation mode which integrates various business activities, trading activities, financial activities and related comprehensive service activities. Obviously, demand for cash balance will be significantly reduced with the development of e-commerce.

More importantly, traditional paper currency will eventually be replaced by electronic money. However, the electronic currency is only a kind of currency of accounting, so people's money demand behavior will change greatly with the generation and wide use of electronic money. Because e-commerce and electronic money are in generation and development and thus the scale is still small, the model built in this paper does not deal with this issue. However, this factor must be taken into account in the analysis of currency demand with the development of e-commerce and e-money.

#### **7.5. Prudent monetary policy and money demand**

Prudent monetary policy has always been the theme of China's monetary policy. Because of the imperfect market mechanism and limited macro-control technology, money demand cannot reflect actual demand, and there is financial repression. The money demand model built in this paper is difficult to include these factors. In fact, because of investment hunger, excess money demand in China's investment field always exists. However, in the field of consumption, because of inadequate effective demand, there is a structural problem of insufficient money demand. In addition, people's money demand behavior will inevitably change significantly in the case of spiral inflation. However, these changes cannot be reflected under the prudent monetary policy (Berkelmans, Kelly, & Sadeghian, 2016).

### **8. Conclusion**

The purpose of this paper is to estimate China's money demand functions with yearly data from 1996 to 2016. Empirical results indicate that standard money demand function, including typical variables such as real income, interest rate and expected inflation rate, is obtained. However, it is difficult to take financial innovation, government debt and capital mobility into China's money demand model under the condition of the current economy.

An interesting implication based on the investigation above is that  $M_2$  appears to have a close and stable relationship with economic activity, and this result is consistent with previous findings (Hafer & Kutan, 1994). Actually, because money and capital markets have not been fully developed in China, the transaction demand for money is directly related to economic activity. Therefore, it is relatively easier for the monetary authority to control  $M_2$  in regulating its growth rate.

The regression results of sample data from different periods show that money demand in China is unstable. China's money demand instability suggests that China's economy may have some problems and risks. Therefore, China must adopt prudent financial and monetary policies to cope with the uncertainty of money demand in the future.

Because China is still in the reform of the financial and monetary system, China has still the problem of structural money demand adjustment. No statistically significant impacts of financial innovation, government debt and capital mobility on money demand show that China's monetary regulation is still relatively strict, resulting in relatively low financial

marketization. This will restrain economic development to some extent. Especially, China's money demand will inevitably appear new characteristics with the internationalization of RMB. Therefore, China must accelerate the pace of the reform of monetary policy and interest rate liberalization in the future.

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