JOURNAL OF ECONOMIC DEVELOPMENT 21
Volume 32, Number 1, June 2007

HOW STABLE IS THE DEMAND FOR MONEY IN CHINA?

MOHSEN BAHMANI-OSKOOEE AND YONGQING WANG*

The University of Wisconsin-Milwaukee

Different authors have tried to estimate the demand for money in different countries. A common theme of almost all studies since 1987 is the application of cointegration technique. The demand for money in China is no exception and has received some attention by researchers. However, finding of cointegration has been interpreted as a sign of constancy of parameter estimates. In this paper we employ CUSUM and CUSUMSQ tests in conjunction with cointegration analysis to show that both M1 and M2 are cointegrated with their determinants. The results of stability tests reveal that while M1 money demand in China is stable, there is some doubt about stability of M2 money demand.

Keywords: Money Demand, China, Bounds Testing, Stability
JEL Classification: E40

1. INTRODUCTION

Reform in China began in 1978 when the Chinese Communist Party decided to shift its focus from "class struggle" to "economic development." Economic reforms that were introduced during 1979-83 period included agriculture reform, opening up the economy, fiscal decentralization, state-owned enterprise reform and financial reform.[1] Before these reforms the only bank in China was the People's Bank of China. This bank served as the central bank as well as a commercial bank. However, after the reforms, China decided to transfer the commercial operations to four specialized banks known as Agriculture Bank of China (for the rural sector), the Industrial and Commercial Bank of China (for the industrial sector), the People's Construction Bank of China (for long-term investment), and the Bank of China (for foreign exchange business). Since 1984 these four banks have been allowed to compete for loans and deposits. Thus, after the reforms the money supply process has become a money creation mechanism through the money multiplier (Yi (1993)). Obviously, the control over the monetary policy works only when the demand for money is responsive to the change of policy tools such as interest rates.

* Valuable comments of an anonymous referee are greatly appreciated. Any error, however, is our own.
[1] For details of each of these reforms see Qian (1999).

Following the path outlined by the Quantity Theory of Money, if an increase in money supply is to be transmitted to an increase in the price level or the level of output, the velocity of money should be stable. Thus, establishing the stability of the velocity or stability of the linear combination of nominal money stock, the price level and the level of output is an important step in conducting monetary policy. Since at equilibrium, existing stock of money in circulation is assumed to be held or demanded, the task is reduced to testing for stability of the demand for money. Since introduction of cointegration technique in 1987 by Engle and Granger (1987) or in 1988 by Johansen (1988) many authors have re-investigated the long-run relationship between the demand for money and its determinants. Examples are Hafer and Jansen (1991), Hoffman and Rasche (1991), McNown and Wallace (1992) for the U.S.; Adams (1991), Johansen (1992) for the U.K.; Frenkel and Taylor (1993) for Yugoslavia; Bahmani-Oskooee and Shabsigh (1996) for Japan and Bahmani-Oskooee (1996) for Iran. A general consensus reached by most authors is that M2 monetary aggregate is cointegrated with income and interest rate but M1 is not.

In line with the literature, the demand for money in China has also received a great deal of attention. Early studies that used standard estimation techniques tackled different monetary issues by estimating the demand for money in China. The list includes Hu (1971), Chow (1987), Feltenstein and Farhadian (1987), Chan *et al*. (1991), Ma (1993), Yi (1993) and Xu (1998). More recent studies, however, have employed cointegration technique in order to establish the cointegration among the variables of the money demand function. The list includes Chen (1989), Burton and Ha (1990), Hafer and Kutan (1994), Huang (1994), Qin (1994), Chen (1997) and Huang (2000). The main conclusion from these studies is that M2 monetary aggregate is cointegrated with income and interest rate and this cointegration is interpreted as a sign of stable demand for money. However, Bahmani-Oskooee and Bohl (2000) have demonstrated that cointegration does not imply constancy of estimated coefficients. By incorporating the CUSUM and CUSUMSQ tests developed by Brown *et al.* (1975) into cointegration and error-correction modeling techniques, they show that in Germany while the variables included in the money demand function are cointegrated, their estimated money demand function is unstable, mostly after the unification.

The main purpose of this paper is to reconsider the demand for money in China and test not only for its cointegrating properties but also for its stability over time. To this end, in Section 2 we formulate the demand for money and introduce a relatively new cointegration technique. In Section 3 we report the empirical results and show that although both M1 and M2 monetary aggregates are cointegrated with income and interest rate, M1 money demand is stable but M2 is not.

2. THE DEMAND FOR MONEY AND THE ARDL APPROACH TO COINTEGRATION

Since in most recent years China has become a major player in the world economy through her increased trade and openness, in formulating the demand for money we make sure to incorporate variables that account for currency substitution. In doing so we rely upon the money demand function proposed by Arango and Nadiri (1981) as outlined by Equation (1):

$$LnM_t = a + bLnY_t + cR_t + dR^*_t + eLnEX_t + \varepsilon_t, \tag{1}$$

where M is a monetary aggregate in real term $(M1$ or $M2)$, Y is the real income, R is the domestic interest rate, R^* is the foreign interest rate, and EX is the nominal effective exchange rate. Following the literature on the transaction demand for money we expect an estimate of b to be positive. On the other hand, following the literature on speculative demand for money, we expect an estimate of c to be negative. As for the effect of foreign interest rate, following the currency substitution literature, if an increase in foreign interest rate induces domestic residents to increase their holding of foreign securities by drawing down their holdings of domestic currency, we would expect an estimate of d to be negative. Finally, an estimate of e is expected to be positive or negative. Arango and Nadiri (1981) argue that a decrease in EX or a depreciation of domestic currency (an appreciation of foreign currency) increases the domestic currency value of foreign securities held by domestic resident. If this increase is perceived as an increase in wealth, the demand for domestic currency by domestic residents could increase yielding a positive estimate of e. On the other hand, Bahmani-Oskooee and Poorheydarian (1990) have argued that when a currency depreciates, there could be expectation of further depreciation. This could induce public to increase holdings of foreign currency by drawing down their holdings of domestic money. McKinnon *et al.* (1984) and McNown and Wallace (1992) who considered the money demand in the United States argue that portfolio shifts between dollar and foreign currency assets could introduce instability into the demand for money unless we include the effective exchange rate of the dollar as another determinant of the demand for money. It should be mentioned at the outset that it was Mundell (1963, pp. 484) who originally conjectured that “the demand for money is likely to depend upon the exchange rate in addition to the interest rate and the level of income”.

Equation (1) outlines the long-run relationship among the variables of the money demand function. Even though our concern is to establish constancy of parameter estimates of (1), we must incorporate short-run dynamics into our testing procedure. Indeed, Laidler (1993, pp. 175-176) writes:

"A complementary line of enquiry has investigated the possibility that some of the problems of instability in recent years have stemmed not from problems with the long-run function, but from inadequate modeling of the short-run dynamics characterizing departures from the long-run relationship."

With existing developments in time series modeling techniques, incorporating short-run dynamics into Equation (1) amounts to expressing (1) in an error-correcting format. If we were to follow, say, Engle-Granger (1997) specification, the error-correction model (ECM) will take the following form:

$$\begin{aligned}\Delta LnM_t = \alpha &+ \sum_{k=1}^{n}\beta_{0,k}\Delta LnM_{t-k} + \sum_{k=0}^{n}\beta_{1,k}\Delta LnY_{t-k} + \sum_{k=0}^{n}\beta_{2,k}\Delta R_{t-k} + \sum_{k=0}^{n}\beta_{3,k}\Delta R^{*}_{t-k} \\ &+ \sum_{k=0}^{n}\beta_{4,k}\Delta LnEX_{t-k} + \delta\varepsilon_{t-1} + \mu_t,\end{aligned} \tag{2}$$

where ε_{t-1} is the lagged stationary error term from Equation (1). Note that in this set up, each variable is assumed to be non-stationary at level or first differenced stationary. What to do in case some of the variables like income is non-stationary and some like interest rates are stationary?

Pesaran *et al*. (2001) introduce a relatively new technique that does not require pre-unit root testing. Their method amounts to replacing ε_{t-1} in Equation (2) with the linear combination of lagged level variables as in Equation (3) below:

$$\begin{aligned}\Delta LnM_t = \alpha &+ \sum_{k=1}^{n}\beta_{0,k}\Delta LnM_{t-k} + \sum_{k=0}^{n}\beta_{1,k}\Delta LnY_{t-k} + \sum_{k=0}^{n}\beta_{2,k}\Delta R_{t-k} \\ &+ \sum_{k=0}^{n}\beta_{3,k}\Delta R^{*}_{t-k} + \sum_{k=0}^{n}\beta_{4,k}\Delta LnEX_{t-k} + \delta_0 LnM_{t-1} + \delta_1 LnY_{t-1} + \delta_2 R_{t-1} \\ &+ \delta_3 R^{*}_{t-1} + \delta_4 LnEX_{t-1} + \mu_t.\end{aligned} \tag{3}$$

In order to justify retention of lagged level variables in (3) which implies cointegration among them, Pesaran at al. (2001) propose applying the familiar F-test with new critical values that they tabulate. Therefore, null of no cointegration, i.e., $\delta_0 = \delta_1 = \delta_2 = \delta_3 = \delta_4 = 0$ is tested against the alternative of $\delta_0 \neq \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq 0.$ Once cointegration is established, we apply the CUSUM and CUSUMSQ tests to the residuals of Equation (3). These tests that are proposed by Brown *et al*. (1975) are updated recursively and are plotted against the break points. For stability of long-run as well as short-run coefficient estimates, the plot of the two statistics must stay within 5% significant level which Brown *et al*. (1975, section 2.3) provide their equations.

3. EMPIRICAL RESULTS AND STABILITY TESTS

We employ quarterly data over 1983I-2002IV period to carry out the empirical analysis. This is the period for which data on all variables were available. In order to determine which monetary aggregate yields stable relationship with income, interest rates and the exchange rate, we use real M1 and real M2 monetary aggregates. Two steps are involved in applying the bound testing or the ARDL approach. In the first step we impose arbitrary and the same number of lags on each first differenced variable in (3) and carry out the F-test. Obviously, as demonstrated by Bahmani-Oskooee and Brooks (1999) the results will depend on the choice of the lag length. Table 1 reports the results of the F-test for different lag length.

Table 1. The Result of the F-test for Cointegration

	Lag Order on Each First Differenced Variable			
	2	4	6	8
M1 Aggregate	1.82	2.08	3.07	5.36
M2 Aggregate	0.82	1.77	1.95	2.96

Notes: The critical value of the F-statistic for upper bound and the lower bound with four regressors are 4.01 and 2.86 respectively, at the 5% level of significance. These come from Pesaran *et al*., 2001, p. 300.

It is clear from Table 1 that only in one case the calculated F is greater than the upper bound critical value of 4.01 supporting cointegration. In the most remaining cases, cointegration among the variables of M1 and M2 money demand function is rejected. However, since lags are selected arbitrary and without using any criterion, following Bahmani-Oskooee and Brooks (1999) and Bahmani-Oskooee (2001) we consider the results preliminary and move to the second and more efficient stage of estimation. In the second stage we try to estimate Equation (3) after imposing maximum of eight lags on each first differenced variable. We then employ Akaike Information Criterion (AIC) for selecting the optimum number of lags on each variable. Only an appropriate lag selection criterion will be able to identify the true dynamics of the model. While Table 2 reports the short-run coefficient estimates, Table 3 reports the long-run estimates as well as some diagnostics statistics to be discussed later.

Table 2. Short-Run Coefficient Estimates

Panel A: M1 Money Demand

	Lag Length							
	0	1	2	3	4	5	6	7
Δ Ln M1		-0.223	-0.239	-0.071	-0.035	0.15	-0.162	
		(1.86)	(2.06)	(0.59)	(0.30)	(1.31)	(1.44)	
Δ Ln Y	0.93	0.44	0.35	0.25	-0.24	-0.45	-0.32	-0.29
	(7.25)	(2.39)	(1.97)	(1.29)	(1.39)	(2.64)	(2.09)	(2.63)
Δ R	1.03	1.10						
	(1.60)	(1.81)						
Δ R*	-0.75	-0.31	0.23	-1.05	-1.00	-2.18		
	(0.80)	(0.30)	(0.26)	(1.32)	(1.27)	(2.54)		
Δ Ln EX	0.10							
	(1.05)							

Panel B: M2 Money Demand

	Lag Length							
	0	1	2	3	4	5	6	7
Δ Ln M2		-0.19	-0.22	-0.08	0.18	-0.06	-0.24	-0.31
		(1.41)	(1.92)	(0.71)	(1.54)	(0.47)	(1.95)	(3.03)
Δ Ln Y	0.64	0.30	0.40	0.23	-0.25	-0.30	-0.23	
	(5.21)	(1.71)	(2.44)	(1.44)	(1.82)	(2.04)	(1.66)	
Δ R	0.42							
	(1.19)							
Δ R*	-2.33	-0.31	1.02	1.02	-0.54	-3.33	-1.62	
	(2.01)	(0.27)	(1.01)	(1.01)	(0.71)	(4.16)	(1.67)	
Δ Ln EX	0.05	0.13						
	(0.49)	(1.36)						

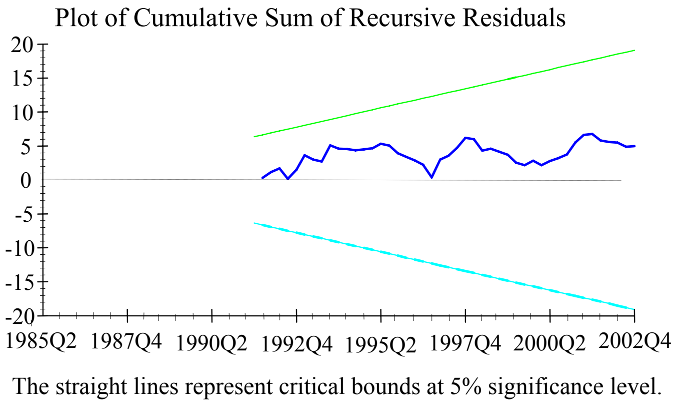
Note: Number inside the parenthesis beneath each coefficient is the absolute value of the t-ratio.

Table 3. Long-Run Coefficient Estimates and Diagnostics

	Normalized Variable	
	Ln M1	Ln M2
Ln Y	1.281 (11.12)	1.691 (10.33)
R	-4.52 (4.39)	-1.54 (1.37)
R*	0.22 (0.12)	0.71 (0.37)
Ln EX	-0.12 (1.00)	-0.17 (1.20)
Diagnostic Statistics		
Adjusted R^2	0.72	0.71
EC_{t-1}	-0.32 (4.55)	-0.28 (3.71)
LM stat.	3.36	5.79
Ramsey's RESET	5.17	3.83
Normality	0.55	42.99

Notes: Number inside the parenthesis next to each coefficient estimate is the absolute value of the t- ratio. LM is the Lagrange multiplier test of residual serial correlation. It has a χ^2 distribution with four degrees of freedom. RESET is Ramsey's test for functional misspecification. It has a χ^2 distribution with one degree of freedom. Normality statistic is based on a test of skewness and kurtosis of residuals.

From Table 2 we gather that except the nominal effective exchange rate (EX), for the remaining variables there is at least one lagged coefficient estimate that is significant at the 5% or 10% level. Since our concern is the long-run, we turn to the long-run coefficient estimates reported in Table 3. It is clear that in the M1 money demand specification while both income and domestic interest rate are highly significant, in the M2 money demand function only income carries a significant coefficient. To further investigate possibility of cointegration among variables of M1 and M2 money demand function, we carry out the F-test for joint significance of lagged level of variables by imposing the optimum number of lags reported in Table 2. For cointegration among the variables of M1 money demand an F-statistic of 6.85 was obtained and for those of M2 money demand, an F-statistic of 4.44 was obtained. Since both are greater than the upper bound critical value, variables in both models are cointegrated. Additionally, we use the long-run estimates from Table 3 in order to construct the linear comibination of lagged level variable in error-correction model (3). Denoting the newly constructed variable by EC_{t-1} we replace the linear combination of lagged level variables by EC_{t-1} and estimate this new model after imposing the optimum number of lags identified in Table 2. Kremers *et al*. (1992) and Bahmani-Oskooee (2001) have shown that a negative and significant lagged error-correction term is a relatively more efficient way of establishing cointegration. Results in Table 3 show that indeed EC_{t-1} carries its negative coefficient with significant t-statistic, thus, confirming cointegration among the variables that is mostly due to income and domestic interest rate in M1 money demand function and only income in the M2 specification. At this stage of estimation, i.e., an error-correction model that includes EC_{t-1}, following Bahmani-Oskooee and Bohl (2000) and Bahmani-Oskooee(2001), we apply CUSUM and CUSUMSQ tests proposed by Brown, Durbin and Evans (1975) to the residuals of these models. The CUSUM test is based on the cumulative sum of recursive residuals based on first set of n observations. It is updated recursively and is plotted against the break points. If the plot of CUSUM statistic stays within %5 significance level (portrayed by two straight lines whose equations are given in Brown et. al (1975, section 2.3)), then coefficient estimates are said to be stable. Similar procedure is used to carry out the CUSUMSQ which is based on the squared recursive residuals. A graphical presentation of these two tests is provided in Figures 1 and 2.



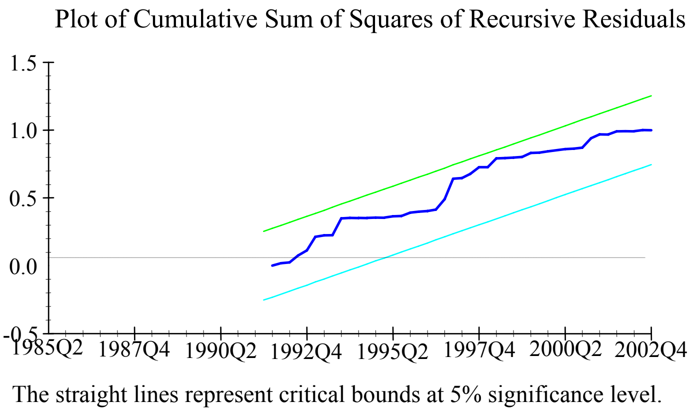
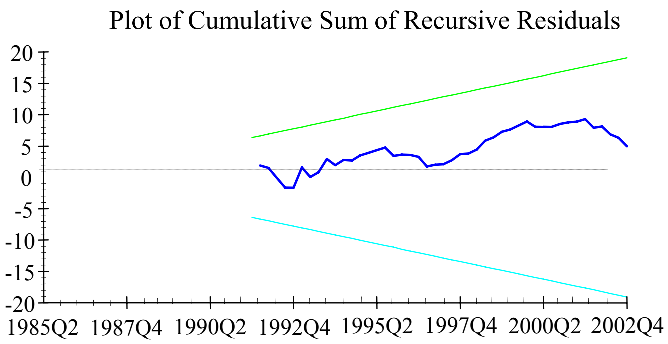


Figure 1. Stability Test Results for M1 Money Demand

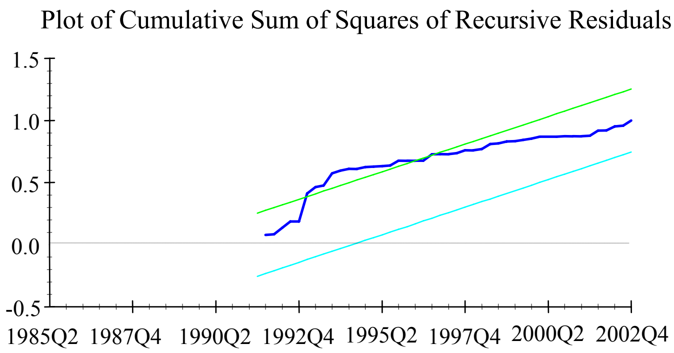
As can be seen from Figure 1, the plot of CUSUM and CUSUMSQ statistics stay within the critical bounds indicating stability in the M1 money demand function. However, Figure 2 reveals that M2 money demand has experienced some instability using at least the CUSUMSQ test.

Given these mixed results for the stability of M2, we thought of providing additional support for instability of M2 money demand by using switching regression technique. From the CUSUMSQ test results we gather that the instability occurred toward end of 1993 and early 1994. Perhaps, the adaptation of a unified market based exchange rate system on January 1, 1994 that replaced the dual exchange rates could be a contributing factor.[2]

[2] For more on foreign exchange reform in China, see Zhang (1999).



The straight lines represent critical bounds at 5% significance level.



The straight lines represent critical bounds at 5% significance level.

Figure 2. Stability Test Results for M2 Money Demand

To provide additional support for instability of M2, we divided the sample to pre-1993Q4 and post 1993Q4 periods and introduced a dummy variable (D) that took a value of zero for the first period and one for the second period. We then tested for the significance of differential intercept and slope terms using the switching regression technique outlined in Kmenta (1986, p. 568) but applied to the error-correction model (3). Results not reported but available from the authors upon request revealed that none of the differential slope terms (short run as well as long run) were significant indicating the fact that the instability observed by CUSUMSQ test was transitory and marginal. Thus, for an effective monetary policy in China, although either monetary aggregates could be manipulated, it is important to pay more attention to M1 because of uncertainty about stability of M2.

4. SUMMARY

Since introduction of the cointegration technique, like any other area in economics, the demand for money has received a renewed attention. With regard to China, several studies have established the cointegrating properties of M1 and M2 money demand function. They have then interpreted their finding of cointegration as a sign of stable demand for money or as a sign of constancy of parameter estimates. In this paper we employ a relatively new cointegration technique known as ARDL approach for cointegration to show that even though the variables could be cointegrated, yet parameter estimates could suffer from instability. We do this by applying CUSUM and CUSUMSQ test to the residuals of an error correction model. The results show that in China while both M1 and M2 are cointegrated with their determinants, M1 money demand is stable but M2 is not. However, additional tests for stability of M2 money demand (switching regression technique) reveal that instability of M2 is transitory and marginal. A policy implication for monetary authority is that in implementing monetary policy, the Chinese central bank would rather target the M1 monetary aggregate.

APPENDIX

Data Definition and Sources

All data are quarterly over 1983I-2002IV period and colleted from the following sources:

M1: Narrow money in real term. Nominal figures that come from the International Financial Statistics of the International Monetary Fund (IFS CD-ROM) are deflated by consumer price index. The price index for 1983Q1-1989Q4 period are from Yi (1993) and for the remaining period come from IFS CD-ROM. Note that M1 included currency outside the banks and demand deposits other than those of the central government.

M2: Broad money in real term. It is defined as nominal M1 plus nominal quasi money (both from IFS CD-ROM) deflated by CPI. Quasi-Money comprises time, savings, and foreign currency deposits of resident sectors other than central government.

Y: Quarterly Real GDP. In the absence of quarterly data, we generated quarterly figures from annual figures using the method by Bahmani-Oskooee ((1998) p. 142). Annual GDP data come from several issues of Chinese Statistical Yearbook.

R: Interest rate defined as deposit rate. Data comes from IFS CD-ROM.

R*: Foreign interest rate defined as US 3-month CD rate. The data comes from the Federal Reserve Statistical Release: Selected interest rates.

EX: Exchange rate defined as the nominal effective exchange rate. It comes from IFS CD-ROM. A decrease reflects a depreciation of domestic currency.

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Mailing Address: The University of Wisconsin-Milwaukee, Milwaukee, WI 53201. Tel: (414) 229 4334, Fax: (414) 229 2348. E-mail: bahmani@uwm.edu

Manuscript received September 2004; final revision received June 2006.