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Optimal dynamic path during the transition of exchange rate regime: Analysis of the People's Republic of China (PRC), Malaysia, and Singapore

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OPTIMAL DYNAMIC PATH DURING THE TRANSITION OF EXCHANGE RATE REGIME: ANALYSIS OF THE PEOPLE'S REPUBLIC OF CHINA, MALAYSIA, AND SINGAPORE

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The paper has been re-drafted to target policy makers. The policy discussion in this paper is based on detailed analyses conducted in two academic research papers Yoshino, Kaji and Asonuma (2014, 2016).

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Abstract

This paper considers the optimal exchange rate regime transition policy for three East Asian countries: the People's Republic of China (PRC), Malaysia, and Singapore. In contrast to two traditional approaches to exchange rate regimes in East Asia, the paper conducts a dynamic transition analysis. Based on a small, open-economy dynamic stochastic general equilibrium model applied to these three countries, we define transition policies from a dollar peg regime to either a basket peg or a floating regime and compare the welfare gains of these policies relative to maintaining the current dollar peg regime. The quantitative analysis using PRC, Malaysian, and Singaporean data shows that the PRC would be better off shifting gradually from a dollar peg to a basket peg. In response to the PRC's shift, both Malaysia and Singapore would opt to shift gradually to a basket peg regime.

JEL Classification: F33, F41, F42

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1. INTRODUCTION

Since the Asian financial crisis in 1997–98, the desirable exchange rate regime in East Asia has been the center of policy debate and academic research.[1] On this issue, there have been major developments in both dimensions of academic research and policy implementation. On the policy implementation, the monetary authorities in East Asia experienced two patterns of shifts in exchange rate regimes: On the one hand, Indonesia, the Republic of Korea, and Thailand abandoned their de facto dollar pegs and shifted to floating or managed floating regimes at the onset of the Asian financial crisis. On the other hand, the People's Republic of China (PRC) and Malaysia maintained their de facto dollar pegs until July 2005. Then, the PRC made a dramatic break from its dollar peg in July 2005 and Malaysia followed by increasing flexibility in exchange rate fluctuations.

On the academic research, there have been two analytical approaches to exchange rate regimes in East Asia since the crisis. The first is a static analysis—initiated by Ito, Ogawa, and Sasaki (1998)—which garnered attention from academic researchers with subsequent studies (Ogawa and Ito 2002; Yoshino, Kaji, and Suzuki 2004; Yoshino, Kaji, and Asonuma 2004). Their analysis relies on the loss over the short term, that is, one quarter, and compares the optimality among a dollar peg, a basket peg, and a floating regime under free capital mobility. The second is a conventional dynamic analysis that has been extended to cover the longer term, 10 years or over the infinite horizon as in Yoshino, Kaji, and Suzuki (2002) and Shioji (2006a; 2006b).[2] Over the specified time frame, the monetary authorities are assumed to maintain the same exchange rate regimes. The main rationale of the conventional dynamic is to consider whether the exchange rate regime, which is desirable in the short run, still remains optimal over the longer term.

In addition to these two traditional approaches, a new and emerging analytical approach has also attracted attention—"dynamic transition analysis" proposed by Yoshino, Kaji, and Asonuma (2014; 2016a). They consider shifts in exchange rate regimes, that is, shifts from a dollar peg to a basket peg or a floating regime over the same time frames set in the conventional dynamic analysis together with maintaining a dollar peg. There are three main advantages to the dynamic transition analysis: Firstly, the analysis compares shifts from the current regime to alternative regimes with the benchmark of maintaining the current regime, a dollar peg. Secondly, it explores how capital controls are relaxed in order to reach the desired regimes under free capital mobility. This coincides with where the PRC and Malaysia stood in the aftermath of the Asian financial crisis. Thirdly, it considers two adjustment options for exchange rate regimes and for capital account restrictions.

By applying the dynamic transition analysis, we attempt to answer two main questions: First, how can the PRC successfully transition to a desirable regime, whether a basket peg or a floating regime, from the current de facto dollar peg regime? Next, are neighboring countries (Malaysia and Singapore) with close economic linkages to the PRC better off loosening their ties to the US dollar when the PRC does so?

[1] See for instance, Ito, Ogawa and Sasaki (1998), Kawai (2004), McKibbin and Le (2002).

[2] See also Yoshino, Kaji, and Asonuma (2012).

To answer these two questions, we construct a small, open-economy, dynamic stochastic general equilibrium (DSGE) model in order to apply it to two cases of East Asian countries: the PRC for the first question and Malaysia and Singapore for the second question, respectively. For each analysis case, we define transition policies and compare the welfare gains of these policies relative to the current regime, i.e. maintaining the dollar peg regime or a basket peg regime.

On the first question, the quantitative analysis using PRC data from 1999Q1 to 2010Q4 provides two policy implications. One of them is that following a gradual adjustment to a basket peg regime is the most desirable path for the PRC to take, with minimal welfare losses associated with the shift in the exchange rate regime.[3] The other is that a sudden shift to the basket peg is the second-best solution, and is superior to a sudden shift to floating.[4]

On the second question the quantitative analysis incorporating exogenous shocks as actually occurred in Malaysia and Singapore from 2005Q1 to 2014Q4 concludes that a gradual adjustment to a basket peg with long-term optimal weights is the best policy for both countries, where optimal weights are derived to minimize the loss function. Further, both a sudden shift to a basket peg with optimal weights and a sudden shift to a floating rate regime are superior to maintaining the dollar peg in Malaysia, but not to maintaining the existing basket peg in Singapore.

Following a literature review, Section 2 presents empirical analysis of exchange rate movements and regimes in the PRC, Malaysia, and Singapore. Section 3 discusses the desirable exchange rate regime transition policy in the PRC. Next, we explore the desirable exchange rate regime transition policy in Malaysia and Singapore in response to the PRC's shift in exchange rate regime in Section 4. Finally, Section 5 concludes our discussion.

Literature Review: The present paper is related to literature on the exchange rate policy in the PRC. McKinnon and Schnabl (2014) recommend that the PRC should focus on stabilizing the renminbi–US dollar exchange rate in order to encourage naturally high wage increases to improve the PRC's international competitiveness. In contrast, Goldstein and Lardy (2006) point out shortcomings of the current exchange rate regime in the PRC and propose the immediate removal of capital restrictions and gradual widening of the band of the exchange rate. Frankel (2005) also stresses the benefits of exchange rate flexibility over the long term and suggests shifting to an intermediate regime, for example through establishing a target zone. Eichengreen (2006) follows by arguing that greater flexibility of the exchange rate would help the PRC's monetary authority tailor monetary conditions to domestic needs.

[3] Our implication has been supported by recent developments in the PRC's exchange rate policy. Since December 2015, the People's Bank of China has published its China Foreign Exchange Trade System (CFETS) (2015) exchange rate index. This index encompasses 13 currencies selected on the basis of international trade weights adjusted for re-export. The CFETS index is intended to bring about a shift in public perception of renminbi exchange rate movements. The launch of the index does not necessarily imply adoption of a basket peg at the current stage, but it may perhaps signify the monetary authority's intention to move in that direction in the future.

[4] Yoshino, Kaji and Asonuma (2015) explore whether actual policies in East Asian countries follow or deviate from the theoretically optimal policies.

The literature explores exchange rate arrangements in the East Asian region after the PRC's shift in exchange rate regime.[5] Shioji (2006b) considers theoretically how the PRC's choice of exchange rate regime interacts with the rest of East Asia's policy choices under two invoicing practices. On policy coordination, Gochoco-Bautista and Fabella (2006) stress that a regional monetary arrangement to address intra-regional fluctuations in response to a change in the PRC's monetary and exchange rate arrangement may not be warranted given the differing directions and size of exchange rate adjustments in individual countries due to asymmetric complementarities with the PRC. In contrast, Volz (2014) argues that there is loose and informal exchange rate cooperation in East Asia based on currency baskets, with the PRC moving toward a managed exchange rate system guided by a currency basket. Henning (2012) finds that Malaysia, the Philippines, Singapore, and Thailand have formed a loose but effective "renminbi bloc" with the PRC since that country's shift in exchange rate policy, with the Republic of Korea participating tentatively in this bloc since the global financial crisis.

2. EXCHANGE RATE MOVEMENTS AND REGIMES IN THE PEOPLE'S REPUBLIC OF CHINA, MALAYSIA, AND SINGAPORE

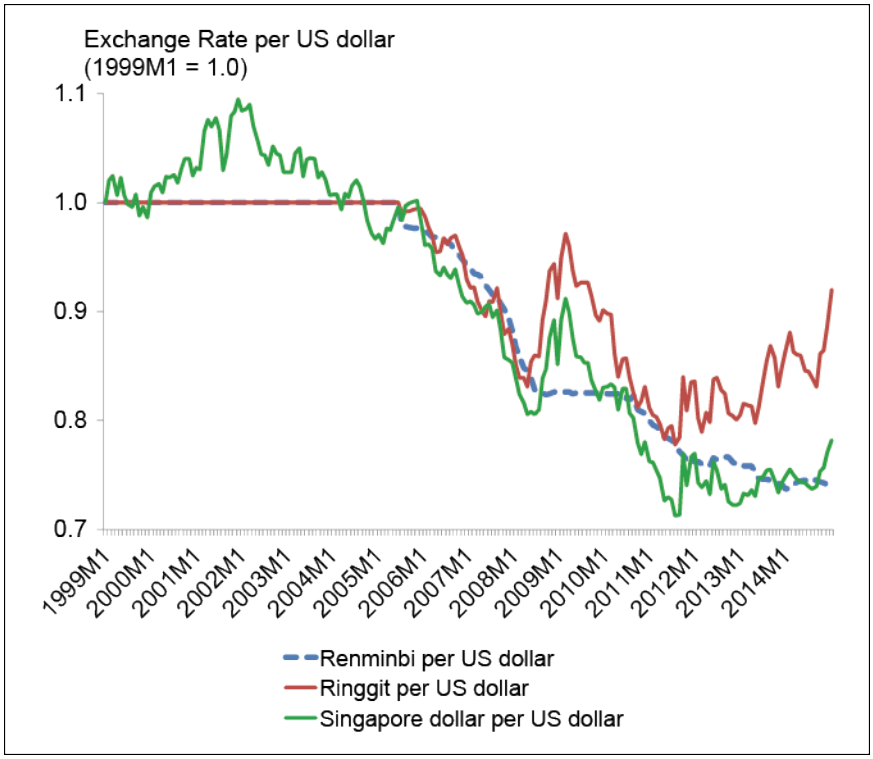
We start from an empirical analysis of exchange rate dynamics in the PRC, Malaysia, and Singapore. Figure 3 shows the dynamics of nominal exchange rate for these countries against the US dollar for the period 1999–2014. Prior to January 1999, the PRC Government set an initial rate of 8.70 yuan to the US dollar in 1994, eventually allowing the rate to rise to 8.28 in 1997. From January 1999, they kept the rate relatively constant up to July 2005. The PRC Government modified its currency policy on 21 July 2005 by announcing that the renminbi–dollar rate would become "adjustable, based on market supply and demand with reference to exchange rate movements of currencies in a basket." From July 2005 to June 2008, the renminbi–dollar rate showed a trend of appreciation 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 slowed down its rate of appreciation through market intervention (period 2). 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 the appreciation trend (period 4).

Following the July 2005 break in the PRC's exchange rate policy, Bank Negara Malaysia announced an immediate switch from a dollar peg to a managed float (Bank Negara Malaysia 2005).[6] In line with the appreciation of the renminbi, the Malaysian ringgit also began to follow an appreciating trend. Similarly, the Singapore dollar, which prior to the PRC's shift had fluctuated without trend with respect to the US dollar, also appreciated, gaining 25% on the US dollar over the period 2005–10.

[5] Ito (2008) analyzes how the PRC's exchange rate policy changed before and after the announcement of a new approach in July 2005 and finds that the post-announcement exchange rate regime is close to a crawling peg against the US dollar and deviates substantially from a basket peg regime.

[6] Bank Negara Malaysia declared its intention to monitor the exchange rate against a currency basket to ensure that the rate remained close to fair value.

Figure 1: Nominal US Dollar Exchange Rates, Monthly 1999–2014



Source: IMF International Financial Statistics.

These exchange rate evolutions in three countries are also consistent in transitions of de jure exchange rate regimes over the period 1999–2010 reported in Table 1. According to the IMF (2014), *de jure* exchange rate arrangements are those that authorities officially announce and are different from the de facto classification based on arrangements on market-determined exchange rates as in Ilzetzki, Reinhart and Rogoff (2010). Both the PRC and Malaysia have experienced a deviation from a conventional pegged arrangement to a crawl-like arrangement or another managed arrangement, respectively. In a similar vein, Singapore has also allowed an increase in flexibility of the exchange rate regime and shifted from a managed floating with no predetermined path for the exchange rate to another managed arrangement.

Table 2 reports estimated weights on the US dollar rate in a currency basket for the PRC and Singapore.[7] Due to both limited variations in the nominal ringgit–US dollar exchange rate and an overlapping shift in the exchange rate regime with the PRC, it is not feasible to differentiate the "pure" weight on the US dollar in the currency basket in Malaysia from the weight on the renminbi. First for the PRC, on the basis of the announcement of the shift in exchange rate regimes and observed fluctuations of nominal exchange rates against the US dollar (Figure 1), we successfully differentiate into four subsample periods where weights on the US dollar rate in the currency basket differ: (1) period 1: May 2003–July 2007, (2) period 2: August 2005–June 2008, (3) period 3: July 2008–May 2010, and (4) period 4: June 2010–June 2012. Period 1 and period 3 coincide with samples under a dollar peg and a temporal recurrence of a dollar peg due to the global financial crisis. In contrast, period 2 and period 4 correspond to a basket peg regime, i.e. departure from a dollar peg. In these sample

[7] See Yoshino, Kaji, and Asonuma (2016b) for detailed explanation on empirical approaches for both cases.

periods (2 and 4), weights on the US dollar in the currency basket are substantially lower by 0.16 and 0.18 than those in period 1 when the renminbi–US dollar rate was completely fixed (1.00). Even in period 3 in which the renminbi–US dollar was held relatively constant, the weight on the US dollar in the currency basket is lower than that under the dollar peg period. This finding clearly indicates that the Chinese renminbi is not completely pegged to the US dollar and is increasingly influenced by other currencies, i.e. increasing weights on other currencies in the basket.

Table 1: Transitions of *De Jure* Exchange Rate Regimes in the PRC, Malaysia, and Singapore

Country	1999[a]	2005[a]	2008[b]	2010[b]
PRC	Conventional pegged arrangement	Conventional pegged arrangement	Stabilized arrangement	Crawl-like arrangement
Malaysia	Conventional pegged arrangement	Managed floating with no predetermined path for the exchange rate	Floating[c]	Other managed arrangement[d]
Singapore	Managed floating with no predetermined path for the exchange rate	Managed floating with no predetermined path for the exchange rate	Floating[e]	Other managed arrangement[d]

PRC = People's Republic of China.

Notes: [a] The categories of exchange rate arrangements over 1999–2007 are: (1) hard pegs comprising (a) exchange arrangements with no separate legal tender and (b) currency board arrangements; (2) soft pegs consisting of (a) conventional pegged arrangements, (b) pegged exchange rates within horizontal bands, (c) crawling pegs, and (d) crawling bands; and (3) floating regimes, under which the exchange rate is market determined and characterized as (a) independent floating or (b) managed floating with no preannounced path for the exchange rate. See IMF (2008).

[b] The categories of exchange rate arrangements over 2008–2010 are: (1) hard pegs comprising (a) exchange arrangements with no separate legal tender and (b) currency board arrangements; (2) soft pegs consisting of (a) conventional pegged arrangements, (b) pegged exchange rates within horizontal bands, (c) crawling pegs, (d) stabilized arrangements, and (e) crawl-like arrangements; (3) floating regimes, under which the exchange rate is market determined and characterized as (a) floating or (b) free floating; and a residual category, other managed arrangements. See IMF (2014).

[c] The ringgit is managed with reference to a currency basket. The composition of the basket is not disclosed. Effective 2 February 2009, the classification of the de facto exchange rate arrangement was changed from managed floating with no predetermined path for the exchange rate to floating, retroactively to 30 April 2008, due to the revision of the classification methodology.

[d] Bank Negara Malaysia operates a *de jure* managed float for the ringgit with reference to a currency basket. The composition of the basket is not disclosed. As a result of the ringgit tracking a composite, although not closely enough to be classified as a stabilized arrangement against a composite, the de facto exchange rate arrangement is classified as another managed arrangement. For Singapore, the *de jure* exchange rate arrangement is floating. The Singapore dollar is allowed to fluctuate within a targeted policy band and is managed against a basket of currencies of the country's major trading partners and competitors.

[e] The Singapore dollar is allowed to fluctuate within a targeted policy band and is managed against a basket of currencies of the country's major trading partners and competitors. The various currencies are assigned weights in accordance with the importance of the countries to Singapore's trade relations with the world. The exchange rate policy is announced every 6 months in the Monetary Policy Statement, typically in terms of changes to the slope of the policy band. The US dollar is the intervention currency.

Source: IMF Annual Report on Exchange Rate Arrangements and Exchange Restrictions (2008, 2009, 2014).

Next, for Singapore, we have two sample periods with different estimated weights. These two sample periods are differentiated due to an identified structural change in the Singapore dollar–US dollar rate supported by a Stepwise Chow Test. In period A, corresponding to pre- and during the global financial crisis (GFC) period, the estimated weight on the US dollar in the currency basket is 0.57. In contrast, in period B (post-GFC period), when the Singapore dollar has appreciated, the estimated weight on the US dollar has reduced to 0.475. While the US dollar has depreciated, Singapore has obviously increased weights on other currencies in the currency basket.

Table 2: Estimates of Basket Weight on the US Dollar Rate

(1) The PRC

	Period 1	Period 2	Period 3	Period 4
Sample period	2003/5 – 2005/7	2005/8 – 2008/6	2008/7 – 2010/5	2010/6 – 2012/6
Estimated weight on the US dollar rate	0.999	0.842	0.918	0.819

(2) Singapore

	Period A	Period B
Sample period	2003/5 – 2009/3	2009/4 – 2016/4
Estimated weight on the US dollar rate	0.570	0.475

Source: Authors' calculation.

3. OPTIMAL EXCHANGE RATE REGIME TRANSITION POLICY FOR THE PEOPLE'S REPUBLIC OF CHINA

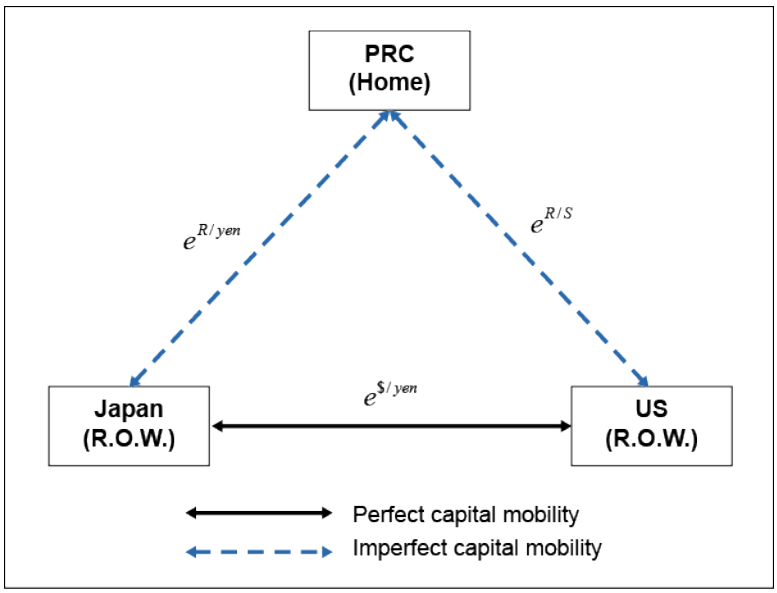
The focus of this section centers on the PRC's optimal exchange rate regime transition path. In particular, we attempt to answer the following policy-relevant question: How can the PRC successfully make the shift from the de facto dollar peg regime to a more desirable regime, whether a basket peg or a floating regime? To answer this question, we construct a small, open-economy DSGE model. We define four transition policies based on a basket peg or a floating regime and compare the welfare gains of these policies relative to maintaining the dollar peg regime. Two main implications are obtained from the quantitative analysis using PRC data from 1999Q1 to 2010Q4. First, following a gradual adjustment to a basket peg regime is the most desirable path for the PRC to take, with minimal welfare losses associated with the shift in the exchange rate regime. Second, a sudden shift to the basket peg is the second-best solution, and is superior to a sudden shift to floating.

3.1 Small, Open-Economy, Dynamic, Stochastic General Equilibrium (DSGE) Model

Our dynamic model closely follows Yoshino, Kaji, and Suzuki (2002) and Dornbusch (1976).[8] There are three countries in this mode: the PRC (Home), Japan, and the US (both of them are the rest of the world). We assume that domestic and foreign assets are imperfect substitutes, while US and Japanese assets are perfect substitutes for domestic investors, implying that interest parity condition for US and Japanese assets holds.

[8] 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, Kaji, and Asonuma (2012, 2016b), which are based on micro foundations.

Figure 2: The Model



PRC = People's Republic of China, R.O.W. = Rest of the world.
Source: Authors' illustration.

The interest parity condition for domestic (Chinese) and foreign assets is shown as:

$$i_{t+1} - i_t = -\lambda \left[i_t - \left\{ i_t^{US} + e_{t+1}^{R/\$,e} - e_t^{R/\$} - \sigma \left(e_t^{R/\$} \right) \right\} \right] \quad (1)$$

where λ denotes the adjustment speed of the domestic interest rate, which also captures the degree of capital control. Moreover, $\sigma\left(e_t^{R/\$}\right)$ denotes a risk premium that depends on the renminbi–dollar exchange rate. If $\lambda = 1$, equation (1) can be rewritten as:

$$i_{t+1} - i_t = i_t^{US} + e_{t+1}^{R/\$,e} - e_t^{R/\$} - \sigma \left(e_t^{R/\$} \right) \quad (1')$$

The equilibrium condition for the money market is:

$$m_t - p_t = -\varepsilon i_{t+1} + \phi(y_t - \bar{y}) \quad (2)$$

where the left-hand side of equation (2) is the real supply of money and the demand for money on the right-hand side of equation (2) depends on the interest rate and GDP gap.

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

$$e_t^{R/yen} = e_t^{R/\$} + e_t^{\$/yen} \quad (3)$$

Equation (4) defines aggregate demand, which comprises consumption, investment, exports, and imports. Therefore it depends on real exchange rates, exchange rate expectations, real interest rate, and exchange rate risks:

$$y_t - \bar{y} = \delta\left(e_t^{\frac{R}{\$}} + p^{US} - p_t\right) + \delta' \; e_{t+1}^{\frac{R}{\$},e} + \theta\left(e_t^{\frac{R}{yen}} + p^{JP} - p_t\right) + \theta' \; e_{t+1}^{\frac{R}{yen},e}$$
$$-\rho\{i_{t+1} - (p_{t+1}^e - p_t^e)\} - \tau\Delta e^{R/\$} - \varsigma\Delta e^{R/yen} \tag{4}$$

Lastly, equation (5) defines the aggregate supply. The inflation rate depends on total productivity, GDP gap, real exchange rates, exchange rate expectations, and exchange rate risks since we assume that the PRC imports materials from Japan and the US and exports final goods to Japan and the US.

$$p_{t+1} - p_t = -\alpha_t + \psi(y_t - \bar{y}) + \eta\left(e_t^{\frac{R}{\$}} + p^{US} - p_t\right) + \eta' \; e_{t+1}^{\frac{R}{\$},e}$$
$$+\mu\left(e_t^{\frac{R}{yen}} + p^{JP} - p_t\right) + \mu' \; e_{t+1}^{\frac{R}{yen},e} + (p_{t+1}^e - p_t^e) + \chi\Delta e^{R/\$} + \xi\Delta e^{R/yen} \tag{5}$$

Table 3 summarizes the variables used in the model.

Table 3: Description of Macroeconomic Variables

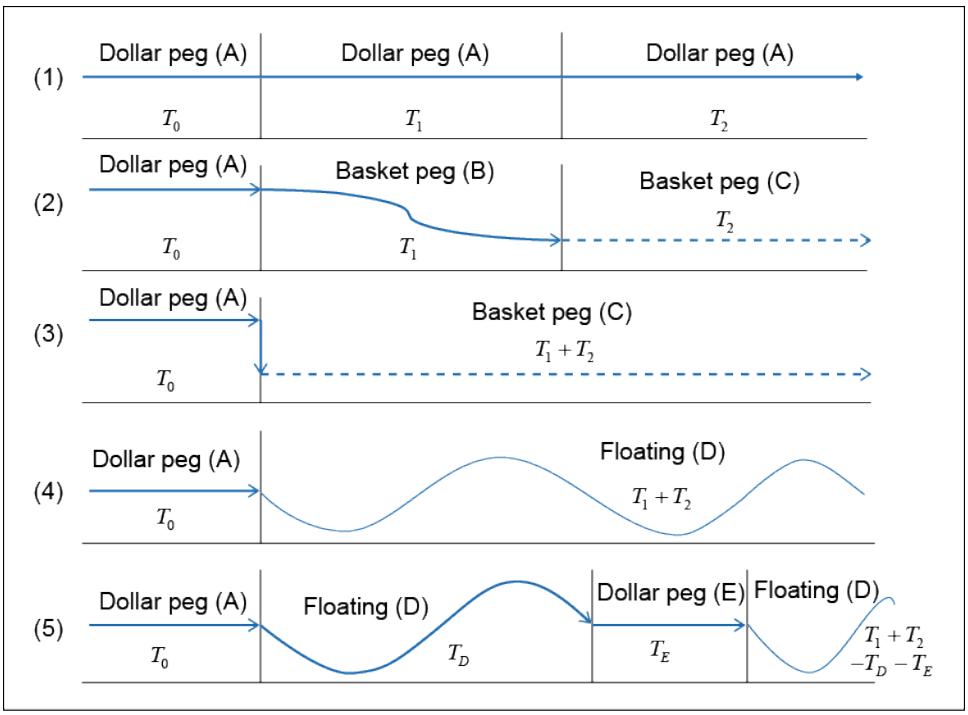
m	Stock of money supply
p	Domestic price level
p^e	Expected domestic price level
p^{US}	The price level in the US
p^{JP}	The price level in Japan
i	Home interest rate
i^{US}	US interest rate
y	Domestic GDP
$\bar{y}$	Potential GDP
$e^{R/\$}$	PRC renminbi/US dollar exchange rate
$e^{R/yen}$	PRC renminbi/Japanese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

3.2 Comparison of Five Transition Policies

In this subsection, we consider the following four transition paths to the target regimes plus maintaining the current regime, the dollar peg regime, with capital control as shown in Figure 3:

1. Maintaining the dollar peg (with strict capital control)
2. Gradual shift from the dollar peg to the basket peg without capital control
3. Sudden shift from the dollar peg to the basket peg without capital control
4. Sudden shift from the dollar peg to the floating regime
5. Sudden shift from the dollar peg to the managed floating regime

Figure 3: Comparison of Five Transition Policies in the PRC



Source: Authors' illustration.

3.2.1 Maintaining the Dollar Peg Regime (With Strict Capital Controls)

Under the first policy (policy 1), the PRC maintains a fixed exchange rate against the US dollar (exogenous) and strict capital controls. Money supply becomes endogenous and the domestic interest rates are a policy instrument (exogenous). From equations (1) to (5), deviations of GDP and the price level from the long-run equilibrium are expressed as follows:

$$\left(y_t - \bar{y}_A^{'}\right) = A_1(t)\hat{e}_t^{\$/yen} + A_2(t)\Delta\hat{e}^{R/yen} + A_3(t)i_{t+1} \tag{6}$$

$$\left(p_t - \bar{p}_A^{'}\right) = A_1^p(t)\hat{e}_t^{\$/yen} + A_2^p(t)\Delta\hat{e}^{R/yen} + A_3^p(t)i_{t+1} \tag{6a}$$

where both deviations are expressed in terms of the yen–US dollar exchange rate and the renminbi–US dollar exchange risk and the domestic interest rate (policy instrument).

3.2.2 Gradual Shift from the Dollar Peg to the Basket Peg without Capital Controls

The second policy (policy 2) includes a transition period, which reflects the adjustment period of capital controls and basket weights. Both during the transition and after the transition, the authorities intervene in the foreign exchange market to maintain the value of the basket. The currency basket is a weighted average of the renminbi–US dollar rate and the renminbi–yen rate shown as:

$$\upsilon e_t^{R/\$} + (1-\upsilon)e_t^{R/yen} = \Gamma \tag{7}$$

where Γ is the value of the basket. The authorities put weight υ to the renminbi–US dollar and $1-\upsilon$ to the renminbi–yen exchange rate.[9] The authorities have the basket weight υ as an instrument. The following reduced forms for three endogenous variables are obtained:

$$\left(y_t - \bar{y}_B^{'}\right) = B_1(t)\upsilon\hat{e}_t^{\$/yen} + B_2(t)\hat{e}_t^{\$/yen} + B_3(t)\hat{z}_t \tag{8}$$

$$(p_t - \bar{p}_B') = \mathrm{B}_1^{\mathrm{p}}(t)\upsilon\hat{e}_t^{\$/yen} + \mathrm{B}_2^{\mathrm{p}}(t)\hat{e}_t^{\$/yen} + \mathrm{B}_3^{\mathrm{p}}(t)\hat{z}_t \tag{8a}$$

$$(i_t - \bar{\imath}_B') = -(1-\upsilon)[(1+\sigma)(1-b_4)](1-\lambda)^{\mathrm{t}}\hat{\mathrm{e}}_t^{\$/yen} \tag{8b}$$

where both deviations are expressed in terms of the yen–US dollar exchange rate, the renminbi–yen and renminbi–US dollar exchange rate risks $\hat{z}_t$, and the basket weight, which is the policy instrument.

3.2.3 Sudden Shift from the Dollar Peg to the Basket Peg without Capital Control

In contrast, the third policy (policy 3) does not include a transition period, implying that the economy will jump to the target basket peg regime. The following reduced forms for two endogenous variables are obtained:

$$\left(y_t - \bar{y}_C^{'}\right) = C_1(t)\upsilon\hat{e}_t^{\$/yen} + C_2(t)\hat{e}_t^{\$/yen} + C_3(t)\hat{z}_t \tag{9}$$

$$\left(p_t - \bar{p}_C^{'}\right) = C_1^p(t)\upsilon\hat{e}_t^{\$/yen} + C_2^p(t)\hat{e}_t^{\$/yen} + C_3^p(t)\hat{z}_t \tag{9a}$$

where both deviations are expressed in terms of the yen–US dollar exchange rate, the renminbi–yen and renminbi–US dollar exchange rate risks $\hat{z}_t$, and the basket weight, which is the policy instrument.

3.2.4 Sudden Shift from the Dollar Peg to the Floating Regime or Managed Floating

The fourth policy (policy 4) involves shifting from the dollar peg to a floating regime without a transition period, implying that the economy will suddenly jump to a floating regime. In both cases, after the shift, the money supply (m_t) becomes a policy instrument for the authorities. The following reduced forms for two endogenous variables are obtained:

$$\left(y_t - \bar{y}_D^{'}\right) = D_1(t)\hat{e}_t^{\$/yen} + D_2(t)\hat{z}_t + D_3(t)m_t \tag{10}$$

$$\left(p_t - \bar{p}_D^{'}\right) = D_1^P(t)\hat{e}_t^{\$/yen} + D_2^p(t)\hat{z}_t + D_3^p(t)m_t \tag{10a}$$

[9] It was often said that the weight on the exchange rate is equal to the trade weight. However, Yoshino, Kaji, and Suzuki (2004) show that the trade weight is not optimal but should depend on the policy objective (such as GDP stability, exchange rate stability etc.) and the structure of the economy in the static model.

where both deviations are expressed in terms of the yen–US dollar exchange rate, the renminbi–yen and renminbi–US dollar exchange rate risks $\hat{z}_t$, and the money supply, which is the policy instrument.

Finally, the last policy (policy 5) involves shifting from the dollar peg regime to a managed floating regime without a transition period. Under the managed floating regime, if the exchange rate fluctuation is remarkably large, the monetary authorities intervene in the foreign exchange market to maintain the exchange rate at a fixed rate. Otherwise, it allows the exchange rate to fluctuate as the exchange rate does not deviate from the desired level. Therefore, reduced forms for endogenous variables can be expressed either by equation (9) and (9a) or equation (10) and (10a).

3.2.5 Benefits and Costs of Five Transition Policies

There are costs and benefits associated with the four transition policies, (2), (3), (4), and (5), together with maintaining the current regime (1) as shown in Table 4. Through focusing on the costs associated with transition policies, we provide estimates of components in each transition policy in Table 5. Note that these estimates of components in costs account for only a fraction of the total cumulative losses. Moreover, these costs and benefits are taken into consideration by quantifying the cumulative losses discussed in Section 3.3.

Table 4: Costs and Benefits of Each Transition Policy

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

On maintaining the dollar peg (policy 1), one advantage is that the private sector (exporting and importing firms and financial sector investing in foreign assets) is not concerned about exchange rate fluctuations and associated risks. However, one disadvantage arises due to a lack of monetary policy autonomy. The central bank cannot control the money supply (or interest rate) for their policy goals, i.e. GDP or the price-level stability. In some cases, the capital control has to be added to avoid massive outflow of foreign reserves.

On a gradual shift to a basket peg (policy 2), the monetary authorities enjoy the benefit of limited impacts on the economy associated with smaller volatility of both interest rates and real exchange rates than with the sudden shift to a basket peg regime (policy 3). In contrast, the monetary authorities suffer the costs of a long adjustment period: It takes time to reach the stable regime and the transition generates adjustment costs.

On a sudden shift to a basket peg (policy 3), the monetary authorities benefit from reaching the stable regime immediately. In contrast, the sudden shift generates large fluctuations of interest rates and real exchange rates, which negatively influence the economy.

The benefits and costs under the sudden shift to a floating regime (policy 4) or a managed floating regime (policy 5) are similar to those of the sudden shift to a basket peg. On the one hand, the sudden shift to the stable regime provides the advantage of limited adjustment costs. On the other hand, the monetary authorities suffer a negative influence due to large volatility in the interest rates and real exchange rates associated with the shift. Under the shift to a managed floating (policy 5), the fluctuation of exchange rates is limited within the specified range due to interventions in the foreign exchange market. As the economy suffers large exchange rate shocks, the frequency and size of interventions increase and these lead to costs for the monetary authorities.

Table 5: Estimates of Costs of Five Transition Policies

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

We consider mainly stabilizing output fluctuation in the analysis consistent with the policy goal of the PRC authorities aimed at achieving sustainable growth. We assume that the time interval for the initial dollar peg regime is T_0. Furthermore, we consider the transition period as T_1 and the time interval after the authority reaches the target regime as T_2. A discount factor is assumed to be β. Figure 2 displays five policies, respectively. For the policy goal of stabilizing the output fluctuations, the cumulative loss function is defined as follows:[10]

$$L(T_1, T_2) = \sum_{t=1}^{T_0+T_1+T_2} \beta^{t-1} (y_t - \bar{y}')^2 \tag{11}$$

3.3 Quantitative Analysis in the Case of Output Stability

The structure of the economy is presented by five equations explained in Section 3.1. Under each policy, the optimal value of the policy instrument is obtained by minimizing the value of the cumulative loss function (11) and is reported in the third row of Table 6. Under policy (1), the interest rate is the policy instrument. Under policies (2) and (3), the basket weight is the policy instrument. Under policies (4) and (5), the level of monetary supply is the policy instrument.

[10] Appendix I discusses the case of the price-level stability.

We apply our model and incorporate exogenous shocks as actually occurred from 2005Q1 to 2014Q4. We then compare the strategies based on values of a cumulative loss function defined in output fluctuation (equation 11). Table 4 also reports a comparison of estimates of the cumulative loss under the five policies (fourth and fifth rows). Among the five policies, maintaining the dollar peg (policy 1) results in the highest cumulative losses. 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 in which the degree of capital controls and basket weights are gradually adjusted provides benefits to the country through minimizing the volatility of interest rates and exchange rates.[11] A comparison between shifts to the basket peg and floating suggests that the shift to the basket leads to smaller cumulative losses. Finally, the shift to managed floating yields better outcomes for the monetary authority than the shift to floating. Reducing exchange rate volatility, which directly affects output fluctuations through occasional interventions, is of benefit to the monetary authority.

Table 6: Values of the Cumulative Losses and Policy Instruments

	Policy (1)	Policy (2)	Policy (3)	Policy (4)	Policy (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

Note: [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.

4. OPTIMAL EXCHANGE RATE REGIME TRANSITION POLICY FOR MALAYSIA AND SINGAPORE IN RESPONSE TO THE PEOPLE'S REPUBLIC OF CHINA'S SHIFT IN EXCHANGE RATE REGIME

The previous section shows that the PRC would be better off shifting gradually to a basket peg regime. Based on this result, this section considers how Malaysia and Singapore might best respond to this transition of the PRC to a new basket peg regime. We apply a DSGE model. We specify five alternative exchange rate strategies that encompass fixed, basket, and floating regimes and gradual versus sudden transitions. Based on the quantitative analysis incorporating exogenous shocks as actually occurred from 2005Q1 to 2014Q4, a gradual adjustment to a basket peg with long-term optimal weights is the best policy for both countries, where optimal weights are derived to minimize the loss function. Further, both a sudden shift to a basket peg with optimal weights and a sudden shift to a floating rate regime are superior to maintaining the dollar peg in Malaysia, but not to maintaining the existing basket peg in Singapore.

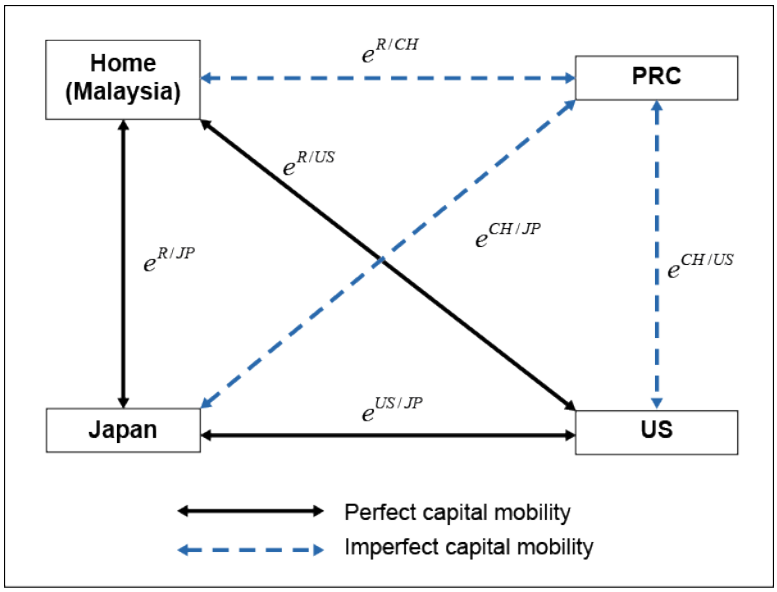
[11] The optimal weights of policies (2) and (3) differ, as explained in Yoshino, Kaji and Asonuma (2014).

4.1 Small, Open-Economy, Dynamic Stochastic General Equilibrium (DSGE) Model

We use the DSGE model of a small open economy, given as either Malaysia or Singapore, with the rest of the world comprising three economically exogenous countries – the PRC, Japan, and the US. Our model is an extended version of that presented in Clarida, Gali, and Gertler (2002), adapted to capture three types of transition: the first, a shift in exchange rate regime; the second, adjustment to the weights on currencies under a basket peg regime; and the third, a shift in the PRC exchange rate regime and the degree of capital mobility.

Figure 4 presents a schematic diagram of the influence of capital mobility on exchange rate determination. Home country currency is denoted as R in the case of the Malaysian ringgit and SD in the case of the Singapore dollar, with the figure capturing the case of Malaysia as the Home country. Currencies for the PRC, Japan, and the US are represented with the symbols CH, JP, and US, respectively. Thus the exchange rate between the ringgit and the Chinese renminbi is given as $e^{R/CH}$.

Figure 4: Model



Source: Authors' illustration.

The economies for all countries consist of three sectors: households, firms, and the central bank. The countries share the same preferences and technologies and produce traded goods that are imperfect substitutes in terms of utility of the representative household. When prices are sticky, output and real exchange rates can differ from their flexible-price equilibrium values. We denote variables in deviation from these equilibrium values as $\hat{a}_t \equiv a_t - a_t^o$ and next-period expected value as $E_t a_{t+1}$. For other variables, output gap x_t is defined as follows: $x_t \equiv y_t - y_t^o$; and inflation rate is $\pi_t^C = \pi_t^C - \pi_t^{C.o}$ where inflation rate at steady state $\pi_t^{C.o} = 0$.

From the optimization problems of households and firms, we derive equilibrium conditions for the Home country, taken to be Malaysia for notational purposes.[12] Seven endogenous variables—output gap x_t, CPI (consumer price index) inflation rate π_t^C, domestic interest rate $(i_t - i_t^o)$, nominal wage $\widehat{w}_t$, real Chinese renminbi exchange rate $\hat{e}_t^{R/CH}$, real Japanese yen exchange rate $\hat{e}_t^{R/JP}$, and real US dollar exchange rate $\hat{e}_t^{R/US}$—are solved with seven equations mentioned above (note that we have two equations for interest parity condition 16). Equations (12) and (13) are the open-economy aggregate supply equation (AS) and investment-savings equation (IS), respectively. Equations (14) and (15) are money market and labor market equilibrium conditions, respectively. Equations (16) and (17) are real interest parity conditions.

$$\pi_t^C = \frac{\beta}{1+\kappa} E_t \pi_{t+1}^C + \frac{\lambda_H \kappa}{1+\kappa}\left\{\alpha \widehat{w}_t + \left(1-\alpha'\right)\hat{q}_t\right\} - \sum_{i\in\{CH,JP,US\}} \frac{\lambda_i}{1+\kappa}\left\{\begin{array}{c}\beta\left(E_t \hat{e}_{t+1}^{\frac{R}{i}} - \hat{e}_t^{\frac{R}{i}}\right) \\ +(1+\kappa)\left(\hat{e}_t^{\frac{R}{i}} - \hat{e}_{t-1}^{\frac{R}{i}}\right)\end{array}\right\} \tag{12}$$

$$\begin{aligned} x_t &= E_t x_{t+1} - \left\{1-(1-\omega_H)\alpha' + \frac{1}{\eta}\right\}(E_t \widehat{w}_{t+1} - \widehat{w}_t) \\ &+ \left\{1-\omega_H - \frac{\omega_H}{\lambda_H} + \frac{1}{\eta}\right\} E_t \pi_{t+1}^C + \frac{1}{\eta}\left(i_t - E_t \pi_{t+1}^C - r_t^o\right) \\ &+ (1-\omega_H)\left(1-\alpha'\right)(E_t \hat{q}_{t+1} - \hat{q}_t) \\ &+ \sum_{i\in\{CH,JP,US\}} \left\{\left(\omega_i + \frac{\omega_H \lambda_i}{\lambda_H}\right)\left(E_t \hat{e}_{t+1}^{\frac{R}{i}} - \hat{e}_t^{\frac{R}{i}}\right)\right\} \end{aligned} \tag{13}$$

$$\begin{aligned} m_t - m_t^o &= \frac{\sigma}{b\omega_H} x_t + \frac{\sigma(1-\omega_H)}{b\omega_H}\left\{\alpha' \widehat{w}_t + \left(1-\alpha'\right)\hat{q}_t\right\} \\ &- \frac{\sigma}{b}\left[\frac{1-2\omega_H}{\omega_H} + \theta\left(\frac{\lambda_H - 1}{\lambda_H}\right)\right]\pi_t^C \\ &- \sum_{i\in\{CH,JP,US\}} \left\{\left(\lambda_i + \frac{\omega_i}{\omega_H}\right)\theta \hat{e}_t^{R/i}\right\} - \left(\frac{1}{b}\right)(i_t - i_t^o) \end{aligned} \tag{14}$$

$$\begin{aligned} x_t &= E_t x_{t+1} - \left\{1-(1-\omega_H)\alpha' + \frac{1}{\eta}\right\}(E_t \widehat{w}_{t+1} - \widehat{w}_t) \\ &+ \left\{1-\omega_H - \frac{\omega_H}{\lambda_H} + \frac{1}{\eta}\right\} E_t \pi_{t+1}^C + \frac{1}{\eta}\left(i_t - E_t \pi_{t+1}^C - r_t^o\right) \\ &+ (1-\omega_H)(1-\alpha')(E_t \hat{q}_{t+1} - \hat{q}_t) \\ &+ \sum_{i\in\{CH,JP,US\}} \left\{\left(\omega_i + \frac{\omega_H \lambda_i}{\lambda_H}\right)\left(E_t \hat{e}_{t+1}^{R/i} - \hat{e}_t^{R/i}\right)\right\} \end{aligned} \tag{15}$$

[12] See Yoshino, Kaji. and Asonuma (2016b).

$$i_t - E_t\pi_{t+1}^C - r_t^o = \hat{r}_t^i + E_t\hat{e}_{t+1}^{R/i} - \hat{e}_t^{R/i} \quad \text{for } i = JP, US \tag{16}$$

$$i_t - E_t\pi_{t+1}^C - r_t^o = \hat{r}_t^{CH} + E_t\hat{e}_{t+1}^{R/CH} - \hat{e}_t^{R/CH} + E_t\hat{\psi}_{t+1} \tag{17}$$

4.2 Comparison of Five Transition Policies

Next, we define some possible transition policies together with maintaining the status quo regime. As discussed in Section 3, we assume that the PRC starts from a dollar peg regime with capital controls, and undergoes a transition to adjust its basket weight and capital controls, and finally adopts a basket peg regime with the long-term desired weight. We consider the following five transition policies for Malaysia and Singapore, respectively, as explained in Figure 5. To reflect precisely where these countries stand respectively, Malaysia starts from a dollar peg, while Singapore starts from a basket peg under perfect capital mobility.

Malaysia:

(M-i) Maintaining a dollar peg under perfect capital mobility (basket weight to the US dollar is always equal to 1);

(M-ii) Gradual shift from a dollar peg to a basket peg with the long-term desirable weight (gradual adjustments of basket weight);

(M-iii) Sudden shift from a dollar peg to a basket peg with the long-term desirable weight (sudden adjustments of basket weight);

(M-iv) Sudden shift from a dollar peg to a basket peg with discretion (sudden and frequent adjustments of basket weight);

(M-v) Sudden shift from a dollar peg to a floating regime.

Singapore:

(S-i) Maintaining a basket peg under perfect capital mobility (keeping basket weight on the US dollar rate at an initial level);

(S-ii) Gradual shift from a basket peg with current weight to a basket peg with the long-term desired weight (gradual adjustments of basket weight);

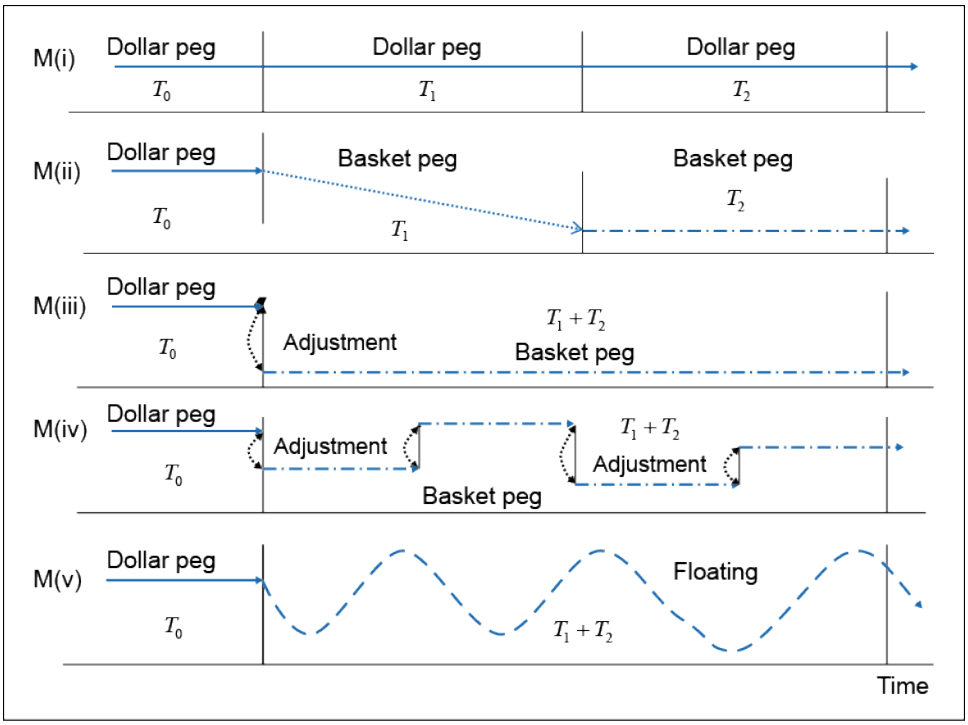
(S-iii) Sudden shift from a basket peg with current weight to a basket peg with the long-term desired weight (sudden adjustments of basket weight);

(S-iv) Sudden shift from a basket peg with current weight to a basket peg with estimated weights (actual weights during 2005–2013) (sudden adjustments of basket weight);

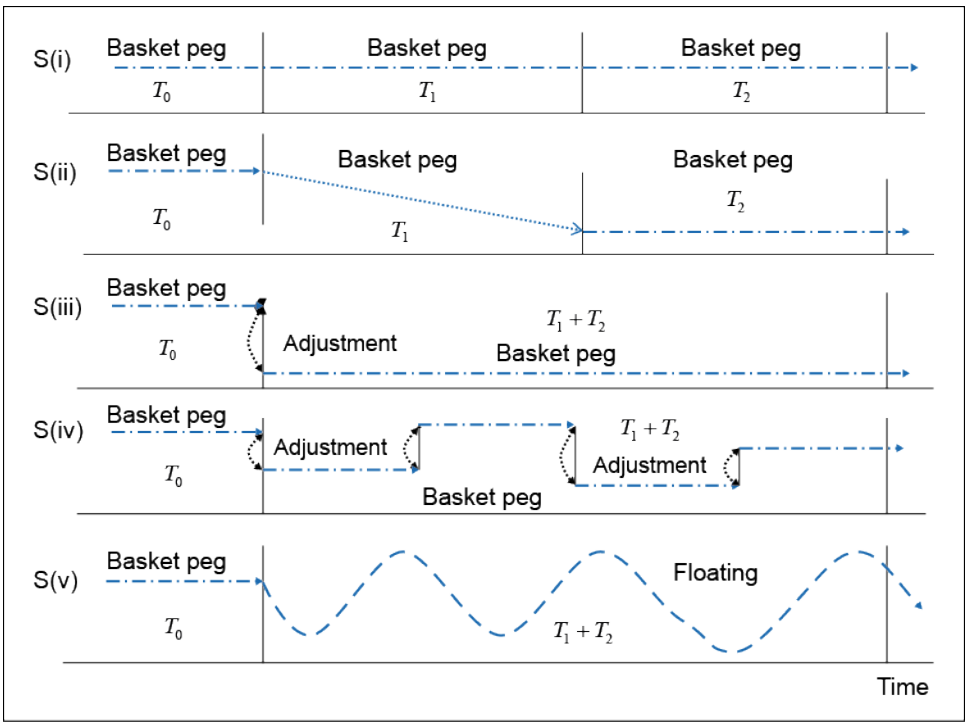
(S-v) Sudden shift from a basket peg to a floating regime.

Figure 5: Transition Policies for Malaysia and Singapore

(A) Malaysia



(B) Singapore



Source: Authors' illustration.

We assume that an initial time period for a dollar peg is T_0. Furthermore, a transition period in which the PRC adjusts its basket weight and capital control is set as T_1 and a time interval after the PRC implements a basket peg with its long-term desired weight is set as T_2. The discount rate is assumed to be β. Through the analysis, the cumulative loss for Malaysia and Singapore for the whole sample period is as follows:

$$L_1 = E_t \sum_{i=0}^{T_0+T_1+T_2} \beta^i \left[\varpi_1 \left(\pi_{t+i}^C\right)^2 + \varpi_2 (x_{t+i})^2 + (1 - \varpi_1 - \varpi_2)\left(\hat{e}_{t+i}^{REER}\right)^2\right] \quad (18)$$

where ϖ_1 and ϖ_2 show weights on policy targets that capture the relative importance of policy targets for the monetary authorities, respectively. This indicates that the monetary authorities attempt to minimize the CPI inflation rate, output gap, and deviations in the real effective exchange rate (REER). There are benefits and costs associated with the five transition policies as explained in Section 3.2. These benefits and costs are clearly included in the cumulative losses defined above.

4.3 Quantitative Analysis

We analyze quantitatively the relative superiority of the transition policies in terms of calibrated cumulative losses. We calculate cumulative losses for five transition policies for Malaysia and Singapore using actual shocks over 40 quarters (Q12005–Q42014). These cumulative losses are measured based on equation (18), which is comprised of the inflation rate, output gap, and real effective exchange rate.

Table 7: Comparison of Transition Policies

(1) Malaysia

	Policy M-i	Policy M-ii	Policy M-iii	Policy M-iv	Policy M-v
Stable Regime	Dollar peg	Basket peg	Basket peg	Basket peg	Floating
Adjustment	No	Gradual	Sudden	Sudden/Discrete	Sudden
Desired Basket Weight	1.00	0.62	0.56	–	–
Cumulative Losses	1.550E-2	1.157E-2	1.226E-2	1.435E-2	1.229E-2
Cumulative Losses (relative to policy M-i)	1.00	0.75	0.79	0.93	0.79

(2) Singapore

	Policy S-i /1	Policy S-ii	Policy S-iii	Policy S-iv	Policy S-v
Stable Regime	Basket peg	Basket peg	Basket peg	Basket peg	Floating
Adjustment	No	Gradual	Sudden	Sudden/Discrete	Sudden
Desired Basket Weight	0.80	0.61	0.44	–	–
Cumulative Losses	4.668E-2	4.648E-2	4.938E-2	4.955E-2	4.874E-1
Cumulative Losses (relative to policy S-i)	1.00	0.996	1.058	1.062	10.44

Note: /1 Initial weight on the US dollar rate under a basket peg regime for Singapore is assumed to be 0.8.

Source: Authors' calculations.

The following three implications emerge from Table 7. First, a gradual shift to a basket peg with the long-term desirable weight is the best choice for both Malaysia and Singapore. Second, a sudden shift to a basket peg with the desirable weight is superior to maintaining the dollar peg in Malaysia, but not to maintaining the initial weight under a basket peg in Singapore. Third, a sudden shift to a basket peg with discretion results in higher cumulative losses than either a gradual shift or a sudden shift to a basket peg with the desirable weight in both Malaysia and Singapore. Lastly, a sudden shift to a floating regime is found to be inferior to maintaining the initial weight under a basket peg regime in Singapore. In contrast, the sudden shift to a floating regime is more desirable than maintaining the dollar peg regime in Malaysia.

5. CONCLUSION

This paper considers the optimal exchange rate regime transition policy for three East Asian countries: the PRC, Malaysia, and Singapore. In contrast to two traditional exchange rate regime approaches in East Asia, the paper follows a new and emerging approach to analysis, a dynamic transition analysis. In particular, we consider shifts in exchange rate regimes, that is, shifts from a dollar peg to a basket peg or a floating regime over fixed time intervals together with maintaining a dollar peg. We construct a small, open-economy DSGE model in order to apply it to the PRC, Malaysia, and Singapore. For each analysis case, we define transition policies and compare the welfare gains of these policies relative to the current regime, i.e. maintaining the dollar peg regime or a basket peg regime. The quantitative analysis using PRC, Malaysian, and Singaporean data shows that the PRC would be better off shifting gradually from a dollar peg to a basket peg. In response to the PRC's shift, both Malaysia and Singapore would opt to shift gradually to a basket peg regime.

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APPENDIX: QUANTITATIVE ANALYSIS IN THE CASE OF THE PRICE-LEVEL STABILITY

We also consider the case where the monetary authorities aim to minimize fluctuations in the price level, i.e. inflation rates over the horizon, shown as:

$$L(T_1, T_2) = \sum_{t=1}^{T_0+T_1+T_2} \beta^{t-1} (p_t - \bar{p}')^2 \quad (11a)$$

The policy instrument under each policy is identical to that in the case of output stability. Table A1 reports a comparison of estimates of loss function under the five policies (fourth and fifth rows in Table A1). Similarly to Table 4, maintaining the dollar peg (policy 1) results in the highest cumulative losses among the five policies. The sudden shift to a floating regime (policy 4) results in smaller cumulative losses than other transition policies. The second-best policy is the sudden shift to the basket peg with gradual adjustments.

Table A1: Values of the Cumulative Losses and Policy 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

Note: [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.