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Dynamic Transition of the Exchange Rate Regime in the People's Republic of China

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In this report, "$" refers to US dollars, unless otherwise stated.

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Abstract

This paper analyzes the optimal transition of the exchange rate regime in the People's Republic of China (PRC). How the PRC can successfully reach the desired regime—whether a basket peg or floating regime—from the current dollar-peg regime remains a major question. To answer it, we develop a dynamic small open-economy general equilibrium model. We construct four transition policies toward the basket-peg or floating regime and compare the welfare gains of these policies to those of maintaining the dollar-peg regime. Quantitative analysis using PRC data from Q1 1999 to Q4 2010 leads to two conclusions. First, a gradual adjustment toward a basket-peg regime seems the most appropriate option for the PRC, and would minimize the welfare losses associated with a shift in the exchange rate regime. Second, a sudden shift to a basket peg is the second-best solution. This is preferable to a sudden shift to a floating regime, since it would enable the authorities to implement optimal weights efficiently in order to achieve policy goals once a decision has been made to adopt a basket-peg regime.

JEL Classification: E42, F33, F41, F42

Contents

1. INTRODUCTION

The global debate on the People's Republic of China (PRC) exchange rate has concentrated on the optimal exchange rate regime for the renminbi (RMB). Some economists have pointed out shortcomings in the current de facto dollar-peg regime and have advocated a more flexible exchange rate under a floating regime, which would help the PRC authorities to tailor monetary conditions to domestic needs. From this perspective, the immediate removal of capital restrictions and a gradual widening of the exchange rate band are proposed.

Others support a basket-peg regime which would overcome the drawbacks of the dollar-peg regime, which is largely influenced by fluctuations in the exogenous exchange rate, for instance, the dollar–yen rate.[1, 2]

For a country like the PRC with close economic relationships with numerous partners, including the European Union, Japan, and the United States, exchange rate stabilization through a basket comprising these currencies would reduce the likelihood of large fluctuations in exchange rates.

Even if either the basket-peg or floating regime is considered an appropriate long-term answer, there remains a major question that has not so far been addressed in the literature on exchange rate regimes. How can the PRC successfully reach the desired regime—either a basket-peg or a floating regime—from the current de facto dollar-peg regime? Needless to say, any departure from the status quo entails substantial costs for the monetary authorities. Along the transition path toward the basket-peg or the floating regime under perfect capital mobility, the monetary authorities would have to remove capital controls and switch policy instruments (basket weight or money supply). To derive an optimal transition policy for the PRC, we develop a small open-economy general equilibrium model and analyze it in a dynamic context.

Our main innovation is to construct four transition policies toward the basket-peg or floating regimes and to quantify the welfare benefits of these policies relative to those associated with maintaining the current regime.

(i) A benchmark policy of maintaining the dollar-peg regime. The monetary authorities implement capital controls and fix a weight to the dollar at 1.

(ii) A policy that includes a transition period, which corresponds to an adjustment period of capital controls and basket weights. The economy starts from the dollar-peg regime, undergoes a transition period, and finally arrives at the basket-peg regime under conditions of perfect capital mobility.

(iii) A policy that does not include a transition period. The monetary authorities shift from the dollar-peg regime to the basket-peg regime without any adjustment period, implying that the economy will jump to the basket-peg regime.

(iv) Another policy without a transition period under which the monetary

[1] Ito, Ogawa, and Sasaki (1998) and Ogawa and Ito (2000) both emphasize this point and advocate adoption of the basket-peg regime in East Asia, in order to avoid the PRC being negatively affected by fluctuations in the dollar–yen exchange rate.

[2] Kawai (2004) recommends that East Asian countries embrace the basket peg regime. Yoshino, Kaji, and Asonuma (2004); and Yoshino, Kaji, and Suzuki (2004) agree. In particular, these countries are better off implementing individual basket weights, rather than common weights.

authorities shift straight from the dollar-peg to a floating regime, i.e., there will be a sudden shift to the floating regime.

(v) A policy where the monetary authorities shift from the dollar-peg regime to the managed floating regime without a transition period. Under the managed floating regime, if the exchange rate fluctuates significantly, the monetary authorities intervene in the foreign exchange market to maintain the exchange rate at a set rate. Otherwise, they allow the exchange rate to fluctuate as long as it does not deviate substantially from the desired level.

There are two main implications from our simulation exercise using PRC data from Q1 1999 to Q4 2010.

First, for a country like the PRC, gradually adjusting toward the basket-peg regime is superior to any other transition policy. One advantage of a gradual adjustment toward the basket peg is that the authorities can minimize the negative influence of both interest rates and exchange rates on output by adjusting the degree of capital controls and basket weights gradually during the transition period.[3] The absence of a sudden change in basket weights clearly results in smooth output fluctuations.

Second, the sudden shift to the basket-peg regime remains the second-best solution, although it clearly gives the authorities less control over the negative influence of interest rates and exchange rates during the shift, which could create large cumulative losses. However, the authorities can still efficiently implement optimal weights to stabilize output fluctuations once they adopt the basket-peg regime. This is obviously better than the sudden shift to the floating regime, since in this case the authorities cannot successfully minimize output fluctuations by implementing the optimal money supply. This is also consistent with findings of Yoshino et al. (2012), who show that a commitment to the basket weight rule is superior to other instrument rules under the floating regime for a small open economy attempting to minimize output fluctuations. Moreover, the sudden shift to the floating regime is even worse than the sudden shift to the managed floating regime because the authorities cannot reduce exchange rate volatility by occasional interventions.[4]

The rest of the paper is organized as follows. Following a literature review, Section 2 presents empirical analysis on exchange rate fluctuations in the PRC. Section 3 provides a small open economy model. Exchange rate regimes are defined in Section 4. We explain four transition policies together with maintaining the current regime in Section 5. Section 6 shows a simulation exercise using PRC data from Q1 1999 to Q4 2010. The policy implications in Section 7 conclude the discussion.

1.1 Literature Review

This paper is part of an extensive literature on exchange rate policy in the PRC.[5] Goldstein and Lardy (2006) point out shortcomings in the current regime, and propose

[3] We consider mainly stabilizing output fluctuation, which is consistent with the policy target of the PRC authorities who are aiming to achieve sustainable growth. Price level stability can also be achieved implicitly and indirectly through output stability.

[4] An extension of price level stability shows that optimal transition policy depends on the policy goals of the authorities. A choice between these transition policies relies on policy goals of the authorities and how instrument rules are effective to achieve policy targets.

[5] Cheung, Chinn, and Fujii (2007) evaluate whether the renminbi (RMB) is misaligned, relying upon conventional statistical methods of inference and suggest that the RMB appears to be undervalued, but not by a statistically significant margin.

the immediate removal of capital restrictions and a gradual widening of the exchange rate band. Frankel (2005) also stresses the benefits of exchange rate flexibility over the long term and emphasizes an intermediate regime such as a target zone. Eichengreen (2006) supports a more flexible exchange rate, which would help the PRC authorities tailor monetary conditions to domestic needs. Ito (2008) empirically analyzes how the PRC exchange rate policy has changed since the announcement of a modification to its policy in July 2005. He finds the post-announcement exchange regime to be close to the crawling peg against the US dollar, deviating significantly from the basket-peg regime. Zhang et al. (2011) find that when the authorities aim to minimize the volatility of the external account, a basket currency with a diversified portfolio of currencies is both advisable and viable. The current paper fills a gap in the literature by comparing some transition policies toward the basket peg or floating regime.

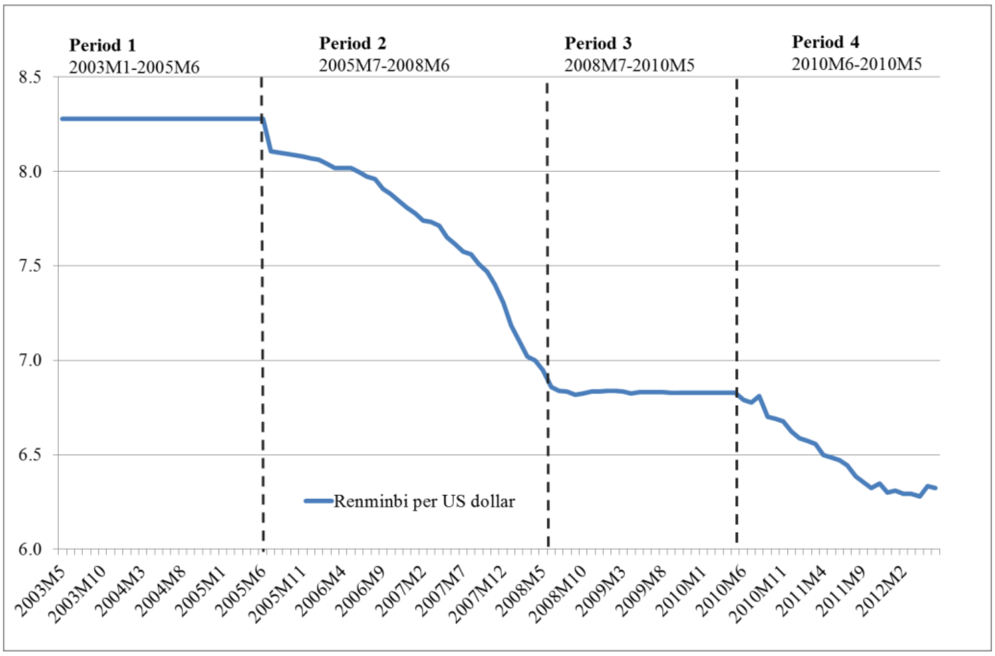
Another stream of literature has studied the optimal monetary policy for the PRC. Chang et al. (2013) examine the optimal monetary policy under the PRC's current circumstances—capital controls, nominal exchange rate targets, and costly sterilization of foreign capital inflows—and find that a combination of capital controls and exchange rate pegs disrupts monetary policy, preventing necessary adjustments that could maintain macroeconomic stability. He et al. (2011) find empirically that the Central Bank of China responded to inflation and output changes, but did not react to asset price fluctuations during the period January 1997–March 2010. Using the structural vector autoregression method, Koivu (2010) shows that a loosening of the PRC's monetary policy indeed leads to higher asset prices, which in turn are linked to household consumption. Our paper complements previous studies by comparing the effectiveness of money supply policy under the floating regime and basket weights under the basket-peg regime as policy instruments.

2. EMPIRICAL ANALYSIS OF EXCHANGE RATE DYNAMICS IN THE PEOPLE'S REPUBLIC OF CHINA

We start our discussion with an empirical analysis of exchange rate dynamics in the PRC. The government set an initial RMB–US dollar rate of 8.70 in 1994 and eventually allowed this to rise to 8.28 in 1997. The rate was then kept relatively constant until July 2005 (period 1 in Figure 1). The government modified its currency policy on 21 July 2005 by announcing that the RMB–dollar rate would become "adjustable, based on market supply and demand with reference to exchange rate movements of currencies in a basket."[6]

[6] It was later announced that the composition of the basket would include the US dollar, yen, euro, and a few other currencies, although the exact composition of the basket has never been revealed.

Figure 1: Fluctuations of the Renminbi per US Dollar Exchange Rate



Source: International Monetary Fund, International Financial Statistics.

From 21 July 2005 to June 2008, the renminbi–dollar rate showed an appreciating trend and the situation at this time might be best described as a "managed float"—market forces determined the general direction of the renminbi–dollar rate movement, but the government limited its rate of appreciation through market interventions (period 2).[7]

After an interval from July 2008 to May 2010 in which the renminbi–dollar rate was held relatively constant at 6.83 (period 3), it reverted to an appreciating trend (period 4).

Using daily exchange rates against the special drawing right (SDR), we apply the following specification to estimate weights on the US dollar per SDR during the sample periods defined below.

$$\mathrm{CNY}_t = \left(b_{0,1} + \textstyle\sum_{i=\{2,3,4\}} b_{0,i} D_i\right) + \textstyle\sum_{j \in C}\left(b_{c,1} + \textstyle\sum_{i=\{2,3,4\}} b_{c,i} D_i\right) X_{j,t} + u_t \quad (1)$$

$$\text{s.t.} \quad C = \{\mathrm{USD}, \mathrm{JPY}, \mathrm{EUR}, \mathrm{GBP}, \mathrm{AUD}, \mathrm{CAD}, \mathrm{KRW}, \mathrm{RUB}, \mathrm{SGD}, \mathrm{THB}, \mathrm{MLR}\}$$

where CNY_t and $X_{j,t}$ are the PRC's and country j's exchange rates against the SDR at time *t*.[8] D_i is a dummy variable for period i. The first bracket on the right-hand side of the equation above shows a constant term. The second bracket captures the effects of country j's exchange rates against the SDR on the PRC exchange rate against the SDR. The inclusion of dummy variables for sample periods helps capture variations in both constant terms and coefficients depending on sample periods.[9]

We obtained the estimates of weights on the US dollar against SDR reported in Table 1. In periods 2 and 4 corresponding to periods when the RMB appreciated, the weights on the US dollar against the SDR are substantially lower, by 0.15, than in period 1 when

[7] Xiaoyi (2011) gives three reasons why the PRC authorities decided to take a gradual approach to reforming the exchange rate mechanism and not allow the exchange rate to float freely.

[8] USD = US dollar, JPY = yen. EUR = euro, GBP = pound sterling, AUD = Australian dollar, CAD = Canadian dollar, KRW = won, RUB = ruble, SGD = Singapore dollar, THB = baht, MLR = ringgit.

[9] Details of regression results are reported in Yoshino (2012).

the renminbi–dollar rate was completely fixed. Even in period 3, in which the renminbi–dollar rate was held relatively constant, the weight on the US dollar against the SDR is lower than that under the dollar-peg period. These clearly indicate that the renminbi is not completely pegged to the US dollar and is increasingly influenced by other currencies.

Table 1: Estimates of Weights on the US Dollar Rate

	Period 1	Period 2	Period 3	Period 4
Sample period	7 May 2003–22 July 2005	25 July 2005–30 June 2008	1 July 2008–28 May 2010	1 June 2010–12 June 2012
Estimated weights on the US dollar rate	0.999** (0.001)	0.842** (0.036)	0.918** (0.017)	0.819** (0.039)

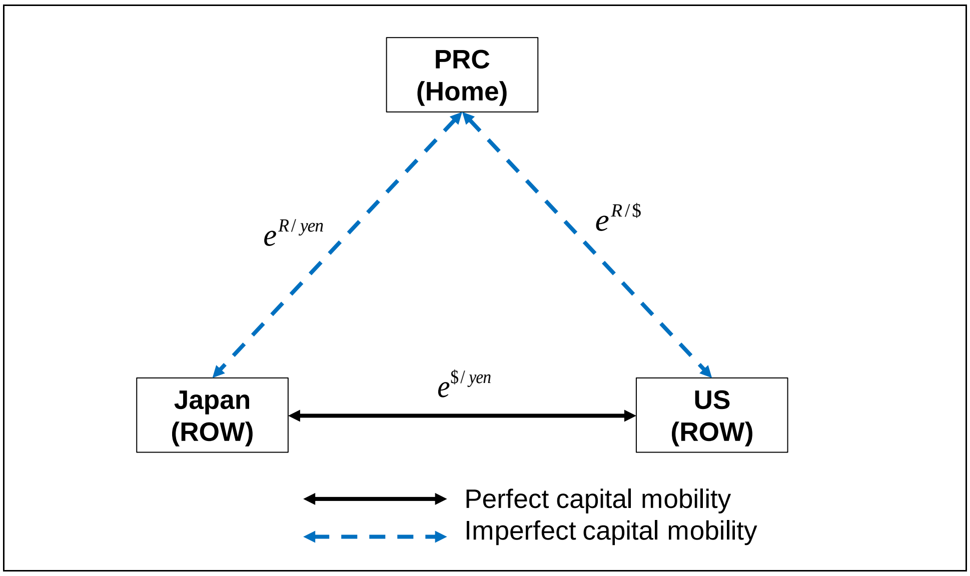
Source: Authors' calculations.

Note: ** denotes significance at the 5% level. Values in parentheses are standard deviations.

3. SMALL OPEN-ECONOMY MODEL

In this section, we provide a small open-economy general equilibrium model.[10] Our model closely follows Yoshino et al. (2002) and Dornbusch (1976) and we analyze in a dynamic context. Although we do not derive equilibrium conditions directly from optimal behaviors of households and firms, our equilibrium conditions are the same as those in Yoshino et al. (2012), which are based on micro foundations. There are three countries in this model: the PRC, the US, and Japan. We assume the PRC is the home country and the US and Japan are the rest of the world (ROW). The yen–dollar exchange rate is exogenous to the PRC.

Figure 2: The Model



PRC = People's Republic of China, ROW = rest of world, US = United States.

Source: Authors' illustration.

[10] Yoshino et al. (2011) consider an extension where the price levels in the US and Japan are highly influenced by the domestic price level.

Table 2: Descriptions of Variables

m	Stock of money supply
p	Price level in home
p^e	Expected domestic price level
p^*	Price level in the US
p^{yen}	Price level in Japan
i	Home interest rate
i^{US}	US interest rate
y	Domestic GDP
$\bar{y}$	Potential GDP
$e^{R/\$}$	Renminbi/US dollar exchange rate
$e^{R/yen}$	Renminbi/Japanese yen exchange rate
$e^{\$/yen}$	US dollar/Japanese yen exchange rate
υ	Basket weight on the US dollar rate
α	Total productvitiy

GDP = gross domestic product, US = United States.

Note: All variables except interest rates are defined as natural logarithms.

We assume that domestic and foreign assets are imperfect substitutes and that US and Japanese assets are perfect substitutes for domestic investors. The interest parity condition is shown as:

$$i_{t+1} - i_t = \lambda \left[i_t - \left\{ i_t^* + e_{t+1}^{R/\$} - e_t^{R/\$} - \sigma \left(e_t^{R/\$} \right) \right\} \right] \tag{2a}$$

where λ denotes the adjustment speed of domestic interest rate, which also captures the degree of capital control. If λ is close to 0, it implies that the domestic interest rate does not respond to a difference in rates of return between home and foreign assets. It means that the domestic interest rate is exogenous and totally independent. We regard this as a case of strict capital control. However, if λ approaches 1, it implies that the domestic interest rate responds completely to a difference in rates of return between home and foreign assets. We consider this to be a case without capital control. Furthermore, $\sigma \left(e_t^{R/\$} \right)$ denotes a risk premium which depends on the renminbi–dollar exchange rate. If $\lambda = 1$, equation (2a) can be rewritten as:

$$i_{t+1} = i_t - \left\{ i_t^* + e_{t+1}^{R/\$} - e_t^{R/\$} - \sigma \left(e_t^{R/\$} \right) \right\} \tag{2b}$$

The equilibrium condition for the money market is:

$$m_t - p_t = \varepsilon\, i_{t+1} + \phi \left(y_t - \bar{y} \right) \tag{3}$$

Demand for goods depends on real exchange rates, real interest rates, and exchange rate risks as:

$$y_t - \bar{y} = \delta \left(e_t^{R/\$} + p^* - p_t\right) + \delta \left(e_t^{R/yen} + p^{yen} - p_t\right) - \rho \{i_{t+1} - (p_{t+1}^e - p_t^e)\} - \tau \Delta e^{R/\$} - \varsigma \Delta e^{R/yen} \quad (4)$$

where the term $(p_{t+1}^e - p_t^e)$ shows expected rate of inflation. $\Delta e^{R/\$}$ and $\Delta e^{R/yen}$ express the renminbi–dollar exchange rate risk and renminbi–yen exchange rate risk respectively.

Since one of three exchange rates is not independent, the renminbi–yen rate can be expressed as:

$$e_t^{R/yen} = e_t^{R/\$} + e_t^{\$/yen} \quad (5a)$$

The inflation rate depends on total productivity, excess demand for goods, the real renminbi–dollar rate, and the expected rate of inflation, shown as:

$$p_{t+1} - p_t = \alpha_t + \phi (y_t - \bar{y}) + \eta \left(e_t^{R/\$} + p^* - p_t\right) + (p_{t+1}^e - p_t^e) + \chi \Delta e^{R/\$} \quad (6)$$

where the first term on the right-hand side shows the total productivity of the home country and the last term denotes the renminbi–dollar exchange rate risk. Aggregate production depends on total productivity, imported materials from the US, and the inflation rate. We assume that the PRC imports materials from the US and exports final goods to Japan and the US.

Among the variables, α_t, $\bar{y}$, p^*, p^{yen}, $e_t^{\$/yen}$, $\Delta e^{R/\$}$, and $\Delta e^{R/yen}$ are common exogenous variables under any exchange rate regimes. We assume that all exogenous variables except $e_t^{\$/yen}$, p_{t+1}^e, and p_t^e are constant (=0) in the analysis below. All the coefficients above are positive.

4. EXCHANGE RATE REGIME

In this section, we derive the long-term equilibrium together with equilibrium values at period *t*. We consider five cases:

(A) dollar-peg regime with strict capital controls;

(B) basket-peg regime with weak capital controls;

(C) basket-peg regime without capital controls;

(D) floating regime without capital controls; and

(E) dollar-peg regime with perfect capital mobility.

4.1 Dollar-Peg Regime with Strict Capital Controls (A)

Under the dollar-peg regime, the renminbi–dollar rate ($e_t^{R/\$}$) becomes exogenous ($e_t^{R/\$} = \bar{e}_t^{R/\$}$). Thus, the expectation of the exchange rate is identical to the current exchange rate. Furthermore, in this case, the money supply (m_t) becomes endogenous, implying that the monetary authority adjusts the money supply by intervening in the foreign exchange market in order to keep the US dollar rate constant. Thus, the impacts of foreign market intervention have been taken into account in this case. Since the monetary authority restricts domestic residents from holding foreign assets, equation (1) does not exist. The domestic interest rate (i_{t+1}) is the policy instrument (exogenous) in this case. As the renminbi–dollar rate is fixed, from equation (4):

$$e_t^{R/yen} = e_t^{\$/yen} \tag{5b}$$

After deriving the long-run equilibrium, we solve for rational expectations and obtain expressions for $y_t - \bar{y}_A^{'}$ and $p_t - \bar{p}_A^{'}$ such as:[11]

$$\left(y_t - \bar{y}_A^{'}\right) = A_1(t)\hat{e}_t^{R/yen} + A_2(t)\,\Delta\,\hat{e}^{R/yen} + A_3(t)i_{t+1} \tag{7a}$$

$$\left(p_t - \bar{p}_A^{'}\right) = A_1^p(t)e_t^{R/yen} + A_2^p(t)\,\Delta\,\hat{e}^{R/yen} + A_3^p(t)i_{t+1} \tag{7b}$$

One shortcoming of the dollar-peg regime with capital controls is that capital inflow is restricted which leads to a lower level of long-run equilibrium value compared with the one under the basket-peg regime without capital controls.

4.2 Basket-Peg Regime with Weak Capital Controls (B)

As the basket peg is one type of fixed exchange rate regime, the endogenous variables are the same as under the dollar-peg regime. In this case, the monetary authority adjusts the money supply by intervening in the foreign exchange market in order to maintain the value of the basket. Thus, the impacts of foreign market intervention have been considered in this case as well. As mentioned above, the basket is a weighted average of the renminbi–dollar rate and the renminbi–yen rate. We have equation (2a) together with the basket equation, which is:

$$\upsilon\, e_t^{R/\$} + (1 - \upsilon)e_t^{R/yen} = \Gamma \tag{8}$$

where Γ is the value of the basket. From this equation and equation (5a), we can obtain

$$e_t^{R/\$} = (1 - \upsilon)e_t^{\$/yen}, \qquad e_t^{R/yen} = \upsilon\, e_t^{\$/yen} \tag{9}$$

After deriving the long-run equilibrium, we solve for rational expectations and obtain expressions for $y_t - y_B^{'}$ and $p_t - p_B^{'}$ such that:[12]

$$\left(y_t - \bar{y}_B^{'}\right) = B_1(t)\,\upsilon\,\hat{e}_t^{\$/yen} + B_2(t)\hat{e}_t^{\$/yen} + B_3(t)\hat{z}_t \tag{10a}$$

$$\left(p_t - \bar{p}_B^{'}\right) = B_1^p(t)\,\upsilon\,\hat{e}_t^{\$/yen} + B_2^p(t)\hat{e}_t^{\$/yen} + B_3^p(t)\hat{z}_t \tag{10b}$$

where $B_3(t)\hat{z}_t$ is comprised of $\Delta\,\hat{e}^{R/\$}$ and $\Delta\,\hat{e}^{R/yen}$ terms.

4.3 Basket-Peg Regime without Capital Controls (C)

As in Section 4.2, we have the same equation (9). As in previous subsections, we solve this for rational expectation to obtain expressions for $y_t - \bar{y}_C^{'}$ and $p_t - \bar{p}_C^{'}$ such that:[13]

$$\left(y_t - \bar{y}_C^{'}\right) = C_1(t)\,\upsilon\,\hat{e}_t^{\$/yen} + C_2(t)\hat{e}_t^{\$/yen} + C_3(t)\hat{z}_t \tag{11a}$$

$$\left(p_t - \bar{p}_C^{'}\right) = C_1^p(t)\,\upsilon\,\hat{e}_t^{\$/yen} + C_2^p(t)\hat{e}_t^{\$/yen} + C_3^p(t)\hat{z}_t \tag{11b}$$

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[11] Expressions $A_1(t)$, $A_2(t)$, $A_3(t)$ $A_1^p(t)$, $A_2^p(t)$, $A_3^p(t)$ are shown in Yoshino et al. (2011).

[12] We show how to solve for rational expectation and derive equation (10a) and (10b) and expression $B_1(t)$, $B_2(t)$, $B_3(t)$ $B_1^p(t)$, $B_2^p(t)$, $B_3^p(t)$ in Yoshino et al. (2011).

[13] We show how to solve for rational expectation and derive equation (11a) and (11b) and expression $C_1(t)$, $C_2(t)$, $C_3(t)$ $C_1^p(t)$, $C_2^p(t)$, $C_3^p(t)$ in Yoshino et al. (2011).

4.4 Floating Regime without Capital Controls (D)

Under the floating regime, money supply (m_t) becomes exogenous. Solving for rational expectation yields expressions, for $y_t - \bar{y}_D^{'}$ and $p_t - \bar{p}_D^{'}$ [14]

$$\left(y_t - \bar{y}_D^{'}\right) = D_1(t)\hat{e}_t^{\$/yen} + D_2(t)\hat{z}_t + D_3(t)m_t \quad (12a)$$

$$\left(p_t - \bar{p}_D^{'}\right) = D_1^p(t)\hat{e}_t^{\$/yen} + D_2^p(t)\hat{z}_t + D_3^p(t)m_t \quad (12b)$$

4.5 Dollar-Peg Regime under Perfect Capital Mobility (E)

As with Section 4.1, the renminbi–dollar rate ($e_t^{R/\$}$) is totally exogenous ($e_t^{R/\$} = \bar{e}_t^{R/\$}$) and the money supply is endogenous. Under free capital mobility, the domestic interest rate (i_{t+1}) is fixed at the level of the US interest rate (endogenous), i.e., $i_{t+1} = i_t^{US}$. Solving for rational expectation yields expressions, for $y_t - \bar{y}_E^{'}$ and $p_t - \bar{p}_E^{'}$:

$$\left(y_t - \bar{y}_A^{'}\right) = A_1(t)\hat{e}_t^{R/yen} + A_2(t)\,\Delta\,\hat{e}^{R/yen} \quad (7c)$$

$$\left(p_t - \bar{p}_A^{'}\right) = A_1^p(t)e_t^{R/yen} + A_2^p(t)\,\Delta\,\hat{e}^{R/yen} \quad (7d)$$

5. TRANSITION PATH TO A NEW EXCHANGE RATE REGIME

In this section, we define four transition policies. Based on the results of static analysis by Yoshino et al. (2004), we consider that the stable desirable regimes are either the basket-peg regime without capital controls (C) or the floating regime without capital controls (D).[15]

We consider the following transition paths to the target regimes, plus maintaining the current regime, and the dollar-peg regime with capital controls (A).

(1) Maintaining the dollar peg (with strict capital controls): ((A) - (A) - (A))

(2) Gradual shift from the dollar peg to the basket peg without capital controls (gradual adjustment of both capital controls and basket weight): ((A) - (B) - (C))

(3) Sudden shift from the dollar peg to the basket peg without capital controls (sudden removal of capital control and sudden shift of basket weights): ((A) - (C) - (C))

(4) Sudden shift from the dollar-peg to the floating regime: (sudden removal of capital controls and sudden increase of flexibility in exchange rate): ((A) - (D) - (D))

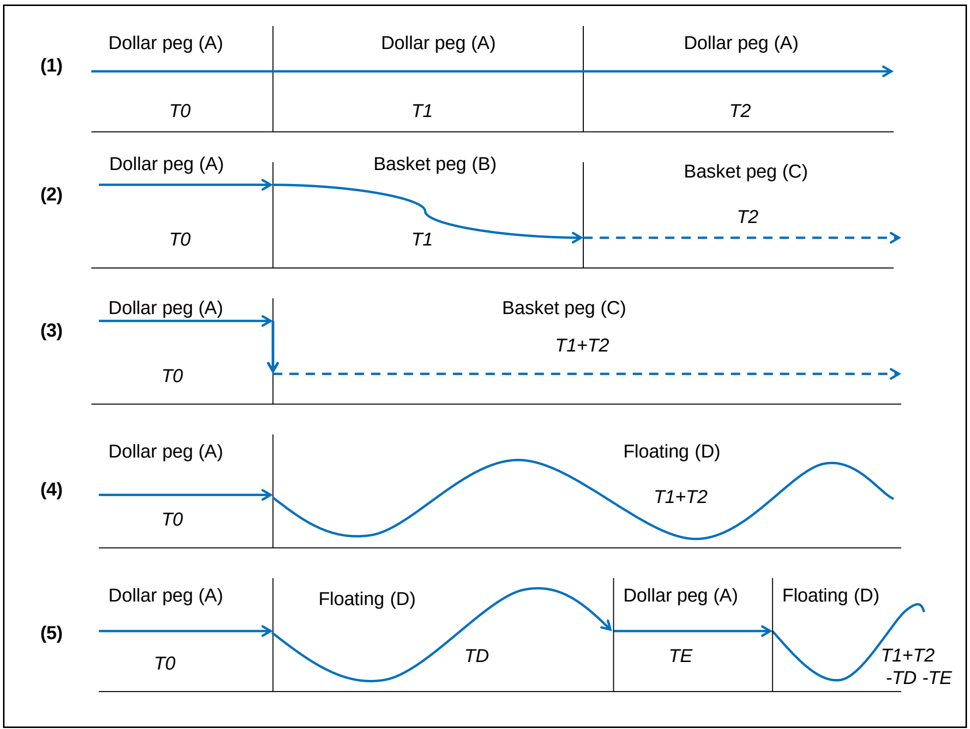
(5) Sudden shift from the dollar peg to the managed floating regime (sudden

[14] We show how to solve for rational expectation and derive equation (12a) and (12b) and expression $D_1(t)$, $D_2(t)$, $D_3(t)$ $D_1^p(t)$, $D_2^p(t)$, $D_3^p(t)$ in Yoshino et al. (2011).

[15] Yoshino, Kaji, and Suzuki (2004) show that for a small open economy like Thailand, it would be desirable to adopt basket-peg or floating rather than dollar-peg under static analysis. Furthermore, Yoshino, Kaji, and Asonumua (2004) confirm that this statement is also true under a two-country general equilibrium model.

removal of capital controls and sudden increase in flexibility in exchange rate with occasional intervention: ((A) - (D) - (E) - (D))

Figure 3: Five Policies toward Stable Regimes



Source: Authors' illustration.

The first policy is maintaining the current regime (the dollar peg). The monetary authority controls capital movement and fixes a weight on the dollar rate at 1.

The second policy includes the transition period (B), which reflects the adjustment period of capital controls and basket weights. It starts from the dollar-peg regime which is followed by the transition period (B), finally arriving at the basket-peg regime without capital controls (C).

The third policy does not includes the transition period (B), so the monetary authority shifts from the dollar-peg regime to the basket-peg regime without a transition period, implying the economy will jump to the target basket-peg regime.

In the fourth policy the monetary authority shifts from the dollar-peg to the floating regime without a transition period, implying the economy will suddenly jump to the floating regime.

The fifth and final policy shifts from the dollar-peg to the managed floating regime without a transition period. Under the managed floating regime, if the exchange rate fluctuation is remarkably large, the monetary authority intervenes in foreign exchange markets to maintain the exchange rate at the desired rate (E). Otherwise, it allows the exchange rate to fluctuate.

We assume that the time interval for the initial dollar-peg regime is T_0. Furthermore, we consider the transition period to be T_1 and the time interval after the authority reaches the target regime to be T_2. A discount factor is assumed to be β. Figure 2 displays the five policies. Throughout this paper, we consider that the monetary authorities aim to minimize output fluctuations shown as:[16]

$$L(T_1, T_2) = \sum_{t=1}^{T_0+T_1+T_2} \beta^{t-1} (y_t - \bar{y}')^2 \quad (13)$$

Note that a reduced form $y_t - \bar{y}$ varies depending on exchange rate regimes as explained in Section 4. We consider that stabilizing output fluctuation is consistent with the policy goal of the PRC authorities who are aiming to achieve sustainable growth. Through equation (6), price stability can also be attained implicitly and indirectly when the authorities attempt to minimize output stability. Cumulative losses depending on transitional paths are defined in Appendix 2.

There are costs and benefits associated with the four transition policies (2), (3), (4) and (5) shown in Table 3. For each component of costs, we provide an estimate in the PRC case based on the quatitative analysis in Table 4. These costs and benefits are taken into consideration by quantifying the cumulative losses defined in Appendix 2.

Table 3: Costs and Benefits of Each Transition Policy

Policy	**Benefits**	**Costs**
(1) Maintaining the dollar peg	No volatility of $e^{R/\$}$	Limited capital inflows
(2) Gradual shift to basket peg	Small volatility of i	Time to reach stable regime
	Small volatility of $e^{R/\$}$, $e^{R/yen}$	Adjustment costs
	Small deviations of $e^{R,\$,e}$, $e^{R,yen,e}$	
(3) Sudden shift to basket peg	Reaching stable regime at once (higher benefits under stable regime)	High volatility of i.
	No adjustment costs	High volatility of $e^{R,\$}$,$e^{R,yen}$
(4) Sudden shift to floating	Reaching stable regime at once (higher benefits under stable regime)	High volatility of i
	No adjustment costs	High volatility of $e^{R,\$}$,$e^{R,yen}$ Large deviations of $e^{R,\$,e}$, $e^{R,yen,e}$
(5) Sudden shift to managed floating	Reaching stable regime at once (higher benefits under stable regime)	High volatility of i
	No adjustment costs	No monetary policy autonomy during interventions
	Limited exchange rate fluctuations	

Source: Authors' compilation.

[16] In the case of price level stability, the cumulative loss can be shown as:

$$L^P(T_1, T_2) = \sum_{t=1}^{T_0+T_1+T_2} \beta^{t-1} (p_t - \bar{p}')^2 \quad (13a)$$

Table 4: Estimates of Costs under Five Policies

Policy	Costs	Estimates
(1) Maintaining the dollar peg	Limited capital inflows	0.033[a]
(2) Gradual shift to basket peg	Time to reach stable regime	0.003[b]
	Adjustment costs	0.0066[c]
(3) Sudden shift to basket peg	High volatility of i.	0.0028[d]
	High volatility of $e^{R,\$}$,$e^{R,yen}$	0.0030[e]
(4) Sudden shift to floating	High volatility of i	0.0034[d]
	High volatility of $e^{R,\$}$,$e^{R,yen}$	0.034[e]
	Large deviations of $e^{R,\$,e}$, $e^{R/yen,e}$	0.0013[f]
(5) Sudden shift to managed floating	High volatility of i	0.0034[d]
	No monetary policy autonomy during interventions	0.023[g]

[a] The proxy is the cumulative loss over 9 quarters (1 initial period and 2 years).
[b] The estimate is the difference between the cumulative losses under transition period of 14 quarters and 18 quarters.
[c] The estimate is the difference in the cumulative losses based on baseline λ and on a 20% deviation from the baseline λ.
[d] The estimate is the change in the cumulative loss due to an increase in interest rate orignally driven by a 0.001-unit deviation of $e^{\$/yen}$ shock.
[e] The estimate is the change in the cumulative loss due to a 0.001-unit $e^{\$/yen}$ shock.
[f] The estimate is the change in the cumulative loss due to a 0.001-unit $e^{\$/yen,e}$ shock.
[g] The estimate is the fraction of the cumulative loss during intervention periods.
Source: Authors' calculations.

6. QUANTITATIVE ANALYSIS TRANSITION PATH TO OTHER EXCHANGE RATE REGIME

We solve the model quantitatively using PRC data. Using estimated parameters for the PRC, we quantify the cumulative losses for all the transition policies. Our numerical results show the following.

First, among the five policies, maintaining the dollar peg (policy 1) yields the highest loss for the PRC.

Second, comparing the two transition policies to the basket-peg regime, a gradual adjustment leads to a smaller loss than a sudden shift.

Third, in comparing the shift to the basket peg and the shift to the floating regime, the desired outcome depends on policy goals: a shift to the basket peg results in a smaller loss for output stabilization, whereas a shift to the floating regime yields a smaller loss for price level stabilization.

6.1 Unit Root Test and Cointegration Tests

We use PRC quarterly data from the International Monetary Fund (IMF) International Financial Statistics (IFS). Except for interest rates and exchange rate risks, variables are denominated in natural logs. For exchange rate risks, we use variances of monthly exchange rates as a proxy. First, we apply the Dicky–Fuller general least squares (DF-GLS) unit root tests. The results of the unit root tests are presented in Table 5. Based on a 10% significance critical value, some variables such as real interest rates and output gap have a unit root. Next, reflecting the outcome of the unit root tests, we examine the Johansen cointegration test for four equations as indicated in Table 6. Using 5% significance criteria, we find that cointegration relationships exist.

Table 5: Dicky–Fuller General Least Squares Unit Root Tests

Variable	Degree	Trend	Lag	DF-GLS	Result
$e^{R/\$}$	Level	0	0	-2.67***	I(0) [b]
$e^{R/yen}$	Level	0	1	-3.06***	I(0) [b]
i	Level	0	0	-1.65*	I(0) [b]
$i-(p^e_{t+1}-p_t)$	Level	0	8	-5.32***	I(1) [c]
i^{US}	Level	0	3	-2.68***	I(0) [b]
$m-p$	Level	0	5	-1.88***	I(0) [b]
$e^{R/\$}-p^{US}-p$	Level	0	0	-2.57***	I(0) [b]
$e^{R/yen}-p^{yen}-p$	Level	0	2	-3.22***	I(0) [b]
$e^{\$/yen}$	Level	0	0	-2.80***	I(0) [b]
$\Delta\, e^{R/\$}$	Level	0	0	-3.31***	I(0) [b]
$\Delta\, e^{R/yen}$	Level	0	0	0.17	
	1st diff.	0	0	-0.684***	I(1) [c]
$p_{t+1}-p_t$	Level	0	8	0.14	
	1st diff.	0	3	-4.95**	I(1) [c]
$y_t-\bar{y}$	Level	0	4	-1.61*	I(0) [b]

DF-GLS = Dicky–Fuller general least squares.
[a] The critical values for the DF-GLS statistics are: 5%, -1.98; 10%, -0.62. Our results on the unit root are based on a 10% critical value.
[b] I(0) shows that the variable follows the stationary process when the level of the variable is used.
[c] I(1) shows that the variable has an unit root of degree 1.
Source: Authors' calculations.

Table 6: Johansen Cointegration Test

Equation	Variable	Trend	Hypothesis	Trace Statistic[a]	P-Value[b]
Aggregate demand	$y_t-\bar{y}$	Deter	None[c]	162.3***	0.00
	$e^{R/\$}-p^{US}-p$		At most 1[c]	118.9***	0.00
	$e^{R/yen}-p^{yen}-p$		At most 2[c]	75.8***	0.00
	$i-(p^e_{t+1}-p_t)$		At most 3[c]	36.9***	0.00
	$\Delta\, e^{R/\$}$		At most 4[c]	14.0*	0.08
	$\Delta\, e^{R/yen}$		At most 5[c]	2.7*	0.09
Aggregate supply	$p_{t+1}-p_t$	Deter	None[c]	171.3***	0.00
	$y_t-\bar{y}$		At most 1[c]	121.8***	0.00
	$e^{R/\$}-p^{US}-p$		At most 2[c]	78.8***	0.00
	$e^{R/yen}-p^{yen}-p$		At most 3[c]	37.8***	0.00
	$\Delta\, e^{R/\$}$		At most 4[c]	14.8*	0.04
	$\Delta\, e^{R/yen}$		At most 5[c]	2.7*	0.09

Deter = deterministic trend.
Note: ***, **, * indicate 1%, 5%, and 10% levels of significance, respectively.
[a] Denotes 5% critical values.
[b] MacKinnon–Haug–Michelis (1999) p-values.
[c] Denotes rejection of the hypothesis at 5% significance level.
Source: Authors' calculations.

6.2 Estimation Results

Based on the results of the unit root and cointegration tests, the instrumental variable (IV) method is applied to estimate parameters simultaneously. We select two sample periods reflecting different exchange rate regimes: (i) Q1 1999–Q2 2005 for the dollar peg and basket peg, and (ii) Q3 2005–Q4 2010 for the floating regime. Since the PRC has never adopted a free floating regime, we use estimated coefficients for the latter sample period. Table 7 shows the estimation results. The first column shows the explanatory variables. The second indicates the estimated coefficients under the fixed (basket-peg) regime, and the third shows those under the floating regime.

Table 7: Estimation Results

Coefficients	**Fixed, Basket-Peg Regime**	**Floating Regime**
Sample	**Q1 1999–Q2 2005**	**Q3 2005–Q4 2010**
λ	-	0.26*** (0.09)
σ	-	0.05*** (0.03)
ε	3.20*** (0.89)	10.13*** (1.89)
Φ	0.23*** (0.05)	0.50*** (0.10)
δ , δ'	-1.20 (2.51)	1.27* (0.69)
θ , θ'	0.70** (0.33)	-0.007 (0.42)
ρ	-0.52 (0.38)	0.63** (0.25)
τ	-36.11 (46.78)	-0.14 (0.77)
ς	0.40 (1.50)	8.66 (15.91)
α	0.16*** (0.02)	0.13*** (0.04)
ϕ	-0.04* (0.02)	0.12** (0.05)
η , η'	-0.06* (0.03)	-0.15** (0.07)
μ , μ'	-1.32*** (0.26)	-0.35*** (0.11)
χ	-7.28** (3.13)	-0.001 (0.14)
ξ	-5.87*** (0.88)	-7.80*** (2.80)
a_4, b_4	0.71*** (0.16)	0.49*** (0.19)
d_5	-	0.98*** (0.07)
d_6	-	0.49*** (0.06)
B	0.99	0.99

Note: Values in parentheses denote standard errors of coefficients. ***, **, * indicate 1%, 5%, and 10% significance levels, respectively.
Source: Authors' calculations.

6.3 Simulation Using the Estimated Coefficients

In the simulation exercise, we compute optimal values of the policy instruments and values of cumulative losses depending on transition policies. For exchange rates and exchange rate risks, the actual data for period Q1 1999–Q4 2010 are used. As we define exogenous shocks as deviations from the long-run values, we use the deviations from the H-P filtered trend value for each exogenous shock. The time period for the dollar peg is set as 1 quarter (T_0=1), the interval for the transition period as 18 quarters (T_1=18), and the periods for the target regime as 18 (T_2=18) quarters.[17] Table 8 reports values of cumulative losses and optimal instruments of five policies for stabilizing output fluctuations.[18]

[17] Yoshino et al. (2011) discuss the relationship between the optimal weights under the basket-peg regime and the time span using Thai data.

[18] Appendix 1 discusses price level stability.

Table 8: Cumulative Losses and Optimal Values of Instruments

	Policy (1)	**Policy (2)**	**Policy (3)**	**Policy (4)**	**Policy (5)** $(\mathbf{T_E = 5})$[b]
Stable regime	Dollar peg	Basket peg	Basket peg	Floating	Managed floating
Adjustment	-	Gradual	Sudden	Sudden	Sudden
Instrument value	$i^* = 4.34$	$\upsilon^* = 0.58$	$\upsilon^{**} = 0.68$	$m^* = 0.016$	$m^{**} = 0.017$
Cumulative loss (value)	17.04	1.80	1.91	2.67	2.31
Cumulative loss (% of $\bar{y}^2$)[a]	23.4	2.4	2.6	3.7	3.2

[a] We calculate the value of $\bar{y}^2$ shown in Section 4 and obtain $\bar{y}^2 = 72.8$.
[b] For $T_E = 7$, the cumulative loss is 3.54 ($m^{**} = 0.017$).
Source: Authors' calculations.

Among the five policies, policy (1) of maintaining the dollar peg results in the highest cumulative losses. The costs of limited capital inflows due to capital controls exceed the benefits of an absence of fluctuations in the dollar rate. Focusing on shifting to the basket-peg regime, policy (2), with gradual adjustment, yields smaller cumulative losses than policy (3), with a sudden shift. Having transition periods of adjusting gradually to capital controls and basket weights provides benefits to the country, enabling it to minimize the volatility of interest rate and exchange rates. The optimal weights of policy (2) and policy (3) differ, as explained in Yoshino et al. (2014).[19]

A comparison between shifts to the basket-peg and to the floating regime suggests that the shift to the basket leads to smaller cumulative losses. This is because the monetary authorities can successfully minimize output fluctuations by balancing exchange rates through the implementation of optimal weights. In a similar context, Yoshino et al. (2012) show that, although no transition periods are included, a commitment to the basket weight rule is superior to other instrument rules under the floating regime for small, open emerging market countries. Lastly, the shift to the managed floating regime yields better outcomes for the authorities than the shift to the floating regime. Reducing exchange rate volatility, which directly affects output fluctuations through occasional interventions, is of benefit for the authorities.

7. POLICY IMPLICATIONS AND CONCLUSION

The PRC faces the question of how to change its exchange rate policy. There have not been many studies on how to adjust the current exchange rate regime and to move toward a desired exchange rate system. This paper compares five policies and computes the value of the cumulative losses of each, measured by output fluctuations.

First, it shows that adopting a gradual adjustment toward the basket-peg regime (under optimal weight for the basket) is superior to any other transition policy. The major advantage of a gradual adjustment toward the optimal basket peg is that the authorities can minimize the negative influence of interest rates and exchange rates on output by adjusting the degree of capital controls and basket weights gradually during the transition periods. The absence of a sudden change in basket weights clearly results in smooth output fluctuations.

[19] It is apparent that the optimal basket weight obtained from our numerical analysis is different from that of Ogawa and Shimizu (2006), which is based on shares in regional GDP measured at purchasing power parity (PPP) and their trade volume shares (sum of the exports and imports).

Second, the sudden shift to the basket-peg regime is the second-best solution. However, it clearly lacks the control of negative influence of interest rates and exchange rates during the shift which creates large cumulative losses.

Thirdly, it is less desirable to implement a sudden shift to a floating regime since the authorities cannot successfully minimize output fluctuations by implementing the optimal money supply. This is consistent with the finding in Yoshino et al. (2012), which showed that a commitment to the basket weight rule is superior to other instrument rules under the floating regime for a small open economy attempting to minimize output fluctuations. Moreover, a sudden shift to a floating regime is even worse than a sudden shift to a managed floating regime since the authorities cannot reduce exchange rate volatility by occasional interventions.

When other losses such as the impact on price level stability are considered, the optimal transition policy depends on how policy instruments affect policy targets.

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APPENDIX 1: EQUILIBRIUM CONDITIONS UNDER EXCHANGE RATE REGIMES

Dollar-Peg Regime (A)

We denote deviations of output and the price level from the new long-run equilibrium value under the basket-peg regime without capital controls (C) as:

$$\left(y_t - \bar{\bar{y}}_A^{'}\right) = \left(y_t - \bar{y}_A^{'}\right) + \left(\bar{y}_A^{'} - \bar{\bar{y}}_A^{'}\right)$$
$$= \{A_1(t) + A'_1(t)\}\hat{e}_t^{R/yen} + A_2(t)\,\Delta\,\hat{e}^{R/yen} + A_2^{'}(t)\,\Delta\,\hat{e}^{R/\$} + A_3(t)i_{t+1} \quad \text{(7a)}$$

$$\left(p_t - \bar{\bar{p}}_A^{'}\right) = \left(p_t - \bar{p}_A^{'}\right) + \left(\bar{p}_A^{'} - \bar{\bar{p}}_A^{'}\right)$$
$$= \left\{A_1^p(t) + A_1^{'\,p}(t)\right\} e_t^{R/yen} + A_2^p(t)\,\Delta\,\hat{e}^{R/yen} + A_2^{'\,p}(t)\,\Delta\,\hat{e}^{R/\$} + A_3^p(t)i_{t+1} \quad \text{(7b)}$$

Note that $\bar{\bar{y}}_A^{'} = \bar{y}_C^{'}$ and $\bar{\bar{p}}_A^{'} = \bar{p}_C^{'}$ are defined in Yoshino et al. (2011).

APPENDIX 2: CUMULATIVE LOSSES UNDER EACH TRANSITION PATH

A. Maintaining the Dollar-Peg Regime (1)

The authorities maintain the dollar-peg regime for the whole time period $T_0 + T_1 + T_2$. The cumulative loss for sustaining the dollar-peg for $T_1 + T_2$ after the initial dollar-peg period T_0 and optimal interest rate is shown as follows:[1]

$$L_1(i^*, T_1 + T_2) = \sum_{t=1}^{T_0} \beta^{t-1}\left(y_t - \bar{y}_A^{'}\right)^2 + \sum_{t=T_0+1}^{T_0+T_1+T_2} \beta^{t-1}\left(y_t - \bar{\bar{y}}_A^{'}\right)^2$$

$$= \sum_{t=1}^{T_0} \beta^{t-1}(y_t - \bar{y}_A^{'})^2 + \sum_{t=T_0+1}^{T_0+T_1+T_2} \beta^{t-1}\begin{bmatrix}\{A_1(t) + A'_1(t)\}\hat{e}_t^{R/yen} + A_2(t)\,\Delta\,\hat{e}^{R/yen} \\ +A_2^{'}(t)\,\Delta\,\hat{e}^{R/\$} + A_3(t) i_{t+1}\end{bmatrix}^2$$

(A1)

$$i^* = \text{argmin} \sum_{t=1}^{T_0+T_1+T_2} \beta^{t-1}\left(y_t - \bar{y}_A^{'}\right)^2$$

(A2)

where $\left(y_t - \bar{y}_A^{'}\right) = A_1(t)\hat{e}_t^{R/yen} + A_2(t)\,\Delta\,\hat{e}^{R/yen} + A_3(t)i^*$. Note that i^* is chosen to minimize the cumulative loss in term of deviation from its stable equilibrium value under the dollar-peg regime.

B. Gradual Adjustment to the Basket Peg with no Capital Controls (2)

We denote the optimal basket weight as υ^* assuming that $0 \leq \upsilon^* \leq 1$. The monetary authorities start by adopting the dollar-peg regime with capital controls (A), indicating that the basket weight is equal to 1. Then they shift to the basket-peg regime and gradually lose the capital controls under regime (B). At the same time, the authorities decrease its weight by $(1 - \upsilon^*)/T_1$ each period during the transition period in order to arrive at υ^* when it reaches the basket-peg regime without capital control. Once the monetary authorities adopt the basket-peg regime, they set the optimal basket weight (υ^*). The cumulative loss of transition policy (2) with optimal basket weight υ^*, transitional period T_1 can be expressed as:[2]

---

[1] The cumulative loss evaluated in term of deviation of the price level from the steady state level is shown as follows:

$$L_1^p(i^*, T_1 + T_2) = \sum_{t=1}^{T_0} \beta^{t=1}\left(p_t - \bar{p}_A^{'}\right)^2 + \sum_{t=T_0}^{T_0+T_1+T_2} \beta^{t=1}\left(p_t - \bar{p}_A^{'}\right)^2$$

(A1a)

$$i^* = \text{argmin} \sum_{t=1}^{T_0+T_1+T_2} \beta^{t=1}\left(y_t - \bar{y}_A^{'}\right)^2$$

(A2a)

[2] The cumulative loss evaluated in term of deviation of the price level from its steady-state level is defined as follows; where

$$L_2\left(\upsilon^{*}, T_1+T_2\right) = \sum_{t=1}^{T_0} \beta^{t-1}\left(y_t - \bar{y}_A^{'}\right)^2 + \sum_{t=T_0+1}^{T_0+T_1} \beta^{t-1}\left(y_t - \bar{y}_B^{'}\right)^2 + \sum_{t=T_0+T_1+1}^{T_0+T_1+T_2} \beta^{t-1}\left(y_t - \bar{y}_C^{'}\right)^2$$

$$= \sum_{t=1}^{T_0} \beta^{t-1}(y_t - \bar{y}_A^{'})^2 + \sum_{t=T_0+1}^{T_0+T_1} \beta^{t-1}\left[B_1(t)\,\upsilon\,(t)\hat{e}_t^{\$/yen} + B_2(t)\hat{e}_t^{\$/yen} + B_3(t)\hat{z}_t\right]^2 + \sum_{t=T_0+T_1+1}^{T_0+T_1+T_2} \beta^{t-1}\left[C_1(t)\,\upsilon\,(t)\hat{e}_t^{\$/yen} + C_2(t)\hat{e}_t^{\$/yen} + C_3(t)\hat{z}_t\right]^2$$

(A3)

where $\left(y_t - \bar{y}_A^{'}\right) = A_1(t)\hat{e}_t^{R/yen} + A_2(t)\,\Delta\,\hat{e}^{R/yen} + A_3(t)i^{*}$ and $\upsilon\,(t) = 1 - \frac{1-\upsilon^{*}}{T_1}(t - T_0)$.

Note that the second and the third terms on right-hand side of equation (A3) show losses during transition periods and under the basket-peg regime (C) respectively. The optimal weight is derived by minimizing the cumulative loss $L_2\left(,\upsilon^{*}, T_1+T_2\right)$ with respect to the weight υ^{*}.

$$\upsilon^{*} = \frac{-1}{H_1}\left[\sum_{t=T_0+T_1+1}^{T_0+T_1+T_2} \beta^{t-1} C_1(t)\hat{e}_t^{\$/yen}\left(C_2(t)\hat{e}_t^{\$/yen} + C_3(t)\hat{z}_t\right) + \sum_{t=T_0+1}^{T_0+T_1} \beta^{t-1} B_1(t)\left(\frac{t-T_0}{T_1}\right)\hat{e}_t^{\$/yen}\begin{pmatrix} B_1(t)\left(\frac{t-T_0}{T_1}\right)\hat{e}_t^{\$/yen} \\ +B_2(t)\hat{e}_t^{\$/yen} + B_3(t)\hat{z}_t \end{pmatrix}\right]$$

(A4)

where $H_1 = \left[\sum_{t=T_0+1}^{T_0+T_1} \beta^{t-1}\left(B_1(t)\left(\frac{t-T_0}{T_1}\right)\hat{e}_t^{\$/yen}\right)^2 + \sum_{t=T_0+T_1+1}^{T_0+T_1+T_2} \beta^{t-1}\left(C_1(t)\hat{e}_t^{\$/yen}\right)^2\right]$

C. Sudden Shift to the Basket Peg with no Capital Control (3)

We denote the optimal basket weight as υ^{**} under the target basket-peg regime. The monetary authorities start with the dollar-peg regime with capital controls (A), implying that the basket weight is fixed at 1, and suddenly shift to the basket-peg regime, adopting the optimal weight (υ^{**}) without capital controls (C). The cumulative loss for policy (3) with optimal basket weight υ^{**} and target regime period $T_1 + T_2$ is shown as:[3]

$$L_2^{p}\left(\upsilon_p^{*}, T_1+T_2\right) = \sum_{t=1}^{T_0} \beta^{t=1}\left(p_t - \bar{p}_A^{'}\right)^2 + \sum_{t=T_0+1}^{T_0+T_1} \beta^{t11}\left(p_t - \bar{p}_B^{'}\right)^2 + \sum_{t=T_0+T_1+1}^{T_0+T_1+T_2} \beta^{t11}\left(p_t - \bar{p}_C^{'}\right)^2 \quad \text{(A5”)}$$

and υ_p^{*} is optimal basket weight for the transition policy of stabilizing the price level.

[3] The cumulative loss for stabilizing the price level is shown as follows;

$$L_3\left(\upsilon^{**}, T_1+T_2\right)=\sum_{t=1}^{T_0}\beta^{t-1}\left(y_t-\bar{y}_A^{'}\right)^2+\sum_{t=T_0+1}^{T_0+T_1+T_2}\beta^{t-1}\left(y_t-\bar{y}_C^{'}\right)^2$$

$$=\sum_{t=1}^{T_0}\beta^{t-1}(y_t-\bar{y}_A^{'})^2+\sum_{t=T_0+1}^{T_0+T_1+T_2}\beta^{t-1}\left[C_1(t)\,\upsilon\,(t)\hat{e}_t^{\$/yen}+C_2(t)\hat{e}_t^{\$/yen}+C_3(t)\hat{z}_t\right]^2$$

(A5)

where $\left(y_t-\bar{y}_A^{'}\right)=A_1(t)\hat{e}_t^{R/yen}+A_2(t)\,\Delta\,\hat{e}^{R/yen}+A_3(t)i^*$ and note that impacts of exchange rate volatility after the shift are included in the second terms on the right-hand side of equation (A5). Differentiating the cumulative loss $L_3\left(\upsilon^{**}, T_1+T_2\right)$ with respect to υ^{**} yields the optimal weight:

$$\upsilon^{**}=\frac{-1}{H_2}\left[\sum_{t=T_0+1}^{T_0+T_1+T_2}\beta^{t-1}C_1(t)\hat{e}_t^{\$/yen}\left(C_2(t)\hat{e}_t^{\$/yen}+C_3(t)\hat{z}_t\right)\right]$$

(A6)

where $H_2=\left[\sum_{t=T_0+T_1+1}^{T_0+T_1+T_2}\beta^{t-1}\left(C_1(t)\hat{e}_t^{\$/yen}\right)^2\right]$. Compared with the basket weight obtained in section B of this appendix, υ^{**} is different from υ^{*} as long as $T_1\neq 0$. This is because υ^{**} is the weight which minimizes the loss under the basket-peg regime without capital controls while υ^{*} is the weight which minimizes the sum of discounted losses under the transition period and the target basket-peg regime period.

D. Sudden Shift from Dollar-Peg to the Floating Regime (4)

We assume the optimal money supply under the floating regime to be m^*. The monetary authorities start with the dollar-peg regime with capital controls (A) and suddenly shift to the floating regime without capital controls. The cumulative loss under policy (4) with the target regime period T_1+T_2 and optimal money supply m^* is shown as follows:[4]

$$L_3^p\left(\upsilon_p^{**}, T_1+T_2\right)=\sum_{t=1}^{T_0}\beta^{t-1}\left(p_t-\bar{p}_A^{'}\right)^2+\sum_{t=T_0+1}^{T_0+T_1+T_2}\beta^{t-1}\left(p_t-\bar{p}_C^{'}\right)^2$$

(A5a)

where $\left(p_t-\bar{p}_A^{'}\right)=A_1^p(t)\hat{e}_t^{R/yen}+A_2^p(t)\,\Delta\,\hat{e}^{R/yen}+A_3^p(t)i_p^*$ and υ_p^{**} is the optimal weight for stabilizing the price level.

[4] The cumulative loss for stabilizing the price level is defined as follows;

$$L_4^p\left(m_p^*, T_1+T_2\right)=\sum_{t=1}^{T_0}\beta^{t=1}\left(p_t-\bar{p}_A^{'}\right)^2+\sum_{t=T_0+1}^{T_0+T_1+T_2}\beta^{t11}\left(p_t-\bar{p}_D^{'}\right)^2$$

(A7a)

where $\left(p_t-\bar{p}_A^{'}\right)=A_1^p(t)\hat{e}_t^{R/yen}+A_2^p(t)\Delta\hat{e}^{R/yen}+A_3^p(t)i_p^*$ and m_p^* is optimal money supply for stabilizing the price level.

$$L_4(m^*, T_1+T_2) = \sum_{t=1}^{T_0} \beta^{t-1}\left(y_t - \bar{y}_A'\right)^2 + \sum_{t=T_0+1}^{T_0+T_1+T_2} \beta^{t-1}\left(y_t - \bar{y}_D'\right)^2$$

$$= \sum_{t=1}^{T_0} \beta^{t-1}(y_t - \bar{y}_A')^2 + \sum_{t=T_0+1}^{T_0+T_1+T_2} \beta^{t-1}\left[D_1(t)\hat{e}_t^{\$/yen} + D_2(t)\hat{z}_t + D_3(t)m_t\right]^2$$

(A7)

where $\left(y_t - \bar{y}_A'\right) = A_1(t)\hat{e}_t^{R/yen} + A_2(t)\,\Delta\,\hat{e}^{R/yen} + A_3(t)i^*$ and note that impacts of exchange rate volatility associated with the shift are included in the second term on the right-hand side of equation (A7). Differentiating the cumulative loss $L_4(m^*, T_1+T_2)$ respect to m^* yields the optimal money supply:

$$m^* = \frac{-1}{H_3}\left[\sum_{t=T_0+1}^{T_0+T_1+T_2} \beta^{t-1} D_3(t)\hat{e}_t^{\$/yen}\left(D_1(t)\hat{e}_t^{\$/yen} + D_2(t)\hat{z}_t\right)\right]$$

(A8)

where $H_3 = \left[\sum_{t=T_0+T_1+1}^{T_0+T_1+T_2} \beta^{t-1}\left(D_1(t)\right)^2\right]$

E. Sudden Shift from Dollar-Peg to the Managed Floating Regime (5)

We assume the optimal money supply under the floating regime to be m^{**}. The monetary authorities start with the dollar-peg regime with capital controls (A) and suddenly shift to the floating regime without capital controls. Often when the dollar rate fluctuates remarkably, the authorities intervene into the foreign exchange market to maintain the dollar rate at a constant level under perfect capital mobility (E). After fluctuations in the dollar rate abate, the authorities resume the floating regime. The cumulative loss under policy (5) with the whole period T_1+T_2, the period of the floating T_D, and the period of the dollar-peg T_E is shown as:[5]

[5] The cumulative loss for stabilizing the price level is defined as follows;

$$L_5^p\left(m_p^{**}, T_1+T_2, T_D, T_E, \tilde{e}_{t,E}^{R/\$,2}\right)$$
$$= \sum_{t=1}^{T_0} \beta^{t-1}\left(p_t - \bar{p}_A'\right)^2 + \sum_{t=T_0+1}^{T_0+T_D} \beta^{t-1}\left(p_t - \bar{p}_D'\right)^2 + \sum_{t=T_0+T_D}^{T_0+T_D+T_E} \beta^{t-1}\left(p_t - \bar{p}_E'\right)^2$$
$$+ \sum_{t=T_0+T_D+T_E+1}^{T_0+T_1+T_2} \beta^{t-1}\left(p_t - \bar{p}_D'\right)^2$$

(A9a)

where $\left(p_t - \bar{p}_A'\right) = A_1^p(t)\hat{e}_t^{R/yen} + A_2^p(t)\Delta\hat{e}^{R/yen} + A_3^p(t)i_p^*$ and m_p^{**} is optimal money supply for stabilizing the price level.

$$L_5\left(m^{**}, T_1+T_2, T_D, T_E, \tilde{e}_{t,E}^{R/\$,2}\right) = \sum_{t=1}^{T_0} \beta^{t-1}\left(y_t-\bar{y}_A^{'}\right)^2 + \sum_{t=T_0+1}^{T_0+T_D} \beta^{t-1}\left(y_t-\bar{y}_D^{'}\right)^2 + \sum_{t=T_0+T_D}^{T_0+T_D+T_E} \beta^{t-1}\left(y_t-\bar{y}_E^{'}\right)^2 + \sum_{t=T_0+T_D+T_E+1}^{T_0+T_1+T_2} \beta^{t-1}\left(y_t-\bar{y}_D^{'}\right)^2 \quad \text{(A7)}$$

where $\left(y_t-\bar{y}_A^{'}\right) = A_1(t)\hat{e}_t^{R/yen} + A_2(t)\,\Delta\,\hat{e}^{R/yen} + A_3(t)i^*$ and $\tilde{e}_{t,E}^{R/\$,2} = \sum_{t=T_0+1}^{T_D+T_E} \beta^{t-1}\hat{e}_{t,E}^{R/\$,2}$ is defined as a sum of discounted squares of the dollar rates during the intervention periods.

Differentiating the cumulative loss $L_5\left(m^{**}, T_1+T_2, T_D, T_E, e_{t,E}^{R/\$,2}\right)$ with respect to m^{**} yields the optimal money supply:

$$m^{**} = \frac{-1}{H_4}\left[\sum_{t=T_0+1}^{T_0+T_D} \beta^{t-1} D_3(t)\left(D_1(t)\hat{e}_t^{\$/yen} + D_2(t)\hat{z}_t\right) + \sum_{t=T_0+T_D+T_E+1}^{T_0+T_1+T_2} \beta^{t-1} D_3(t)\left(D_1(t)\hat{e}_t^{\$/yen} + D_2(t)\hat{z}_t\right)\right] \quad \text{(A8)}$$

where $H_4 = \left[\sum_{t=T_0+1}^{T_0+T_D} \beta^{t-1}\left(D_3(t)\right)^2 + \sum_{t=T_0+T_D+T_E+1}^{T_0+T_1+T_2} \beta^{t-1}\left(D_3(t)\right)^2\right]$.

APPENDIX 3 : SIMULATION EXERCISE: PRICE LEVEL STABILITY

In the case of price level stability, the shift to the floating regime yields the smallest cumulative losses. The monetary authorities can effectively minimize price level fluctuations by implementing the optimal money supply.

The gradual adjustment or the sudden shift to the basket-peg are the second best options. A difference in cumulative losses between the sudden shift to the floating regime and the gradual adjustment to the basket-peg is not large. However, the shift to the managed floating regime is not attractive as the cumulative losses are sizable. This clearly indicates inefficiency of fixing the exchange rate at a constant rate to minimize the impacts on the price level when the exchange rate volatility is large.

As in the case of output stability, maintaining the dollar-peg results in the largest cumulative losses. Maintaining the status quo is not a desirable solution over the long run.

Table A3: Cumulative Losses and Optimal Values of Instruments

	Policy (1)	**Policy (2)**	**Policy (3)**	**Policy (4)**	**Policy (5) ($T_E = 5$) [b]**
Stable regime	Dollar-peg	Basket-peg	Basket-peg	Floating	Managed floating
Adjustment	-	Gradual	Sudden	Sudden	Sudden
Instrument value	$i^* = 1.14$	$\upsilon^* = 0.65$	$\upsilon^{**} = 0.78$	$m^* = 0.11$	$m^{**} = 0.01$
Cumulative loss (value)	0.30	0.020	0.021	0.013	0.033
Cumulative loss (% of $\bar{p}^2$) [a]	33.0	2.2	2.3	1.4	3.3

[a] We calculate the value of $\bar{p}^2$ shown in Section 4 and obtain $\bar{p}^2 = 0.91$.
[b] For $T_E = 7$, the cumulative loss is 0.050 ($m^{**} = 0.015$).
Source: authors' calculations.