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In Search of an Optimal Strategy for Yuan's Real Revaluation

Meixing Dai^a

Abstract: International commentators seem to have a consensus view that the Chinese yuan is substantially undervalued and the Chinese monetary authority must take speedy actions to redress the currency misalignment by rapid nominal revaluation. This paper argues for a gradualist but comprehensive strategy for adjusting RMB's exchange rate. Taking into consideration of the facts that the yuan's undervaluation is caused by an array of domestic and international factors and the Chinese central bank cannot effectively invest its growing holdings of foreign reserves, we develop a framework to provide a theoretical underpinning for the optimal strategy for renminbi's gradual revaluation. With this strategy, the renminbi undervaluation problem is gradually redressed through a combination of nominal appreciation and higher inflation plus some other structural and macroeconomic policies. This strategy can also allow absorb external imbalances hence strengthening the foundation of China's long-term growth.

Keywords: Real revaluation; renminbi (RMB); foreign reserves; external imbalances; macroeconomic adjustment

JEL codes: E52, E61, F31, F41.

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1. Introduction

Since its accession to the WTO in December 2001, China has rapidly increased its external trade and has managed to achieve strong economic performance despite the break-out of the recent global financial crisis. The ensuing large accumulation of the nation's foreign reserves and its persistent trade surplus have fuelled international pressure for China to quickly revalue its currency, the yuan also known as the renminbi (RMB).

In the United States, the undervaluation of the yuan and its rectification are brought to the forefront since exchange-rate adjustment is viewed by many as one of the critically important policy tools to revive the U.S. economy, given that American fiscal policy is at verge of violating the solvency constraint and the monetary policy hits the zero lower bound (ZLB) on the nominal interest rate while the extreme looseness of these policies seems to have aggravated erratic movements of the dollar.

Even though some authors do not believe that a RMB appreciation could fix American trade imbalances with China (Tatom 2007), a large group of researchers seem to agree that the yuan is undervalued while differing in their views about the degree and origin of the undervaluation.¹ Only a few economists contest that the equilibrium value of the yuan is undervalued (Chu 2005; Cheung *et al.* 2007; Wang *et al.* 2007; J. Chen 2009) and their empirical findings indicate that exchange rate policy per se may have played only a limited role in China's trade surpluses. Wen (2011) suggests that the RMB may depreciate substantially if China abandons the exchange rate peg and unleashes the massive precautionary savings of Chinese households toward international markets in search of higher returns.

To resorb the yuan's undervaluation, most discussions in the vast and growing literature

¹ For an overview of the literature on the quantitative assessment of the yuan's undervaluation, see Das (2009). For related studies see Peng *et al.* (2008) and Wang (2010).

on the yuan's exchange rate policy are concerned with the nominal exchange rate. The debate mainly focuses on the speed of revaluation. Liu (2004) and Mundell (2004) defend the *status quo* because currency appreciation would aggravate unemployment and financial fragility. Tung and Baker (2004), arguing that revaluation could boost Chinese per capita income and purchasing power in dollar terms, discard the potential destabilizing effects of a one-step maxi revaluation, while Voon *et al.* (2006) maintain that the negative impacts of an appreciation of the real exchange rate (RER) on exports may be diluted by the positive impacts attributing to a reduction in the RER misalignment. Wang (2010) suggests a gradual appreciation of the RMB against the dollar at an annual rate of between 6% and 10%. If a one-step maxi revaluation is not adopted, macroeconomic policies and regulations and economic reforms must be skilfully implemented to ensure external and internal balances (Liu 2004; Dai 2006; Woo 2006; Eichengreen and Hatase 2007; Hong *et al.* 2008; N'Diaye 2010).

It is well known in open-economy macroeconomics that for the purposes of economic adjustment, use of the exchange rate as a policy tool can be performed in two ways, i.e. changing the nominal level of the currency or the adjustment in the real economy, hence the change of the RER. However, discussions on the RER adjustment are somehow largely missing in the current international debate on China's exchange rate policy.

This paper argues for a real revaluation route for the renminbi adjustment and has prescribed a policy mix for the course of action. In effect, a multitude of international and domestic factors has led to real undervaluation of the yuan, implying that the latter cannot be dealt only with nominal revaluation. The inability of PBOC to effectively invest its growing holdings of foreign reserves has also played a critical role in the yuan's undervaluation saga. Their importance implies that rapid nominal revaluation of the yuan could bring large unmanageable disruptions in Chinese economy while a gradual nominal revaluation without

being accompanied by other policy adjustments might not resolve the problem. This calls for a new strategy for China to revalue the yuan.

The paper thus aims to contribute to the literature on China's exchange rate policy by providing a theoretical framework justifying an optimal strategy for yuan's adjustment featuring association of yuan's gradual nominal revaluation with higher inflation to bring the RER to its equilibrium level. We propose that the central bank should set, besides inflation and output targets, a gradually decreasing target for foreign reserves. To reduce the amplitude of revaluation and to avoid potential risks of such a strategy during the transition, we also advocates adopting some structural and macroeconomic policies to help rebalance China's internal and external imbalances while laying down the foundation for China's future growth. The approach proposed by this paper highlights a critical aspect of the issue of renminbi adjustment, which has been unduly ignored for long. Therefore, this paper enriches policy options for unwinding the Chinese currency problem and hence adds to the current debate on an important issue of the world economy.

The remainder of the paper is organised as follows. Section 2 analyses the factors leading to the yuan's undervaluation. Section 3 argues for its real revaluation through setting a target of foreign reserves. Section 4 theoretically shows the optimal combination of monetary and exchange rate policies for realising a real revaluation. Section 5 discusses policy measures helping achieve the latter. Section 6 concludes.

2. Factors leading to the yuan's undervaluation

Before conceiving an optimal strategy for yuan's adjustment, we review the role played by some most important factors in inducing the yuan's undervaluation, such as low unitary labour costs in China, rapid progress in productivity, adhesion to the WTC, domestic fiscal,

monetary and exchange rate policies and their foreign counterparts, and foreign direct investment (FDI). These factors, directly and indirectly related to the balance of payments, contribute to the one-directional and accelerating accumulation of Chinese foreign reserves beginning in 1994 (Figure 1), which constitutes the appropriate measure for the yuan's undervaluation.

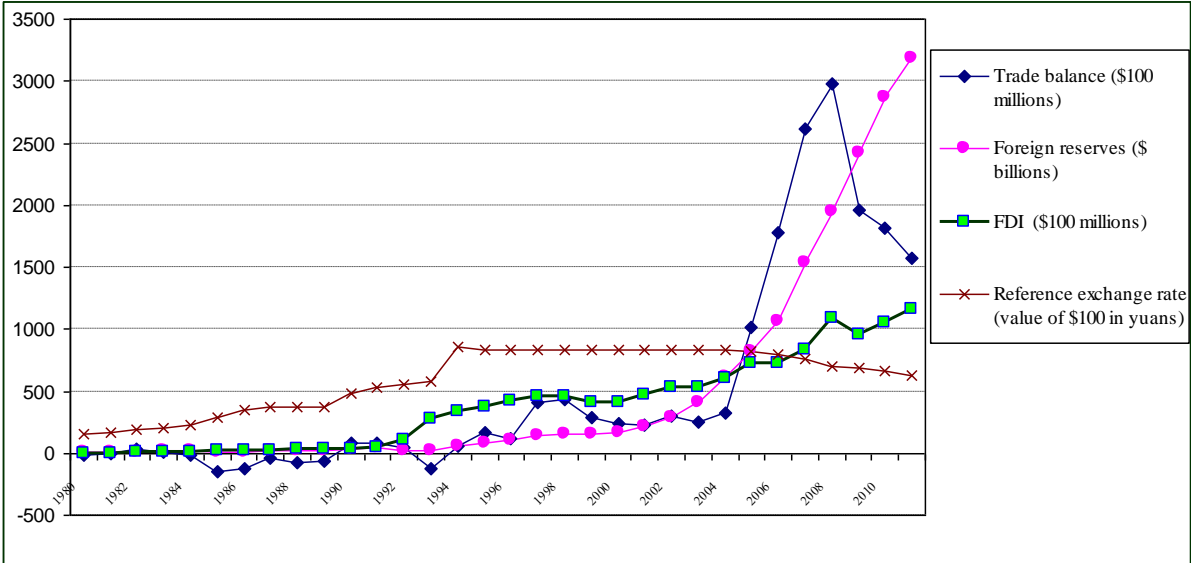
The balance of payments under an exchange rate peg is described by:

$$X_t - X_{t-1} = \frac{P_t^h}{E_t} Z(Y_t^*, T_t^*, i_t^*, \frac{P_t^* E_t}{P_t^h}, B_t^*) - P_t^* H(Y_t, T_t, i_t, \frac{P_t^* E_t}{P_t^h}, B_t) + i_t^* X_{t-1} + F(i_t - i_t^* - \frac{E_{t+1} - E_t}{E_t}, Y_t, \frac{W_t^*}{W_t}), \tag{1}$$

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where $Z(\dots)$ and $H(\dots)$ represent exports and imports, respectively, P_t^h the price of home goods, Y_t the output, T_t the taxes, i_t the nominal interest rate, E_t the nominal exchange rate, B_t trade barriers, and X_t stands for foreign reserves. $F(\dots)$ represents capital flows including FDI which positively reacts to the output (i.e. market size) and the ratio of foreign wage (W_t^*) to domestic wage (W_t). Corresponding foreign variables are marked with an asterisk.

Figure 1. Exchange rate of the RMB, foreign reserves, FDI and trade balance of China.



Sources: National Bureau of Statistics of China, UNCTAD, and PBOC.

Consider now these factors in historical and economic perspective. When China opened its door to international trade and FDI in the early 1980s to modernize its economy, it was an insignificant player in international goods and financial markets. The average Chinese wage was only about 95.67 yuans (or USD 32.58) in 1985 per month while it was 2687 yuans in 2009 (USD 393.35).² Despite a very low labour cost, China often experienced trade deficits until 1993 because it did not supply goods needed by other countries. Thus, a low labour cost in itself is not sufficient for ensuring trade surpluses and accumulation of foreign reserves.

The key to understanding Chinese structural trade surpluses since mid-1990s is that China has become increasingly competitive through a combination of disinflation, currency devaluations, FDI-friendly policy, wage moderation, and favourable international environment (i.e., adhesion to the WTO and very accommodative macroeconomic policies in developed countries since the early 2000s).

Following high inflation rates during 1988-1989 and 1993-1994, triggered by the price liberalization and a loose monetary policy, the yuan had to be devaluated by 33.16% against the dollar in August 1994 despite its gradual devaluation since 1980. Between August 1994 and July 2005, China adopted a monetary regime of exchange-rate targeting, which was named a managed float but was a *de facto* peg at around 8.28 yuan/USD, as a nominal anchor against high inflation.³ It allowed successfully slow down Chinese inflation.

During the 1997 Asian crisis, many international commentators considered that the yuan was overvalued and predicted its large devaluation because the South-east Asian economies have sharply devalued their currencies. China maintained the yuan's peg to avoid competitive devaluations, keeping its neighbours from an even more catastrophic financial and economic

² The exchange rate was 2.9366 and 6.8310 for 1985 and 2009 respectively. See Ceglowski and Golub (2011) for international comparison of labour costs in manufacturing.

³ For a review of Chinese exchange rate policy, see Xu (2000), Lin and Schramm (2003), Huang and Wang (2004), Corden (2009) and Sun (2010).

downturn. Instead, China sought to placate exporters by offering a 17% value-added export tax rebate, i.e., a disguised devaluation of the yuan.

These policies, while keeping China competitive, would not generate large balance-of-payments surpluses if not for the FDI-friendly policy. The FDI in China began to rapidly increase from 1992 due to three factors: the passage of a very favourable fiscal law in 1991, the reaffirmation of China's determination to open the economy, and the yuan's aggressive devaluation in 1994. Besides the capital inflows it brought, the FDI has especially contributed to the accumulation of foreign reserves through its stimulant effects on exportation by greatly increasing the labour productivity and the production of high quality goods desired by Western consumers (Whalley and Xin 2010; Ceglowski and Golub 2011). These effects have been largely amplified by the elimination of trade barriers after China's accession to the WTO and accommodative macroeconomic policies in developed countries. The resulting massive increase in foreign reserves since 2001 has revealed the hidden real undervaluation of the yuan against major currencies.

The combination of these factors has produced snowballing effects on the accumulation of foreign reserves because Chinese policymakers did not adjust their policy to the new economic environment due the hysteresis in their attitude vis-à-vis the role of the USD.

After its economic opening, China was faced with a period of dollar shortage. This experience and financial turmoil experienced by some emerging countries due to dollar shortage have convinced China to accumulate dollars at all costs (Corden 2009).

The period of dollar shortage ended with the implementation of extremely loose US monetary policy, i.e. very low interest rates for a prolonged period, to stimulate the economy after the burst of the Internet bubble in 2000. The easy access to cheap credit by American businesses and households has resulted in exceptional growth of the global dollar supply. The supplementary dollars held by foreign central banks returned to American financial markets

with the effects of plunging the median- and long-term interest rates, further stimulating credit activities. This policy created a large bubble in the property market, which has excessively stimulated the U.S. consumption through the virtual wealth effect. In 2005-2007, annual U.S. trade deficits represented about 6% of U.S. GDP, indicating a large excess of money supply and a lack of savings.

In this new environment, Chinese exchange rate policy was not anymore appropriate. In the mid-2000s, China was under intense pressure from the USA, Japan and the EU to revalue the yuan and to introduce a more flexible exchange rate regime. The yuan's undervaluation against the dollar was then estimated in a range of 18 to 60% (Zhang and Pan 2004; Coudert and Couharde 2007). China undertook a 22% nominal revaluation of the yuan against the dollar from July 2005 to July 2008, while shifting from the dollar peg to a peg to a basket of currencies, with a fluctuation range of $\pm 0.3\%$ per day. With the onset of the global financial crisis, the PBOC kept the yuan at about 6.83 per dollar after July 2008, as part of the stimulus package to help China weather the global recession.

Yet, at the time, the yuan's revaluation was incomplete. In fact, the yuan's undervaluation to some extent was reinforced over time by the continuous depreciation of the RMB's RER induced by, among other things, the capability of foreign and domestic firms in China to produce and export more goods of higher values at low costs. Hence, previous revaluation of the yuan had no significant negative effects on the U.S. imports from China, contrary to the prediction by some empirical studies (Thorbecke and Smith 2010). There was therefore a one-way-bet in the Chinese foreign exchanges market, attracting not only inflows of hot money but also inhibiting private capital outflows from counterbalancing China's large trade surplus (McKinnon and Schnabl 2009). This resulted into rapid build-up of foreign reserves, gradual but consistent erosion of monetary controls and hence the instability of the yuan's peg (Ma and Sun 2007). These developments in turn led to the rising pressure on the yuan to further

revalue and the need for a more flexible exchange rate regime (Liu and Zhang 2009). In this context, the PBOC announced in June 2010 new reform of the renminbi exchange rate policy, which launched again the yuan's nominal revaluation.

However, nominal revaluation might not easily resorb the yuan's undervaluation given the dynamic nature of the issue, the complexity of interactions between multiple factors, and inadequate domestic and foreign policy choices. The above analysis justifies our proposal for a real revaluation strategy and some prescriptions for China's exchange rate policy in following sections.

3. Real revaluation of the yuan through having an objective of foreign reserves

The previous analysis shows that the causes of the yuan's undervaluation are multiple and implies that there might be different policy options to resolve the problem. This section revisits some arguments according to which China's current external disequilibrium is manageable, and argues that foreign reserves must be regarded as an objective in a real revaluation strategy, under which monetary and exchange rate policies are optimally determined.

In the 1980s and 1990s, China had an explicit objective of stabilizing its exchange rate. This actually became an implicit objective of accumulating as much foreign currencies as possible, leading to the adoption of policies limiting the access of private agents to foreign currencies, restricting imports, stimulating exports and attracting the FDI. This implicit objective and corresponding policy choices, not revised in time, played a great role in the explosive accumulation of foreign reserves.

China's current reserves (\$3240.01 billions in June 2012) have far exceeded the optimal level corresponding to its objective of exchange rate stabilisation. Four main policy options

are available for China to rectify this situation: spending and investing them, diversifying them through appropriate management of portfolios while avoiding unnecessary risks, gradual liberalization of the capital account, and a switch in their holders (Zheng and Yi 2007).

However, none of these options provides a viable and definitive solution for Chinese external disequilibrium. Moreover, given the current global environment, it is a great challenge for the PBOC and Chinese sovereign fund managers to preserve and increase the value of Chinese official holdings of foreign reserves in terms of purchasing power because international investment opportunities are limited and management of the risk involved may prove to be a very challenging task.

First, in many industrialized countries, governments are faced with an increasingly difficult mission to control public debt within a sustainable level because politicians would be overwhelmed by the need to attract votes at the expense of future generations due to the quasi-absence of intergenerational altruism in the public sphere. There is growing eventuality that public finance may collapse and hence needs unchecked money creation.

Second, Anglo-Saxon hedge funds and speculators have been quick in their response to the new context. One prominent development in this regard is their extensive activities in international commodity markets, to hedge against inflation and to heap speculative profits. The erratic price movements on these markets make them a very risky place for sovereign investment, especially those newcomers to the markets.

Third, Chinese outward FDI is often not attainable because of various constraints. Investments in well-established international firms could be obstructed for political or regulatory reasons. One conspicuous example is the unsuccessful takeover case of Conoco Phillips by China National Offshore Oil. The U.S. Congress finally blocked the deal on the ground of national security. Investment in foreign financial institutions as proposed by Q. Chen (2009), who urges the PBOC to invest its reserves in major US banks, is probably

equally unworkable. Outward FDI in developing countries with rich endowment of raw materials also proves problematic. For one thing, in these countries domestic stability is often disrupted by internal conflicts or external interferences. Nationalist feelings in these countries often run high, leading to labelling Chinese investment as neo-colonialist hence create a negative environment for the Chinese business. It is unlikely that China can invest a substantial portion of its reserves in there. China must therefore not be overambitious in deploying foreign investments as an effective way to absorb its growing foreign reserves.

Moreover, if the yuan is not or insufficiently revaluated and given the industrial and macroeconomic policies pursued by China and its trading partners, China will continuously increase its foreign reserves. Despite recent large wage rises, China's unit labour costs remain very low compared to these in Western countries. In the long term, Chinese workers will likely be trained to perform as productively as their Western counterparts. Hence, competitiveness will play in favour of China over a long period: as long as the cumulative increase in productivity exceeds the cumulative wage rise, and foreign and domestic firms improve the quality and the scope of goods produced for export, China will continue to experience trade surpluses with the RER depreciating over time. Furthermore, strong growth in China will attract not only FDI but also hot money, further accentuating the problem.

The accumulation of foreign reserves is desirable to the extent that it may facilitate governments' macro-prudential policy including maintaining stability of the nominal exchange rate. Beyond a certain level however, its utility would diminish or even become negative because "too much of a good thing", i.e. the excessive reserves, would incur considerable social costs. Even for a normal level of reserves, the cost of carrying the reserves could be high as well. The real returns on these reserves would often be negative since the rate of real return may become less than the rate of real appreciation of the domestic currency. In addition, inflation may erode the purchasing power of the foreign assets. Thus, it is flawed

for Chinese policymakers to harbour the illusion that it is a good thing to increase the sheer number of foreign governments' treasuries on their computers.

Inaction (and delayed action) allows China to temporarily have some competitive advantages with the drawback that low wages in dollar terms encourage firms to uphold the standard below the international level in capital investment and R&D, preventing China from acquiring strategic positions in high-tech and service industries. Growth gained through lower labour costs could later be offset by the inevitable revaluation of the yuan. Indeed, the longer China waits, the more the adjustment will be painful hence more difficult to conduct, with rising costs for China and the world economy as well. Revaluation of the renminbi thus is desirable and imperative.

China must now revalue its currency in a way which avoids large economic disruptions. To accomplish this, what Chinese policymakers should consider is real rather than nominal revaluation of the yuan. International experiences show that the yuan's real appreciation, well managed, would not damage Chinese development but would, on the contrary, contribute to restructuring the Chinese economy towards a domestic demand-based growth track while helping ensure domestic financial market stability, mitigate overheating of the economy and soaring inflation, and boost job creation in the service sector (Oberpriller *et al.* 2008; Xu 2009).

The current literature provided little guidance about how to realise real revaluation and at what rhythm. While real appreciation via nominal appreciation is common among low inflation OECD economies, a far more frequent occurrence is real appreciation via faster wage rise and inflation for economies that took off from a very low level of per-capita income (Xu 2009). For China, there are thus three options for redressing the yuan's undervaluation: 1) rapid nominal revaluation; 2) "uncompetitive inflation"; 3) intermediate option.

Huang (2010) advances that rapid nominal yuan revaluation could be better than the price adjustment because the latter requires a long period for its effect to rebalance the trade position and induce adjustment of output and inflation. However, several important factors could work in favour of price adjustment. First, Chinese wages and prices are quite flexible on the upside, implying that the costs due to price adjustment may not be too high. Second, nominal revaluation provides huge capital gains to market operators holding yuan-denominated assets but induces high adjustment costs for businesses. Third, rapid nominal revaluation of the yuan could induce a large devaluation of the dollar with the risk of seriously undermining macroeconomic stability of the world economy (McKinnon and Schnabl 2006). Finally, empirical evidence shows that, while the domestic economy could pick up some of the external slack due to a large exchange-rate revaluation, the prospect of sharp decelerations in export growth will remain a concern for policymakers and warrants careful attention especially in developing countries (Kappler *et al.* 2011) because it could induce a massive destruction of firms and jobs, leading to loss of competences, less FDI and slower progress in labour productivity, and hence lower long-term growth potential. We could not exclude these very undesirable short- and long-term effects on the Chinese economy when referring to Japanese experiences. Following the Plaza accord imposing rapid yen appreciation, Japan has experienced a short-term recession followed by a speculative boom and finally a lost decade (Hamada and Okada 2009).

No evidence shows that “uncompetitive inflation” has been deliberately conceived as a policy option. Its inverse, i.e. “competitive disinflation”, was experienced with some success by France under fixed nominal exchange rate (Blanchard and Muet 1993; Fitoussi *et al.* 1993). Germany replicated this strategy to gain competitiveness after having joined the eurozone (Creel and Le Cacheux 2006). The success of such a strategy is based on the capacity of an economy to make internal adjustments in terms of wages, prices and production

combined with restrictive monetary and fiscal policies to make the strategy credible. One limit to the competitive disinflation is therefore that it could lead to temporary higher unemployment if it takes time to be entirely credible or when nominal wages are rigid. In the case of “uncompetitive inflation”, such a limit will be transformed into an advantage (higher employment) even though the latter is not expected to be important because wages in China are upwardly flexible. However, “uncompetitive inflation” must not be solely used to achieve the yuan’s real revaluation since it implies too high inflation.

The Chinese government seems agree that, in a long-term perspective, China as a large economy should adopt a flexible exchange rate regime. During the transition to this regime, the intermediate option should be adopted.

Under this option, China could choose to arbitrarily fix the rhythm of nominal revaluation. This choice is not recommendable for two reasons. First, concerns for not creating economic and social disruptions could make Chinese policymakers reluctant to decide a sufficiently large nominal revaluation and hence misses to attain the key objective of restoring the external equilibrium and stabilising the domestic economy. Second, China will be under the pressures of foreign governments to revalue the yuan with the timing and amplitude of revaluation interfered by foreign political agendas (Liu and Pauwels, 2012), and hence not necessarily optimal from the Chinese point of view.

Under the intermediate option, I advocate that China adopts a strategy which simultaneously takes into account inflation and output stabilization and the restoration of the external equilibrium. Since the best indicator of external disequilibrium is the level of foreign reserves and their excessive level induces welfare losses, the government’s loss function should include their deviations from the target. The latter should be fixed to avoid economic disruptions, implying that China should first reduce the rhythm of accumulation and then the level of foreign reserves.

In the next section, we study how the policymaker could optimally combine two instruments, i.e. domestic credit and nominal exchange rate, to attain his internal and external objectives. Then, section 5 discusses, how other policies can support this strategy.

4. An optimal combination of policies for real revaluation

We now examine, using a theoretical model, how China can optimally combine gradual nominal revaluation and “uncompetitive inflation” to redress the yuan’s real undervaluation.

The model has four equations similar to these of Blanchard and Muet (1993) and Fitoussi *et al.* (1993). We add the LM and balance-of-payments equations while modifying the IS equation as follows:

$$w_t = E_{t-1}p_t + \gamma(y_t - y^n) + \varepsilon_{w,t}, \quad \gamma > 0, \quad (2)$$

$$p_t = \alpha p_{h,t} + (1 - \alpha)(p_t^* + e_t), \quad 0 < \alpha < 1, \quad (3)$$

$$p_{h,t} = \beta(p_t^* + e_t) + (1 - \beta)w_t + \varepsilon_{p,t}, \quad 0 < \beta < 1, \quad (4)$$

$$y_t = -\varphi(i_t - E_t\pi_{t+1}) + \theta(p_t^* + e_t - p_{h,t}) + \varepsilon_{d,t}, \quad \varphi, \theta > 0, \quad (5)$$

$$m_t - p_t \equiv \zeta(e_t + \chi_t) + (1 - \zeta)h_t - p_t = l_1 y_t - l_2 i_t + \varepsilon_{l,t}, \quad \zeta \in [0,1] \text{ and } l_1, l_2 > 0, \quad (6)$$

$$\chi_t - \chi_{t-1} = -\eta_1 y_t + \eta_2(p_t^* + e_t - p_{h,t}) + \eta_3(i_t^* + \chi_{t-1}) + \nu[i_t - i_t^* - (E_t e_{t+1} - e_t)] + \varepsilon_{f,t}, \quad \eta_1, \eta_2, \eta_3, \nu > 0, \quad (7)$$

where all variables except i_t and π_t are in log. The lower case variables correspond to the logarithm of the upper case variables defined previously. p_t is the domestic price level, y^n the potential output, $\pi_t \equiv p_t - p_{t-1}$ the inflation rate, m_t the money supply, h_t the domestic component of money supply (i.e., domestic credit). $\varepsilon_{w,t}, \varepsilon_{p,t}, \varepsilon_{d,t}, \varepsilon_{l,t}$ and $\varepsilon_{f,t}$ represent exogenous shocks affecting the labour market, the production, the goods demand, the money market and the foreign exchange market, respectively. We assume rational expectations with

E_t , representing expectation operator.

Equation (2) describes how the nominal wage adjusts with the expected price level and the output gap. Equation (3) shows that the consumer price is the weighted average of the prices of domestic and foreign goods. Equation (4) gives the price of domestic goods as a weighted average of the wage and the price of foreign goods. Equations (5) and (6) are the equilibrium condition in goods and money markets, respectively. Equation (7) is a linear form of (1) with some variables neglected for simplicity.

The Chinese government stabilizes inflation and output around their respective targets. To realize the yuan's real revaluation, it must fix an inflation target π_t^T (implying $p_t^T \equiv p_{t-1} + \pi_t^T$) higher than the foreign inflation but lower than what is tolerable for the population. This avoids the accumulation of inflationary pressures, induced by foreign quantitative easing policies, to result in a stronger pressure for revaluing the yuan. Moreover, it smoothly reduces foreign reserves by fixing a target χ_t^T in each period. The government minimizes the loss function:

$$L_t = E_t \sum_{j=0}^{\infty} \rho^j \frac{1}{2} \left[\lambda_1 (y_{t+j} - y_{t+j}^n)^2 + \lambda_2 (p_{t+j} - p_{t+j}^T)^2 + (\chi_{t+j} - \chi_{t+j}^T)^2 \right], \quad \lambda_1, \lambda_2 > 0, \quad (8)$$

where ρ is the discount factor, λ_1 and λ_2 the weights assigned to output and inflation stabilization, respectively.

Minimizing (8) subject to (2)-(7) leads to following optimal targeting rules:

$$y_t - y_t^n = -\frac{\lambda_2 \Psi}{\lambda_1} (p_t - p_t^T), \quad (9)$$

$$\chi_t - \chi_t^T = -\frac{\lambda_2 \varphi [1 - \alpha(1 - \beta)]}{(\varphi \eta_2 + \nu \theta + \alpha \varphi \nu)(1 - \beta)} \left[(p_t - p_t^T) - \rho(1 + \eta_3)(E_t p_{t+1} - p_{t+1}^T) \right], \quad (10)$$

where $\Psi \equiv \frac{(\varphi \eta_1 + \nu)[1 - \alpha(1 - \beta)] + \gamma(\varphi \eta_2 + \nu \theta + \alpha \varphi \nu)(1 - \beta)}{(\varphi \eta_2 + \nu \theta + \alpha \varphi \nu)(1 - \beta)}$. Rules (9)-(10) ensures the

optimal trade-off between price level, output and foreign reserves stabilisation.

To implement rules (9)-(10), optimal policy rules are determined using them and equations (5)-(7) as:

$$h_t - p_t = \frac{\varsigma}{(1-\varsigma)} p_t^T - c_1(p_t - p_t^T) - c_2(E_t\pi_{t+1} - E_t\pi_{t+1}^T) - \frac{l_2}{1-\varsigma} E_t\pi_{t+1} - \frac{\varphi\varsigma + l_2\theta(1-\beta)}{\varphi(1-\varsigma)} e_t \quad (11)$$

$$+ \frac{l_2 + \varphi l_1}{\varphi(1-\varsigma)} y_t^n + \frac{l_2\theta(1-\beta)}{\varphi(1-\varsigma)} E_{t-1}p_t - \frac{\varsigma}{(1-\varsigma)} \chi_t^T - \frac{l_2\theta(1-\beta)}{\varphi(1-\varsigma)} p_t^* + \Sigma_\varepsilon^h,$$

$$e_t = \Theta \left[\begin{array}{l} \varphi\chi_t^T - f_1(p_t - p_t^T) + f_2(E_t\pi_{t+1} - E_t\pi_{t+1}^T) - \varphi v E_t\pi_{t+1} + \varphi v E_t e_{t+1} + (\eta_1\varphi + v)y_t^n \\ + \varphi(v - \eta_3)i_t^* - \varphi(1 + \eta_3)\chi_{t-1} - (\eta_2\varphi + v\theta)(1-\beta)(p_t^* - E_{t-1}p_t) + \Sigma_\varepsilon^e \end{array} \right], \quad (12)$$

where

$$c_1 = \frac{l_2[1 + \theta(1-\beta)\gamma] + \varphi l_1}{\varphi(1-\varsigma)} \frac{\lambda_2\Psi}{\lambda_1} - \frac{\varsigma\lambda_2\varphi[1 - \alpha(1-\beta)]}{(1-\varsigma)(1-\beta)(\eta_2\varphi + v\theta + \alpha\varphi v)} - \frac{\varsigma}{(1-\varsigma)};$$

$$c_2 = \frac{\varsigma\lambda_2\varphi\rho(1 + \eta_3)[1 - \alpha(1-\beta)]}{(1-\varsigma)(1-\beta)(\eta_2\varphi + v\theta + \alpha\varphi v)} > 0; \quad \Theta = \frac{1}{v\varphi + (\eta_2\varphi + v\theta)(1-\beta)} > 0;$$

$$\Sigma_\varepsilon^h = \frac{1}{1-\varsigma} \varepsilon_{l,t} + \frac{l_2\theta(1-\beta)}{\varphi(1-\varsigma)} \varepsilon_{w,t} + \frac{l_2\theta}{\varphi(1-\varsigma)} \varepsilon_{p,t} - \frac{l_2}{\varphi(1-\varsigma)} \varepsilon_{d,t};$$

$$f_1 = \frac{\lambda_2\varphi^2[1 - \alpha(1-\beta)]}{(\eta_2\varphi + v\theta + \alpha\varphi v)(1-\beta)} + \frac{\lambda_2\Psi[(\eta_1\varphi + v) + (\eta_2\varphi + v\theta)(1-\beta)\gamma]}{\lambda_1} > 0;$$

$$f_2 = \frac{\lambda_2\varphi^2\rho(1 + \eta_3)[1 - \alpha(1-\beta)]}{(\eta_2\varphi + v\theta + \alpha\varphi v)(1-\beta)} > 0; \quad \Sigma_\varepsilon^e = (\eta_2\varphi + v\theta)(1-\beta)\varepsilon_{w,t} + (\eta_2\varphi + v\theta)\varepsilon_{p,t} - \varphi\varepsilon_{f,t} - v\varepsilon_{d,t}.$$

The policy rules (11)-(12) imply the simultaneous utilization of monetary (“uncompetitive inflation”) and exchange rate policies to eliminate the yuan’s undervaluation while stabilizing the economy. The real domestic credit depends on the current nominal exchange rate optimally set by the government, while the optimal exchange rate in each period depends on how the monetary policy is conducted. The domestic credit affects the exchange rate through its impacts on the price level, nominal interest rate, and output and hence the actual level of foreign reserves. The rule (12) implies a gradual revaluation of the yuan since the deviation of

its exchange rate from the equilibrium takes many periods to be totally absorbed along with the planned reduction of foreign reserves.

According to the rule (11), domestic credit increases with the price level target, the expected current price and the potential output, and decreases with foreign price level. In the absence of trade-off between the price level and foreign reserves, domestic credit should decrease if the current price exceeds the target level. We admit that this effect is still dominant even though the new trade-off induces some contrary effects (i.e. $c_1 > 0$ and $c_2 > 0$). Higher expected future inflation or its positive deviations from the target imply a decrease in real domestic credit. Higher foreign reserves in terms of the yuan will reduce the need for increasing the domestic credit to satisfy the liquidity demand. The domestic credit should be increased to accommodate positive shocks affecting money demand ($\varepsilon_{l,t}$), wage ($\varepsilon_{w,t}$) and aggregate demand ($\varepsilon_{d,t}$), but has to be decreased in response to a cost shock ($\varepsilon_{p,t}$).

The rule (12) implies that the nominal exchange rate should be revaluated in response to a lower target of foreign reserves, a positive deviation of domestic price from its target (implying a negative deviation of the output from its target), an expected future revaluation of domestic currency (i.e., lower $E_t e_{t+1}$), an increase in foreign reserves in the past period, and an increase in foreign price level relative to domestic one. A positive deviation of expected future inflation from its target implies a positive deviation of current foreign reserves from its target according to (10) and hence less pressures for revaluation. Higher foreign interest rate reduces capital inflows but increases the revenue on existing reserves, and it reduces the pressure for revaluation if the first effect dominates the second one. A positive change in some factors reduce revaluation pressures through reducing the nominal interest rate, inducing thus more imports and less capital inflows. An increase in domestic potential output reduces the nominal interest rate by reducing inflation pressures while wage and cost-push shocks achieve this by inducing lower output and hence money demand. In the opposite, higher

expected inflation implies a higher domestic nominal interest rate as the initial reduction of the real interest rate leads to higher aggregate demand, and hence higher output and money demand. A positive demand shock (i.e., it directly increases the aggregate demand) works through a similar but shorter transmission mechanism, while a positive balance-of-payments shock simply adds pressures for revaluation.

The equilibrium has a unique non-explosive rational expectations solution. Known as the “minimal state variable” (MSV) solution, it is obtained using the method of undetermined coefficients (McCallum, 1983) but not presented here for its cumbersomeness.⁴

The real revaluation strategy underlying policy rules (9)-(10) or instrument rules (11)-(12) combines the optimal conduct of the monetary policy with gradual adjustment of nominal exchange rate in the process of achieving the yuan’s real appreciation. This strategy implies that foreign reserves could be increased in the short-run if their decrease or stability implies a too rapid nominal revaluation and hence too high adjustment costs for productive sectors. In the medium term, as the RER approaches its equilibrium level, the reduction of foreign reserves will be put on the government’s agenda. Compared to rapid nominal revaluation, the real revaluation strategy has the disadvantage of generating higher inflation during some periods. However, the new strategy will avoid the possible costs due to irreversible and massive destruction of firms induced by rapid nominal revaluation. Furthermore, the latter could induce asset prices bubbles with very undesirable economic consequences as showed the Japanese experiences (Hamada and Okada, 2009).

5. Policies supporting the real revaluation strategy

⁴ A technical appendix is available upon request.

Policy rules (11)-(12) imply that structural and macroeconomic policies affect the optimal combination of monetary and exchange rate policies through policy components of exogenous shocks and structural parameters. Under multiplicative uncertainty, the use of complementary policies to support the real revaluation strategy could reduce overall adjustment costs because each policy instrument is less intensively used, reducing hence the systemic risk for the economy (Brainard 1967).

Faced with important uncertainty about the transmission mechanism of economic policies besides a major external disequilibrium to be eliminated without incurring large costs, Chinese policymakers should follow the “Brainard’s conservatism principle” by diversifying policy instruments and by being cautious about their utilization.

In support of the real revaluation strategy, structural and macroeconomic policies should be designed to: 1) reduce the overall amplitude of nominal revaluation, 2) alleviate the downward pressures put on domestic growth by a real revaluation, or/and 3) counterbalance the undesirable consequences of nominal revaluation and higher inflation. In conceiving such policies, the government should carefully consider China’s trade structure, financial fragility and macroeconomic imbalances. Henceforth, I will selectively discuss some of these measures and propose some new ones.⁵

To redress external imbalances with the aim of reducing the need of revaluation, China could reduce distortionary subsidies and tax rebates for exports, cut tariffs and restrictions on imports, increase taxation on capital gains realised by foreign corporations and financial institutions while restricting short-term capital movements. The government should gradually remove excessive fiscal incentives granted to FDI-funded firms while reducing incentives for local officials in attracting foreign investors by severing the linkage between the FDI amounts

⁵ A number of these measures have already been advocated to deal with the yuan’s undervaluation issue (Liu 2004; Dai 2006; Woo 2006; Eichengreen and Hatase 2007; Hong *et al.* 2008; N’Diaye 2010).

they attracted and political promotion. Stricter environmental requirements could be applied to stop polluter production lines moving to China.

An income policy, which allows the wage to grow more rapidly, could reduce the yuan's real undervaluation and hence structural trade surpluses. Until recently, the wage growth has been behind the growth in productivity while foreign investors and consumers are able to enjoy *de facto* favourable treatment.

Excessive foreign reserves have, as counterpart, abundant domestic savings. To absorb the latter, the government should strive to create more domestic savings instruments by increasing good-quality financial assets through, e.g., selling more shares of public enterprises at fair prices, debt issuance by firms and creation of venture capital funds. The authority should gradually relax its control on the foreign exchange settlement system, allow the private sector to hold foreign currencies, and encourage foreign assets to be denominated in RMB through accommodative policies allowing for example RMB funds raised offshore to invest in mainland Chinese markets (Zheng and Yi 2007; Zhu 2010).

In the short run, the loss of competitiveness due to nominal revaluations and wage rises could induce high unemployment due to weaker growth, and severe financial and economic disruptions, and hence could put the Chinese government under great political pressures. Adjustment of the income policy might have limited negative effects on growth because FDI-funded firms will stay in China for production destined to export if the wage growth does not exceed that of productivity. Besides, higher purchasing power due to real revaluation and wage rise means higher domestic demand, hence a bigger domestic market for foreign firms. Rising wages will likely price out firms that create lower value addition but incite innovative ones to migrate to produce for higher value addition through introducing new products, new production processes and new distribution techniques. This is a process that will not be easily

jumpstarted if wages stay very low and will be subject to disruptions caused by sudden and large revaluations that may lead to many firms failing simultaneously.

To alleviate the negative pressures put on domestic growth by a real revaluation, the government could employ some policy measures in accordance with the objectives set recently, which aim at shifting from the export-led development strategy to a growth strategy based on domestic demand.⁶ These measures could include expansionary fiscal policy with a focus on education and infrastructure investment, a package of policies to stimulate domestic consumption (including higher expenditures on health care, social safety nets and poverty reduction, income policies to reduce inequality and to increase wage), the establishment of an efficient financial intermediation mechanism with good regulations and supervision, and reforms destined to level the playing field between the tradable and the non-tradable sector and to further open up the economy to foreign competition.

More precisely, public expenditures destined to improve supply conditions in the long term should be implemented and they could be partly financed by the purchase of government bonds by the PBOC. The government can modulate their levels to avoid a slump in growth during the real revaluation process. Additional funds should be mobilised to: 1) improve superior and professional education, develop basic research and stimulate R&S in Chinese firms, helping hence build the foundation of a knowledge economy and enable China to narrow the technology gap with industrialised countries; 2) improve the infrastructure by realising numerous projects (airports, bridges, high-speed railways, highways, ports, subways, etc.) notably in underdeveloped areas, and small and medium cities; 3) modernize agriculture to improve the capacity of coping with high inflationary pressures in food prices and the likely shortage of other agricultural products. This is to be achieved with particular emphases

⁶ See the speech of President Jingtao Hu at the 17th Congress of the Chinese Communist party, the 24th, October 2007, Beijing, China.

on providing more funding to farmers, developing farmer-training centres and financing more public and private food research.

Some measures could be put in place to reassure Chinese consumers, to encourage them to spend more or to stimulate their consumption needs. A sound social security system for a large part of the population could be established to reduce excessive precautionary savings. To mitigate high educational costs for Chinese families induced by previous educational reforms, more financial support to low-income households should be introduced to help the young generation to fulfil its inspiration for knowledge, hence promote long-term growth.

An important measure to take is to end the one-child policy for urban dwellers. This policy has helped accelerate China's growth since the 1980s by generating more savings but makes little sense today as China exports capital. It creates problems linked to an aging population (retirement funding, healthcare etc.), not to mention the difficulties faced by every young couple to take care of four aging parents. These concerns lead households to save more. Its reform can immediately deliver more spending for consumption.

Managing macroeconomic and social risks that may accompany nominal revaluation and higher inflation should be an integral part of the real revaluation strategy and must be high on government's agenda. Nominal revaluation and higher inflation might bring with them some undesirable consequences. Often, a not too high inflation could hide excessive increases in the prices of basic goods, and the process of nominal revaluation could fuel housing price bubbles. Both consequences are particularly detrimental to low-revenue households. The focal points of policy concerns are the following : 1) Stabilising food prices since they are especially important to low-income families in China. 2) Cooling down the property market to prevent speculations from generating a full-fledged economic and financial crisis. The consequences of bubble bursting in China's property market could be grave and have global repercussions (Ueda 2010).

These measures and others not discussed here, in complement to the real revaluation strategy considered in section 4, will gradually reduce the yuan's undervaluation, and internal and external imbalances while mitigating its negative effects on China's growth by increasing domestic demand, wages and inflation, and by reducing net exports and net capital inflows. The Chinese government should give full consideration to these policies and apply them with diligence in the new international context.

6. Conclusions

The international debate on the desirability and necessity of the yuan's revaluation has become increasingly important in recent years. This paper contributes to this debate by proposing a comprehensive strategy that puts complementary policies together to achieve real revaluation of the yuan given that the latter's undervaluation is a result of an array of domestic and international factors. We argue that a gradualist approach to the yuan's real revaluation is preferable to hurried nominal revaluation of the yuan against other major currencies because the latter has large disruptive effects on the nation's growth, especially in the short run. The accumulation of foreign reserves, originally intended to ensure the stability of nominal exchange rate, is no longer beneficial for China because excessive reserves incur substantial social cost. Refusal to timely revalue the yuan implies costlier adjustment in the future for China and the world economy, while a well-managed process of the yuan's revaluation will prove to be welfare improving without compromising China's growth.

Using a theoretical framework, the paper has also shown how to conduct an optimal strategy combining gradual nominal revaluation with higher inflation to achieve the yuan's real revaluation and to rebalance China's external position through setting a target for foreign reserves. To reduce the adjustment costs, structural and macroeconomic policies should be

designed to decrease the amplitude of nominal revaluation (higher wages, and new fiscal and regulatory rules aiming at reducing net exports and net capital inflows); to alleviate the downward pressures put on domestic growth (more public expenditures on infrastructure, additional funds for national education and R&D, and reforming the social security and the one-child policy); and to offset the undesirable consequences of this strategy (food and housing policies).

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