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CHE-CHEONG POON AND FUK-KIN WONG

China's Monetary Policy and Its Transmission Mechanisms Before and After the Financial Tsunami

Abstract: *Since 2000 the Chinese economy has consistently maintained its rapid growth momentum. It has recently also experienced a high degree of volatility that is mainly due to overheating and shock absorbed from the 2008 global financial tsunami. In light of the economic instability derived from the financial tsunami, this article examines empirical evidence regarding the effectiveness of China's monetary policy to dampen the swing of economic cycles. Using the vector autoregression (VAR) model, it concludes that a traditional Keynesian interest-rate channel was China's major monetary transmission mechanism before the financial tsunami, but afterward it changed to an asset-price channel.*

Since the outbreak of the Asian financial crisis in July 1997 and its entry into the World Trade Organization (WTO) in December 2001, China has increasingly been involved in global economic activities and has speeded up reforms in its financial sector. At the same time, Chinese businesses have been adjusting to the rules of the game in the world markets. From 2000 on, however, while the Chinese economy has consistently maintained its rapid growth momentum, it has been suffering a high degree of volatility that may be due mainly to an overheating economy and the shock absorbed from the 2008 global financial tsunami.

In 2008, gross domestic product (GDP) grew 9 percent to over RMB30 trillion and the inflation rate was 5.9 percent, the highest since 1996. As a result, the People's Bank of China (PBC) implemented a tight monetary policy to contain the risk of overheating and placed stronger upward pressure on prices.[1] However,

Che-cheong Poon is an associate professor and Fuk-kin Wong is an assistant professor in the Department of Economics and Finance at Hong Kong Shue Yan University; e-mails: ccpoon@hksyu.edu and joewong@hksyu.edu.

facing the collapse of Lehman Brothers in September 2008 and the impact of the resulting credit crunch, the PBC decisively and swiftly switched its tight monetary policy to a moderately loose monetary policy, in line with the overall arrangements of the Central Committee of the Chinese Communist Party (CCP) and the State Council. To do this, a series of monetary measures have been implemented to bail out the economy and counter the effects of the financial tsunami. These measures include reducing open market sales of central bank securities, decreasing the required reserve ratio, lowering the RMB benchmark lending and deposit rates, adjusting the floor mortgage-lending rate for individual housing loans down to 70 percent of the benchmark lending rate, and lowering the minimum down payment ratio to 20 percent.

Additionally, on November 5, 2008, the State Council decided on a RMB4 trillion investment package to further stimulate the economy. Since the beginning of 2009, to implement the State Council's Ten Measures and Thirty Opinions to Further Expand Domestic Demand and Support Economic Growth, the PBC continued to conduct this moderately loose monetary policy and enhance credit-policy guidance. By the end of June 2009, money supply M1 and M2 reached RMB19.3 trillion and RMB56.9 trillion respectively, representing a year-on-year growth of 24.8 percent and 28.5 percent, the highest rates since May 1995 and May 1996 respectively. Meanwhile, GDP recorded a year-on-year growth of 7.1 percent for the first six months of 2009.

As stated in the China Monetary Policy report, "In general, the moderately loose monetary policy has been transmitted effectively" (PBC, Second Quarter 2009, 2). The PBC was quite satisfied with the monetary policy tools adopted and the effects of monetary policy transmission during the financial tsunami. However, this does not mean that the effectiveness of China's monetary policy tools is unquestioned. In order to put forward our argument, this study examines empirical evidence on the effectiveness of China's monetary policy to dampen the swing of economic cycles. The study discusses the monetary tools used by the PBC—namely, reform of the deposit reserve system, reform of open market operations, and market-based interest rate reforms—and summarizes the empirical evidence by means of a vector autoregression (VAR) model. Based on these findings, the transmission mechanisms of monetary policy in China before and after the global financial tsunami are examined.

China's Monetary Policy

Although some economists believe that window guidance (jawboning) and credit policy guidance are the main monetary policy instruments available in China (Geiger 2008). This article will concentrate on the three general monetary policy tools: open-market operations, reserve requirements, and a market-based interest rate system. This investigation will provide an institutional background for our discussion of the evolution of monetary transmission mechanisms in China.

Open Market Operations

Open market operations (OMOs) are a means of implementing monetary policy by which a central bank controls the national money supply by buying and selling government securities on the open market. Generally speaking, the PBC withdraws monetary base by issuing central bank bills and injects monetary base by redeeming them.

The OMOs of the PBC included both RMB and foreign exchange operations. The RMB operation resumed its transactions on May 26, 1998, and has grown ever since, while the foreign exchange operation started its operation in March 1994. In 1998, the PBC set up an open-market primary-dealer system. Financial institutions with the capacity to handle large transactions in bonds were selected to conduct the OMO transactions. In April 2003, the PBC started issuing central bank bills, thereafter regularly auctioning bills with 3-month, 6-month, and 1-year maturities. In 2004, the PBC adopted a number of process innovations to make its open-market operations more effective, such as increasing the frequency of operations, extending the trading time, developing new products, and improving support systems (HKMA 2005).

Early in July 2008, faced by the global financial crisis, the PBC preemptively suspended the issuance of 3-year central bank bills, and it gradually reduced the size and frequency of central bank issues. A total of RMB4.3 trillion of central bank bills were issued in 2008, and the outstanding balance was RMB4.65 trillion by the end of 2008. In order to lessen the adverse consequences of the financial tsunami, the PBC continued to conduct open-market operations by funneling liquidity to the banking system in 2009. In the first six months of 2009, a total of RMB2.29 trillion of repo operations were conducted and RMB1.41 trillion of central bank bills were issued, with the total outstanding amount reaching RMB4.15 trillion (PBC, Second Quarter, China Monetary Policy Report, 15).

OMOs have an effect on the cost and availability of bank reserves, and on the growth of bank credit and money supply. Therefore, theoretically, of all the weapons available to the PBC, the most active, flexible, and scale-unlimited one is clearly the OMO. However, as the operational framework of China's monetary policy is still in an early stage of transition, there are some weaknesses in the OMO, including high interest costs for central bank bonds issued and the impact on market interest rates.

The Deposit Reserve System

In fact, the PBC is aware of the weakness of large-scale issuance of central bank bonds. Since 2004, it has been trying to find alternatives. Adjusting the required reserve ratio is one alternative, and it has the advantage of being low-cost.

In March 1998, the PBC began to reform the reserve requirement system by merging the accounts for required reserves and excess reserves and adopting a

uniform interest rate. In December 2003, the PBC reformed the interest rate system for deposit reserves by differentiating the rates of interest on required reserves and excess reserves. The interest rate for the excess reserves of financial institutions was lowered from 1.89 percent to 1.62 percent, while the interest rates of the required reserves remained unchanged at 1.89 percent. On April 25, 2004, the PBC adopted a differentiated required reserve ratio system.[2] Under the new system, financial institutions whose capital adequacy ratios and nonperforming loan (NPL) ratios failed to attain certain standards were required to hold an additional 0.5 percent penalty required reserve ratio.[3] This was designed as an incentive that would reward institutions with good performance and punish those behaving badly.

The PBC adjusted the required reserve ratio upward twenty times from 6 percent in November 1999 to 17.5 percent in June 2008 and then decreased the ratio four times to 14.5 percent in December 2008. Consequently, GDP growth rates steadily fluctuated up and down by about one to two percentage points, hovering around 9 percent during this period. The effectiveness of these monetary policy tools can be justified in terms of their counter-cyclical effect, assuming that all other forces affecting general economic activities remained unchanged.

Although raising the required reserve ratio instead of issuing central bank bonds has the advantage of lower operating costs, the effectiveness of this measure is questionable. The whole problem derived from some fundamental flaws embedded in China's required reserve system.

In contrast with foreign central banks, some of which pay interest only on required reserves and others pay no interest at all on deposit reserves, the PBC pays relatively high interest on all kinds of deposit reserves. A relatively high interest rate on excess reserves attracts financial institutions to maintain substantial amounts of excess reserves at the PBC. As a result, it reduces the sensitivity of financial institutions with respect to the central bank's conduct of monetary policy and undermines the effectiveness of monetary policy management. Evidence shows that this arrangement has distorted the role of deposit reserves as a monetary policy by giving financial institutions a good investment alternative to earn interest income from the central bank. Facing this problem, the PBC cut the interest rate on excess reserves of financial institutions from 1.62 percent to 0.99 percent on March 17, 2005, and kept the rate on required reserves intact at 1.89 percent. On November 27, 2008, the PBC again lowered interest rates on reserve requirements and excess reserves from 1.89 percent to 1.62 percent and 0.99 percent to 0.72 percent respectively. The cuts in these two interest rates were believed to be a catalyst for commercial banks to enhance the efficiency of capital use and promote market-based interest-rate reforms. However, due to the rather high interest rate of 0.72 percent on excess reserves and the limited alternative investment options, banks may still decide to put money into the central bank for a guaranteed return. Therefore, it is recommended that excess-reserve ratios have to be reduced in order to strengthen the effectiveness of monetary policy (Green 2005).

In 1998, the PBC removed the restrictions on the excess-reserve ratio and allowed

financial institutions to decide on their own the amount of excess reserves they would deposit in the central bank.[4] After this the excess-reserve ratio of China's financial institutions fell year by year, and dropped from a rate as high as 10 percent in 1999 to 2.28 percent at the end of March 2009 (PBC, Second Quarter 2008, 7; First Quarter 2009, China Monetary Policy Report, 8). There are several reasons for the decline in the excess-reserve ratio. First, financial institutions tend to lower the excess-reserve ratio and make good use of their funds to increase the returns. Second, the interest rate paid on excess reserves decreased significantly from 8.82 percent in 1996 to 0.72 percent in 2008. Therefore, a decrease in the interest rate on excess reserves can exert pressure on financial institutions to manage their assets and liabilities effectively and prudently, especially in the case of banks listed on the stock exchanges. Third, financial institutions can manage their liquidity more easily due to the more efficient money market.

Based on the downward trend of excess-reserve rates, the total reserve ratio was 16 percent in 1999, which comprised a 6 percent required reserve ratio and a 10 percent excess-reserve ratio. More recently, the total reserve ratio was 16.78 percent at the end of March 2009, which comprised a 14.5 percent required reserve ratio and 2.28 percent excess-reserve ratio. Therefore, the total reserve ratios in 1999 and 2009 were more or less the same, and further, the ratios fluctuated only within 4 percent from 1999 to 2009. With the consideration of the interest-earning feature of the required reserve and excess-reserve accounts and the effectiveness of the reserve system, which depends on the overall level of reserves (the sum of required reserves and excess reserves), we conclude that the seeming contractionary or expansionary effects of raising or lowering the required reserve ratios have little effect on general economic activity.

Market-Based Interest Rates

Since 1993, the PBC has taken many important steps toward the liberalization of market interest rates. In 1993, a blueprint for carrying out a market-based interest rate reform was drawn up in the Decision on Issues Concerning Establishment of the Socialist Market Economic System adopted by the Third Plenum of the Fourteenth CCP National Congress and the State Council's Decision on the Reform of the Financial System. In 2002, it was decided in the report of the Sixteenth CCP National Congress to "steadily advance the market-based interest rate reform and improve the allocation of financial resources" (PBC 2005). One year later, the Decision on Issues Concerning Improvement of the Socialist Economic System adopted by the Third Plenum of the Sixteenth CCP National Congress further pointed out the steps that would be taken to "steadily advance the market-based interest rate reform and improve the interest rate formation mechanism based on the market supply and demand." At the end of 1997, the PBC decided to terminate mandatory planning on the lending of state-owned commercial banks, indicating that China's macroeconomic management would be implemented in a more indirect style.

Table 1

Changes of Benchmark Interest Rates for RMB-Denominated Loans and Deposits (% per annum)

	1990 04.15	1991 04.21	1993 07.11	1995 07.01	2002 02.21	2007 12.21	2008 12.23
Loans (1-year) (%)		8.64		12.06	5.31	7.47	5.31
Changes in %*				+3.42	–6.75	+2.16	–2.16
No. of changes				3	8	9	5
Duration (in years)				4.25	9.25	5.83	1.00
No of changes per year				0.7	0.9	1.5	5.0
Deposits (1-year) (%)	10.0	7.56	10.9		1.98	4.14	2.25
Changes in %*		–2.52	+3.42		–9	+2.16	–1.89
No. of changes		2	2		8	8	4
Duration (in years)		1.00	2.25		8.58	5.83	1.00
No. of changes per year		2.0	0.9		0.9	1.4	4.0

Source: PBC, *China Monetary Policy Report*, various issues.

*the figure in that year compared with the previous highest or lowest figure.

Historically, interest rates on deposits and loans were set by the PBC and subject to other restrictions it established. However, in the past decade, the PBC has implemented a series of initiatives designed to gradually liberalize interest rates and move toward a more market-based interest rate regime. In October 2004, the PBC removed the upper limit of the RMB lending rate of financial institutions, excluding urban credit cooperatives (UCCs) and rural credit cooperatives (RCCs), and allowed the downward adjustment of deposit rates. For UCCs and RCCs, the ceiling was increased to 2.3 times the benchmark rate. In other words, the PBC imposed ceilings only on deposit rates and floors on lending rates. The most recent policy has lowered the floor lending rate for individual housing loans to 70 percent of the benchmark rate and the minimum down payment ratio to 20 percent in October 2008. Moreover, for the past two decades, the PBC has actively adjusted the benchmark interest rates for RMB-denominated loans and deposits. The changes in benchmark interest rates for RMB-denominated loans and deposits are shown in Table 1.

From April 1991 to July 1995, the PBC changed the benchmark lending rate (1-year loans) three times, from 8.64 percent to 12.06 percent, in 4.25 years—about

0.7 changes per year. Subsequently, the number of changes per year in successive periods gradually increased to five times as of the end of 2008. The same pattern held for the benchmark deposit rate (1-year deposits). This reveals that the PBC has adjusted benchmark interest rates more actively and frequently. In 2009, there was an excess of liquidity and the PBC reported (China Monetary Policy Report, Second Quarter 2009, 13) that some commercial banks were offering depositors a rate lower than the RMB benchmark deposit rate. This banking practice indicates that the level of deposit rates has become more market based.

In their study of the effect of interest rate liberalization on the mechanism of monetary transmission, Fang and Xiong (2005) found that interest rate policy in China is not fully effective and real output has a longer time lag than price. They argue that interest rate liberalization is an important way to improve the effectiveness of transmitting interest rates. Nevertheless, Dai (2003) states that liberalization of interest rates will lead to fiercer market competition among banks because the differences will be reduced. He warns, "If we are a little careless, the economy will be in turmoil for a long time and on a large scale, or even the loss of national currency and economical sovereignty"(n.p.). Therefore, a gradual approach to interest-rate liberalization would be more appropriate in China.

Transmission Mechanism of Monetary Policy

Monetary policy refers to actions taken by central banks to affect monetary and other financial conditions in order to dampen the swing of economic cycles. To design and implement a monetary policy for a country, policymakers have to understand the relationship between operational target variables and ultimate target variables.

A monetary transmission mechanism is a system of mutually adapted economic variables that work together to communicate monetary impulses to the real sector of the economy. As the structural factors that mediate the functioning of a monetary economy differ in different times and places, there are likely to be different monetary transmission mechanisms at different times in a country or across countries. Therefore, the consensus view of economists and central bankers holds that an understanding of the mechanisms of monetary transmission is a prerequisite for a successful monetary policy.

A number of conceivable causal relationships between money supply and aggregate expenditure have received prominent treatment in the literature (Britton and Whitley 1997; Mishkin 2006, 616–26; Ramlogan 2004; Romer and Romer 1990). Four different monetary policy transmission mechanisms are summarized in Table 2: (1) the traditional Keynesian interest-rate channel, (2) the asset-price channel, (3) the credit-availability channel, and (4) the expectations channel.

The traditional Keynesian interest-rate channel is the channel through which expansionary monetary policy makes real interest rates fall, in turn causing a rise in investment spending, residential housing investment, and consumer durables

Table 2

Monetary Policy Transmission Mechanisms

(1)	Traditional Keynesian interest-rate channel			
	M^s	→ Real interest rates	→	Aggregate expenditure(s)
(2)	Asset-price channel			
(3)	Credit-availability channel			
	M^s	→ Bank deposits → Bank loans	→	Aggregate expenditure(s)
		Stock prices → Firms' net worth → Moral hazard and/or adverse selection → Lending activity		
		Nominal interest rates → Cash flow→ Moral hazard and/or adverse selection→ Lending activity		
		Unanticipated price level → Firms' real net worth → Moral hazard and/or adverse selection → Lending activity		
(4)	Expectations channel			
	M^s	→ Expectations (adaptive and/or rational)	→	Aggregate expenditure(s)

Note: "→" represents the link in the causal chain.

expenditures, thereby leading to an increase in aggregate expenditures. There are three subchannels under the asset-price channel: exchange-rate effects, Tobin's q (valuation of stock) effects, and wealth effects. Referring to exchange-rate effects, an expansionary monetary policy leads to a fall in domestic real interest rates and then the exchange rate depreciates, thereby causing a rise in net exports and aggregate expenditures. Tobin's q provides another explanation in the asset-price channel. An expansionary monetary policy may lead to higher stock prices due to the fact that the public has excess money in hand and spends it in the stock market, which in turn increases the market value of firms and the chance of issuing stock for higher investment spending. The wealth-effects channel refers to the rise of stock prices and real estate values, leading to an increase in consumers' wealth and consumption.

The credit-availability channel is based on the problem of asymmetric information in credit markets. It has four subchannels. The first one works through effects on bank lending. An expansionary monetary policy leads to an increase in bank deposits, thereby increasing the availability of bank loans for borrowers who borrow the money and increase their investment spending. The other three sub-

channels operate such that an expansionary monetary policy raises the net worth, cash flow, and real net worth of firms respectively, lowering adverse selection and moral hazard problems, and producing a rise in lending and investment spending. Finally, the expectations channel considers the role of public expectations (both adaptive and rational) in the transmission mechanism of monetary policy. A change in the central bank's stance on monetary policy affects the public's expectations of future economic activity and prices. This in turn affects their responsiveness to the change and thus the transmission channel of monetary policy. If the link (as indicated by the symbol "→" in Table 2) breaks down in any of these four transmission channels or their subchannels, it means that a particular monetary transmission is not operating.

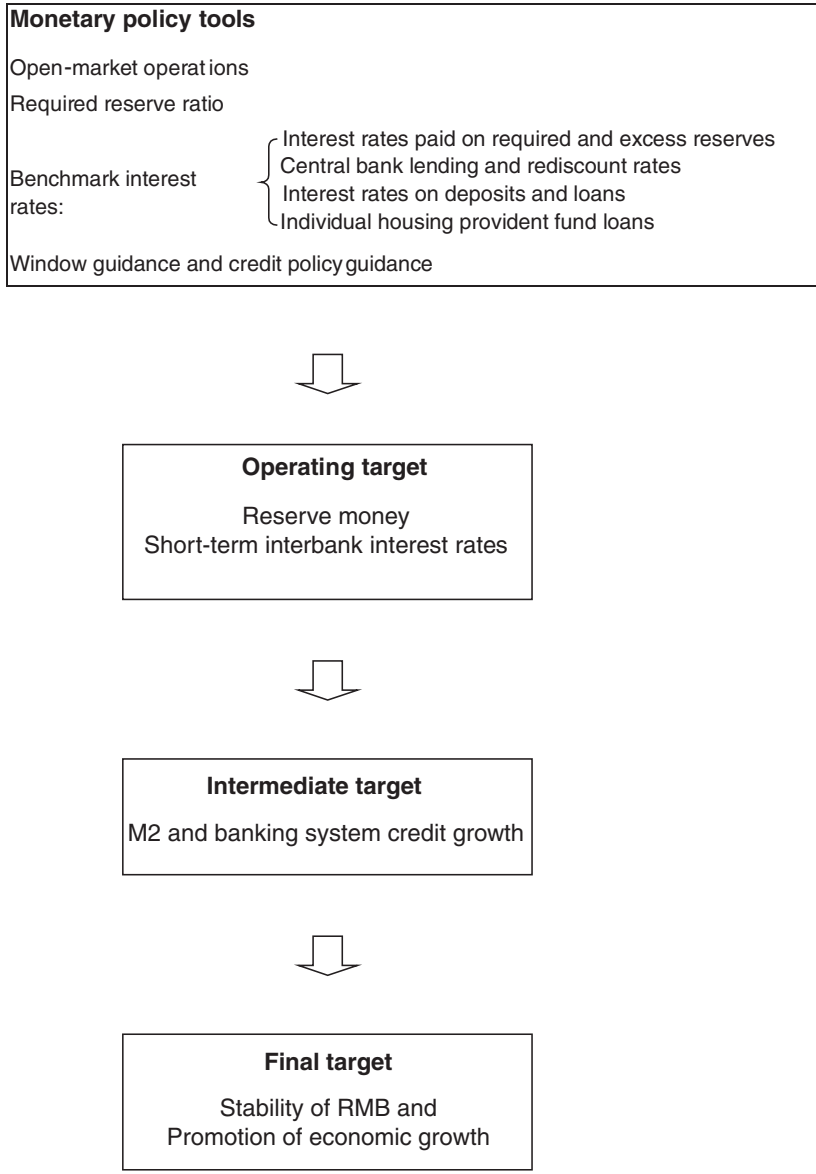
The objective of monetary policy in China is to maintain the stability of the renminbi and thereby promote economic growth. Although there is no explicit articulation of China's mechanism for the transmission of monetary policy (HKMA 2005), Figure 1 summarizes its different elements. Data for expectations are not available, but the three other above-mentioned transmission mechanisms are discussed in the following literature. Yue and Zhou (2007) used the Granger causality test to study the transmission mechanism represented by the traditional Keynesian interest-rate channel of monetary policy transmission. Their results show that there is no causality between investment expenditure and the market interest rate nor between household consumption and the market interest rate, suggesting that the transmission of monetary policy in China is impeded. They argue that tight control of market interest rates weakens the transmission of monetary policy.

Wang and Wang (2000) thought that the credit-availability channel was the main way in which monetary policy was transmitted in China, and that the total volume of credit reported by financial institutions could explain the real GDP to a great degree, whereas money supply had no apparent impact on real GDP.[5] Zhang and Sun (2006) used a general equilibrium model with durable and nondurable goods to explore the role of an expanding consumer credit sector in monetary transmission. They found that expansion of the consumer credit sector amplifies the credit channel of the monetary transmission mechanism and improves the efficiency of the interest-rate channel.[6] The two policy implications derived from the model suggest that the central bank should encourage the development of the consumer credit sector and rely more on market-based monetary policy tools, especially interest rate tools.

Yi (2008) argued that with further enhancements in financial innovation and the introduction of financial derivatives, a monetary policy transmission mechanism with money supply as its intermediate target will face more challenges. He provided four suggestions to solve the existing problems in monetary policy transmission: improve the RMB exchange rate formation regime, steadily advance market-based interest rate reform, push forward the reform of state-owned commercial banks and rural credit cooperatives, and promote further financial market development.

Our analysis aimed at identifying the major channel for transmission of mon-

Figure 1. Transmission Mechanism of Monetary Policy in China



etary policy in China before and after the financial tsunami and at evaluating the effectiveness of the PBC's monetary tools follows in the next section. We use a vector autoregression (VAR) model to facilitate the analysis.

Vector Autoregression (VAR)

Methodology and Data

The use of a VAR model to analyze the effect of monetary policy on major macroeconomic variables can be traced back to the 1980s. Professor Christopher Sims (1986) used a six-variable unrestricted VAR of quarterly data from 1948 to 1979 with four lags and a constant term to study the endogeneity of monetary policy instruments.[7] The estimates suggested that a money supply shock had little effect on prices, output, or interest rates. The VAR approach was further developed by Johansen (1988), Johansen and Juselius (1990, 1992), and Sargent and Hansen (1984), with VAR studies increasing in frequency and importance over the past twenty years. Chen (2002), Hafer and Kutan (1997), Kaufmann and Kugler (2008), Leeper, Sims, and Zha (1996), Mojon and Peersman (2001), Ramaswamy and Slok (1998), Schmidt and McCarthy (1997), and Zhao and Du (2007) are good examples of literature in this area.

VAR is commonly used to forecast systems of interrelated time series and to analyze the dynamic impact of random disturbances on the system of variables. The VAR approach sidesteps the need for structural modeling by treating every endogenous variable in the system as a function of the lagged values of all of the *k* endogenous variables in the system. The model is written as:

$$y_t = \boldsymbol{A}_1 y_{t-1} + \boldsymbol{A}_2 y_{t-2} + \cdots + \boldsymbol{A}_p y_{t-p} + c_t + \varepsilon_t, \quad (1)$$

where y_t is a k vector of endogenous variables, c_t is a k vector of the constant term, $\boldsymbol{A}_1, \boldsymbol{A}_2, \ldots$, and $\boldsymbol{A}_p$ are matrices of coefficients to be estimated, and ε_t is a vector of innovations that may be contemporaneously correlated, but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand-side variables. Since only lagged values of the endogenous variables appear on the right-hand side of the equations, simultaneity is not an issue and ordinary least squares (OLS) yield consistent estimates. Moreover, even though the innovations ε_t may be contemporaneously correlated, OLS is efficient and equivalent to generalized least squares (GLS), because all equations have identical regressors (EViews 5 User's Guide 2004, 717).

Because of the differences between the monetary transmission mechanisms of China today and the United States economy in the 1970s, and because of the nonavailability of statistics, a list of variables somewhat different from the six-variable VAR model used by Professor Christopher Sims has been adopted. After considering the exogenous and endogenous variables included in the four typical monetary transmission mechanisms mentioned previously, the transmission mechanism of

monetary policy in China as shown in Figure 1, and the availability of monthly macroeconomic variable statistics, we use a seven-variable VAR of monthly data from January 2000 to August 2009 to enable us to distinguish among behaviorally distinct sources of disturbance in China's monetary sector. The variables used are the M1 measure of money (Y_1), total loans (Y_2), total deposits (Y_3), consumer price inflation (Y_4), the benchmark 6-month interest rate for RMB-denominated loans (Y_5), the SSE Composite Index (Y_6), and total retail sales of consumer goods (Y_7). [8]

Compare our model with the six-variable model used by Professor Christopher Sims. Although all of the variables except monetary supply are somewhat different, the two VAR models are conceptually similar. First, since the monthly gross national product (GNP) and GNP price deflator are not available in China, the consumer price index is used as a proxy for Sims's GNP price deflator (Y_4). Second, since the total retail sales of consumer goods (Y_7) appear to be highly correlated with GNP, we use it together with (Y_4) to represent Sims's real GNP. Furthermore, since the SSE Composite Index (Y_6) and total loans (Y_2) are good indicators of investment behavior, we use these two variables together with (Y_4) to represent Sims's real business fixed investment. Third, because the Chinese government has largely manipulated the labor market, and unemployment statistics do not reflect the supply and demand of labor at the prevailing wage level, we decided to exclude the unemployment variable used in Sims's model. Instead, we used total deposits (Y_3) and total retail sales of consumer goods (Y_7) to represent the unemployment situation. Finally, because the market-based interest rate reform is still in progress and China's money market is immature, we use the benchmark 6-month interest rate for RMB-denominated loans (Y_5) to represent Sims's treasury-bill rates. In order to filter out the trend and seasonal effects from the observed time series, except for the lending interest rate (Y_5), we use the year-on-year rates of change in the variables. In consequence, the number of monthly observations is reduced from 116 to 104. Figure 2 shows the time-movement pattern (in percent) of these seven time series.

To demonstrate the pattern of correlation between paired variables before and after the financial tsunami, we have calculated a correlation matrix of the seven variables over a twelve-month period from September 2007 to August 2008 and from September 2008 to August 2009.[9] The results are listed in Tables 3 and 4. Besides the marked difference between the corresponding correlation coefficients in the two tables, we note in particular that there has been a drastic change in the relationship (the correlation coefficients are in boldface) between the rate of change in total loans (Y_2) and each of the other six endogenous variables in the two observed periods. Thus, we have reason to believe that there should be a significant change in the monetary transmission mechanism before and after the financial tsunami. In the following sections, we use the VAR model to capture the evolution and interdependencies of these seven time series to identify the major monetary transmission mechanism functioning in China before and after the financial tsunami.

Figure 2. Year-on-Year Rates of Change of the Seven Variables, January 2001–August 2009

Figure 2a. M1 (Y_1) and Total Loans (Y_2)

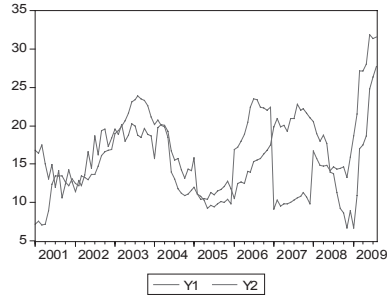


Figure 2b. M1 (Y_1) and Total Deposits (Y_3)

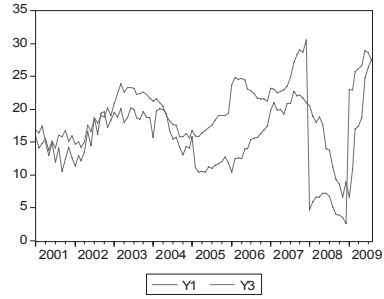


Figure 2c. M1 (Y_1) and CPI Inflation Rate (Y_4)

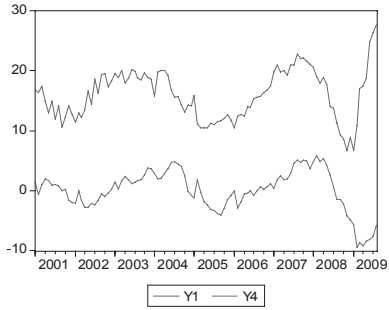


Figure 2d. M1 (Y_1) and Lending Interest Rate (Y_5)

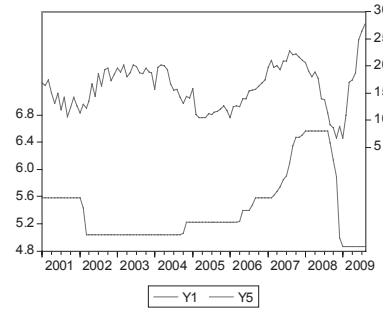


Figure 2e. M1 (Y_1) and Stock Price Index (Y_6)

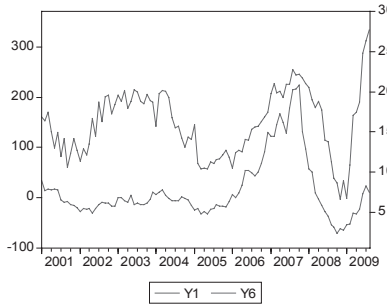
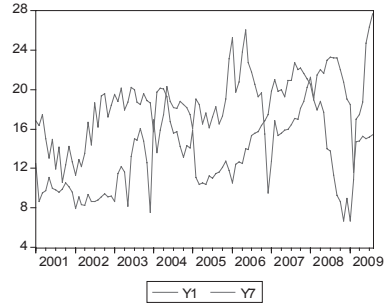


Figure 2f. M1 (Y_1) and Retail Sales (Y_7)



Empirical Results and Derivation of Impulse Response Functions

After examining the adjusted *R*-squared for each estimated equation, the Akaike and Schwarz information criteria for all the estimated equations in the VAR output statistics for different lags, we decided to use an unrestricted VAR with five lags of each variable and a constant term from January 2001 to August 2009. Table 5 is

Table 3

Correlation Matrix of the Seven Variables, September 2007–August 2008

	Y1	Y2	Y3	Y4	Y5	Y6	Y7
Y1	1						
Y2	–0.48541	1					
Y3	0.688287	–0.95735	1				
Y4	0.833529	–0.0782	0.27398	1			
Y5	–0.6074	0.763548	–0.81635	–0.25273	1		
Y6	0.849415	–0.69419	0.854754	0.535201	–0.85219	1	
Y7	–0.85381	0.596436	–0.76094	–0.63895	0.812541	–0.94252	1

Table 4

Correlation Matrix of the Seven Variables, September 2008–August 2009

	Y1	Y2	Y3	Y4	Y5	Y6	Y7
Y1	1						
Y2	0.94588	1					
Y3	0.753842	0.913972	1				
Y4	–0.50647	–0.72815	–0.82764	1			
Y5	–0.54529	–0.73538	–0.81142	0.863407	1		
Y6	0.970944	0.928367	0.781325	–0.50162	–0.56166	1	
Y7	–0.59141	–0.76982	–0.84689	0.953649	0.86763	–0.57615	1

based on the EViews 5 VAR estimation output in which each column corresponds to an equation in the VAR. The variable at the column head is the dependent variable, and the variables with five lags on the stub are independent variables. Our model has seven columns (or seven autoregression equations), thirty-five independent variables, and a constant term on the stub.

Statistically, if we have sufficient observations before and after the financial tsunami to generate two sets of VAR for comparison, it would be possible to arrive at a robust conclusion regarding the evolution of the interrelated variables. Unfortunately, since the number of observations is less than the number of parameters to be estimated for the period after the 2008 financial tsunami, we cannot produce a

Table 5

Vector Autoregression Estimates, June 2001–August 2009

	Y1	Y2	Y3	Y4	Y5	Y6	Y7
Y1(–1)	0.219208	0.020117	–0.116367	0.182843	0.007869	–0.053076	0.524002
	[1.88947]	[0.12545]	[–0.57150]	[2.29829]	[0.94678]	[–0.03985]	[2.90723]
Y1(–2)	0.240602	–0.036651	0.114234	–0.078354	0.011648	–2.871189	0.121912
	[1.82633]	[–0.20128]	[0.49406]	[–0.86733]	[1.23422]	[–1.89836]	[0.59565]
Y1(–3)	0.280926	0.086164	0.216517	–0.028775	0.007844	–0.260126	0.064519
	[2.27784]	[0.50547]	[1.00029]	[–0.34024]	[0.88784]	[–0.18372]	[0.33673]
Y1(–4)	–0.019275	–0.091263	0.127456	–0.012716	–0.012022	0.389286	–0.229247
	[–0.16412]	[–0.56221]	[0.61835]	[–0.15790]	[–1.42884]	[0.28872]	[–1.25643]
Y1(–5)	0.198030	0.124460	–0.250989	0.003011	–0.015187	0.796408	–0.037504
	[1.68367]	[0.76559]	[–1.21587]	[0.03733]	[–1.80236]	[0.58979]	[–0.20524]
Y2(–1)	0.102617	0.788802	0.169663	–0.176499	0.002764	–0.639959	–0.391896
	[1.09785]	[6.10564]	[1.03423]	[–2.75366]	[0.41275]	[–0.59637]	[–2.69872]
Y2(–2)	0.018464	0.251923	0.030518	0.207085	–0.008575	–0.094406	0.199173
	[0.14884]	[1.46925]	[0.14017]	[2.43435]	[–0.96487]	[–0.06629]	[1.03344]
Y2(–3)	–0.036166	–0.148964	0.124360	–0.022176	0.005121	1.870461	–0.093163
	[–0.27262]	[–0.81240]	[0.53411]	[–0.24377]	[0.53886]	[1.22810]	[–0.45202]
Y2(–4)	0.241728	0.005123	–0.091603	0.001702	0.002751	1.572308	–0.023367
	[1.84492]	[0.02829]	[–0.39835]	[0.01894]	[0.29306]	[1.04526]	[–0.11479]

Y2(–5)	–0.181532	–0.072900	–0.294330	–0.032156	–0.009524	–0.890596	–0.137961
	[–1.92517]	[–0.55935]	[–1.77851]	[–0.49730]	[–1.40991]	[–0.82269]	[–0.94175]
Y3(–1)	0.012705	0.187289	0.530136	–0.138598	0.009635	–0.894404	0.052797
	[0.17533]	[1.86986]	[4.16820]	[–2.78907]	[1.85596]	[–1.07505]	[0.46895]
Y3(–2)	0.060318	0.086571	–0.028706	0.194222	–0.002869	1.737412	0.040791
	[0.70755]	[0.73471]	[–0.19186]	[3.32236]	[–0.46969]	[1.77519]	[0.30799]
Y3(–3)	–0.174177	–0.050726	–0.028673	–0.146039	–0.003806	–2.386129	0.196526
	[–2.10359]	[–0.44324]	[–0.19731]	[–2.57207]	[–0.64170]	[–2.51016]	[1.52776]
Y3(–4)	0.051568	0.041634	–0.104855	0.113701	–0.000180	–0.175947	0.129734
	[0.66146]	[0.38638]	[–0.76634]	[2.12684]	[–0.03219]	[–0.19658]	[1.07113]
Y3(–5)	0.102509	–0.017824	0.045043	–0.031793	–0.001049	–0.859751	0.008580
	[1.55713]	[–0.19588]	[0.38985]	[–0.70426]	[–0.22236]	[–1.13756]	[0.08389]
Y4(–1)	–0.547016	–0.324180	0.327129	0.964061	–0.009740	2.986192	–0.014768
	[–2.79135]	[–1.19685]	[0.95113]	[7.17402]	[–0.69375]	[1.32730]	[–0.04851]
Y4(–2)	–0.061581	0.240558	–0.480416	–0.158029	0.008327	–2.330487	0.315172
	[–0.24328]	[0.68757]	[–1.08139]	[–0.91042]	[0.45922]	[–0.80194]	[0.80144]
Y4(–3)	0.040439	0.283637	0.120589	0.011227	0.014894	–4.916467	0.181592
	[0.16322]	[0.82826]	[0.27732]	[0.06608]	[0.83911]	[–1.72844]	[0.47176]
Y4(–4)	–0.047930	–0.452628	0.278079	0.109188	0.027104	4.128133	–0.386768
	[–0.19931]	[–1.36180]	[0.65888]	[0.66214]	[1.57333]	[1.49528]	[–1.03525]
Y4(–5)	0.054319	0.063151	–0.169425	–0.070924	–0.021513	–2.523703	0.320599
	[0.32536]	[0.27368]	[–0.57823]	[–0.61952]	[–1.79874]	[–1.31671]	[1.23607]

(*continued*)

Table 5 (*continued*)

	Y1	Y2	Y3	Y4	Y5	Y6	Y7
Y5(–1)	1.145068	–4.048605	–13.77917	–0.235216	0.963719	–1.204304	–1.406290
	[0.66728]	[–1.70696]	[–4.57517]	[–0.19989]	[7.83939]	[–0.06113]	[–0.52749]
Y5(–2)	–2.827185	5.236212	10.65356	–0.267400	–0.050133	–21.80442	5.018134
	[–1.02946]	[1.37947]	[2.21032]	[–0.14199]	[–0.25482]	[–0.69157]	[1.17615]
Y5(–3)	–2.142919	–5.147700	–3.324111	0.516182	0.067900	13.86925	–5.966850
	[–0.73665]	[–1.28028]	[–0.65108]	[0.25876]	[0.32582]	[0.41528]	[–1.32027]
Y5(–4)	–0.866806	4.374466	–1.527348	–0.943833	–0.112574	–5.383012	4.319332
	[–0.29847]	[1.08978]	[–0.29965]	[–0.47393]	[–0.54109]	[–0.16145]	[0.95732]
Y5(–5)	3.077022	0.704735	2.914316	0.158608	–0.019829	–20.93414	1.887441
	[1.56165]	[0.25877]	[0.84275]	[0.11739]	[–0.14048]	[–0.92544]	[0.61658]
Y6(–1)	0.017521	–0.002364	0.025855	0.004305	0.000211	1.096691	0.001825
	[1.49207]	[–0.14563]	[1.25453]	[0.53469]	[0.25062]	[8.13500]	[0.10005]
Y6(–2)	0.002107	–0.035752	0.112317	–0.019224	0.000388	–0.068745	–0.018363
	[0.12408]	[–1.52301]	[3.76798]	[–1.65059]	[0.31927]	[–0.35256]	[–0.69592]
Y6(–3)	0.007212	0.024403	–0.110654	0.034047	–0.002553	0.007669	–0.012071
	[0.37771]	[0.92463]	[–3.30185]	[2.60024]	[–1.86647]	[0.03498]	[–0.40689]
Y6(–4)	–0.016054	–0.011596	0.026550	–0.025302	0.000911	–0.133319	0.005003
	[–0.80422]	[–0.42028]	[0.75782]	[–1.84840]	[0.63719]	[–0.58174]	[0.16132]
Y6(–5)	0.022471	0.013752	–0.015177	0.012263	0.001766	0.441869	–0.038082
	[1.43230]	[0.63417]	[–0.55119]	[1.13982]	[1.57164]	[2.45321]	[–1.56241]

Y7(–1)	0.042046	0.318188	–0.018417	0.013529	–0.001838	0.418648	0.583840
	[0.51266]	[2.80694]	[–0.12795]	[0.24056]	[–0.31291]	[0.44463]	[4.58213]
Y7(–2)	–0.150536	–0.125626	0.162004	0.004351	0.002490	0.238256	0.070387
	[–1.53815]	[–0.92870]	[0.94317]	[0.06482]	[0.35513]	[0.21205]	[0.46293]
Y7(–3)	0.062631	–0.114897	–0.080124	0.065527	–0.000250	0.078933	0.160507
	[0.63153]	[–0.83821]	[–0.46033]	[0.96354]	[–0.03524]	[0.06933]	[1.04175]
Y7(–4)	–0.081128	–0.072570	–0.138380	–0.020650	0.000695	–1.501191	0.235499
	[–0.85647]	[–0.55429]	[–0.83238]	[–0.31792]	[0.10242]	[–1.38043]	[1.60028]
Y7(–5)	0.021427	0.045807	0.165074	–0.064569	0.003595	1.008168	–0.000557
	[0.27011]	[0.41778]	[1.18568]	[–1.18700]	[0.63267]	[1.10701]	[–0.00452]
C	8.197870	–10.09238	35.85153	3.535691	0.795565	236.2904	–28.90153
	[1.07695]	[–0.95924]	[2.68353]	[0.67735]	[1.45889]	[2.70381]	[–2.44387]
R^2	0.937075	0.931965	0.913806	0.955595	0.978069	0.962687	0.879984
Adj. R^2	0.902116	0.894168	0.865920	0.930925	0.965885	0.941958	0.813308
Akaike information criterion			26.80795				
Schwarz criterion			33.41371				

Source: Eviews 5 User's Guide 2004.

Note: Included observations: 99 after adjustments*t*-statistics in [].

VAR for comparison with the VAR for the period before the financial tsunami.[10] In order to show the evolution of China's monetary policy transmission mechanism, we try to estimate another unrestricted VAR with five lags of each variable and a constant term over the period from January 2001 to August 2008. If the results are significantly different from those calculated from January 2001 to August 2009, taking into account the overlapping years in the two observed periods, we have reason to conclude that the changes were caused by the financial tsunami.

For argument's sake, we assume that the money supply is always equal to the money demand. That is, when Y_1 is on the left-hand side of the equation (the dependent variable), we view it as money demand; when Y_1 is on the right-hand side (the independent variable), we view it as money supply. By using a significance level of $\alpha = 0.05$ to remove those independent variables with a coefficient that is insignificantly different from zero in each of the autoregression functions, we calculated a new set of regression equations for the remaining variables over the period from January 2001 to August 2008 (period A), and from January 2001 to August 2009 (period B), respectively.[11] Since these regression equations trace out the response of a variable of interest to changes in the chosen independent variables, we call them impulse response functions (Elder 2003). Table 6 tabulates the impulse response functions derived from the VAR analysis.

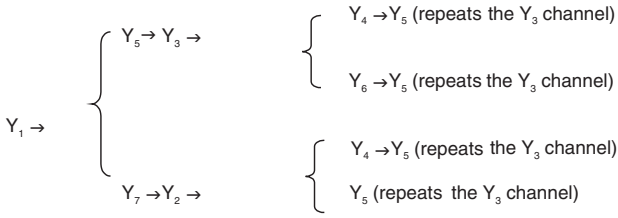
Identification of Monetary Transmission Channels

Although it is not easy to identify the explanatory power of these seven variables, and the relationships among them, in terms of their volatility, the interpretability of the resulting impulse response function will be useful to justify the connotation of the monetary transmission mechanisms before and after the financial tsunami. To illustrate, we use a simple recursive method, starting from an autonomous change in money supply, to produce a channel of monetary transmission and then continuously substitute the lagged independent variables for the dependent variables according to their relationship as specified by the impulse response functions (Stokey, Lucas, and Prescott 1993, 3–7). The monetary transmission channels from January 2001 to August 2008 (period A), and from January 2001 to August 2009 (period A) are depicted in Figure 3.

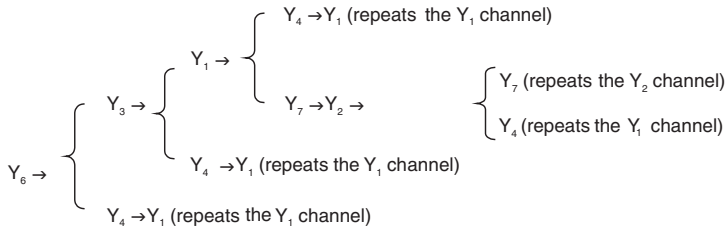
In period A, the monetary transmission channels appear to be consistent with the notion that an autonomous change in money supply (Y_1) has a direct effect on interest rate (Y_5) and income (Y_7), and an indirect influence on consumer price inflation (Y_4) and stock prices (Y_6) through its effects on total loans (Y_2) and deposits (Y_3). However, the transmission channels in period B suggest that a money supply shock has little effect on total loans (Y_2), deposits (Y_3), the interest rate (Y_5), and stock prices (Y_6). Therefore, we can conclude that the financial tsunami did have a significant impact on China's monetary transmission mechanism. In addition to the fact that the financial tsunami weakened the ability of monetary policy to regulate economic activities, this suggests that monetary policy is likely to affect

Figure 3. Monetary Transmission Channels

Period A: January 2001 to August 2008



Period B: January 2001 to August 2009



$Y_5 \rightarrow$ Y_3 (follow the Y_1 and Y_4 channels)

Notes: Y_1 is money supply growth, Y_2 is total loans growth, Y_3 is total deposits growth, Y_4 is inflation rate growth, Y_5 is the interest rate, Y_6 is stock price index growth, and Y_7 is total retail sales of consumer goods growth.

the real sector by altering asset prices rather than interest rates and availability of credit. This means that the traditional Keynesian interest-rate monetary transmission mechanism is an insignificant channel to transmit impulses from the monetary sector to the real sector in China today.

Furthermore, Snyder (2004) advocated in her empirical study on consumption responses to shocks in the stock market and monetary policy that if stock market wealth effects are growing, they potentially alter the transmission mechanisms of money. Interestingly, when we look at the explanatory power of the stock price index (Y_6) in the impulse response functions listed in Table 6, we discover that it did have obvious impacts on economic activity through its effects on total deposits (Y_3) and consumer price inflation (Y_4). Since movements in the stock price index may resemble movements in other major asset prices, including housing prices, for the sake of simplicity we use movements in the stock price index to represent asset price movements.[12] With this in view, we can conclude that the effect of changes in asset prices or in stock market financial wealth have been performing a more and more important role in the monetary transmission mechanism as well as the overall economic setting, especially after the financial tsunami.

Table 6

Impulse Response Functions

Period A: January 2001–August 2008 (87–91 observations depending on number of lags)	Adj. R^2
1. $Y_1 = 5.489255 + 0.659234Y_{1(-5)}$	0.415459
2. $Y_2 = 0.82264 + 0.90095Y_{2(-1)} + 0.046859Y_{7(-1)}$	0.838760
3. $Y_3 = 65.46676 - 8.83964Y_{5(-4)} + 0.136047Y_{6(-2)} - 0.08033Y_{6(-3)}$	0.757003
4. $Y_4 = -1.93212 + 0.010239Y_{2(-1)} + 0.161122Y_{2(-2)} - 0.08328Y_{3(-2)} - 0.08421Y_{3(-3)} + 0.145453Y_{3(-4)} + 0.028119Y_{6(-3)}$	0.500366
5. $Y_5 = 6.008255 - 0.00497Y_{1(-2)} - 0.04346Y_{2(-5)} + 0.100285Y_{4(-2)} + 0.003125Y_{6(-1)}$	0.582952
6. $Y_6 = -9.08593 + 1.678564Y_{3(-2)} - 1.17883Y_{3(-3)} + 0.948042Y_{6(-1)}$	0.928417
7. $Y_7 = 0.310554 + 0.068537Y_{1(-1)} + 0.915057Y_{7(-1)}$	0.807235
Period B: January 2001–August 2009 (99–103 observations depending on number of lags)	
1. $Y_1 = -4.18096 + 1.016397Y_{1(-3)} + 0.231009Y_{3(-3)} - 0.68319Y_{4(-1)}$	0.7173
2. $Y_2 = 0.269424 + 0.961234Y_{2(-1)} + 0.036531Y_{7(-1)}$	0.874914
3. $Y_3 = 70.01169 - 8.70394Y_{5(-1)} - 0.89754Y_{5(-2)} + 0.153787Y_{6(-2)} - 0.08689Y_{6(-3)}$	0.742293
4. $Y_4 = -2.42691 + 0.115389Y_{1(-1)} - 0.14644Y_{2(-1)} + 0.107516Y_{2(-2)} - 0.07832Y_{3(-1)} + 0.126582Y_{3(-2)} - 0.05821Y_{3(-3)} - 0.074491Y_{3(-4)} + 0.830951Y_{4(-1)} - 0.00078Y_{6(-3)}$	0.937786
5. $Y_5 = 0.107088 + 0.978985Y_{5(-1)}$	0.947074
6. $Y_6 = 0.780862 + 0.026286Y_{3(-3)} + 1.06995Y_{6(-1)} - 0.14244Y_{6(-5)}$	0.934535
7. $Y_7 = 0.425916 + 0.108429Y_{1(-1)} - 0.04734Y_{2(-3)} + 0.911115Y_{7(-1)}$	0.801389

Source: Calculated from the dataset after removing the insignificant independent variables.

Conclusion

Faced with the collapse of Lehman Brothers in September 2008 and the resulting credit crunch, the People's Bank of China decisively and swiftly switched from a tight monetary policy to a moderately loose monetary policy. The effects of this, together with the successive RMB4 trillion investment package to further stimulate the economy, have won praise for China's contribution to the worldwide economic recovery. The PBC was satisfied with the monetary policy tools adopted and the effectiveness of its monetary policy. This study examines empirically the impact of the financial tsunami on China's monetary transmission mechanism. A seven-variable unrestricted VAR of monthly data was used to examine the differences between the channels through which monetary impulses were transmitted to the real

sector before and after the financial tsunami. The study found that the asset-price channel has replaced the traditional Keynesian interest-rate channel as the major monetary transmission channel in China. The results show that the three subchannels of the asset-price channel, namely wealth effects, Tobin's q theory (valuation of stock) effects, and exchange-rate effects, are more important than the traditional Keynesian interest-rate channel and the credit-availability channel in transmitting impulses from the financial sector to the real sector.

It is worth noting that the operating framework of China's monetary policy is still in an early stage of its transition. The effectiveness of monetary policy has been greatly hampered by the weaknesses of the major monetary tools, including high interest costs for central bank bonds, the undesirable impact on market interest rates, the interest rates paid on required and excess reserves, the minor effect of changes in the required reserve ratio on the overall level of reserves, the slow pace of interest rate liberalization, and the imperfection of the financial market. As a natural consequence, although the PBC wanted to switch the tight monetary policy to a loose monetary policy in times of financial crises, it is hardly possible that the targeted growth rate of M1 could have been achieved. In order to make the PBC's monetary policy stronger and more effective, we suggest that it abolish the payment of interest on excess reserves and required reserves step by step. We also suggest that it move toward a more market-based interest rate regime so as to further develop the consumer credit market, thereby facilitating the financial intermediation function of financial institutions, and to improve the auction system of open-market operations in the hope of lowering the cost of central bank bonds. In addition, because the ambiguity of M2 in terms of the deposit component covering a vast variety of financial institutions, we suggest that the PBC change to the use of M1 instead of M2 as the intermediate monetary target.

Our findings suggest that China's policymakers give more consideration to asset-price effects when formulating monetary policy. As China is determined to be more open and influential in the global financial arena, it will be more susceptible to international financial contagion because of its relatively underdeveloped financial markets. Through the asset-price channel, the formation and subsequently the bursting of asset-price bubbles will inevitably exaggerate economic cycles. Therefore it is imperative that China foster financial market reforms with sound supervision and regulatory frameworks, extended market width and depth, and greater transparency and efficiency. Policymakers should consider this as they design and implement monetary policy.

Notes

1. The People's Bank of China legally became the country's central bank on March 18, 1995, when the Law of the People's Republic of China (PRC) on the PBC was passed in the Third Plenum of the Eighth National People's Congress. In the sixteen years since then, the PBC has not only gone through tremendous changes in the use of monetary policy tools but also has made great improvements in the monetary policy transmission mechanism.

2. For details of the differentiated required reserve ratio system, read PBC, *China Monetary Policy Report*, 2004, First Quarter, Box 2.

3. The NPL ratio refers to the ratio of nonperforming loans to total loans (gross of allowance for probable losses), inclusive of interbank loans.

4. The proportion of excess reserves in deposits is called the excess reserve ratio. Before 1998, the PBC used to require financial institutions to maintain an excess reserve ratio of 5–7 percent.

5. Research on the credit channel is plentiful. See Mishkin (2001).

6. They argue that liquidity and consumer loan availability increases when the central bank injects money into the economy. Thus, monetary policy directly affects consumer demand through the consumer credit sector.

7. In his "Are Forecasting Models Usable for Policy Analysis?" under the heading of an example of identifying a VAR model, Professor Christopher Sims wrote:

We will examine a simple six-variable quarterly postwar VAR model of the U.S. economy over the period 1948:1 to 1973:3. . . . The variables are real GNP, real business fixed investment, the GNP price deflator, the M1 measure of money, unemployment, and the Treasury-bill rates. This list of variables is chosen to allow an interesting discussion while still being manageably short. The list is too short, however, for us to be sure that it will allow us to distinguish among behaviorally distinct sources of disturbance. In particular, since it does not include any monetary aggregate closely controlled by policy authorities, it forces us to lump together the money supply effects arising from the way the banking system uses reserves and effects arising directly from actions by the Federal Reserve System. Also, since the list includes no fiscal variables, changes in expectations about future tax and spending policies—which could be important—can show up in the model only indirectly.

8. Since the Consumer Price Index for the same month last year = 100, we can take that as the year-on-year inflation rate.

9. $| r | > 0.55$ implies $\rho \neq 0$ at 5% significance level.

10. We have only twelve monthly observations after the outbreak of the financial tsunami in September 2008.

11. Their *t*-statistics in absolute value are less than 2.0076 for the January 2001–August 2008 data set ($df = 87 - 35 + 1 = 51$), and less than 1.9983 for the January 2001–August 2009 data set ($df = 99 - 35 + 1 = 63$).

12. In recent empirical research, Zhang and Fung (2006) show that the rates of change in the stock composite index are negatively correlated with housing-price movements, but nonetheless their analysis supports the finding that in China stock prices, on average, are positively related to profitability of listed companies.

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