

Pressure to Revalue the RMB: Policy Options*

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Abstract

We build a monetary model to show how expected appreciation lead to revaluation pressure on a pegged exchange rate regime. This is one of the major challenges currently facing to China after accession to the WTO. This model assumes current account convertibility and some degree of capital control, and fundamentally sound domestic policies and economy, as is the case in China. The model demonstrates that market-oriented interest rates can act as an automatic stabilizer to ease appreciation pressures, but cannot resolve them completely because the nominal interest rate has a zero nominal bound. Therefore, the official parity will eventually collapse and the appreciation expectations can be self-fulfilling, in the absence of external intervention. The results of Granger causality tests are consistent with the findings of our theoretical model. There are a number of alternative policy intervention measures that can extend the life of pegged exchange rate regime.

Keywords: Hot Money, Revaluation Pressure, Pegged Exchange Rate Regime, Government Intervention

JEL codes: E58, F31

1. Introduction

There are two well-known benefits of a fixed exchange rate regime. First, a fixed exchange rate transfers the exchange rate risk from the private sector to the government and hence reduces the market uncertainty and transaction costs. Thus, a fixed exchange rate can encourage international trade and investment, and therefore promote economic growth. The second benefit is the anchor effect of the fixed exchange rate that can help stabilize the domestic price level. A great deal of empirical evidence supports these conclusions (Obstfeld and Taylor, 2002; Reinhart and Rogoff, 2004).

Many developing countries officially choose a fixed exchange rate regime. In addition many other emerging economies have adopted *de facto* fixed exchange rate regimes, although officially they are floating ones (Calvo and Reinhart, 2001; Calvo and Reinhart, 2002). For example, according to the Regulations on Foreign Exchange of China, which was implemented in 1996 and revised in 1997, China officially has a managed floating exchange rate regime. However, since 1998 China has effectively adopted a fixed exchange rate regime that pegged Chinese currency renminbi in a tight range against the US dollar at a rate of 8.28.

However, according to Fischer (2001), only a currency board and dollarization are sustainable (hard-pegged) fixed exchange rate regimes. All other soft-pegged exchange rate regimes will eventually be given up, be converted into hard-pegged, or switched to free floating ones. This polarization of the exchange rate regimes implies that the intermediate arrangements of the exchange rate regimes are intrinsically unstable. Although the three generation models in the literature illustrate various causes of devaluations of the currencies (Eichengreen, Ross and Wyplosz, 1995; Ma and Kanas, 2000; Tsang and Ma, 2002), they did not analyze the pressure for

revaluation.

In the last couple of years after China joined the WTO, expectations for renminbi revaluation have been increasing rapidly due to China's persistent trade surplus and large amount of foreign capital inflows (Ma, 2001). In 2002, the item of errors and omissions in China's balance of payments swung to US\$7.8 billion from -US\$4.9 billion in 2001 (State Administration of Foreign Exchange of China, 2001, 2002), which indicates to some extent the size of capital inflows brought by speculators to bet on a sharp appreciation of the renminbi. Although the item of errors and omissions was about US\$4.7 billion in the first-half of 2003 (State Administration of Foreign Exchange of China, 2003), a report suggested that US\$20 to 25 billion of "hot money" sneaked into mainland China (Zhao, 2004). Another estimate suggested that there might be US\$ 50 billion of "hot money" entered China through various channels (Kynge, 2004). These higher estimates are approximately equal to the amount of foreign direct investment in China over the same period.

The large scale inflow of "hot money" threatens the stability of the money supply in China. If the monetary authority can not dissolve the revaluation pressure, the renminbi will eventually have to be revalued. Thus, revaluation expectations would be self-fulfilling, similar to the outcome of devaluation expectations (Obstfeld, 1996). This is one of the major challenges facing China after her accession to the WTO.

This paper builds a sticky-price continuous-time monetary model to show that persistent appreciation pressure will cause excess accumulation of international reserves. The main findings of this paper are that market-oriented interest rates can act as an automatic stabilizer to ease the appreciation pressures, but cannot resolve them to ensure a stable pegged exchange rate regime. If there is not any external

intervention from the government, the pegged parity will finally collapse under appreciation pressures. Our model highlights some optional intervention measures and suggestions for system reform in China.

The remainder of the paper is organized as follows: A sticky-price continuous-time monetary model under the pegged exchange rate regime is built in Section 2, showing how an external expectation shock gives rise to appreciation pressure. In Section 3, the model is adapted to explain the automatic stabilization effect of the market-oriented interest rate in relieving appreciation pressures and its limit as an automatic stabilizer. In Section 4, we employ Granger causality tests to examine the main findings of our theoretical model. Policy options are discussed in Section 5, based on an analysis of changes in major parameters of the model that trigger or postpone currency crisis. A summary is provided in Section 6.

2. Emergence of appreciation pressures

Our sticky-price continuous-time monetary model begins with a conventional money demand function:

$$M^d(t) / P(t) = k Y - h r(t) \quad (1)$$

Where $M^d(t)$ is the domestic nominal money demand at time t , $P(t)$ represents a price index and, according to the sticky-price hypothesis, it is assumed $P(t)=1$; Y is the real GDP; $r(t)$ is the nominal interest rate at time t , k and h are fixed parameters representing the sensitivity of money demand to national income and the interest rate respectively.

Then, the money supply function is:

$$M^s(t) = m[D + R(t)] \quad (2)$$

Where $M^s(t)$ is the nominal money supply at time t , D represents domestic credit of the central bank that is taken as a constant; this implies the central bank executes its

monetary policies independent of fiscal policy². $R(t)$ represents the official foreign exchange reserve denominated in domestic currency, and m represents the monetary creation multiplier.

Assuming that the domestic monetary market maintains instantaneous equilibrium, namely $M^d(t) = M^s(t)$, then

$$r(t) = [kY - mD - mR(t)] / h \quad (3)$$

In the domestic goods market, GDP is determined by autonomous expenditures A and interest rate:

$$Y = A - b r(t) \quad (4)$$

where b is a fixed parameter representing the sensitivity of national income to the interest rate.

Substituting (4) into (3), we get the equilibrium interest rate,

$$r(t) = [kA - mD - mR(t)] / (kb + h) \quad (5)$$

Define the “desired” demand for net domestic assets as:

$$K^*(t) = s[r(t) - r^* - E(t) - I] \quad (6)$$

where $K^*(t)$ represents the net stock of domestic assets that investors desire to hold at time t . The nominal foreign interest rate, r^* , is assumed to be a constant to simplify the analysis. The term $E(t)$ represents the expected appreciation rate. When there is a common expectation that the domestic currency will be revalued, we have $E(t) < 0$. Then $r - r^* - E(t)$ represents the excess rate of return on domestic assets over foreign assets. We assume that $E(t) = -j t$, where j is a constant and is defined as the appreciation expectations shock to capital account. The term I is a positive risk premium parameter measuring the degree of asset substitutability (Krugman and

² In the first-generation model of currency crisis (Krugman, 1979; Flood and Garber, 1984), it assumes that domestic credit increases with the rise of fiscal deficits; currency crisis is triggered by improper domestic policies. The model in this paper is different from the first generation model in this point.

Obstfeld, 2000; Meredith and Ma, 2002; Ma, Meredith and Yiu, 2002). If $I = 0$, then domestic and foreign assets are perfect substitutes, and the choice of assets from different countries and the amount held will only depend on the excess rate of return on domestic assets over foreign assets. If $I > 0$, then investors consider that the risk on domestic assets will be higher than that on foreign assets and if the rate of return on domestic assets equals to that on foreign assets, investors prefer to hold foreign assets. The substitution of assets is mainly determined by the macroeconomic environment, especially by international differences in financial systems, which may be affected by policies in the short run and also may be changed with the evolution of financial markets in the long run. Since China is a developing country with a large amount of nonperforming loans, this paper considers the circumstance of $I > 0$. Finally, s is a positive parameter which measures the sensitivity of asset demand to the excess rate of return.

Therefore (6) can be rewritten as:

$$K^*(t) = s[r(t) - r^* + j t - I] \quad (7)$$

Let $k(t)$ represent the actual net stock of domestic assets, and it may not equal $K^*(t)$ until investment portfolios have been adjusted to the desired levels. Actual net foreign capital inflow at time t is assumed to be a partial adjustment process,

$$\begin{aligned} dK(t)/dt &= \lambda [K^*(t) - K(t)] \\ &= \lambda s [r(t) - r^*] + \lambda s j t - \lambda s I - \lambda K(t) \quad 0 = \lambda = +\infty \end{aligned}$$

(8)

where λ is the capital adjustment coefficient reflecting the degree of capital mobility. Theoretically, international capital mobility reflects the possibility, cost and time lag for adjustment of existing portfolios towards desired levels; while in practice, the degree of capital mobility is not only restrained by international settlement facilities,

but also by rules of capital control, which can be totally changed overnight. With the extreme convenience of transactions provided by the international capital market, θ is mainly dependent on how the authorities operate capital control. If $\theta = +8$, it means there is free, unrestricted capital flow, and investors can adjust their portfolios to desired levels instantaneously and capital mobility is perfect. If $\theta = 0$, capital movement is under full control and cannot move at the will of investors. If $0 < \theta < +8$, capital is under partial control, incomplete mobility exists, and at each moment, adjustment of capital stock can only make up part of the gap between $K(t)$ and $K^*(t)$. According to current regulations and policies, mobility of international capitals is under partial control in China (Guo, 2003). So this paper assumes $0 < \theta < +8$.

To simplify the analysis, this paper also assumes that when $t = 0$, the net capital stock is zero, the monetary market is in equilibrium, and the domestic interest rate is identical to the foreign one:

$$K(0)=0, \quad r(0)=[kA - mD - mR(0)]/(kb+h), \quad r(0) = r^* \quad (9)$$

The balance of international payments equals the rate of change of official foreign exchange reserve $dR(t)/dt$. It is the sum of the net capital inflow, $dK(t)/dt$, and the balance on current account CA:

$$dR(t)/dt = dK(t)/dt + CA \quad (10)$$

In a standard analysis, the domestic and foreign national incomes, real exchange rate, marginal propensity to import and taste are independent variables in the function of CA. Although it is assumed that domestic income shall grow with the decrease of interest rate and imports will increase, exports may grow with the increase of the supply capacity, and the real exchange rate will be fixed under the pegged regime and sticky-price assumption. For simplicity, the CA is assumed to be constant. Thus, the Current Account is an autonomous variable for economic agents, which is fully

reflected in international payment statement under current account convertibility (Sun, 2003).

Integrating both sides of (10) with respect to t , we obtain the foreign exchange reserve held by central bank up to t :

$$R(t) = R(0) + K(t) + CA t \quad (11)$$

Where $R(0)$ is the initial level of foreign exchange reserve.

Based on (8) and (5), we obtain

$$\frac{dK(t)}{dt} = \mathbf{q} s \left[\frac{kA - mD - mR(t)}{kb + h} - r^* \right] + \mathbf{q} s \mathbf{j} t - \mathbf{q} K(t) - ?s \mathbf{l} \quad (12)$$

Substituting (11) and (9) into (12):

$$\begin{aligned} \frac{dK(t)}{dt} &= \mathbf{q} s \left[\frac{kA - mD - mR(0) - mK(t) - mCA t}{kb + h} - r^* \right] + \mathbf{q} s \mathbf{j} t - \mathbf{q} K(t) - ?s \mathbf{l} \\ &= \mathbf{q} s \left[\frac{-mK(t) - mCA t}{kb + h} \right] + \mathbf{q} s \mathbf{j} t - \mathbf{q} K(t) - ?s \mathbf{l} \end{aligned} \quad (13)$$

Rearranging (13), we have

$$dK(t)/dt + \mathbf{a} K(t) = -\mathbf{b} t - ?s \mathbf{l} \quad (14)$$

where

$$\mathbf{a} = \mathbf{q} sm/(kb + h) + \mathbf{q} = \mathbf{q} (d+1) > 0,$$

$$\mathbf{b} = \mathbf{q} [s mCA/(kb + h) - s \mathbf{j}] = \mathbf{q} (dCA - s \mathbf{j}), \quad (14a)$$

$$d = s m/(kb + h) > 0.$$

The solution of (14) is

$$K(t) = (1 - e^{-\mathbf{a} t}) \frac{\mathbf{b}}{\mathbf{a}^2} - t \frac{\mathbf{b}}{\mathbf{a}} - ?s \mathbf{l} (1 - e^{-\mathbf{a} t}) / \mathbf{a} \quad (15)$$

Differentiating both sides of (15) with respect to t , we obtain

$$\frac{dK(t)}{dt} = -(1 - e^{-a t}) \frac{b}{a} - \rho s I e^{-a t} \quad (16)$$

Substituting (16) into (10), and we find that the balance of international payment is dependent on the current account balance CA , appreciation expectations shock j , degree of capital mobility ρ and other parameters:

$$\begin{aligned} \frac{dR(t)}{dt} &= \frac{dK(t)}{dt} + CA = -(1 - e^{-a t}) \frac{b}{a} - \rho s I e^{-a t} + CA \\ &= CA \frac{1 + d e^{-a t}}{1 + d} + s j \frac{1 - e^{-a t}}{1 + d} - \rho s I e^{-a t} \end{aligned} \quad (17)$$

Denote the balance of international payments as: $D(t) = \frac{dR(t)}{dt}$.

Given the revaluation expectations shock to the capital account ($j > 0$) and surplus on current account ($CA > 0$), we have $D(t) > 0$ if the risk premium $I = 0$. By continuity, there exists a positive number $I_1 > 0$, such that for a small risk premium $I \in [0, I_1]$, we have

$$D(t) > 0. \quad (17a)$$

A positive balance of payments implies a continuous accumulation of international reserves. The consequence is that the expectation of appreciation may be self-fulfilled.

However, the risk premium I in a developing country could be quite high. That would offset the capital inflow induced by the excess rate of return on domestic assets and would release some of the appreciation pressure. China as a developing country has an immature financial market and a large amount of nonperforming loans in the banking sector. Hence China might have a significant high risk premium I on her domestic assets. Nevertheless, the Chinese government provides implicit insurance for its financial system that effectively has reduced the risk premium. As a result, the

risk premium cannot offset the hot money inflow attracted by the revaluation expectations on the Chinese currency renminbi. The estimated large amount of hot money inflow (see Section 1) indeed indicated that speculators did not perceive the Chinese assets were highly risky. Therefore, in the remaining part of the paper, we will focus on the case that there is a revaluation pressure, i.e., we assume $\pi(t) > 0$ for the remaining part of the paper.

3. The market-oriented interest rate as an automatic stabilizer to the pegged exchange rate regime and its limitations

Flexible adjustment of market interest rates may affect both the domestic money market and the international payment in a interconnected way: Equation (1) indicates that domestic money demand is a decreasing function of the interest rate, and equation (3) shows that the equilibrium interest rate in the domestic money market and international reserves are negatively correlated with each other. In the case of a positive shock to international payments, an increase in international reserves will result in an increase in the domestic money supply. An excess money supply causes market interest rates to fall which stimulates the domestic demand for money, and when the increased domestic money demand equals the increase in money supply, the equilibrium in the domestic money market is restored. This process shows partially the mechanism of market-oriented interest rate in the domestic monetary market (Sun, 2000), but it is not the whole picture of the function of market-oriented interest rate. With respect to international payments, we can see from equation (8) that the net capital inflow is an increasing function of domestic interest rates. When a positive shock to international payments occurs, a fall in domestic interest rates reduces the capital inflow and may give rise to capital outflow, which reduce excess accumulation

of foreign exchange reserves and ease appreciation pressures. Inasmuch as

$$\frac{1+d e^{-a t}}{1+d} < 1, \quad \frac{1-e^{-a t}}{1+d} < 1,$$

equation (17) shows that the overall balance of international payment surplus shall be smaller than the sum of current account surplus and revaluation expectations shock to the capital account. Therefore, market-oriented interest rates can facilitate the stability of the exchange rate parity, which acts as the automatic stabilizer to a pegged exchange rate regime. Furthermore, as shown in equation (8) the influence of the automatic stabilizer is dependent on θ . When θ is large, which means a high level of openness of the capital account, a large amount of capital outflow will be occurred by a small decrease in interest rate. That will ease significantly the revaluation pressure from the excess accumulation of foreign exchange reserves.

However, we can see from equation (17) that the interest rate adjusting mechanism has its limit. In the case of a shock of revaluation expectations and a persistent current account surplus, namely $j > 0$ and $CA > 0$, respectively, domestic interest rates can fall, yet the capital outflow resulting from this is not sufficient to offset the capital inflow caused by the shocks; the interest rate adjusting mechanism cannot reverse the trend of escalating foreign exchange reserves. That is, when the balance of payment $B(t) > 0$, the domestic money supply continues to increase, and nominal domestic interest rates drop persistently according to equation (3). When the nominal interest rate reaches zero, it cannot fall any further. Then the pegged exchange rate collapses.

Assume at $t = t_A$, $r(t_A) = 0$, i.e., the nominal interest rate can not be lowered any more and foreign exchange reserves rise to the maximum level according to equation (5):

$$R(t_A) = A k/m - D \quad (18)$$

Although the mechanism of market-oriented interest rate can act as the automatic stabilizer for a pegged exchange rate regime, the effect is limited and is not strong enough to maintain the pegged parity.

It is indicated from the above analysis that the mechanism of market-oriented interest rate can ease some of the revaluation pressure induced from the excess accumulation of foreign exchange reserves, yet the market mechanism with its automatic adjustment can not fully resolve the effects from the shock, notwithstanding prudent domestic monetary policies. To resolve the appreciation pressures and maintain a pegged parity, additional prevention measures may have to be applied.

To illustrate the solution of our model, we depict the four time paths of hot money, official foreign reserves, money supply, and nominal interest rate in Figs 1 to 4, respectively. Fig 1 shows the increase of hot money over time and Fig 2 gives the picture of rising official foreign reserves due to foreign exchange market (non-sterilized) interventions by the central bank in dealing with hot money inflow. The impact of growing reserves on money supply is illustrated in Fig 3. Finally, Fig 4 presents the falling nominal interest rate to maintain the money market equilibrium and the time of collapse of the pegged exchange rate regime when the interest rate hits the zero floor.

Fig 1. Hot money

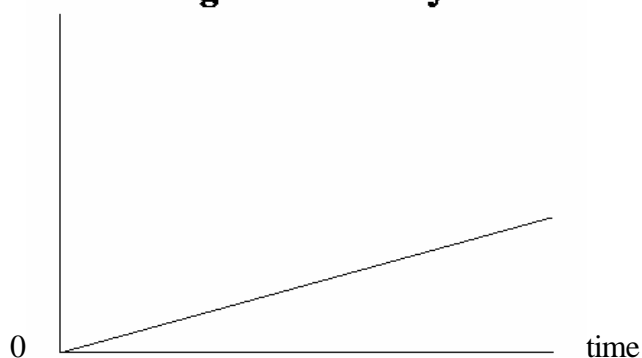


Fig 2. Official foreign reserves

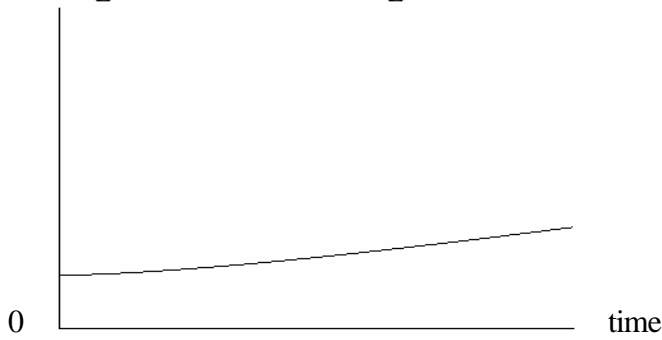


Fig 3. Money supply

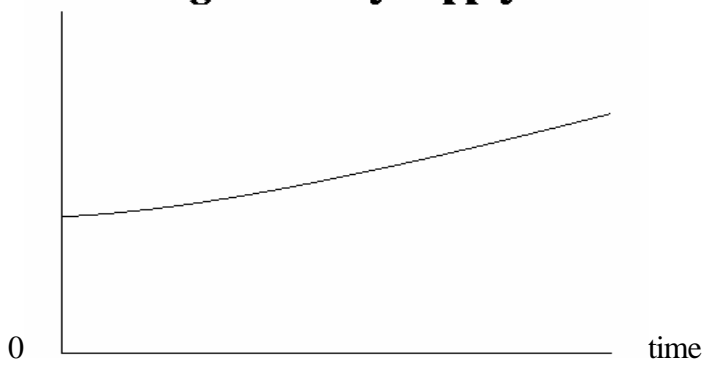
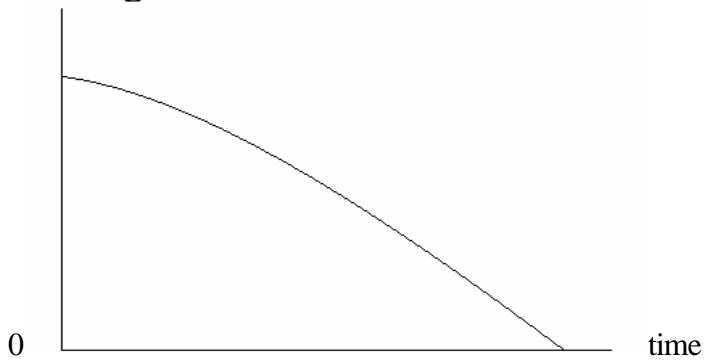


Fig 4. Nominal interest rate



4. Empirical evidence

To test the main conclusions of our theoretical model, we examine the Granger causalities (a) from foreign reserves to M2 and (b) from M2 to interest rate. We utilized monthly data over the sample period of January 2001 to July 2002.

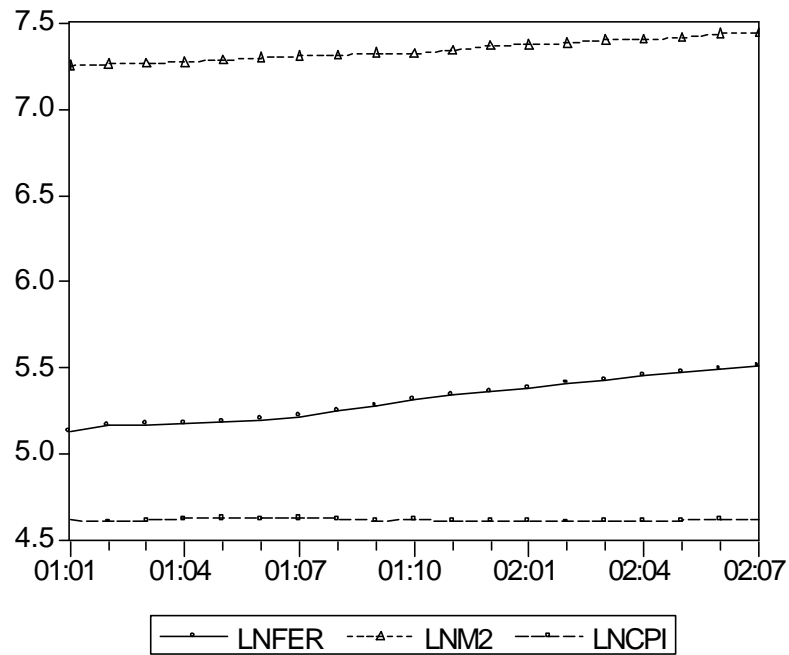
We chose this sample period based on the following observations. Before year

2000, Asian emerging economies were experiencing devaluations due to the lagged effects of Asian financial crisis. Exports of China also suffered significant negative impacts. The slowdown in economic growth in China presented a devaluation pressure to renminbi. Since year 2000, the devaluation pressure on renminbi has gradually been released due to the increasing exports of China. The international pressure on renminbi revaluation started after 2001.

There are two early articles to suggest renminbi revaluation. One is “China’s cheap money” published in Financial Times (2001). The other is “Expectations of renminbi revaluation – an advancement of the theory of Chinese threat” published in Japanese Economic News (2001) (see Tan and He, 2003). Some Chinese scholars also recommended a “moderate revaluation” of renminbi (see, for example, Zhang, 2003). On the other hand, there are scholars argued that a stable renminbi is beneficial for both China and world economies (see, for example, McKinnon and Schnab, 2003)

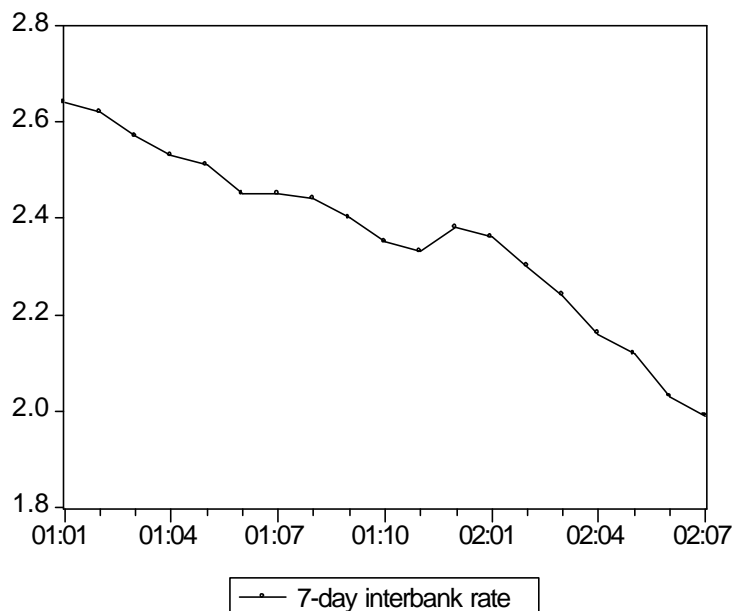
Since 2001, Chinese foreign reserves has been increasing dramatically due to the surpluses on both capital account and current account as well as repeated, non-sterilized, interventions by the People’s Bank of China on the foreign exchange market. That had increased the money supply (cf. Fig 5). The consequence was the continuous decline of interbank interest rates (cf. Fig 6).

Fig 5. Log of Foreign Exchange Reserves (LNFER), M2 (LNM2) and CPI (LNCPI)
(Jan. 2001 to July 2002)



Source: People's Bank of China, China Monthly Economic Indicators.

Fig 6. Seven-day Interbank Interest Rate



Source: China Statistical Information & Service Centre.

Our theoretical model explained quite well of this whole development. However, the People's bank of China started to buy in treasury bills in the open market to sterilize the increase of money supply resulted from the rise of foreign reserves. This led to the rebound of interbank interest rate. For simplicity, we did not consider the issue of sterilization in our theoretical model; hence, we did not consider this issue in our empirical work also.

The monthly data source of foreign reserves (FER) and M2 is People's bank of China. CPI is obtained from "China's Economic Prospect Monthly". Nominal value-added of industry (VAI) and the interbank interest rate (IIR07) are from China Economic Information Centre. Since China did not publish monthly GDP series, we approximate it by the value-added of industry series.

According to the Phillips-Perron unit root tests, we found all time series are I(1) (cf. Table 1).

Table 1. Unit Root Test			
Variable name	Phillips-Perron test statistic		Conclusion
	H ₀ : I(1)(level)	H ₀ : I(2)(1st difference)	
lnFER	0.228190	-3.080867*	I(1)
lnM2	-2.478580	-4.981554*	I(1)
IIR07	0.973261	-3.128625*	I(1)
lnVAI	-3.476153	-4.173924*	I(1)
lnCPI	-1.882243	-4.360283*	I(1)

Notes: * significant at the 5% level for rejection of null hypothesis of a unit root. Lag truncation for Bartlett kernel: 2. All variables are in logs except 7-day interbank interest rate IIR07. Sample period: Jan. 2001 to July 2002.

From the Johansen cointegration test, we found foreign reserves (lnFER) and M2

(lnM2) have one cointegration relationship. The cointegration equation for the sample period of Jan. 2001 to July 2002 is:

$$\ln M2 = 0.51 \ln FER + 3.33 \text{ Constant} + \text{cointegration error term}$$

This indicates that money supply equation (2) holds. According to the vector error-correction estimation, foreign reserves do Granger cause to M2. Although foreign reserves is not significant in the short run in the M2 equation, the error correction term is significant, which indicates that when the foreign reserves and M2 deviate from their long run relation, there is an automatic adjustment mechanism to restore the long run equilibrium (cf. Table 2).

Explanatory Variables	Coefficient	Standard errors	t-statistics
Cointegration error term(-1)	-0.679063	0.24727	-2.74623*
D(lnM2(-1))	0.129019	0.24998	0.51611
D(lnM2(-2))	-0.422221	0.24721	-1.70792
D(lnFER(-1))	0.019002	0.22569	0.08419
D(lnFER(-2))	-0.404683	0.24010	-1.68548
Constant	0.022203	0.00673	3.29944*
Adj. R-squared	0.358180	S.E. of regression	0.005923
Note: * significant at the 5% level.			

From the Johansen cointegration test, we found 7-day interbank interest rate (IIR07), lnM2 and lnCPI also have one cointegration relationship. The cointegration equation for the sample period of Jan. 2001 to July 2002 is:

$$IIR07 = -6.30 \ln M2 + 13.30 \ln CPI + \text{cointegration error term}$$

According to the error-correction estimation, lnM2 does Granger cause to interest rate. In the short run, lnM2, lnCPI and output (lnVAI) do not affect interest rate significantly. However, in the long run, the error-correction mechanism will adjust the interest rate to the equilibrium relationship (cf. Table 3).

Table 3. Error-correction equation of interest rate IIR07 (Jan. 2001 to July 2002)

Explanatory Variables	Coefficient	Standard Error	t-Statistic
Cointegration error term(-1)	-0.031165	0.012643	-2.465040*
D(lnM2(-1))	1.819183	1.487152	1.223267
D(lnCPI(-1))	-1.054388	1.576450	-0.668837
D(lnVAI(-1))	-0.090045	0.092041	-0.978310
D(IIR07(-1))	-0.034723	0.292120	-0.118864
Adjusted R-squared	0.243471	S.E. of regression	0.032885

Note: * significant at the 5% level.

This conclusion is consistent with our recent findings that M2 did not Granger cause CPI during the period of January 2000 to June 2002 (Sun and Ma, 2004). From the cointegration equation of interest rate, lnM2 and lnCPI, we also found that the long-run elasticity of CPI with respect to M2 is 0.48, which is less than unity. According to the error-correction estimation of lnCPI, lnM2 does not Granger cause to lnCPI. In the short run, lnM2, IIR07 and output (lnVAI) do not affect lnCPI significantly. In the long run, the error correction mechanism will not adjust the interest rate to the equilibrium relationship (to save space, we did not present the details of the test results, which are available on request). This implies that the price index of China is not sensitive to the money supply within our sample period. All these arguments give support for the sticky-price assumption in our theoretical model.

5. Alternative strategy for government

By combining equation (15) and (11), and we can see that international reserves are determined by the initial level of foreign exchange reserve, the expected appreciations, the external shock to the current account:

$$R(t) = R(0) - e^{-a t} \left[\frac{b}{a^2} \right] - t \frac{b}{a} + \frac{b}{a^2} + CA t - ? sI (1 - e^{-a t}) / a \quad (19)$$

Then insert (18) into (19), we obtain

$$R(0) - e^{-a t_A} \left[\frac{b}{a^2} \right] + \frac{b}{a^2} - \left(\frac{b}{a} - CA \right) t_A - ? sI (1 - e^{-a t_A}) / a = A k/m - D \quad (20)$$

This indicates that the life of a pegged exchange rate t_A is a implicit function of revaluation expectation shock (\mathbf{j}), the risk premium of domestic assets I , the mobility of international capital $?$, and autonomous expenditure A . Based on this function, partial derivatives of t_A with respect to the above variables can be determined, and through analyzing the effects of these derivatives, suggestions for constructive strategy can then be put forward.

(1) Expected revaluation shock (\mathbf{j})

Based on equation (20), we have

$$\frac{dt_A}{d\mathbf{j}} = \frac{-\frac{s\mathbf{q}}{a} \left[t_A - \frac{1}{a} (1 - e^{-a t_A}) \right]}{\Delta(t_A)} \quad (21)$$

By defining the function in the brackets of the numerator as $f(t) = t - \frac{1}{a} (1 - e^{-a t})$, we have $f(0) = 0$, when $t > 0$, we have $t_A - \frac{1}{a} (1 - e^{-a t})$ namely, $f(t)$ is a positive monotonic increasing function, therefore $t_A - \frac{1}{a} (1 - e^{-a t}) > 0$.

When the balance of international payment continues to be positive, $\mathbf{D}(t_A) > 0$ [cf. (17a)], we have $\frac{dt_A}{d\mathbf{j}} < 0$, and this indicates that if the size of the appreciation shock (\mathbf{j})

to the capital account is reduced, then the pegged exchange rate regime can be stabilized. In terms of China's current situation, consideration can be given to the repeated government declaration that there will be no revaluation. The government has also sought to reduce speculative pressures through discussion of the Qualified Domestic Institutional Investor (QDII) system, so as to boost the outflow of capital and offset a greater amount of capital inflow.

(2) Risk premium I

Based on equations (20), we have

$$\frac{dt_A}{dI} = \frac{q s(1 - e^{-a t_A}) / a}{\Delta(t_A)} > 0 \quad (22)$$

This means that if the risk premium I goes up, the lifetime t_A of the pegged rate will be extended. The risk premium will act as a natural barrier to keep the speculative capital outside the door. But when there are high appreciation pressures already, government's action to reduce the risk premium of domestic assets may induce more speculative capital inflow and shorten the life of the pegged exchange rate system.

(3) International mobility of capital (?)

Based on equation (20), we have

$$\frac{dt_A}{dq} = \frac{b \left[\frac{1 - e^{-a t_A}}{a} - t_A e^{-a t_A} \right] + t_A s I e^{-a t_A}}{\Delta(t_A)} \quad (23)$$

Define the function in the brackets of the numerator as $g(t) = \frac{1 - e^{-a t}}{a} - t e^{-a t}$,

we have $g(0)=0$, when $t>0$, we have $dg(t)/dt = t a e^{-a t} > 0$, Namely, $g(t)$ is a positive

monotone increasing function, therefore $\left[\frac{1 - e^{-a t_A}}{a} - t_A e^{-a t_A} \right] > 0$.

Nevertheless, the impact of capital mobility (?) on life of pegged exchange rate t_A depends on the relative sizes of the current account shock CA and the revaluation expectations shock j .

(a) The relative size of the revaluation expectations shock j is large but the

current account surplus shock CA is small.

Assume that both $CA=0$ and the risk premium $I=0$, we have $\mathbf{b} = -\mathbf{q} \mathbf{s} \mathbf{j} < 0$, and hence

$$\frac{dt_A}{dq} = \frac{\mathbf{b}}{\mathbf{q}\mathbf{a}} \left[\frac{1 - e^{-a t_A}}{\mathbf{a}} - t_A e^{-a t_A} \right] < 0.$$

By continuity, there exist two positive numbers $CA^* > 0$ and $I^* > 0$, such that for $CA \in [0, CA^*]$ and $I \in [0, I^*]$, then $\frac{dt_A}{dq} < 0$.

This indicates that if the revaluation pressure is dominated by the revaluation expectations shock \mathbf{j} over the current account surplus shock CA , the resistance capacity of pegged exchange rate can be improved by enhancing the control over foreign exchange (i.e., reducing ?).

(b) The relative size of the revaluation expectations shock \mathbf{j} is small but the current account surplus shock CA is large.

Assume that $\mathbf{j}=0$ we have $\mathbf{b} = \mathbf{q} \mathbf{d} CA > 0$, and hence $\frac{dt_A}{dq} > 0$.

By continuity, there exist a positive numbers $\mathbf{j}^* > 0$, such that for $\mathbf{j} \in [0, \mathbf{j}^*]$ then

$$\frac{dt_A}{dq} > 0.$$

This shows that if the revaluation pressure is dominated by the current account surplus shock CA over the revaluation expectations shock \mathbf{j} , then an increase of the control over capital movements (i.e., ? goes down) will nevertheless impede the outflow of capital, weaken the stability of the exchange rate parity provided by the interest rate adjustment, and therefore accelerate the collapse of pegged exchange rate

regime. In this circumstance, the correct government action should be to relax the control of capital movements (i.e., τ goes up).

From the analyses of (a) and (b) above, we found that when the revaluation pressures is stemming from sustained balance of payment surpluses, the authority must identify whether it is brought about by current account surpluses or by revaluation expectations induced capital inflows. This is because the foreign exchange control under different circumstances requires totally different policy actions.

(4) Autonomous expenditure A

Based on equation (20), we have

$$\frac{dt_A}{dA} = -\frac{k/m}{(1 - e^{-a t_A})\left(\frac{b}{a}\right) - CA} = \frac{k/m}{\Delta(t_A)} > 0 \quad (24)$$

Given a positive shock to balance of payments (i.e., $\Delta(t_A) > 0$), an increase in the autonomous expenditure will be favourable to the duration of fixed exchange rate. The increase in autonomous expenditure raises the demand for money, which absorbs the increase of money supply as a result of the increase in foreign reserves. That decelerates the downside of interest rate and releases the pressure of appreciation.

6. Summary

The simple open macroeconomic model established in this paper reflects the economic features of a pegged exchange rate regime: full convertibility of the current account, partial convertibility of the capital account, market determined interest rate, sound domestic policies, sound economic fundamentals, and the existence of a revaluation expectation shock on international payments. This theoretical model simulates the appreciation pressures on the pegged exchange rate through pushing

down the interest rate. Our empirical studies support the main results obtained from our theoretical model. We found that the market-oriented interest rate mechanism can alleviate, but not completely dissolve, such pressure. Therefore a currency crisis under appreciation pressure may develop. However, based on this model we can suggest some options for policy intervention, which may be utilized to make up for the deficiency of the automatic stabilizer effect of the interest rate mechanism and to help maintain the pegged exchange rate.

For example, when the relative size of the revaluation expectations shock is small but the current account surplus shock is large, the authority may *relax* the control of capital movements. This would enhance the stability of the exchange rate parity provided by the interest rate adjustment, and therefore delay the collapse of pegged exchange rate regime. In contrast, if the revaluation pressure is dominated by capital inflow induced by the revaluation beliefs, then the authority has to *tighten up* the capital control to stabilize the pegged exchange rate.

Another finding of this paper is that an increase in the domestic autonomous expenditure can enhance the role of the interest rate mechanism, delay the excess accumulation of reserves, and help maintain the pegged exchange rate.

In addition to the short-term policy recommendations, the authors believe that, in terms of financial system construction, the attitude towards the acceleration of market-oriented reform of interest rates should be supported. This is because the acceleration of the market-oriented reform of interest rates, while improving the allocation of domestic financial resources, will also help offset the negative impact of revaluation expectation shocks.

Furthermore, the government should gradually remove the implicit insurance to the banking system and allow the market to assess the true risk of Chinese domestic

assets which would stop some of the speculative capital inflows.

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