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Is There Really a Renminbi Bloc in Asia?

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Abstract

This paper examines whether the renminbi (RMB) has supplanted the US dollar as the major anchor currency in the currency baskets of East Asian economies. First, we systematically demonstrate that existing techniques to address the problem of severe multicollinearity in estimations of the Frankel–Wei regression model, with the movements in both the RMB and the US dollar included on the right-hand side of the equation, remain limited in providing stable and robust results. Then we propose a simple modification of the Frankel–Wei regression model to estimate the RMB weight in an economy's currency basket. Using this new approach, we find that there is not yet an RMB bloc in East Asia, contrary to claims made by some recent studies. We find that the US dollar continues to be the dominant anchor currency in the region. The RMB has taken on some importance in the currency baskets of many East Asian economies in recent years and this appears to have occurred at the expense of the yen. In short, despite the rising importance of the RMB, it has not eclipsed the US dollar as the dominant anchor currency in East Asia.

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1. INTRODUCTION

The growing importance of the People's Republic of China (PRC) in the world economy has raised the question: can its national currency, the renminbi (RMB), become a major international currency? This issue comes on the heels of a realization during the recent global financial crisis that the over-reliance of the international monetary system on a single dominant reserve currency, the US dollar, poses an ever present danger to its stability. In light of the recent moves by the PRC authorities to increase the international usage of the RMB in the PRC's international trade and in financial and investment transactions, the RMB has emerged as a potential way of diversifying global reserve currencies in the international monetary system, thereby reducing its dependence on the US dollar.

Three roles underpin an international currency. A currency is considered international once foreigners, in both official and private sectors, begin to demand the currency as (i) a store of value (for saving and investment), (ii) a medium of exchange (for settlement), and (iii) a unit of account (for denomination). In other words, an international currency fulfills roles that are comparable to those of a domestic currency (Ito 2011). This paper does not deal with the first two roles, i.e., store of value and medium of exchange, but concentrates on the role of a currency as the unit of account in the official sector. Specifically, the paper addresses the role of an international currency when it is used as an anchor for exchange rate stabilization or when it is the most important currency in the official or unofficial currency basket of a country.[1]

Against this backdrop, the main question we attempt to answer is whether the RMB has become the anchor for exchange rate stabilization or the most important currency in the currency basket of economies in the Asian region. Finding that the RMB has become the major reference currency of choice in the currency basket of not just one but a number of Asian economies would be evidence of a remarkable shift away from the US dollar as the dominant anchor currency and toward the formation of an RMB bloc in the region.

Recent evidence provided by Henning (2012) and Subramanian and Kessler (2013) indicates that there has, indeed, been an alleged formation of an RMB bloc in East Asia. On the basis of the widely-used Frankel–Wei regression model that includes the movements of the RMB on the right-hand side of the equation, they obtained estimated weights of the RMB that are not only strongly significant but also larger in value than the estimates for the US dollar for a number of East Asian currencies during recent periods when the exchange rate of the RMB has been reasonably flexible.

In this paper we demonstrate that the evidence provided by Henning (2012) and Subramanian and Kessler (2013) of an alleged formation of an RMB bloc should be treated with utmost caution. On the basis of rolling regression estimates of the same Frankel–Wei regression that these two studies employed, we have found that the collinearity between the movements in the RMB and the US dollar remains a major concern even during those periods during which the RMB exhibited some flexibility against the US dollar. In that regard, the paper introduces a simple and easy to implement alternative approach, which substantially reduces the problem of multicollinearity in the Frankel–Wei regression model. Using this alternative approach, we find no evidence of an RMB bloc forming in the region. We find that the US dollar continues to be the most dominant anchor currency in East Asia. The RMB has taken on some importance in the currency baskets of many East Asian economies in recent years but not to the extent that it has supplanted the US dollar as the most important anchor currency in the region.

[1] The other unit of account role is in the private sector when the international currency is used as the unit of account to denominate trade and financial transactions.

The paper is structured as follows. Section 2 presents some trends illustrating the growing importance of the PRC in trade, globally and in the Asian region. Section 3 reviews and discusses the relevant literature. Section 4 explains the previous approaches undertaken by recent studies in surmounting the problem of multicollinearity in Frankel–Wei regressions that include the movements in the RMB on the right-hand side of the equation. Section 5 presents our alternative approach to resolving the problem of multicollinearity, and employs this new approach to examine whether an RMB bloc has been formed in East Asia. Section 6 concludes.

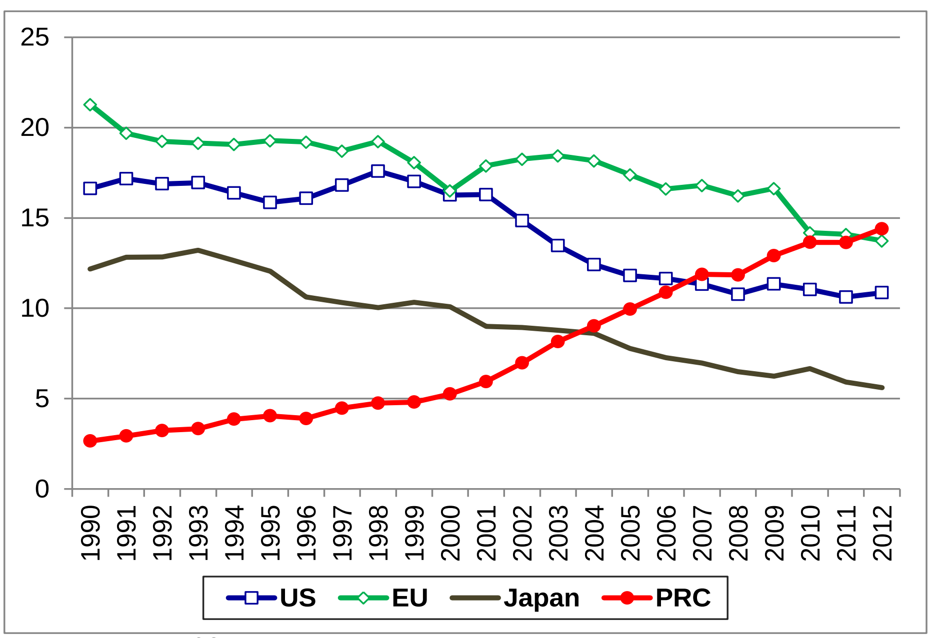
2. IMPORTANCE OF THE PEOPLE'S REPUBLIC OF CHINA IN THE GLOBAL ECONOMY AND ASIA

One likely important driver of a country's decision to attach importance to the RMB in its official or unofficial currency basket is that its decision can be understood as a natural response to the growing weight of the PRC's trade and investment flows in the world economy. The two figures that follow underscore the rising importance of the PRC's economy in the global economy based on trade data. Figure 1 clearly shows the extraordinary rise in the PRC's global share of exports. Starting from a very low base of a 2.7% share of global world exports in 1990, the PRC's share of global exports has risen steadily and in 2004 it overtook Japan as a global exporter. In 2007, it outstripped the US and then, eventually, the EU (European Union), in 2012 to become the world's largest exporter, accounting for 14% of global exports.

Figure 2 shows the PRC's share of global imports and is an almost mirror image of Figure 1. It shows the spectacular rise in the PRC's share of global imports from 2.4% of global world imports in 1990 to 12.2% in 2012. The PRC overtook Japan in 2003 as a major world importer, and has kept rising. It was ranked behind only the EU (15%) and the US (16%) in 2012.

Figure 1: Global Share of Exports

(%)

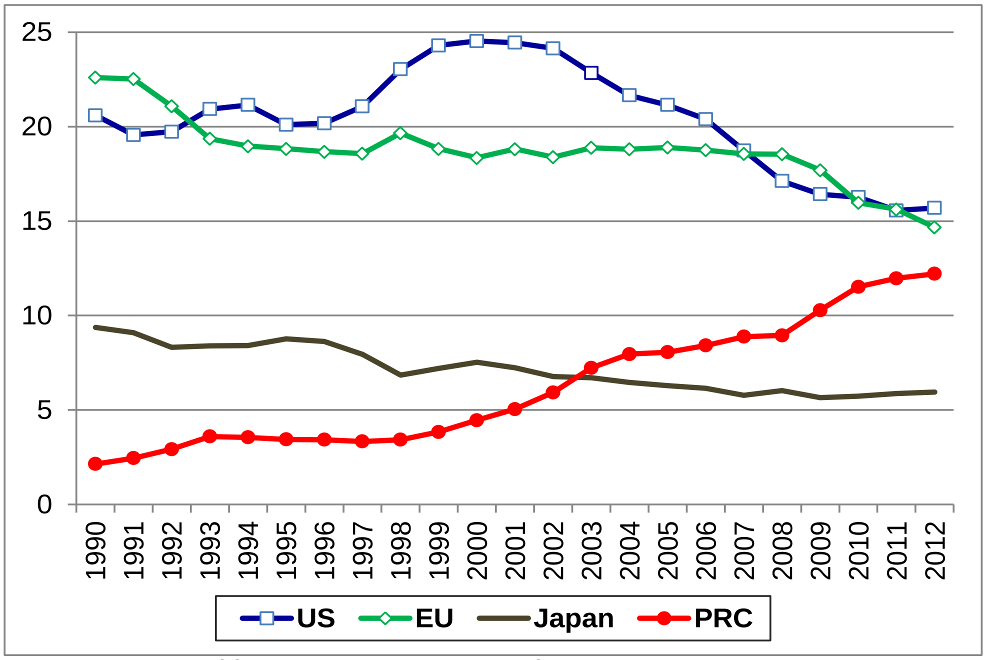


PRC = People's Republic of China, EU = European Union, US = United States.

Note: EU exports are net of intra-EU exports.

Source: International Monetary Fund, *Direction of Trade Statistics*.

Figure 2: Global Share of Imports
(%)



PRC = People's Republic of China, EU = European Union, US = United States.

Note: EU imports are net of intra-EU imports.

Source: International Monetary Fund, *Direction of Trade Statistics*.

It should come as no surprise that trade integration between the PRC and the rest of the economies in East Asia has accelerated during the past two decades. As Table 1 shows, between 1990 and 2012, Asian economies have more than doubled their trade with the PRC. This is one reasonable and potential explanation of why the RMB may matter in the exchange rate policy of economies in Asia. The phenomenal increase in trade integration between Asian economies and the PRC has created the incentive for policy makers in the region to maintain relatively stable exchange rates vis-à-vis the RMB. They may wish to keep their international price competitiveness with the PRC and in third markets by avoiding large currency appreciation against the RMB, and smooth their trading relationships with the PRC by reducing large exchange rate fluctuations against the RMB. Essentially, the policymakers in the region may wish to closely track the movements in the RMB in their exchange rate policies.

Table 1: Share of Trade with the PRC, Selected Asia and Pacific Economies
(%)

	Exports 1990	Imports 1990	Exports 2012	Imports 2012
Australia	2.46	2.66	29.51	18.36
Bangladesh	1.51	3.39	1.41	17.83
Brunei Darussalam	0.14	2.70	2.71	21.33
Cambodia	0.39	5.91	2.50	19.46
Hong Kong, China	24.67	36.74	54.08	47.05
India	0.10	0.13	5.01	10.69
Indonesia	3.25	2.97	11.40	15.33
Japan	2.13	5.12	18.06	21.27
Korea, Republic of	0.00	0.00	24.52	15.55
Lao, People's Democratic Rep. of	9.08	10.72	21.48	16.23
Malaysia	2.10	1.92	12.64	15.12
Mongolia	11.35	21.50	88.96	37.54
Myanmar	8.14	20.62	14.29	36.93
New Zealand	0.96	1.20	15.01	16.37
Pakistan	1.20	4.57	11.18	19.69
Philippines	0.75	1.40	11.85	10.80
Singapore	1.51	3.44	10.76	10.31
Taipei,China	3.11	0.64	26.80	15.12
Thailand	1.16	3.31	11.72	14.84
Viet Nam	0.31	0.16	11.18	25.78

Source: International Monetary Fund, *Direction of Trade Statistics*.

3. LITERATURE

Since officials often do not publicly disclose the weights they attach to the important international currencies that comprise the operation of an explicit or implicit exchange rate currency basket, researchers go at length to infer these currency weights. The standard workhorse equation used to estimate the influence of important international currencies in the currency basket of individual countries is the equation developed and popularized by Frankel–Wei (1994), which is expressed below as:

$$\Delta\log\left(\frac{x}{\mathrm{CHF}}\right)= \alpha_0 + \alpha_1\Delta\log\left(\frac{\mathrm{USD}}{\mathrm{CHF}}\right)+\alpha_2\Delta\log\left(\frac{\mathrm{EURO}}{\mathrm{CHF}}\right) + \alpha_3\Delta\log\left(\frac{\mathrm{JPY}}{\mathrm{CHF}}\right)+\alpha_4\Delta\log\left(\frac{\mathrm{GBP}}{\mathrm{CHF}}\right)+u, \quad (1)$$

where $\Delta\log\left(\frac{k}{\mathrm{CHF}}\right)$, $k = x$, *USD, EURO, JPY, GBP*, is the logarithmic change in the exchange rate of currency k (a particular East Asian emerging currency x, US dollar, euro, Japanese yen and pound sterling) per Swiss franc. The exchange rates are taken in logs and transformed into first differences in order to ensure stationarity. The important international anchor (or reference) currencies are on the right-hand side of this equation and the estimated coefficients of these reference or anchor currencies are their implied weights in the currency basket of a particular country; that is, the effect of the respective international currencies on a particular currency. This equation is useful to determine, for instance, the official US dollar peg of the Hong Kong dollar, in which case we would expect the coefficient on the US dollar to be significant and exactly or very close to one and the rest of the coefficients on the remaining international currencies to be close to zero. As one can also see from the above equation, the exchange rate is measured against a common numeraire currency which in this particular case is the Swiss franc, although in other studies the special drawing right (SDR) is used as the numeraire currency.

Since it was first formulated, the Frankel–Wei regression model has been useful in documenting the so-called adoption of an informal US dollar peg in East Asia several years before the onset of the Asian financial crisis. To be specific, using pre-1997 exchange rate data, researchers such as Kawai and Akiyama (1998) and Ogawa and Ito (2002) applied the model and revealed the strong influence of the US dollar on East Asian currencies. The finding of an informal US dollar peg before the Asian financial crisis was of great significance for policymakers and scholars alike because it is widely believed to have been a major contributory factor to the severity of the impact of the Asian financial crisis because of the double mismatch problem that occurred in the period leading to the crisis.

A few years after the Asian financial crisis, the Frankel–Wei regression model was also employed to show that, while the informal US dollar peg broke down momentarily during the Asian financial crisis, it was quickly re-established thereafter. McKinnon and Schnabl (2004) coined the phrase, "the resurrection of an East Asian dollar-standard," a finding that was corroborated by Benassy-Quere and Coeure (2006). Somewhat different evidence was provided, however, by Kawai (2008) who found that, with the exception of a few US dollar peg economies in the East Asian region such as the PRC and Hong Kong, China, most East Asian currencies began to exhibit greater exchange rate flexibility a few years after the Asian financial crisis, and some currencies adopted currency basket systems in which the yen played an important part.

Several recent studies have examined whether the RMB has started to figure in the currency baskets of individual economies, particularly in the Asian region—e.g., Ho, Ma, and McCauley (2005); Balasubramaniam, Patnaik, and Shah (2011); Chow (2011); Fratzscher and Mehl (2011); Henning (2012); and Subramanian and Kessler (2013). These employed the Frankel–Wei regression model by including movements in the RMB on the right-hand side of the equation such as the one below:

$$\Delta\log\left(\frac{x}{\mathrm{CHF}}\right) = \alpha_0 + \alpha_1\Delta\log\left(\frac{\mathrm{USD}}{\mathrm{CHF}}\right) + \alpha_2\Delta\log\left(\frac{\mathrm{EURO}}{\mathrm{CHF}}\right) + \alpha_3\Delta\log\left(\frac{\mathrm{JPY}}{\mathrm{CHF}}\right) + \alpha_4\Delta\log\left(\frac{\mathrm{GBP}}{\mathrm{CHF}}\right) + \alpha_5\Delta\log\left(\frac{\mathrm{RMB}}{\mathrm{CHF}}\right) + u', \quad (2)$$

where $\Delta\log\left(\frac{\mathrm{RMB}}{\mathrm{CHF}}\right)$ is the logarithmic change in the RMB per Swiss franc exchange rate, and the rest of the variables are as defined previously. The coefficient attached to the movements in the RMB measures the influence or importance of the RMB to the currency basket of a particular economy's currency, x. The difficulty with this regression, as has been pointed out by past studies, is that the correlation between the logarithmic changes in the US dollar and the RMB—particularly during the periods in which the PRC pursued an official US dollar peg—is remarkably high. For instance, the estimated correlations between the logarithmic changes in the US dollar and RMB per Swiss franc exchange rates during the period right before the PRC reformed its exchange rate regime in the middle of July 2005 (i.e., January 2000–June 2005) was an almost perfect correlation of 0.999. During the recent period when the PRC reverted to a US dollar fixed peg (August 2008–May 2010), the estimated correlations were almost identical at 0.991. In other words, regression estimates of equation (2) will most likely suffer from the problem of multicollinearity due to the very strong association between the movements in the US dollar and the RMB.

Nonetheless, some possible remedies are available and the recent literature has attempted to ascertain the influence the RMB may have in the currency baskets of individual countries. For instance, Henning (2012) and Subramanian and Kessler (2013) conducted regression estimates using the standard version of the Frankel–Wei regression model that includes the movements in the RMB on the right-hand side during the periods in which the RMB exhibited relative flexibility against the US dollar. Both studies concluded that an RMB bloc had emerged in the Asian region. In addition to the discussion on the other remedies that have been tried to resolve the multicollinearity problem, these two studies will be discussed in detail in the following section.

4. RECENT APPROACHES TO ADDRESS THE MULTICOLLINEARITY PROBLEM

4.1 Choosing Periods of the Renminbi's Relative Flexibility

The previous literature has attempted to surmount the problem of multicollinearity in three ways. The first, as already mentioned, is to estimate the Frankel–Wei regression with the movements in the RMB included on the right-hand side at the two known periods in which the PRC authorities allowed the RMB to exhibit some flexibility against the US dollar. In other words, the Frankel–Wei model was estimated during two periods in which there was a supposed de-linking in the relationship between the US dollar and the RMB. Henning (2012) estimated the Frankel–Wei regression with the RMB movements included on the right-hand side for the period 22 July 2005–2 July 2009 and also for the period 18 June 2010–30 December 2011. The more recent study by Subramanian and Kessler (2013) estimated the regression for the periods July 2005–August 2008 and July 2010–July 2013.

In adopting this approach, Henning (2012) obtained results that led him to conclude that:

> Malaysia, Thailand, Singapore and the Philippines have formed a loose but effective 'renminbi bloc' with [the People's Republic of] China, and … [the Republic of] Korea has participated tentatively since the global financial crisis. (Henning 2012: 1)

Subramanian and Kessler (2013), on the other hand, were more forthcoming in their conclusion:

> The renminbi has now become the dominant reference currency in East Asia, eclipsing the dollar and the euro. There is now a de facto renminbi currency bloc in East Asia….Currencies of [the Republic of] Korea, Indonesia, Malaysia, the Philippines, [Taipei,China], Singapore and Thailand now more closely track the renminbi than the dollar. (Subramanian and Kessler 2013: 3)

We examine these findings in more detail by first reproducing the estimates obtained by the two studies. Henning's estimates are presented in Table 2 and Subramanian and Kessler's in Table 3. In both of these tables, columns 1–4 are the actual coefficient estimates of the US dollar and the RMB that Henning and Subramanian, and Kessler obtained for specific periods in their respective papers. Comparing columns 1 and 3 of Table 2, one can see, for instance, that during the first period (22 July 2005–2 July 2009) that Henning examined, two currencies, the Malaysian ringgit and the Singapore dollar, accorded a statistically significant weight for the RMB. During the second period (18 June 2010–30 December 2011), the number of East Asian currencies that reported a stronger weight for the RMB included not only the ringgit and the Singapore dollar, but the Korean won, the Philippine peso, and the Thai baht (comparison between columns 2 and 4, Table 2). This result is consistent with the quotation from Henning above.

Table 2: Henning (2012) Estimation Results

	Henning Own Estimates				Replication of Henning Estimates			
	US dollar		RMB		US dollar		RMB	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	22 Jul 2005– 2 Jul 2009	18 Jun 2010– 30 Dec 2011	22 Jul 2005– 2 Jul 2009	18 Jun 2010– 30 Dec 2011	22 Jul 2005– 2 Jul 2009	18 Jun 2010– 30 Dec 2011	22 Jul 2005– 2 Jul 2009	18 Jun 2010– 30 Dec 2011
Korean won	0.085	-0.507*	-0.018	**0.646*** **	0.173***	-0.471	-0.339	**1.100*** **
Malaysian ringgit	0.087	-0.085	**0.624*** **	**0.774*** **	0.444***	-0.184	**0.368*** **	**0.989*** **
Philippine peso	0.457***	0.063	0.142	**0.694*** **	0.787***	0.227	-0.011	**0.611*** **
Singapore dollar	0.025	-0.265*	**0.485*** **	**0.374*** **	0.357***	-0.102	**0.288*** **	**0.577*** **
Thai baht	0.340	0.170	0.164	**0.339*** **	0.483***	0.265**	**0.260** **	**0.492*** **

RMB = renminbi.

Notes:

(a) Columns 1–4 are the actual estimates from Henning (2012), taken from Table 2 and Table 4 of his study.

(b) Columns 5–8 summarize regression results based on the same Frankel–Wei equation employed by Henning (2012), but using our own exchange rate dataset.

(c) The estimating equation employed by Henning (2012), who uses the special drawing right (SDR) as the numeraire currency, is:

$$\Delta \log \left(\frac{x}{SDR}\right) = \alpha_0 + \alpha_1 \Delta \log \left(\frac{USD}{SDR}\right) + \alpha_2 \Delta \log \left(\frac{EURO}{SDR}\right) + \alpha_3 \Delta \log \left(\frac{JPY}{SDR}\right) + \alpha_4 \Delta \log \left(\frac{RMB}{SDR}\right) + u'$$

(d) Asterisks, *, **, ***, indicate statistical significance at the 10%, 5% and 1% levels, respectively. The significantly estimated RMB coefficients are in boldface.

Sources: Henning (2012); and the authors' computation.

Table 3: Subramanian and Kessler (2013) Estimation Results

	Subramanian–Kessler Own Estimates				**Replication of Subramanian–Kessler Estimates**			
	US dollar		RMB		US dollar		RMB	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Jul 2005–Aug 2008	Jul 2010–Jul 2013	Jul 2005–Aug 2008	Jul 2010–Jul 2013	Jul 2005–Aug 2008	Jul 2010–Jul 2013	Jul 2005–Aug 2008	Jul 2010–Jul 2013
Korean won	0.261	-0.359**	**0.580*** **	**1.196*** **	0.377***	-0.223	**0.316*** **	**1.007*** **
NT dollar	0.359***	0.281***	**0.519*** **	**0.639*** **	0.176***	0.274***	**0.579*** **	**0.619*** **
Indonesian rupiah	0.621***	0.473***	0.162	**0.503*** **	0.490***	0.488***	**0.159* **	**0.402*** **
Malaysian ringgit	0.214**	-0.188	**0.653*** **	**1.056*** **	0.316***	-0.147	**0.469*** **	**0.981*** **
Philippine peso	0.696***	0.076	0.163	**0.821*** **	0.490***	0.181*	**0.269*** **	**0.664*** **
Singapore dollar	0.343***	0.039	**0.300*** **	**0.495*** **	0.180***	0.123	**0.424*** **	**0.472*** **
Thai baht	0.522**	0.181*	0.29	**0.692*** **	0.165***	0.308***	**0.548*** **	**0.463*** **

RMB = renminbi.

Notes:

(a) Columns 1–4 are the actual estimates from Subramanian and Kessler (2013) and taken from Table A.2 of their study.

(b) Columns 5–8 summarize regression results based on the same Frankel–Wei equation employed by Subramanian and Kessler (2013), but using our own exchange rate dataset.

(c) The estimating equation employed by Subramanian and Kessler (2013), who use the Swiss franc as the numeraire currency, is:

$$\Delta \log\left(\frac{x}{CHF}\right) = \alpha_0 + \alpha_1 \Delta \log\left(\frac{USD}{CHF}\right) + \alpha_2 \Delta \log\left(\frac{EURO}{CHF}\right) + \alpha_3 \Delta \log\left(\frac{JPY}{CHF}\right) + \alpha_4 \Delta \log\left(\frac{RMB}{CHF}\right) + u'$$

(d) Asterisks, *, **, ***, indicate statistical significance at the 10%, 5% and 1% levels, respectively. The significantly estimated renminbi coefficients are in boldface.

Sources: Subramanian and Kessler (2013); and authors' computation.

Columns 1–4 of Table 3 summarize the actual coefficient estimates of the US dollar and the RMB as reported by Subramanian and Kessler (2013). Four East Asian currencies (the ringgit, Singapore dollar, won, and NT dollar),[2] attached a large weight to the RMB during the period July 2005–August 2008 (comparison between columns 1 and 3 of Table 3). In the next period, when the RMB was relatively flexible against the US dollar (July 2010–July 2013), the rupiah, peso, and baht join the first group of four East Asian currencies in attaching a larger and significant weight to the RMB than to the US dollar (comparison between columns 2 and 4 in Table 3). This finding is also consistent with the quotation from Subramanian and Kessler above.

Columns 5–8 of Tables 2 and 3 report our reproduction of the US dollar and RMB estimated coefficients using our own exchange rate dataset for the same two periods that Henning and Subramanian and Kessler considered in their studies. Both tables confirm the strongly significant and larger values of the RMB coefficients than the US dollar coefficients which are smaller in value and characterized by a marked variation in statistical significance.[3] Despite small differences in the magnitudes of our estimated coefficients for the US dollar and the RMB, the overall conclusion in this part of the reported estimates supports the earlier conclusion made by these two studies of an alleged eclipsing of the US dollar by the RMB in the exchange rate policies of many economies in East Asia.

Perhaps the important question that needs to be answered at this juncture is: how much confidence can we have in the evidence that is presented of the alleged formation of an RMB bloc in a number of economies in East Asia? The answer will depend on how effective the authors have been at surmounting the problem of multicollinearity by producing estimates using the Frankel–Wei regression with the movements in the RMB included on the right-hand side during the periods in which the PRC authorities loosened the link of the RMB to the US dollar. A quick indication of the likely presence of multicollinearity is to again examine the correlations of the US dollar and the RMB as per the numeraire currency used in the Henning and Subramanian and Kessler studies.[4] The estimated correlations in the two respective periods that Henning and Subramanian and Kessler considered are: 0.955 in the first period (22 July 2005–2 July 2009) and 0.935 in the second period (18 June 2010–30 December 2011) in the Henning case; and 0.836 in the first period (July 2005–August 2008) and 0.989 in the second period (July 2010–July 2013) in the Subramanian–Kessler case.[5]

[2] The NT dollar is the local currency of Taipei,China.

[3] In fact, our own replications of the Henning (2012) and Subramanian and Kessler (2013) estimates reported in columns 5–8 of both tables portray a stronger result in support of an RMB bloc in Asia. For instance, comparing columns 5 and 7 columns of Table 2, we can observe that the baht joined the ringgit and the Singapore dollar during the first period that Henning considered in his study. Comparing columns 5 and 7 of Table 3, not only is the magnitude of the estimated US dollar coefficient for the rupiah smaller in our estimates, the estimated RMB coefficient for the rupiah is now weakly significant at the 10% level during the first period that Subramanian and Kessler considered. More to the point regarding a supposed RMB bloc in Asia is that our own reproduction of the Subramanian and Kessler (2013) estimates suggests that the peso and the baht have also accorded an important weight to the RMB, joining the ringgit, Singapore dollar, won and the NT dollar, which have been found by Subramanian and Kessler to attach a significant weight to the RMB in the first period that they examined.

[4] Henning (2012) uses the special drawing right (SDR) while Subramanian and Kessler (2013) use the Swiss franc as their respective numeraire currencies. Both studies include the US dollar, the euro, the yen and the RMB on the right-hand side of the equations, excluding the pound sterling.

[5] The correlation coefficients between any pair of currencies other than the RMB and the US dollar are not as high as those between the RMB and the US dollar, with the maximum value of 0.69 between the movements in the RMB and the yen with the Swiss franc as numeraire during the second period (July 2010–July 2013) examined by Subramanian and Kessler (2013).

These estimated correlations are lower than the earlier estimated correlations between the movements in the US dollar and the RMB during periods in the 2000s in which the RMB was tightly pegged to the US dollar, but they are still quite large in absolute terms, suggesting that one must still be wary of the problem of multicollinearity when estimating the Frankel–Wei regression and including on the right-hand side the movements in the RMB.

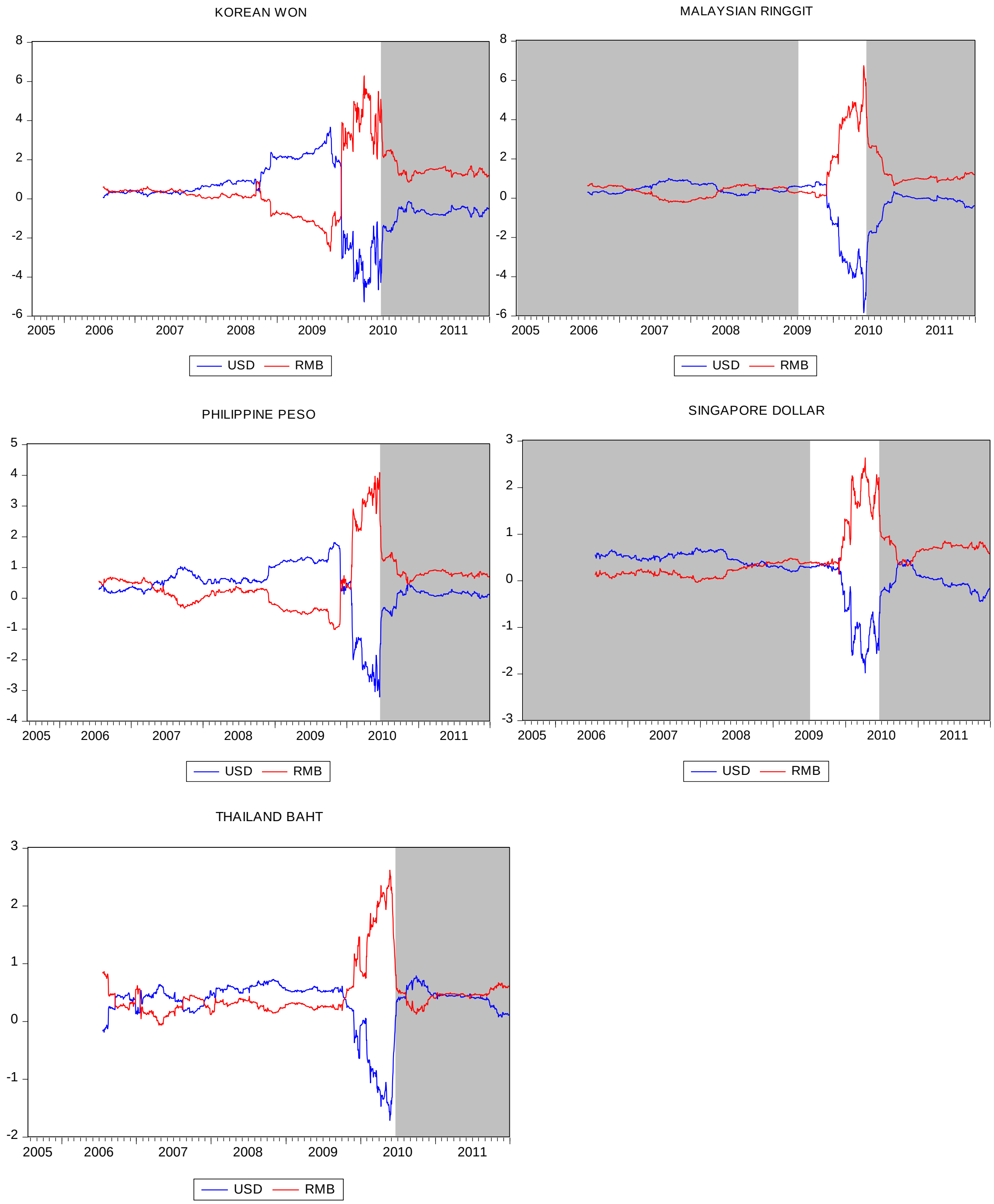
In addition to this cue from the estimated correlations, we dig deeper into the effectiveness of surmounting the problem of multicollinearity by estimating the Frankel–Wei regression with RMB movements included on the right-hand side in those two periods in which the PRC authorities permitted a de-linking in the relationship between the RMB and the US dollar. At this point, we estimated the same Frankel–Wei regression models with the RMB movements included on the right-hand side that were employed by Henning and Subramanian and Kessler. However, instead of obtaining only single point estimates of the US dollar and RMB coefficients in each of the periods that were considered by the two studies, we conducted a 'rolling' regression of the Frankel–Wei model with the RMB movements included on the right-hand side.

The rolling regression is carried out by first specifying a window width of 260 daily trading observations (equivalent to a year) that begins on 22 July 2005 (the day following the announcement by the People's Bank of China that it would allow relative flexibility in the RMB exchange rate against the US dollar). This specified window width is then moved by estimating the Frankel–Wei regression with RMB movements included on the right-hand side at a step-size of one daily observation at a time and through the remaining observations. As with Subramanian and Kessler, the last observation was at 31 July 2013. In each of the regressions using the specified window width, we are then able to arrive at a collection of point estimates of the coefficients (i.e., weights) of the currencies on the right-hand side of the Frankel–Wei regression model, including the US dollar and the RMB. This collection of point estimates of the US dollar and the RMB weights is depicted in Figures 3 and 4 for the group of East Asian currencies that Henning and Subramanian and Kessler found to have formed an RMB bloc in the region.[6] Portions of the charts presented in Figures 3 and 4 are highlighted in grey shading to denote the two periods that Henning and Subramanian–Kessler considered in their studies.

The advantage of undertaking a rolling regression of the Frankel–Wei model is that one is able to get a clear picture of the behavior of the US dollar and RMB weights particularly over the estimation periods that Henning and Subramanian–Kessler used. Two observations are clearly apparent from these charts: first, the US dollar weights (in blue) move in the opposite direction from the RMB weights (in red) exhibiting highly negative correlations. Second, in almost all of the charts, both the US dollar and RMB weights show instability in the form of quite large or small coefficients (in a few periods, estimated magnitudes are actually larger than 1 in absolute value). This affirms without a doubt what we have alluded to above when we examined the correlations between the movements in the US dollar and the RMB: estimating the Frankel–Wei regression with the RMB included on the right-hand side during the periods in which the PRC authorities loosened the link of the RMB to the US dollar is not a guaranteed approach to surmounting the problem of multicollinearity.

[6] For the sake of clarity in highlighting the relationship between the US dollar and the RMB weights, we omit the weights of the remaining currencies—i.e., the euro and the yen—in the figures.

Figure 3: Estimated US Dollar and Renminbi Weights from Rolling Regressions of the Frankel–Wei Model Used by Henning (2012)

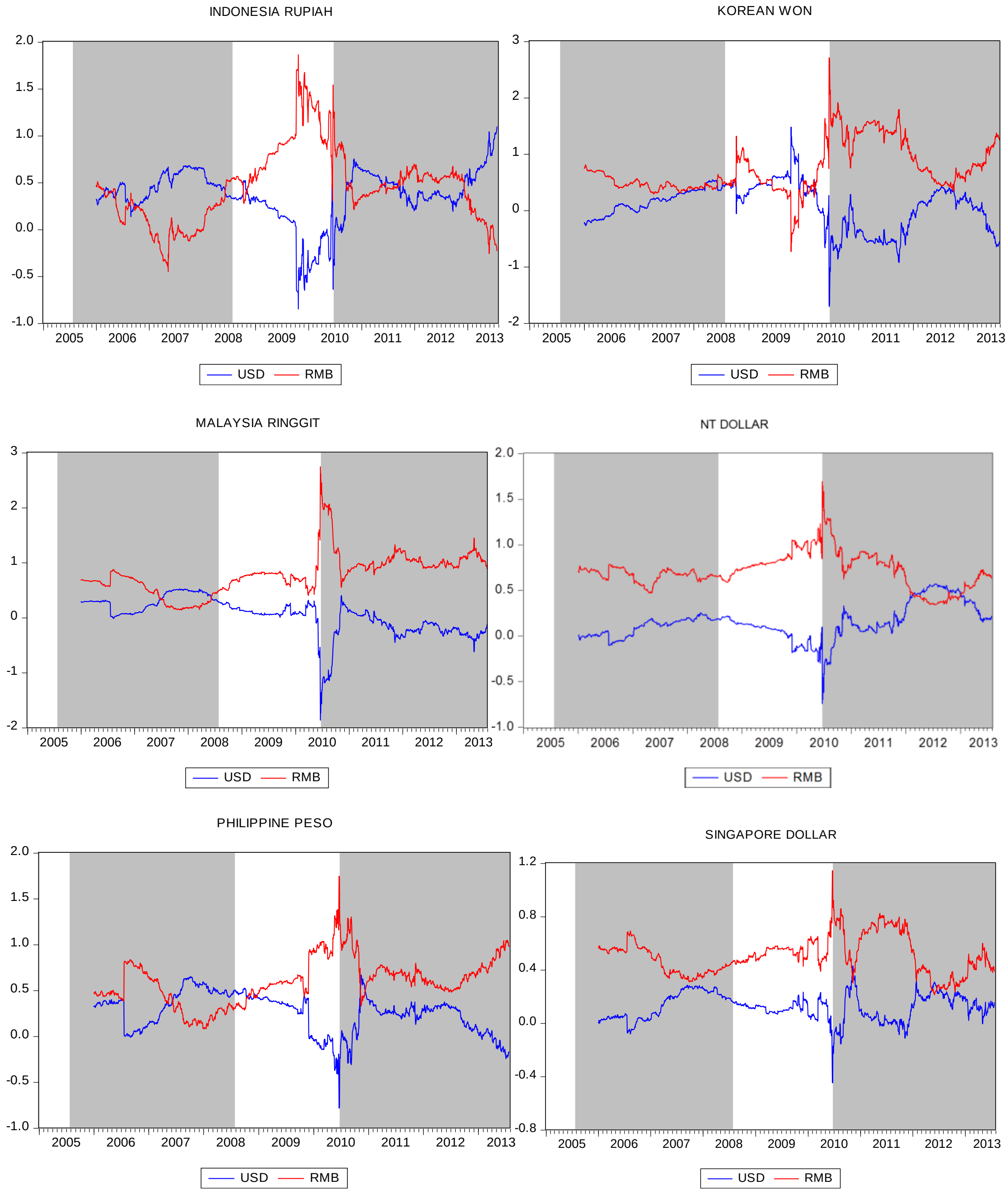


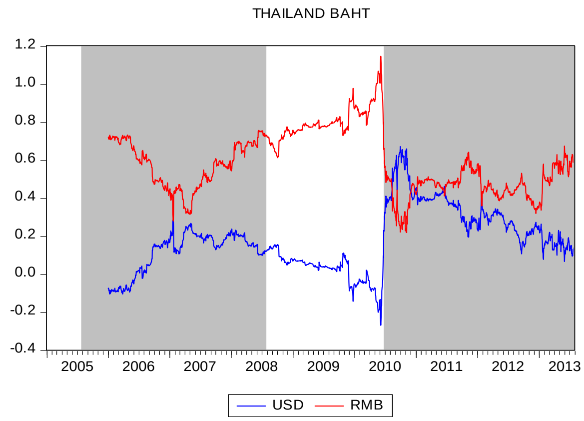
RMB = renminbi, USD = US dollar.

Note: The estimated weights of the euro and yen are not depicted.

Source: Authors' computation.

Figure 4: Estimated US Dollar and Renminbi Weights from Rolling Regressions of the Frankel–Wei Model Used by Subramanian and Kessler (2013)





RMB = renminbi, USD = US dollar.

Note: The estimated weights of the euro and yen are not depicted.

Source: Authors' computation.

4.2 Using the US dollar as the Numeraire Currency

The second way of surmounting the problem of multicollinearity is to express all the exchange rates in terms of the US dollar and place the RMB–US dollar rate on the right-hand side of the regression equation. This approach removes the US dollar movements from the right-hand side of the Frankel–Wei regression model, making the dollar the numeraire currency, and then uses the movements in the RMB rate per US dollar as one of the right-hand side variables. The regression equation is expressed as:

$$\Delta\log\left(\frac{x}{\mathrm{USD}}\right) = \alpha_0 + \alpha_2\Delta\log\left(\frac{\mathrm{EURO}}{\mathrm{USD}}\right) + \alpha_3\Delta\log\left(\frac{\mathrm{JPY}}{\mathrm{USD}}\right) + \alpha_4\Delta\log\left(\frac{\mathrm{GBP}}{\mathrm{USD}}\right) + \alpha_5\Delta\log\left(\frac{\mathrm{RMB}}{\mathrm{USD}}\right) + u''. \quad (3)$$

This equation is essentially the same as equation (2) except that the term, $\Delta\log\left(\frac{\mathrm{USD}}{\mathrm{CHF}}\right)$, is subtracted from both sides of (2) under the assumption that the weights of the currencies on the right-hand side sum up to one, i.e., $\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4 + \alpha_5 = 1$. In this way, the multicollinearity problem can be expected to be resolved in principle. The US dollar weight is thus implied from the estimation of this modified Frankel–Wei model and obtained as: $\alpha_1 = 1 - \alpha_2 - \alpha_3 - \alpha_4 - \alpha_5$. For instance, Ho, Ma, and McCauley (2005) employed this approach by using the movements in the RMB non-deliverable forward (NDF) rate per US dollar as the RMB variable on the right-hand side of equation (3).[7] Their results are summarized in Table 4.

Columns 1–6 of the table summarize the actual coefficient estimates of the euro, yen, and RMB NDF weights from the Ho–Ma–McCauley (2005) study. Specifically, the authors conducted the estimation of their modified version of the Frankel–Wei regression for two separate years, 2003 (columns 1–3) and 2004 (columns 4–6). According to their study's findings, the role of the RMB was significant even after controlling for yen and euro movements, and most of the Asian currencies they considered tracked the RMB. The importance of the RMB rose in three currencies, the rupiah, won, and NT dollar, between 2003 and 2004.

[7] In addition, Ho, Ma, and McCauley (2005) excluded the pound sterling from the right-hand of the equation by assuming $\alpha_4 = 0$.

Table 4: Ho, Ma, and McCauley (2005) Estimation Results

	Ho–Ma–McCauley Own Estimates						**Replication of Ho–Ma–McCauley Estimates**							
	2003			2004			2003				2004			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	Euro	Yen	RMB NDF	Euro	Yen	RMB NDF	Euro	Yen	RMB NDF	US dollar	Euro	Yen	RMB NDF	US dollar
Korean won	0.04	0.33***	0.17*	0.12***	0.32***	0.30***	-0.01	0.37***	0.06	0.57***	0.03	0.30***	0.19**	0.46***
NT dollar	0.03**	0.09***	0.12***	0.00	0.20***	0.28***	0.55***	0.14	0.20***	0.09	0.45***	0.33***	0.10*	0.10
Indonesian rupiah	0.09**	0.15***	0.12	0.12***	0.28***	0.30***	0.00	0.13**	0.09	0.75***	0.07	0.21***	0.41***	0.29**
Philippine peso	0.01	0.09**	0.02	0.02	0.08***	0.00	0.08*	0.12*	0.09	0.70***	0.22***	0.25***	-0.13	0.65***
Singapore dollar	0.08***	0.21***	0.15***	0.11***	0.22***	0.11*	0.05***	0.27***	0.15***	0.51***	0.10***	0.32***	0.07	0.49***
Thai baht	0.04*	0.24***	0.14**	0.08***	0.22***	0.13**	0.04**	0.22***	0.15**	0.57***	0.05**	0.22***	0.21***	0.50***

RMB NDF = renminbi non-deliverable forward.

Notes:

(a) Columns 1–6 are the actual estimates from Ho, Ma and McCauley (2005) and taken from Table 3 of their study.

(b) Columns 7–12 summarize regression results based on the same Frankel–Wei equation employed by Ho, Ma, and McCauley (2005), but using our own exchange rate dataset. Columns 10–14 report the implied US dollar weights, which are obtained from the equation in (c) as $\alpha_1 = 1 - \alpha_2 - \alpha_3 - \alpha_5$.

(c) The estimating equation employed by Ho, Ma, and McCauley (2005), who use the US dollar as the numeraire currency, is:

$$\Delta \log\left(\frac{x}{USD}\right) = \alpha_0 + \alpha_2 \Delta \log\left(\frac{EURO}{USD}\right) + \alpha_3 \Delta \log\left(\frac{JPY}{USD}\right) + \alpha_5 \Delta \log\left(\frac{RMB\ NDF}{USD}\right) + u'' \quad ,$$

(d) Asterisks, *, **, ***, indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The significantly estimated RMB coefficients are in boldface.

Sources: Ho, Ma, and McCauley (2005); and authors' computation.

Columns 7–14 of Table 4 report our reproduction of the Ho–Ma–McCauley results using our own exchange rate dataset. Specifically, columns 7–9 and columns 11–13 present our reproduction of their estimates for 2003 and 2004, respectively. We also report in columns 10 and 14 the implied US dollar weights from our reproduction of the Ho–Ma–McCauley estimates for 2003 and 2004, respectively.[8] While there is some slight variation in our estimates from the Ho–Ma–McCauley actual estimates, our results are still consistent with their assertion of a general tracking of RMB movements by most of these Asian currencies and a significant role for the RMB during 2003 and 2004.

More specifically, a comparison of the RMB and implied US dollar weights in columns 9 and 10 of the table show that the NT dollar had already attached a larger weight to the RMB than to the US dollar in 2003. A comparison of columns 13 and 14 indicates that while the NT dollar seems to have reduced its RMB weight in 2004, the rupiah attached a much larger weight to the RMB than to the US dollar in that year. Thus, the results of Ho, Ma, and McCauley suggested a *de facto* formation of the RMB bloc in some economies even in 2003 and 2004.

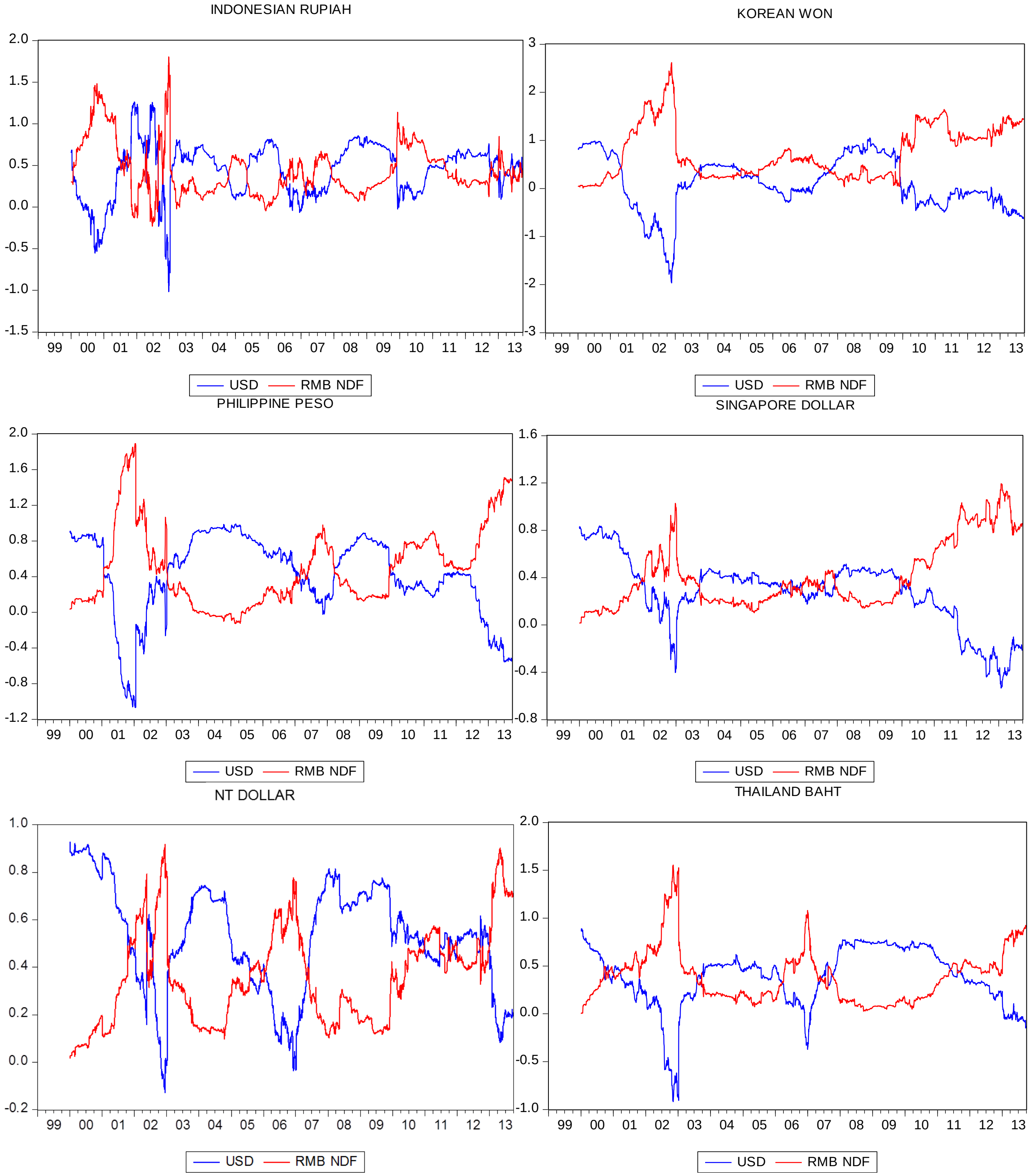
The important question is: how much confidence should we place in the above estimates? In other words, how effective is this approach in surmounting the problem of multicollinearity between movements in the US dollar and the RMB when the movements in the RMB–US dollar rate are removed from the right-hand side of the equation and the US dollar is made the numeraire currency? Our recourse in answering these questions is to employ the same strategy that we employed in the previous subsection and to conduct rolling regression estimates of the Frankel–Wei regression employed by Ho, Ma and McCauley. That is, we first specify a window width of 260 daily trading observations and this specified window width is then moved by estimating the Frankel–Wei regression employed by Ho, Ma, and McCauley at a step size of one daily observation at a time and through the remaining observations ending in 2013. Just as in the previous sub-section, in each of the regressions using the specified window width, we can obtain a collection of point estimates of the weights of the currencies on the right-hand side of the Frankel–Wei regression considered by Ho, Ma, and McCauley, including the RMB weights.

Figure 5 depicts the collection of RMB weights (in red) as well as the implied US dollar weights (in blue).[9] Despite the omission of the movements in the RMB-US dollar rates from the right-hand side of the equation, we still observe unstable and very large and small values for both the implied US dollar weights and the RMB weights. These weights behave in contrasting and opposite directions with highly negative correlations. This holds regardless of which period one examines, i.e., the period when the RMB was pegged to the US dollar and the period when it was relatively flexible. The figure plots results using the RMB NDF, but it turns out that results are very similar if we use the RMB spot exchange rate instead of the RMB NDF rate (although this not shown in the figure). These observations suggest that the modified Frankel–Wei regression, equation (3), is not useful in providing stable, robust patterns of currency weights for the US dollar or the RMB. In other words, even though the equation used by Ho, Ma, and McCauley (2005) does not have a problem of multicollinearity, the implied US dollar coefficients behave much like being multicollinear vis-à-vis the RMB coefficients.

[8] Ho, Ma and McCauley (2005) did not report the implied US dollar weights from their actual estimates. However, based on the above discussion of equation (3) the weights of the US dollar can easily be inferred from their estimates as $1-\alpha_2-\alpha_3-\alpha_5$ in the equation under the assumption that $\alpha_4=0$.

[9] Just as in the previous figures, we do not show the weights of the remaining currencies (the euro and yen) on the right-hand side of the equation in order to emphasize the relationship between the US dollar and RMB weights.

Figure 5: Estimated US Dollar and Renminbi Weights from Rolling Regressions of the Frankel–Wei Model Used by Ho, Ma, and McCauley (2005)



RMB NDF = renminbi non-deliverable forward, USD = US dollar.

Note: The estimated USD weights are “implied” values. The estimated weights of the euro and yen are not depicted.

Source: Authors’ computation.

4.3 Removing the US Dollar Component from the Renminbi Movements

The third way of surmounting the problem of multicollinearity in the Frankel–Wei regression model that includes the RMB movements on the right-hand side is the more technical approach of first purging the US dollar component from the RMB movements and then incorporating these 'independent' movements of the RMB in the Frankel–Wei model. This approach has been suggested by several authors, including Balasubramaniam, Patnaik, and Shah (2011) and Fratzscher and Mehl (2011). The approach involves estimating a two-step regression by first regressing RMB exchange rate movements in the US dollar exchange rate movements:

$$\Delta \log\left(\frac{\text{RMB}}{\text{CHF}}\right) = \theta_0 + \theta_1 * \Delta \log\left(\frac{\text{USD}}{\text{CHF}}\right) + \varepsilon, \tag{4}$$

where $\Delta \log\left(\frac{\text{RMB}}{\text{CHF}}\right)$ and $\Delta \log\left(\frac{\text{USD}}{\text{CHF}}\right)$ are, as before, the logarithmic changes in the RMB and US dollar per Swiss franc exchange rates, respectively. Then from this regression, the estimated residuals ($\hat{\varepsilon}$) are obtained and are used in the second-step Frankel–Wei regression as a proxy for the logarithmic change in the RMB per Swiss franc exchange rate:

$$\Delta \log\left(\frac{x}{\text{CHF}}\right) = \beta_0 + \beta_1 \Delta \log\left(\frac{\text{USD}}{\text{CHF}}\right) + \beta_2 \Delta \log\left(\frac{\text{EURO}}{\text{CHF}}\right) + \beta_3 \Delta \log\left(\frac{\text{JPY}}{\text{CHF}}\right) + \beta_4 \Delta \log\left(\frac{\text{GBP}}{\text{CHF}}\right) + \beta_5 \hat{\varepsilon} + u''', \tag{5}$$

where $\hat{\varepsilon} = \Delta \log\left(\frac{\text{RMB}}{\text{CHF}}\right) - [\hat{\theta}_0 + \hat{\theta}_1 * \Delta \log\left(\frac{\text{USD}}{\text{CHF}}\right)]$.

In this equation, $\Delta \log\left(\frac{x}{\text{CHF}}\right)$ is the logarithmic change in an Asian currency per Swiss franc exchange rate and the rest of the exchange rates are as defined earlier.

In their study, Balasubramaniam, Patnaik, and Shah (2011) find that all the East Asian currencies they consider attached importance to the US dollar, and that beginning in October 2005 only two Asian currencies attached importance to the RMB—the ringgit (until June 2007) and the NT dollar (until February 2011). But in June 2007, the ringgit stepped away from giving importance to the RMB. In October 2009, movements in the RMB started to matter for the dong. Thus, at the end of their period of observation, only two Asian currencies, the NT dollar and the dong, were found to have accorded importance to movements in the RMB.

Columns 1–2 of Table 5 show the actual estimates from the same Balasubramaniam–Patnaik–Shah study and these estimates confirm the evidence found by this study. That is, the estimated weights on both the US dollar and the RMB are large in value and statistically significant. For the Viet Nam dong, in particular, the estimated RMB coefficient is larger than the estimated US dollar coefficient. The last columns of Table 5 provide results based on our reproduction of the Balasubramaniam–Patnaik–Shah method, using our own exchange rate dataset.[10] The reproduction shows that the estimated US weights which remain statistically significant are slightly smaller than the original Balasubramaniam–Patnaik–Shah estimates and that the estimated RMB weights are larger than the estimated US dollar weights. Our reproduction of the actual estimates is broadly consistent with the evidence found by Balasubramaniam, Patnaik, and Shah.

[10] Movements in the pound sterling per Swiss franc rate are now included on the right-hand side of equation (5) because Balasubramaniam, Patnaik, and Shah (2011) included the movements in these specific rates in their estimations.

Table 5: Balasubramaniam, Patnaik, and Shah (2011) Estimation Results

		Balasubramaniam–Patnaik–Shah Own Estimates		Replication of Balasubramaniam–Patnaik–Shah Estimates	
Currency		US dollar	RMB	US dollar	RMB
Start date	End date	(1)	(2)	(3)	(4)
Malaysian ringgit		1.23***	**1.13*** **	0.74***	**0.95*** **
14 Oct 2005	11 Jun 2007				
NT dollar		1.03***	**0.45*** **	0.69***	**0.75*** **
14 Oct 2005	11 Feb 2011				
Viet Nam dong		0.82***	**1.39*** **	0.57***	**0.94*** **
16 Oct 2009	11 Feb 2011				

RMB = renminbi.

Notes:

(a) Columns 1 and 2 are the actual estimates from Balasubramaniam, Patnaik, and Shah (2011) and taken from Table 8 of their study.

(b) Columns 3 and 4 summarize regression results based on the same two-step regression employed by Balasubramaniam, Patnaik, and Shah, but using our own exchange rate dataset.

(c) The estimating equation employed by Balasubramaniam, Patnaik, and Shah, who use the Swiss franc as the numeraire currency, is:

$$\Delta\log\left(\frac{\mathrm{RMB}}{\mathrm{CHF}}\right) = \theta_0 + \theta_1 \Delta\log\left(\frac{\mathrm{USD}}{\mathrm{CHF}}\right) + \varepsilon,$$

$$\Delta\log\left(\frac{x}{\mathrm{CHF}}\right) = \beta_0 + \beta_1\Delta\log\left(\frac{\mathrm{USD}}{\mathrm{CHF}}\right) + \beta_2\Delta\log\left(\frac{\mathrm{EURO}}{\mathrm{CHF}}\right) + \beta_3\Delta\log\left(\frac{\mathrm{JPY}}{\mathrm{CHF}}\right) + \beta_4\Delta\log\left(\frac{\mathrm{GBP}}{\mathrm{CHF}}\right) + \beta_5\hat{\varepsilon} + u''',$$

where $\hat{\varepsilon} = \Delta\log\left(\frac{\mathrm{RMB}}{\mathrm{CHF}}\right) - [\hat{\theta}_0 + \hat{\theta}_1\Delta\log\left(\frac{\mathrm{USD}}{\mathrm{CHF}}\right)]$.

(d) Asterisks, *, **, ***, indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The significantly estimated RMB coefficients are in boldface.

Sources: Balasubramaniam, Patnaik and Shah (2011); and authors' computation.

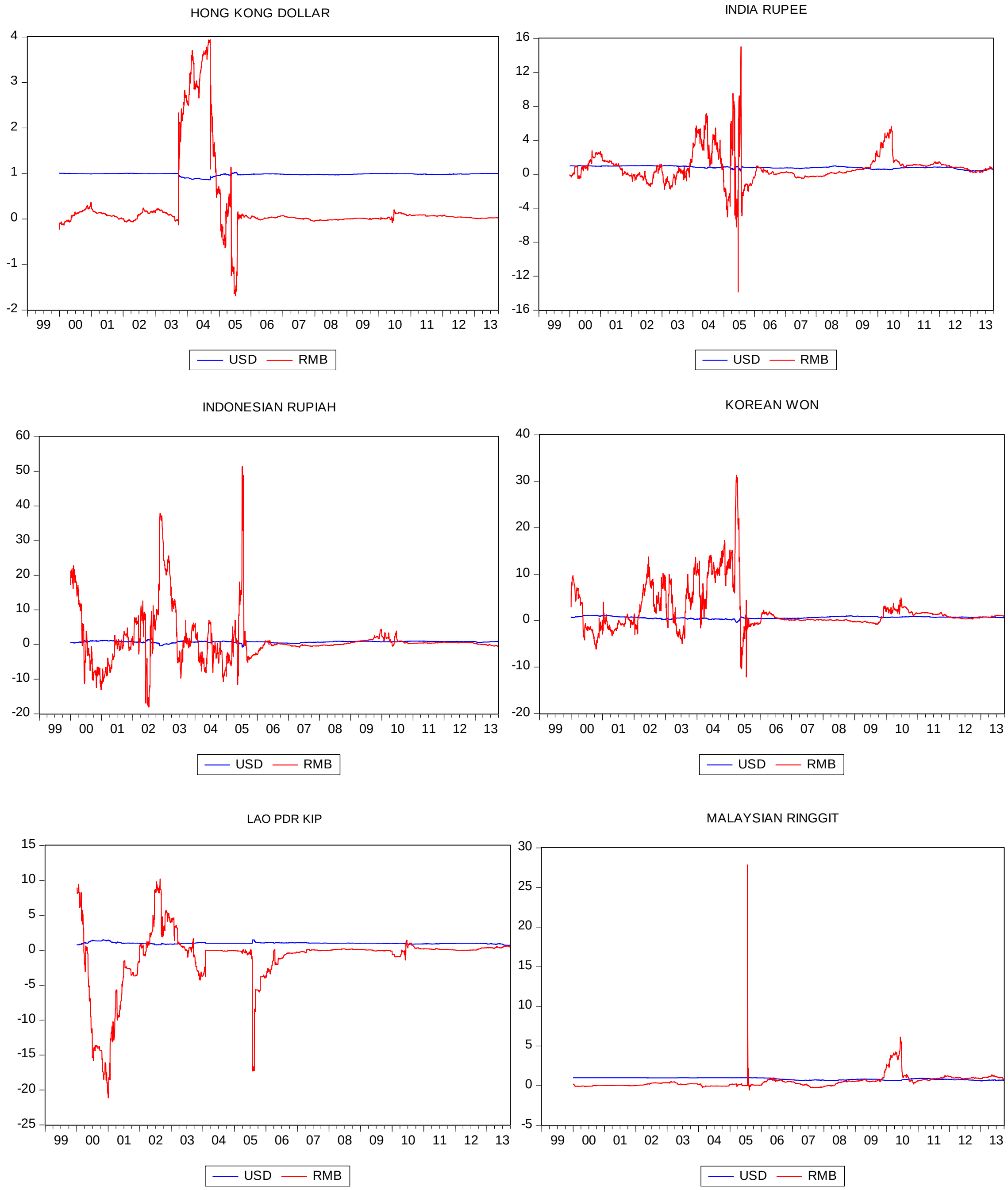
Once again we need to assess how effective this alternative approach is in surmounting the problem of multicollinearity between movements in the US dollar and the RMB. In addition to the issue of multicollinearity, the sum of the US dollar and RMB weights exceeds one by a large margin, suggesting the possibility of an overestimation of at least one of the two currency weights, most likely of the RMB.

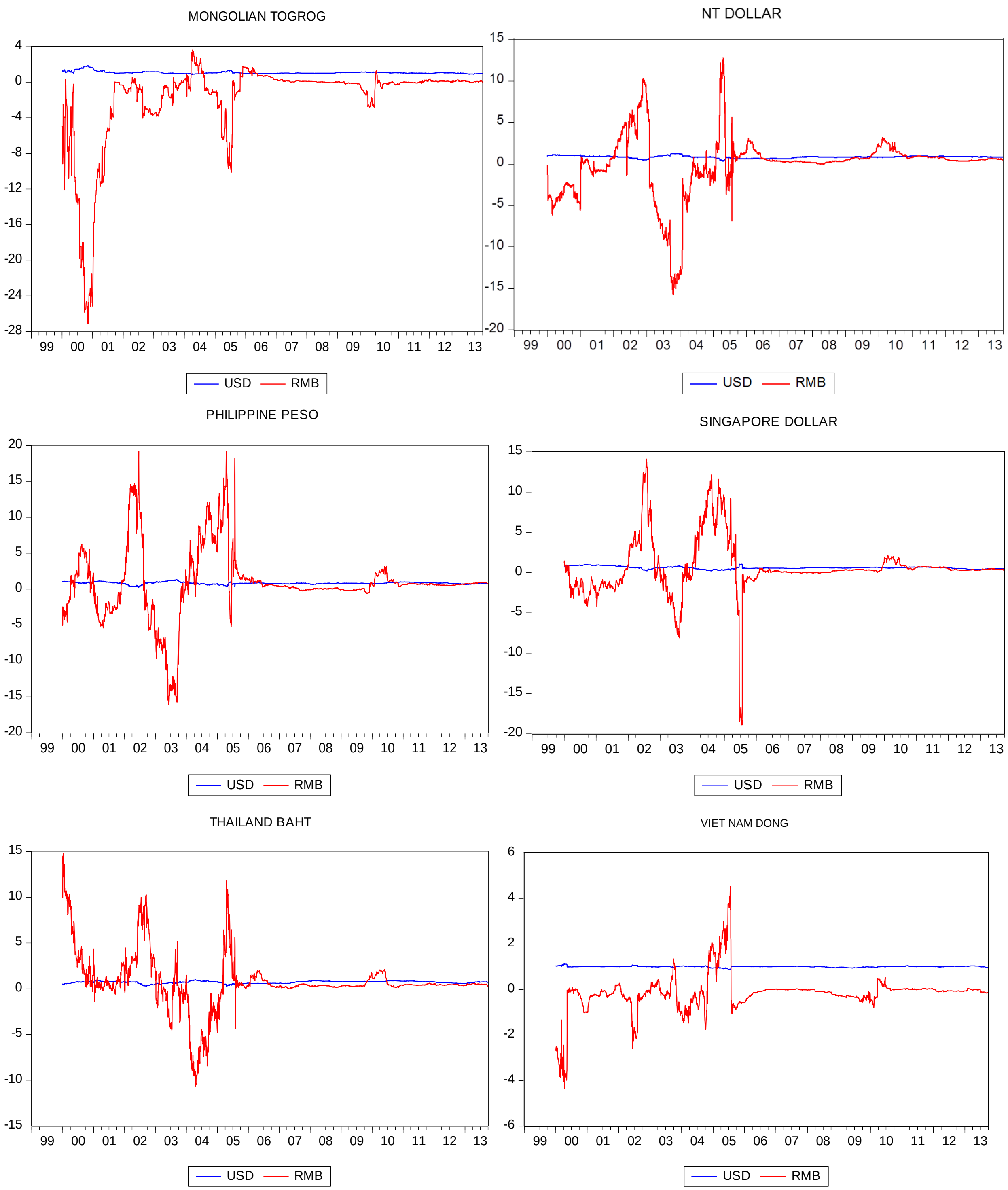
We again employ the rolling regression adopted in the previous subsections. That is, after removing the US dollar component from the RMB movements and obtaining these independent RMB movements from the first-step regression, we then conduct rolling regressions of the second-step Frankel–Wei regression. As explained earlier, in the second step, the residuals obtained from the first-step regression are included on the right-hand side. The way the rolling regressions are carried out in the second-step Frankel–Wei regression are the same as those in the previous sub-sections: we first specify a window width of 260 daily trading observations and this specified window width is then moved by estimating the second-step regression at a step-size of one daily observation at a time and through the remaining observations. In each of the regressions using the specified window width, we obtain a collection of point estimates of the weights of the currencies on the right-hand side of the second-step Frankel–Wei regression, including the US dollar weights and the RMB weights.

Figure 6 depicts the estimated weights of the US dollar (in blue) and the RMB (in red), from the rolling regressions of the second-step Frankel–Wei regression.[11] It is obvious that, using this approach, the US dollar weights have now become more stable than those in the previous sub-sections, although the RMB weights remain very volatile. That is, the Balasubramaniam–Patnaik–Shah approach captures the official peg of the Hong Kong dollar to the US dollar, the peg of the dong, and the pre-July 2005 peg of the ringgit to the US dollar and its shift to a more flexible exchange rate thereafter. It also shows that other East Asian currencies—including the peso, ringgit (following its decision in the middle of July 2005 to relax its US dollar peg), rupiah, Singapore dollar, baht and won—have attached large weights, close to unity, to the US dollar particularly in the early 2000s. The only remaining concern is that the estimated RMB weights which exhibit unstable and very large or small values for almost the whole period of observation. This is the case even if we exclude the observation period that focuses on the RMB's US dollar-peg, i.e., from January 2000 to July 2006 and the period from mid-2009 to early 2011.

[11] In constructing the figure, the first-step regression is conducted over the entire sample period for simplicity, while the second-step regression is carried out for each moving window of 260 days. Our preliminary investigation suggests that even when the first-step regression is conducted for each window of 260 days, the second-step regression results turn out to be very similar. In Tables 6 and 10 to be discussed later, both the first-step and second-step regressions are run for each of the specific sub-sample periods.

Figure 6: Estimated US Dollar and Renminbi Weights from Rolling Regressions of the Second-Step Frankel–Wei Regression Used by Balasubramaniam, Patnaik, and Shah (2011)





Lao PDR = Lao People’s Democratic Republic, RMB = renminbi, USD = US dollar.

Note: The estimated weights of the euro, pound sterling, and yen are not depicted.

Source: Authors’ computation.

5. A NEW ESTIMATION METHOD

5.1 A New Two-Step Approach

This section presents our own method of surmounting the problem of multicollinearity in the Frankel–Wei regression model that includes the RMB movements on the right-hand side. In our method we still conduct a two-step regression and follow at first the strategy of removing the 'dependent' components of the movements in the RMB from the movements of major international currencies, including the US dollar, and obtaining the residuals from the following first-step regression:

$$\Delta\log\left(\frac{\mathrm{RMB}}{\mathrm{NZD}}\right) = \phi_0 + \phi_1\Delta\log\left(\frac{\mathrm{USD}}{\mathrm{NZD}}\right) + \phi_2\Delta\log\left(\frac{\mathrm{EURO}}{\mathrm{NZD}}\right) + \phi_3\Delta\log\left(\frac{\mathrm{JPY}}{\mathrm{NZD}}\right) + \phi_4\Delta\log\left(\frac{\mathrm{GBP}}{\mathrm{NZD}}\right) + \omega, \quad (6)$$

where $\Delta\log\left(\frac{k}{\mathrm{NZD}}\right)$, k = *RMB, USD, EURO, JPY, and GBP*, is the logarithmic change in the exchange rate of currency k (the RMB, US dollar, euro, yen, and pound sterling, respectively) per New Zealand dollar. Equation (6) can be interpreted as determining the weights accorded by the PRC authorities to the major international currencies in their own exchange rate currency basket. This should not be regarded as new because since the July 2005 official reform of its exchange rate management regime, the PRC has allegedly introduced relative flexibility against a basket of currencies.[12]

Notice also from equation (6) that our choice of the numeraire currency is the New Zealand dollar. This is because there are problems with the two typical numeraire currencies, the Swiss franc and the SDR. The Swiss franc has been pegged to the euro since September 2011 and as such estimation of the Frankel–Wei model from this period on goes against the typical notion of a numeraire currency, that it should be freely-floating. The SDR, on the other hand, comprises the same currencies that are included on the right-hand side of equation (6). The choice of the New Zealand dollar in our estimation is based on the fact that it is a freely-floating currency of a small and open economy without capital and exchange controls and one that we ought to reasonably believe should not accord of major importance or significant weight to the currency baskets of the Asian economies that we examine here.[13]

Once the estimated residuals from the above estimation, $\hat{\omega}$, are obtained, we subtract these residuals from both sides of the Frankel–Wei regression model as in equation (5), i.e., the previously discussed model of including the residuals on the right-hand side of the Frankel–Wei model as a proxy for the actual RMB movements. The Frankel–Wei regression model that corresponds to equation (5) is:

$$\Delta\log\left(\frac{x}{\mathrm{NZD}}\right) = \gamma_0 + \gamma_1\Delta\log\left(\frac{\mathrm{USD}}{\mathrm{NZD}}\right) + \gamma_2\Delta\log\left(\frac{\mathrm{EURO}}{\mathrm{NZD}}\right) + \gamma_3\Delta\log\left(\frac{\mathrm{JPY}}{\mathrm{NZD}}\right) + \gamma_4\Delta\log\left(\frac{\mathrm{GBP}}{\mathrm{NZD}}\right) + \gamma_5\hat{\omega} + v, \quad (7)$$

[12] On 21 July 2005, the PRC modified its currency policy by announcing that the RMB's exchange rate would become "adjustable, based on market supply and demand with reference to exchange rate movements of currencies in a basket." It was later announced that the composition of the basket would include the US dollar, yen, euro, and a few other currencies. Then, the PRC's currency appreciation policy was momentarily halted in the mid-summer of 2008 which continued to the early-summer of 2010. On 19 June 2010, the PRC decided to proceed further with reform of the RMB exchange rate regime by enhancing the flexibility of the RMB. It should be noted that there is little difference in the results when only the US dollar is included on the right-hand side of equation (6). The results are available from the authors upon request.

[13] It turns out that using other floating currencies such as the Canadian dollar would not change the qualitative results of our empirical analysis.

where $\hat{\omega} = \Delta\log\left(\frac{\text{RMB}}{\text{NZD}}\right) - [\hat{\phi}_0 + \hat{\phi}_1\Delta\log\left(\frac{\text{USD}}{\text{NZD}}\right) + \hat{\phi}_2\Delta\log\left(\frac{\text{EURO}}{\text{NZD}}\right) + \hat{\phi}_3\Delta\log\left(\frac{\text{JPY}}{\text{NZD}}\right) + \hat{\phi}_4\Delta\log\left(\frac{\text{GBP}}{\text{NZD}}\right)]$.

Subtracting the residuals, $\hat{\omega}$, from both sides of equation (7) under the assumption that the weights of the currencies on the right-hand side of (7) sum up to one, i.e., $\gamma_1 + \gamma_2 + \gamma_3 + \gamma_4 + \gamma_5 = 1$, we obtain the modified version of the Frankel–Wei regression model for a particular East Asian emerging economy currency, x:

$$\Delta\log\left(\frac{x}{\text{NZD}}\right) - \hat{\omega} = \gamma_0 + \gamma_1\left[\Delta\log\left(\frac{\text{USD}}{\text{NZD}}\right) - \hat{\omega}\right] + \gamma_2\left[\Delta\log\left(\frac{\text{EURO}}{\text{NZD}}\right) - \hat{\omega}\right] + \gamma_3\left[\Delta\log\left(\frac{\text{JPY}}{\text{NZD}}\right) - \hat{\omega}\right] + \gamma_4\left[\Delta\log\left(\frac{\text{GBP}}{\text{NZD}}\right) - \hat{\omega}\right] + v \qquad (8)$$

Estimation of this modified Frankel–Wei regression equation (8) yields the implied RMB coefficient as: $\gamma_5 = 1 - \gamma_1 - \gamma_2 - \gamma_3 - \gamma_4$. The statistical significance of the implied RMB coefficient obtained from equation (8) can be tested using a standard hypothesis test.[14]

5.2 Estimation Results

Figure 7 presents the rolling regression estimates of the US dollar (blue), RMB (red), euro (yellow), yen (green), and pound sterling (gray) weights using our new approach. The estimated RMB weights are the "implied" values. We conduct rolling regressions in a way identical to the approach taken in the previous section. We specify a window width of 260 daily trading observations and then move this specified window width by estimating the second-step regression above (equation (8)) at a step size of one daily observation at a time and through the remaining observations.[15] We again observe the benefit of the use of our rolling regression estimates in the sense that we are able to get a clear picture of the behavior of these respective weights throughout our period of examination. More to the point, our alternative estimation approach provides us with reasonable estimates of the weights of all the currencies on the right-hand side of this modified version of the Frankel–Wei model.

Several important observations can be made from Figure 7. First, this new approach produces much more stable and smoothly changing estimates on the RMB weights, in addition to the US dollar weights, than in the previous approaches. There are a few observations where the RMB weights sharply change and the RMB and other non-US dollar major currencies exhibit strong negative correlations, such as the riel in late 2004 and the kip in 2005–2006. Apart from these episodes, the RMB coefficients depicted in the figure are much less volatile than those in earlier figures. This suggests a superior estimation outcome to those of all other approaches examined in this paper.

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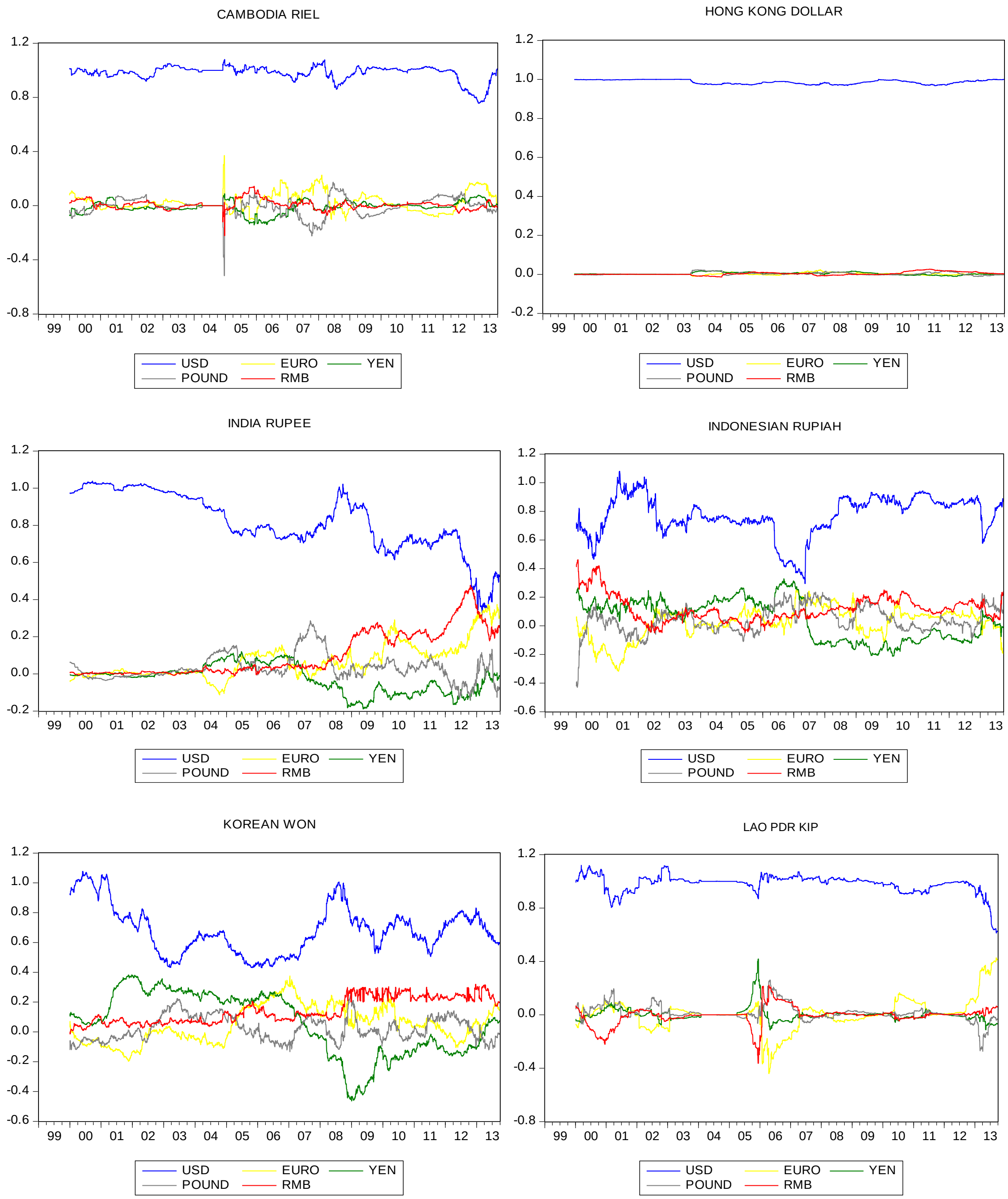
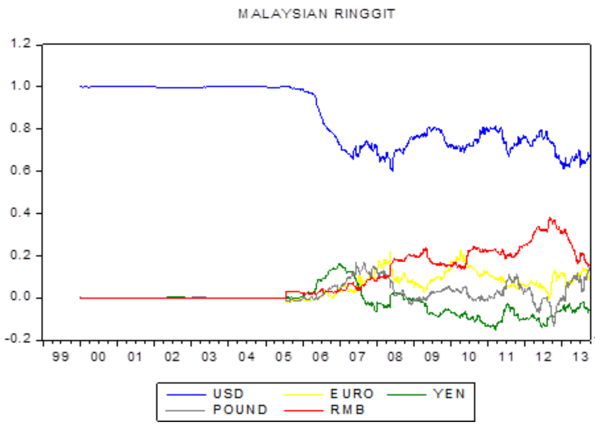
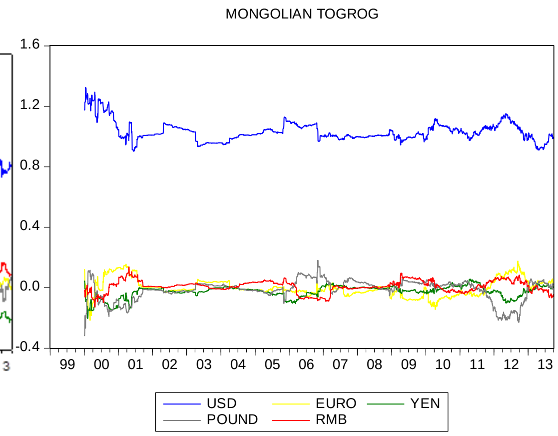
[14] Appendix Table A.1 summarizes the correlation coefficients among pairs of the logarithmic changes in the RMB, US dollar, euro, yen, and pound sterling per New Zealand dollar for various sub-sample periods.

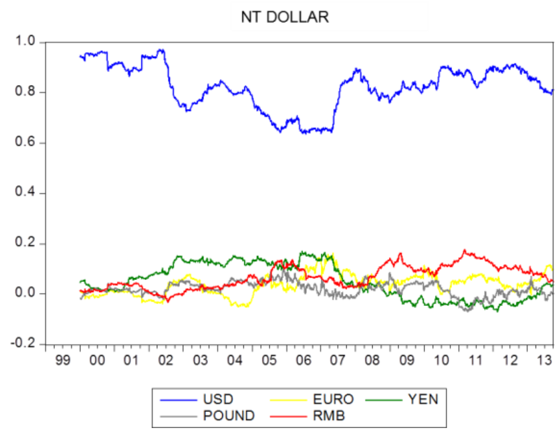
[15] In producing the figure, the first-step regression is conducted over the entire sample period for simplicity, while the second-step regression is carried out for each moving window of 260 days. Our preliminary investigation suggests that even when the first-step regression is conducted for each window of 260 days, the second-step regression results turn out to be very similar. In Tables 6–10 and the Appendix tables to be discussed later, both the first-step and second-step regressions are run for each of the specific sub-sample periods.

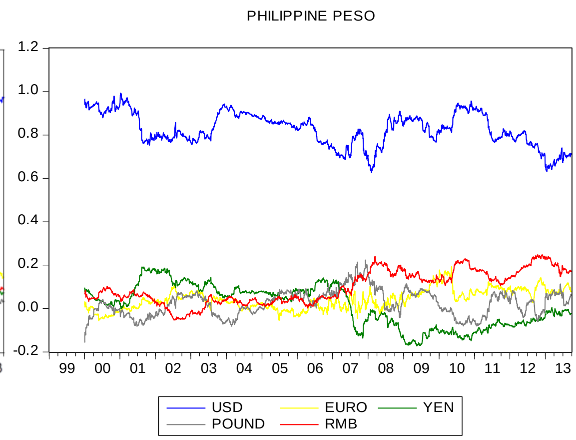
Figure 7: Estimated US Dollar, Renminbi, Euro, Pound Sterling, and Yen Weights from Rolling Regressions Using the New Approach

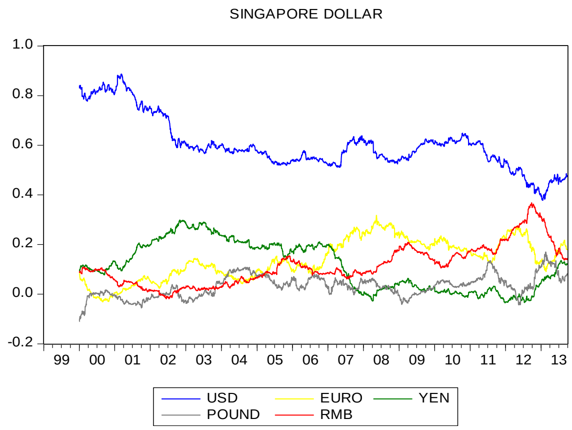


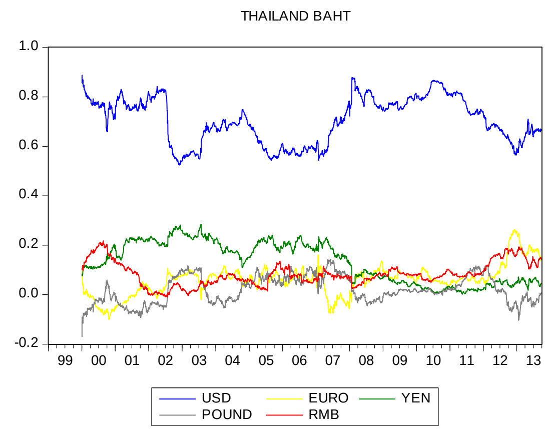

MALAYSIAN RINGGIT
USD
EURO
YEN
POUND
RMB

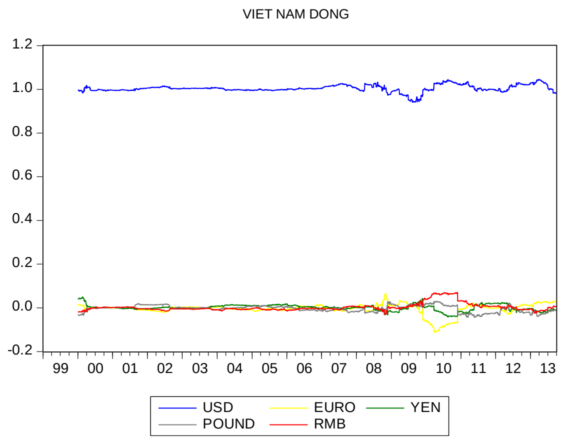

MONGOLIAN TOGROG
USD
EURO
YEN
POUND
RMB


NT DOLLAR
USD
EURO
YEN
POUND
RMB


PHILIPPINE PESO
USD
EURO
YEN
POUND
RMB


SINGAPORE DOLLAR
USD
EURO
YEN
POUND
RMB


THAILAND BAHT
USD
EURO
YEN
POUND
RMB



Lao PDR = Lao People's Democratic Republic, POUND = pound sterling, RMB = renminbi, USD = US dollar.

Note: The estimated RMB weights are "implied" values obtained from equation (8).

Source: Authors' calculations.

The superiority of the new method over the Balasubramaniam–Patnaik–Shah method can be confirmed by comparing the goodness-of-fit of the two methods. Table 6 presents the goodness-of-fit measured in terms of the constructed *R*-squared values of the new method and the Balasubramaniam–Patnaik–Shah method. The constructed *R*-squared values are clearly larger under the new method (columns 3 and 4) than under the Balasubramaniam–Patnaik–Shah method (columns 1 and 2) and this is the outcome regardless of the numeraire currency—that is, comparing columns 1 and 3 for the Swiss franc and comparing columns 2 and 4 for the New Zealand dollar. The analysis in the previous section, reported in Figure 6, shows that even though the Balasubramaniam–Patnaik–Shah method addresses the multicollinearity problem, the estimated RMB coefficients are unstable. The new method, which is an extension of the Balasubramaniam–Patnaik–Shah method, addresses both the multicollinearity problem and the unstable RMB coefficient problem, and yields much higher goodness-of-fit measured in terms of constructed *R*-squared.[16]

Second, for all the emerging Asian currencies considered, the US dollar reigns supreme as the major anchor currency in view of the much higher estimated weights. As in Figure 6, the new approach captures the official US dollar peg of the Hong Kong dollar and the pre-July 2005 ringgit. Furthermore, throughout the estimation period, the US dollar is also the most important anchor currency for the kip, togrog, NT dollar, and dong. These currencies are followed by another large group of Asian currencies, namely, the peso, post-July 2005 ringgit, rupiah, Singapore dollar, baht, and won, which have attached less importance to the US dollar in recent years. Although the estimated US dollar weights for these currencies have declined since the mid-2000s, the US dollar's role has not been replaced by that of the RMB. In the case of the Indian rupee, sometime in the beginning of 2012, the importance of the US dollar in its currency basket declined but began to bounce back in 2013.

[16] One should then note that a comparison of the goodness-of-fit of the new method and the other previous approaches (Ho, Ma, and McCauley 2005; Henning 2012; Subramanian and Kessler 2013) via constructed R-squared values are not plausible. The reason for this is that these studies involve the problem of multicollinearity and as such the constructed R-squared values of these other approaches are inflated and are not appropriate measures of goodness of fit.

Table 6: Goodness-of-Fit of the Estimation Results Using the Balasubramaniam–Patnaik–Shah (2011) Approach and the New Method

		Goodness-of-Fit of the Replication of Balasubramaniam–Patnaik–Shah Estimates		Goodness-of-Fit of the Estimation Results Using the New Method	
Currency		With Swiss franc as numeraire	With New Zealand dollar as numeraire	With Swiss Franc as numeraire	With New Zealand dollar as numeraire
Start date	End date	(1)	(2)	(3)	(4)
Malaysian ringgit		0.51	0.41	0.76	0.89
14 Oct 2005	11 Jun 2007				
NT dollar		0.27	0.39	0.75	0.91
14 Oct 2005	11 Feb 2011				
Viet Nam dong		0.48	0.53	0.68	0.80
16 Oct 2009	11 Feb 2011				

Notes:

(a) The R-squared values, showing goodness-of-fit, are constructed by using the standard definition of assessing the fit between the actual values of y to its predicted values ($\hat{y}$). The latter is constructed by using the estimated currency basket weights and the actual logarithmic changes of the currencies on the right-hand side of the equation. Specifically, the predicted values ($\hat{y}$) for columns 1 and 2 and columns 3 and 4 of the table are constructed as in (b) and (c) below, respectively.

(b) Using the Balasubramaniam–Patnaik–Shah method in column 1, the predicted values ($\hat{y}$) are obtained as:

$$\widehat{\Delta \log\left(\frac{x}{\mathrm{CHF}}\right)} = \widehat{\beta_0} + \widehat{\beta_1}\,\Delta\log\left(\frac{\mathrm{USD}}{\mathrm{CHF}}\right) + \widehat{\beta_2}\Delta\log\left(\frac{\mathrm{EURO}}{\mathrm{CHF}}\right) + \widehat{\beta_3}\Delta\log\left(\frac{\mathrm{JPY}}{\mathrm{CHF}}\right) + \widehat{\beta_4}\Delta\log\left(\frac{\mathrm{GBP}}{\mathrm{CHF}}\right) + \widehat{\beta_5}\Delta\log\left(\frac{\mathrm{RMB}}{\mathrm{CHF}}\right) + \varepsilon$$

where the estimated beta coefficients are obtained from the estimation of the equations: equations:

$$\Delta\log\left(\frac{\mathrm{RMB}}{\mathrm{CHF}}\right) = \theta_0 + \theta_1\Delta\log\left(\frac{\mathrm{USD}}{\mathrm{CHF}}\right) + \varepsilon,$$

$$\Delta\log\left(\frac{x}{\mathrm{CHF}}\right) = \beta_0 + \beta_1\Delta\log\left(\frac{\mathrm{USD}}{\mathrm{CHF}}\right) + \beta_2\Delta\log\left(\frac{\mathrm{EURO}}{\mathrm{CHF}}\right) + \beta_3\Delta\log\left(\frac{\mathrm{JPY}}{\mathrm{CHF}}\right) + \beta_4\Delta\log\left(\frac{\mathrm{GBP}}{\mathrm{CHF}}\right) + \beta_5\hat{\varepsilon} + u''',$$

where $\hat{\varepsilon} = \Delta\log\left(\frac{\mathrm{RMB}}{\mathrm{CHF}}\right) - [\hat{\theta}_0 + \hat{\theta}_1\Delta\log\left(\frac{\mathrm{USD}}{\mathrm{CHF}}\right)]$.

In column 2, the equations used to obtain the predicted values ($\hat{y}$) and the equations used to estimate the beta coefficients are the same as those above except that CHF is replaced by NZD.

(c) Using the new method in column 3, the predicted values ($\hat{y}$) are obtained using the equation:

$$\widehat{\Delta \log\left(\frac{x}{\mathrm{CHF}}\right)} = \widehat{\gamma_0} + \widehat{\gamma_1}\,\Delta\log\left(\frac{\mathrm{USD}}{\mathrm{CHF}}\right) + \widehat{\gamma_2}\Delta\log\left(\frac{\mathrm{EURO}}{\mathrm{CHF}}\right) + \widehat{\gamma_3}\Delta\log\left(\frac{\mathrm{JPY}}{\mathrm{CHF}}\right) + \widehat{\gamma_4}\Delta\log\left(\frac{\mathrm{GBP}}{\mathrm{CHF}}\right) + \widehat{\gamma_5}\Delta\log\left(\frac{\mathrm{RMB}}{\mathrm{CHF}}\right) + \varepsilon$$

where the estimated gamma coefficients are obtained from the estimation of the equations:

$$\Delta\log\left(\frac{\mathrm{RMB}}{\mathrm{CHF}}\right) = \phi_0 + \phi_1\Delta\log\left(\frac{\mathrm{USD}}{\mathrm{CHF}}\right) + \omega$$

$$\Delta\log\left(\frac{x}{\mathrm{CHF}}\right) - \hat{\omega} = \gamma_0 + \gamma_1\left[\Delta\log\left(\frac{\mathrm{USD}}{\mathrm{CHF}}\right) - \hat{\omega}\right] + \gamma_2\left[\Delta\log\left(\frac{\mathrm{EURO}}{\mathrm{CHF}}\right) - \hat{\omega}\right] + \gamma_3\left[\Delta\log\left(\frac{\mathrm{JPY}}{\mathrm{CHF}}\right) - \hat{\omega}\right] + \gamma_4\left[\Delta\log\left(\frac{\mathrm{GBP}}{\mathrm{CHF}}\right) - \hat{\omega}\right] + v$$

where $\hat{\omega} = \Delta\log\left(\frac{\mathrm{RMB}}{\mathrm{CHF}}\right) - [\hat{\phi}_0 + \hat{\phi}_1\Delta\log\left(\frac{\mathrm{USD}}{\mathrm{CHF}}\right)]$.

In column 4, the equations used to obtain the predicted values ($\hat{y}$) and the equations used to estimate the gamma coefficients are the same as those above except that CHF is replaced by NZD.

Source: Authors' computation.

Third, the importance of the Japanese yen has varied in the 2000s and 2010s for some currencies, notably the peso, rupiah, Singapore dollar, baht, NT dollar, and the won. The weights of the yen were high between the end of the Asian financial crisis and the beginning of the global financial crisis but have declined since then.

Finally, it is only in recent years that the importance of the RMB has risen in some of the Asian currencies that we have examined. This holds true particularly in the case of the Indian rupee, peso, ringgit, Singapore dollar, baht, NT dollar, and won. In a sense the weights of the RMB rose at the expense of the yen. Nonetheless, these estimated weights for the RMB in recent times are not sufficient for us to be able to conclude that the RMB has supplanted the US dollar in the currency baskets of these economies.

5.3 A Renminbi Bloc in Asia?

While the evidence above has already given us an indication on whether there is indeed an RMB bloc in Asia, we can deal with this question by examining the US dollar and RMB weights obtained from our new method for the same group of East Asian currencies that earlier authors focused on. In other words, using our new method, we now arrive at individual point estimates of the US dollar and RMB weights of those East Asian currencies that have been found previously by Ho, Ma, and McCauley (2005); Balasubramaniam, Patnaik and Shah (2011); Henning (2012); and Subramanian and Kessler (2013) to have formed an RMB bloc during those same periods that they have considered in their studies. The results presented in this section should then further reinforce the evidence presented in the previous section on the issue of the existence of an RMB bloc in Asia. The results are presented below in Table 7 for Ho, Ma and McCauley (2005), Table 8 for Henning (2012), Table 9 for Subramanian and Kessler (2013), and Table 10 for Balasubramaniam, Patnaik, and Shah (2011).

Period of US dollar-peg of the RMB

Columns 1–4 of Table 7 repeat columns 9 and 10 and columns 13 and 14 of Table 4, in which we reproduced the Ho–Ma–McCauley results for 2003 and 2004 using the Frankel–Wei equation that they had employed, but using our exchange rate dataset. Unlike other authors, they used the RMB NDF rate to represent the RMB. To recap, the key findings from these results are that the RMB already played a prominent role in several East Asian currencies even in 2003 and 2004 and that the RMB’s role was particularly pronounced in the case of the NT dollar in 2003 and the rupiah, won, and baht in 2004. In 2003, the NT dollar already attached a larger weight to the RMB than to the US dollar, while in 2004 the rupiah attached a larger weight to the RMB than to the US dollar. So these economies were *de facto* in an RMB bloc in as early as 2003–2004.

Columns 5–12 of Table 7 summarize the results obtained from our new method for 2003 and 2004. Columns 5–8 report results using the RMB NDF rate as was done by Ho, Ma, and McCauley (2005), and columns 9–12 report results using the RMB spot exchange rate. We can see that the estimated weights of the US dollar are very similar in magnitude and statistical significance whether we use the RMB NDF rate or the RMB spot rate. In contrast, the magnitude and statistical significance of the implied RMB weights are slightly greater when the RMB NDF rate is used than when the RMB spot rate is used. The overall qualitative indications, however, are similar.

Looking at the results from our new method, we can observe what Ho, Ma, and McCauley partially found: the RMB weights were already significant in several economies (four economies using the RMB NDF and one economy using the RMB spot rate) even in 2003, and the importance of the RMB rose between 2003 and 2004. On the other hand, we do not observe

Ho, Ma, and McCauley's other findings as our results indicate that the US dollar commanded much larger weights than did the RMB in 2003 and 2004 in all the East Asian currencies considered. For example, the estimated RMB weights were mostly significant in 2004 but still much smaller in value than the US dollar weights. In the case of the NT dollar, we can see that, while the estimated RMB weights were significant in 2003 using the RMB NDF rate (column 7), they were markedly smaller than the Ho–Ma–McCauley estimate (column 3). In the case of the rupiah and won, the estimated RMB weights were significant in 2004 (columns 8 and 12), but their magnitudes were considerably smaller than the Ho–Ma–McCauley estimates (column 4). Thus, overall, there is no evidence of the emergence of an RMB bloc in 2003–2004, although the RMB seemed to have accounted for more than 10% in terms of currency weights in some economies (such as the Republic of Korea and Indonesia).

Period of relative flexibility of the RMB against the US dollar

Columns 1–4 of Tables 8 and 9 simply repeat what was reported in columns 5–8 of Table 2 and Table 3. To recap, columns 5–8 of Tables 2 and 3 reported our reproduction of the US dollar and RMB weights from an estimation of the standard Frankel–Wei model for the same two periods that Henning (2012) and Subramanian and Kessler (2013) considered in their studies but using our own exchange rate dataset. The overall conclusion in that part of our estimations was that, despite small differences in the magnitudes of our estimated coefficients for the US dollar and the RMB, the reported estimates indicate strongly significant and larger magnitudes of the RMB coefficients than the US dollar coefficients, which are smaller in value and with a marked variation in statistical significance. Thus, as earlier emphasized, these results support the conclusion made by these two studies of an alleged eclipsing of the US dollar by the RMB in the exchange rate policies of many economies in East Asia.

Columns 5–8 of Tables 8 and 9 show the estimated US dollar and RMB weights using our new method but noting that the numeraire currencies used in the regression were the SDR (Table 8) and the Swiss franc (Table 9).[17] In both tables, the US dollar weights (columns 5 and 6), however, show larger and significant weights during the two respective periods, whereas the RMB weights were either significant yet smaller in magnitude than the US dollar weights (Table 8), or were mostly significant but estimated to be almost zero or negative (Table 9).

Columns 9–12 of Tables 8 and 9 show the US dollar and RMB weights using our new method and choosing the New Zealand dollar as the numeraire currency.[18] Again, in both tables, the US dollar weights (columns 9 and 10) show larger and significant weights during the two respective periods than those estimated by Henning (2012) and Subramanian and Kessler (2013). The estimated RMB weights (columns 11 and 12), however, are all significant at conventional levels and larger in value than when using the SDR as numeraire, but the estimated magnitudes are likewise smaller than the US dollar weights. Thus, our new method does not support the earlier finding that the RMB weights are larger than the US dollar weights for the won, ringgit, Singapore dollar, baht, and peso.

Finally, Table 10 compares the estimated US dollar and RMB coefficients obtained from the replication of the Balasubramaniam–Patnaik–Shah method using our exchange rate dataset (columns 1 and 2) and those obtained from our new method (columns 3–6). Recall that columns

[17] The first-step regression refers to equation (6) of the previous section except that the numeraire currencies used in columns 5–8 of Tables 8 and 9 are the SDR and the Swiss franc, respectively, instead of the New Zealand dollar. Recall that the choices of these two numeraire currencies follow on from the Henning (2012) and Subramanian–Kessler (2013) studies which used these currencies as their numeraires.

[18] The estimations conducted at this point are now entirely in line with our discussion in the previous section particularly, of equations (6) and (8). For a justification of the use of the New Zealand dollar as the numeraire currency, also refer to the previous section.

1 and 2 of the table repeat what has been reported in columns 3 and 4 of Table 5. There we highlight that our reproduction of the Balasubramaniam–Patnaik–Shah estimates indicates that the estimated US dollar coefficients are statistically significant but slightly smaller than the original Balasubramaniam–Patnaik–Shah estimates and that the RMB weights are larger than the US dollar weights. Thus the implication of the Balasubramaniam–Patnaik–Shah method is that the RMB is a more important anchor currency for the three emerging Asian currencies, particularly the dong.

The estimation results using our new method with the Swiss franc and the New Zealand dollar serving as the numeraire currencies are reported in columns 3–4 and columns 5–6 of Table 10, respectively. In line with the previous assessments of the Henning (2012) and Subramanian and Kessler (2013) results, we again observe that the US dollar weights have much larger and significant weights during the respective periods for the three emerging Asian currencies, while the RMB weights are mostly significant (with the exception of the dong) yet much smaller in magnitude than the US dollar weights. Thus, once again there is no evidence of the emergence of an RMB bloc that replaces the US dollar in the East Asian economies.

To further substantiate the results presented by the new method, the tables in the Appendix present estimates for a larger number of emerging Asian economies using our new method during the period of the PRC's tight US dollar peg from January 2000 to June 2005 as well as during the two periods of relative flexibility of the RMB against the US dollar. These tables confirm the conclusion that the importance of the RMB in the currency baskets of most emerging East Asian economies has risen recently, but not to the extent that it has replaced the US dollar as the dominant anchor currency in the region.

Table 7: Estimation Results Using the Ho–Ma–McCauley (2005) Approach and the New Method

	Replication of Ho–Ma–McCauley Estimates Using Own Dataset (with US Dollar as Numeraire)				Estimation Results Using the New Method, with RMB NDF Rate (with New Zealand Dollar as Numeraire)				Estimation Results Using the New Method, with RMB Spot Rate (with New Zealand Dollar as Numeraire)			
	US dollar		RMB NDF		US dollar		RMB NDF		US dollar		RMB spot	
	(1) 2003	(2) 2004	(3) 2003	(4) 2004	(5) 2003	(6) 2004	(7) 2003	(8) 2004	(9) 2003	(10) 2004	(11) 2003	(12) 2004
Korean won	0.57***	0.46***	0.06	0.19**	0.66***	0.64***	0.10**	0.13***	0.66***	0.63***	0.07	0.12***
NT dollar	0.09	0.10	0.20***	0.10*	0.83***	0.78***	0.05***	0.09***	0.83***	0.77***	0.03	0.06***
Indonesian rupiah	0.75***	0.29**	0.09	0.41***	0.80***	0.67***	0.05	0.15**	0.80***	0.67***	0.04	0.10*
Philippine peso	0.70***	0.65***	0.09	-0.13	0.90***	0.89***	0.03	0.00	0.90***	0.88***	0.03	0.01
Singapore dollar	0.51***	0.49***	0.15***	0.07	0.61***	0.57***	0.06***	0.10***	0.61***	0.57***	0.02	0.09***
Thai baht	0.57***	0.50***	0.15**	0.21***	0.66***	0.67***	0.08***	0.09***	0.66***	0.67***	0.04**	0.07***

RMB = renminbi; NDF = non-deliverable forward.

Notes:

(a) Columns 1–4 summarize regression results obtained from the same F-W equation employed by Ho, Ma, and McCauley (2005), but using our own exchange rate dataset. The estimated US dollar weights are the implied values, $1-\alpha_2-\alpha_3-\alpha_5$, obtained from the equation below employed by Ho, Ma, and McCauley (2005), who use the US dollar as the numeraire currency:

$$\Delta\log\left(\frac{x}{\mathrm{USD}}\right) = \alpha_0 + \alpha_2\Delta\log\left(\frac{\mathrm{EURO}}{\mathrm{USD}}\right) + \alpha_3\Delta\log\left(\frac{\mathrm{JPY}}{\mathrm{USD}}\right) + \alpha_5\Delta\log\left(\frac{\mathrm{RMB}}{\mathrm{USD}}\right) + u''.$$

(b) Columns 5–8 summarize regression results obtained from the modified two-step Frankel–Wei equations proposed by our new method, using the New Zealand dollar as the numeraire currency and the RMB NDF rate for the RMB. Columns 9–12 summarize regression results obtained from our new method that uses the RMB spot rate instead of its NDF rate. The estimated RMB weights (whether the NDF or spot rate is used) are the implied values, $1-\gamma_1-\gamma_2-\gamma_3$, obtained from the second equation below. The new two-step estimating equations are:

$$\Delta\log\left(\frac{\mathrm{RMB}}{\mathrm{NZD}}\right) = \phi_0 + \phi_1\Delta\log\left(\frac{\mathrm{USD}}{\mathrm{NZD}}\right) + \phi_2\Delta\log\left(\frac{\mathrm{EURO}}{\mathrm{NZD}}\right) + \phi_3\Delta\log\left(\frac{\mathrm{JPY}}{\mathrm{NZD}}\right) + \omega,$$

$$\Delta\log\left(\frac{x}{\mathrm{NZD}}\right) - \hat{\omega} = \gamma_0 + \gamma_1\left[\Delta\log\left(\frac{\mathrm{USD}}{\mathrm{NZD}}\right) - \hat{\omega}\right] + \gamma_2\left[\Delta\log\left(\frac{\mathrm{EURO}}{\mathrm{NZD}}\right) - \hat{\omega}\right] + \gamma_3\left[\Delta\log\left(\frac{\mathrm{JPY}}{\mathrm{NZD}}\right) - \hat{\omega}\right] + v,$$

where $\hat{\omega} = \Delta\log\left(\frac{\mathrm{RMB}}{\mathrm{NZD}}\right) - [\hat{\phi}_0 + \hat{\phi}_1\Delta\log\left(\frac{\mathrm{USD}}{\mathrm{NZD}}\right) + \hat{\phi}_2\Delta\log\left(\frac{\mathrm{EURO}}{\mathrm{NZD}}\right) + \hat{\phi}_3\Delta\log\left(\frac{\mathrm{JPY}}{\mathrm{NZD}}\right)].$

(c) Asterisks, *, **, ***, indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Sources: Authors' computation.

Table 8: Estimation Results Using the Henning (2012) Approach and the New Method

	Replication of Henning Estimates Using Own Dataset (with Special Drawing Right as Numeraire)				Estimation Results Using the New Method (with Special Drawing Right as Numeraire)				Estimation Results Using the New Method (with New Zealand Dollar as Numeraire)			
	US dollar		RMB		US dollar		RMB		US dollar		RMB	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	18 Jul 2005–2 Jul 2009	18 Jun 2010–30 Dec 2011	18 Jul 2005–2 Jul 2009	18 Jun 2010–30 Dec 2011	18 Jul 2005–2 Jul 2009	18 Jun 2010–30 Dec 2011	18 Jul 2005–2 Jul 2009	18 Jun 2010–30 Dec 2011	18 Jul 2005–2 Jul 2009	18 Jun 2010–30 Dec 2011	18 Jul 2005–2 Jul 2009	18 Jun 2010–30 Dec 2011
Korean won	0.173***	-0.471	-0.339	1.100***	0.872***	0.494***	-0.021	0.464***	0.725***	0.666***	0.109***	0.367***
Malaysian ringgit	0.444***	-0.184	0.368***	0.989***	0.774***	0.665***	0.059*	0.278***	0.778***	0.760***	0.100***	0.223***
Singapore dollar	0.357***	-0.102	0.288***	0.577***	0.613***	0.419***	0.021	0.353***	0.579***	0.561***	0.112***	0.255***
Thai baht	0.483***	0.265**	0.260**	0.492***	0.717***	0.693***	0.050	0.173***	0.705***	0.769***	0.080***	0.121***
Philippine peso	0.787***	0.227	-0.011	0.611***	0.790***	0.756***	0.149***	0.193***	0.818***	0.836***	0.126***	0.133***

RMB = renminbi.

Notes:

(a) Columns 1–4 summarize regression results obtained from the same Frankel–Wei equation employed by Henning (2012), but using our own exchange rate dataset. Henning (2012) does not include the pound sterling on the right-hand side of the Frankel–Wei equation.

(b) Columns 5–8 summarize regression results obtained from the modified Frankel–Wei equation proposed by our new method, but using the special drawing right (SDR) as the numeraire currency. The estimated RMB weights are the implied values, $1-\gamma_1-\gamma_2-\gamma_3$, obtained from the second equation below. The two-step estimating equations are:

$$\Delta\log\left(\frac{\text{RMB}}{\text{SDR}}\right) = \phi_0 + \phi_1\Delta\log\left(\frac{\text{USD}}{\text{SDR}}\right) + \phi_2\Delta\log\left(\frac{\text{EURO}}{\text{SDR}}\right) + \phi_3\Delta\log\left(\frac{\text{JPY}}{\text{SDR}}\right) + \omega,$$

$$\Delta\log\left(\frac{x}{\text{SDR}}\right) - \hat{\omega} = \gamma_0 + \gamma_1\left[\Delta\log\left(\frac{\text{USD}}{\text{SDR}}\right) - \hat{\omega}\right] + \gamma_2\left[\Delta\log\left(\frac{\text{EURO}}{\text{SDR}}\right) - \hat{\omega}\right] + \gamma_3\left[\Delta\log\left(\frac{\text{JPY}}{\text{SDR}}\right) - \hat{\omega}\right] + v,$$

where $\hat{\omega} = \Delta\log\left(\frac{\text{RMB}}{\text{SDR}}\right) - [\hat{\phi}_0 + \hat{\phi}_1\Delta\log\left(\frac{\text{USD}}{\text{SDR}}\right) + \hat{\phi}_2\Delta\log\left(\frac{\text{EURO}}{\text{SDR}}\right) + \hat{\phi}_3\Delta\log\left(\frac{\text{JPY}}{\text{SDR}}\right)]$.

(c) Columns 9–12 summarize regression results obtained from our new method, using the New Zealand dollar as the numeraire currency. The estimating equations are the same as those in (b) above except that SDR is now replaced by the New Zealand dollar.

(d) Asterisks, *, **, ***, indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Sources: Authors' computation.

Table 9: Estimation Results Using the Subramanian–Kessler (2013) Approach and the New Method

	Replication of Subramanian–Kessler Estimates Using Own Dataset (with Swiss Franc as Numeraire)				Estimation Results Using the New Method (with Swiss Franc as Numeraire)				Estimation Results Using the New Method (with New Zealand Dollar as Numeraire)			
	US dollar		RMB		US dollar		RMB		US dollar		RMB	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Jul 2005–Aug 2008	Jul 2010–Jul 2013	Jul 2005–Aug 2008	Jul 2010–Jul 2013	Jul 2005–Aug 2008	Jul 2010–Jul 2013	Jul 2005–Aug 2008	Jul 2010–Jul 2013	Jul 2005–Aug 2008	Jul 2010–Jul 2013	Jul 2005–Aug 2008	Jul 2010–Jul 2013
Korean won	0.377***	-0.223	0.316***	1.007***	0.569***	0.727***	-0.365***	0.012	0.714***	0.639***	0.122***	0.324***
NT dollar	0.176***	0.274***	0.579***	0.619***	0.545***	0.859***	-0.218***	0.031**	0.749***	0.828***	0.068***	0.121***
Thai baht	0.165***	0.308***	0.548***	0.463***	0.515***	0.745***	-0.181***	0.046**	0.697***	0.713***	0.088***	0.130***
Indonesian rupiah	0.490***	0.488***	0.159*	0.402***	0.580***	0.868***	-0.348***	0.028	0.700***	0.843***	0.125***	0.102***
Malaysian ringgit	0.316***	-0.147	0.469***	0.981***	0.614***	0.778***	-0.205***	0.036*	0.764***	0.716***	0.119***	0.238***
Philippine peso	0.490***	0.181*	0.269***	0.664***	0.672***	0.809***	-0.297***	0.031*	0.818***	0.767***	0.121***	0.165***
Singapore dollar	0.180***	0.123	0.424***	0.472***	0.449***	0.569***	-0.174***	0.052***	0.576***	0.500***	0.118***	0.259***

RMB = renminbi.

Notes:

(a) Columns 1–4 summarize regression results obtained from the same Frankel–Wei equation employed by Subramanian and Kessler (2013), but using our own exchange rate dataset. Their estimation does not include the pound sterling on the right-hand side of the equation.

(b) Columns 5–8 summarize regression results obtained from the modified Frankel–Wei equation proposed by our new method, but using the Swiss franc (CHF) as the numeraire currency. The estimated RMB weights are the implied values, $1-\gamma_1-\gamma_2-\gamma_3$, obtained from the second equation below. The two-step estimating equations are:

$$\Delta\log\left(\frac{RMB}{CHF}\right)=\phi_0+\phi_1\Delta\log\left(\frac{USD}{CHF}\right)+\phi_2\Delta\log\left(\frac{EURO}{CHF}\right)+\phi_3\Delta\log\left(\frac{JPY}{CHF}\right)+\omega$$

$$\Delta\log\left(\frac{x}{CHF}\right)-\hat{\omega}=\gamma_0+\gamma_1\left[\Delta\log\left(\frac{USD}{CHF}\right)-\hat{\omega}\right]+\gamma_2\left[\Delta\log\left(\frac{EURO}{CHF}\right)-\hat{\omega}\right]+\gamma_3\left[\Delta\log\left(\frac{JPY}{CHF}\right)-\hat{\omega}\right]+v$$

where $\hat{\omega}=\Delta\log\left(\frac{RMB}{CHF}\right)-[\hat{\phi}_0+\hat{\phi}_1\Delta\log\left(\frac{USD}{CHF}\right)+\hat{\phi}_2\Delta\log\left(\frac{EURO}{CHF}\right)+\hat{\phi}_3\Delta\log\left(\frac{JPY}{CHF}\right)]$.

(c) Columns 9–12 summarize regression results obtained from our new method, using the New Zealand dollar as the numeraire currency. The estimating equations are the same as those in (b) above except that the Swiss franc is now replaced by the New Zealand dollar.

(d) Asterisks, *, **, ***, indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Sources: Authors' computations.

Table 10: Estimation Results Using the Balasubramaniam–Patnaik–Shah (2011) Approach and the New Method

		Replication of Balasubramaniam–Patnaik–Shah Estimates Using Own Dataset (with Swiss Franc as Numeraire)		Estimation Results Using the New Method (with Swiss Franc as Numeraire)		Estimation Results Using the New Method (with New Zealand Dollar as Numeraire)	
Currency		US dollar	RMB	US dollar	RMB	US dollar	RMB
Start date	End date	(1)	(2)	(3)	(4)	(5)	(6)
Malaysian ringgit 14 Oct 2005	11 Jun 2007	0.74***	0.95***	0.60***	0.32*	0.57***	0.09**
NT dollar 14 Oct 2005	11 Feb 2011	0.69***	0.75***	0.59***	0.26***	0.58***	0.13***
Viet Nam dong 14 Oct 2005	11 Feb 2011	0.57***	0.94***	0.92***	0.12	0.91***	0.08

RMB = renminbi.

Notes:

(a) Columns 1 and 2 summarize regression results based on the same two-step regression method employed by Balasubramaniam, Patnaik, and Shah (2011), but using our own exchange rate dataset. Their estimation includes the pound sterling on the right-hand side of the Frankel–Wei equation.

(b) Columns 3 and 4 summarize regression results obtained from the modified Frankel–Wei equation proposed by our method, but using the Swiss franc as the numeraire currency. The estimated RMB weights are the implied values, $1-\gamma_1-\gamma_2-\gamma_3-\gamma_4$, obtained from the second equation below. The two-step estimating equations are:

$$\Delta\log\left(\frac{RMB}{CHF}\right)=\phi_0+\phi_1\Delta\log\left(\frac{USD}{CHF}\right)+\phi_2\Delta\log\left(\frac{EURO}{CHF}\right)+\phi_3\Delta\log\left(\frac{JPY}{CHF}\right)+\phi_4\Delta\log\left(\frac{GBP}{CHF}\right)+\omega.$$

$$\Delta\log\left(\frac{x}{CHF}\right)-\hat{\omega}=\gamma_0+\gamma_1\left[\Delta\log\left(\frac{USD}{CHF}\right)-\hat{\omega}\right]+\gamma_2\left[\Delta\log\left(\frac{EURO}{CHF}\right)-\hat{\omega}\right]+\gamma_3\left[\Delta\log\left(\frac{JPY}{CHF}\right)-\hat{\omega}\right]+\gamma_4\left[\Delta\log\left(\frac{GBP}{CHF}\right)-\hat{\omega}\right]+v,$$

where $\hat{\omega}=\Delta\log\left(\frac{RMB}{CHF}\right)-[\hat{\phi}_0+\hat{\phi}_1\Delta\log\left(\frac{USD}{CHF}\right)+\hat{\phi}_2\Delta\log\left(\frac{EURO}{CHF}\right)+\hat{\phi}_3\Delta\log\left(\frac{JPY}{CHF}\right)+\hat{\phi}_4\Delta\log\left(\frac{GBP}{CHF}\right)].$

(c) Columns 5 and 6 summarize regression results obtained from our new method, using the New Zealand dollar as the numeraire currency. The estimating equations are the same as those in (b) above except that the Swiss franc is now replaced by the New Zealand dollar.

(d) Asterisks, *, **, ***, indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Sources: Authors' computation.

6. CONCLUSION

In this paper we have demonstrated that existing techniques to address the problem of the severe multicollinearity in estimations of the Frankel–Wei regression equation when the movements in the RMB are included on the right-hand side of the equation remain limited. Then we have proposed a simple and easy to implement modification of the Frankel–Wei regression model with the RMB movements included on the right-hand side. Using this new method, we have found that there is not yet an RMB bloc in the region, contrary to claims made by several authors in recent studies. In particular, we have demonstrated that the US dollar continues to be the most dominant anchor currency in East Asia. The RMB has taken on some importance in the currency baskets of several regional economies—including India; Indonesia; the Republic of Korea; Malaysia; the Philippines; Singapore; Taipei,China; Thailand; and Viet Nam—in recent years. In a sense the weights of the RMB rose at the expense of the weights of the yen, which were high for some Asian economies between the end of the Asian financial crisis and the beginning of the global financial crisis, but have declined since then. Thus, we can safely conclude that the RMB has not supplanted the US dollar as the major anchor currency in the region and that there is no RMB bloc, at least not yet, but that the RMB began to command some weight in the currency baskets of several East Asian economies.

In view of the increasing importance of the PRC economy in the region, one should not entirely discount the possibility that the RMB's role in the region will continue to grow over time. But this will likely depend on the progress of the PRC's domestic reforms that support further RMB internationalization. Nor can one dismiss the possibility that the yen will come back as the region's limited anchor currency in the currency baskets of the East Asian economies if Japan's ongoing attempt at economic revitalization under Abenomics succeeds.

REFERENCES

Balasubramaniam, V., I. Patnaik, and A. Shah. 2011. Who Cares about the Chinese Yuan? NIPFP Working Paper No. 89. New Delhi: National Institute of Public Finance and Policy.

Benassy-Quere, A., and B. Coeure. 2006. On the Identification of De facto Currency Pegs. *Journal of the Japanese and International Economies* 20(1): 112–127.

Chow, H. K. 2011. Towards an Expanded Role for Asian Currencies: Issues and Prospects. ADBI Working Paper No. 285. Tokyo: Asian Development Bank Institute.

Frankel, J., and S. J. Wei. 1994. Yen Bloc or Dollar Bloc? Exchange Rate Policies of the East Asian Economies. In *Macroeconomic Linkages: Savings, Exchange Rates and Capital Flows*, edited by T. Ito and A. Krueger. Chicago: University of Chicago Press.

Fratzscher, M., and A. Mehl. 2011. China's Dominance Hypothesis and the Emergence of a Tri-Polar Global Currency System. ECB Working Paper No. 1392. Frankfurt: European Central Bank.

Henning, R. 2012. Choice and Coercion in East Asian Exchange Rate Regimes. Working Paper 12-15. Washington: Peterson Institute for International Economics.

Ho, C., G. Ma, and R. McCauley. 2005. Trading Asian Currencies. *BIS Quarterly Review* (March). Basel: Bank for International Settlements.

Ito, T. 2011. The Internationalization of the RMB: Opportunities and Pitfalls. CGS/IIGG Working Paper. New York: Council on Foreign Relations.

Kawai, M., and S. Akiyama. 1998. The Role of Nominal Anchor Currencies in Exchange Rate Arrangements. *Journal of Japanese and International Economies* 12(4): 334–387.

Kawai, M. 2008. Toward a Regional Exchange Rate Regime in East Asia. *Pacific Economic Review* 13 (1): 83–102.

McKinnon, R., and G. Schnabl. 2004. The East Asian Dollar Standard, Fear of Floating, and Original Sin. *Review of Development Economics* 8(3): 331–360.

Ogawa, E., and T. Ito. 2002. On the Desirability of a Regional Currency Basket Arrangement. *Journal of Japanese and International Economies* 16(3): 317–334.

Subramanian, A., and M. Kessler. 2013. The Renminbi Bloc is Here: Asia Down, Rest of the World to Go? Working Paper 12-19. Washington, DC: Peterson Institute for International Economics.

APPENDIX

Table A.1: Estimated Correlation Coefficients between the Renminbi and Major International Currencies per New Zealand Dollar for Various Sub-Periods

Period: 3 January 2000–30 June 2005 (Period of US dollar-peg of the RMB)

	US Dollar	Euro	Yen	Pound sterling	RMB
US dollar	1.000				
Euro	0.632	1.000			
Yen	0.640	0.586	1.000		
Pound sterling	0.639	0.621	0.620	1.000	
RMB	**0.999**	0.632	0.684	0.693	1.000

Period: 21 July 2005–21 July 2008 (Period of relative flexibility of the RMB)

	US dollar	Euro	Yen	Pound sterling	RMB
US dollar	1.000				
Euro	0.698	1.000			
Yen	0.692	0.714	1.000		
Pound sterling	0.708	0.770	0.645	1.000	
RMB	**0.988**	0.706	0.702	0.706	1.000

Period: 1 August 2008–31 May 2010 (Period of US dollar-repeg of the RMB)

	US dollar	Euro	Yen	Pound sterling	RMB
US dollar	1.000				
Euro	0.651	1.000			
Yen	0.685	0.646	1.000		
Pound sterling	0.667	0.685	0.599	1.000	
RMB	**0.998**	0.659	0.788	0.670	1.000

Period: 21 June 2010–31 July 2013 (Period of relative flexibility of the RMB)

	US dollar	Euro	Yen	Pound sterling	RMB
US dollar	1.000				
Euro	0.605	1.000			
Yen	0.663	0.512	1.000		
Pound sterling	0.684	0.636	0.661	1.000	
RMB	**0.990**	0.619	0.760	0.684	1.000

RMB = renminbi.

Note: The correlation coefficients between the RMB and the US dollar are in boldface.

Source: Authors' computation.

Table A.2: Estimation Results Using the New Method, with Renminbi Spot Rate

Period: 3 January 2000–30 June 2005 (Period of US dollar-peg of the RMB)

	US dollar	Euro	Yen	Pound sterling	RMB	R^2
PRC RMB	0.999*** [0.000]	0.000 [0.000]	0.000 [0.000]	-0.000 [0.000]	-----	0.999
Korean won	0.638*** [0.030]	-0.022 [0.021]	0.270*** [0.021]	0.065** [0.025]	0.048*** [0.017]	0.768
NT dollar	0.810*** [0.017]	0.031** [0.014]	0.094*** [0.011]	0.045*** [0.012]	0.016* [0.010]	0.924
Hong Kong dollar	0.988*** [0.002]	0.000 [0.000]	0.004*** [0.001]	0.004*** [0.001]	0.001 [0.001]	0.998
Singapore dollar	0.611*** [0.017]	0.082*** [0.011]	0.219*** [0.012]	0.036*** [0.013]	0.049*** [0.009]	0.911
Cambodian riel	0.992*** [0.015]	0.011 [0.015]	-0.022 [0.017]	0.036 [0.026]	-0.017 [0.017]	0.897
Indonesian rupiah	0.779*** [0.052]	-0.101 [0.049]	0.180*** [0.041]	0.028 [0.050]	0.113*** [0.035]	0.411
Lao PDR kip	0.996*** [0.016]	-0.029 [0.041]	-0.003 [0.019]	0.038 [0.033]	-0.000 [0.016]	0.821
Malaysian ringgit	0.999*** [0.000]	0.000 [0.000]	0.000 [0.000]	-0.000 [0.000]	0.000 [0.000]	0.999
Indian rupee	0.915*** [0.016]	0.007 [0.008]	0.024*** [0.008]	0.028*** [0.010]	0.023*** [0.006]	0.956
Mongolian togrog	1.026*** [0.033]	0.063 [0.065]	-0.025 [0.021]	-0.104 [0.079]	0.039 [0.033]	0.696
Philippine peso	0.878*** [0.024]	0.012 [0.018]	0.144*** [0.039]	-0.055 [0.039]	0.019 [0.013]	0.723
Thai baht	0.652*** [0.023]	0.033* [0.018]	0.231*** [0.018]	0.020 [0.022]	0.061*** [0.015]	0.847
Viet Nam dong	1.000*** [0.002]	-0.003 [0.002]	0.001 [0.001]	0.003 [0.003]	-0.002 [0.001]	0.996

Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China, RMB = renminbi.

Notes:

(a) The estimates for the PRC RMB are obtained from the first regression equation below and those for other currencies are obtained from the following two-step regressions:

$$\Delta \log\left(\frac{\mathrm{RMB}}{\mathrm{NZD}}\right) = \phi_0 + \phi_1 \Delta \log\left(\frac{\mathrm{USD}}{\mathrm{NZD}}\right) + \phi_2 \Delta \log\left(\frac{\mathrm{EURO}}{\mathrm{NZD}}\right) + \phi_3 \Delta \log\left(\frac{\mathrm{JPY}}{\mathrm{NZD}}\right) + \phi_4 \Delta \log\left(\frac{\mathrm{GBP}}{\mathrm{NZD}}\right) + \omega,$$

$$\Delta \log\left(\frac{x}{\mathrm{NZD}}\right) - \hat{\omega} = \gamma_0 + \gamma_1\left[\Delta \log\left(\frac{\mathrm{USD}}{\mathrm{NZD}}\right) - \hat{\omega}\right] + \gamma_2\left[\Delta \log\left(\frac{\mathrm{EURO}}{\mathrm{NZD}}\right) - \hat{\omega}\right] + \gamma_3\left[\Delta \log\left(\frac{\mathrm{JPY}}{\mathrm{NZD}}\right) - \hat{\omega}\right]$$
$$+\gamma_4\left[\Delta \log\left(\frac{\mathrm{GBP}}{\mathrm{NZD}}\right) - \hat{\omega}\right] + v,$$

where $\hat{\omega} = \Delta \log\left(\frac{\mathrm{RMB}}{\mathrm{NZD}}\right) - [\hat{\phi}_0 + \hat{\phi}_1 \Delta \log\left(\frac{\mathrm{USD}}{\mathrm{NZD}}\right) + \hat{\phi}_2 \Delta \log\left(\frac{\mathrm{EURO}}{\mathrm{NZD}}\right) + \hat{\phi}_3 \Delta \log\left(\frac{\mathrm{JPY}}{\mathrm{NZD}}\right) + \hat{\phi}_4 \Delta \log\left(\frac{\mathrm{GBP}}{\mathrm{NZD}}\right)]$.

(b) Asterisks, *, **, ***, indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The values in brackets are the estimated robust standard errors.

Source: Authors' computation.

Table A.3: Estimation Results Using the New Method, with Renminbi Non-Deliverable Forward Rate

Period: 3 January 2000–30 June 2005 (Period of US dollar-peg of the RMB)

	US dollar	Euro	Yen	Pound sterling	RMB NDF	R^2
PRC RMB	0.903*** [0.013]	-0.020** [0.010]	0.052*** [0.009]	0.039*** [0.010]	-----	0.942
Korean won	0.640*** [0.030]	-0.028 [0.021]	0.268*** [0.021]	0.047* [0.026]	0.071*** [0.017]	0.773
NT dollar	0.806*** [0.017]	0.028** [0.013]	0.093*** [0.011]	0.039*** [0.012]	0.032*** [0.009]	0.926
Hong Kong dollar	0.987*** [0.002]	0.000 [0.000]	0.004*** [0.001]	0.003** [0.001]	0.004*** [0.001]	0.998
Singapore dollar	0.611*** [0.017]	0.079*** [0.011]	0.219*** [0.012]	0.030** [0.013]	0.059*** [0.010]	0.915
Cambodian riel	0.991*** [0.014]	0.010 [0.014]	-0.023 [0.017]	0.035 [0.026]	-0.014 [0.017]	0.900
Indonesian rupiah	0.777*** [0.052]	-0.107** [0.050]	0.178*** [0.041]	0.010 [0.049]	0.140*** [0.036]	0.415
Cambodian kip	0.996*** [0.016]	-0.028 [0.041]	-0.003 [0.019]	0.041 [0.034]	-0.005 [0.015]	0.824
Malaysian ringgit	0.999*** [0.000]	0.000 [0.000]	0.000 [0.000]	-0.000 [0.000]	0.000 [0.000]	0.999
Indian rupee	0.914*** [0.016]	0.007 [0.008]	0.023*** [0.008]	0.029*** [0.010]	0.025*** [0.007]	0.959
Mongolian togrog	1.025*** [0.034]	0.065 [0.067]	-0.025 [0.022]	-0.102 [0.077]	0.036 [0.031]	0.702
Philippine peso	0.881*** [0.024]	0.008 [0.018]	0.143*** [0.039]	-0.066 [0.038]	0.033** [0.014]	0.728
Thai baht	0.653*** [0.023]	0.030* [0.018]	0.228*** [0.017]	0.009 [0.021]	0.078*** [0.014]	0.855
Viet Nam dong	1.000*** [0.002]	-0.003 [0.002]	0.001 [0.001]	0.003 [0.003]	-0.001 [0.001]	0.996

PRC = People's Republic of China, RMB = renminbi; NDF = non-deliverable forward.

Notes:

(a) The estimates for the PRC RMB are obtained from the first regression equation below and those for other currencies are obtained from the following two-step regressions:

$$\Delta\log\left(\frac{\text{RMB}}{\text{NZD}}\right) = \phi_0 + \phi_1\Delta\log\left(\frac{\text{USD}}{\text{NZD}}\right) + \phi_2\Delta\log\left(\frac{\text{EURO}}{\text{NZD}}\right) + \phi_3\Delta\log\left(\frac{\text{JPY}}{\text{NZD}}\right) + \phi_4\Delta\log\left(\frac{\text{GBP}}{\text{NZD}}\right) + \omega,$$

$$\Delta\log\left(\frac{x}{\text{NZD}}\right) - \hat{\omega} = \gamma_0 + \gamma_1\left[\Delta\log\left(\frac{\text{USD}}{\text{NZD}}\right) - \hat{\omega}\right] + \gamma_2\left[\Delta\log\left(\frac{\text{EURO}}{\text{NZD}}\right) - \hat{\omega}\right] + \gamma_3\left[\Delta\log\left(\frac{\text{JPY}}{\text{NZD}}\right) - \hat{\omega}\right] + \gamma_4\left[\Delta\log\left(\frac{\text{GBP}}{\text{NZD}}\right) - \hat{\omega}\right] + v,$$

where $\hat{\omega} = \Delta\log\left(\frac{\text{RMB}}{\text{NZD}}\right) - [\hat{\phi}_0 + \hat{\phi}_1\Delta\log\left(\frac{\text{USD}}{\text{NZD}}\right) + \hat{\phi}_2\Delta\log\left(\frac{\text{EURO}}{\text{NZD}}\right) + \hat{\phi}_3\Delta\log\left(\frac{\text{JPY}}{\text{NZD}}\right) + \hat{\phi}_4\Delta\log\left(\frac{\text{GBP}}{\text{NZD}}\right)]$.

(b) Asterisks, *, **, ***, indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The values in brackets are the estimated robust standard errors.

Source: Authors' computation.

Table A.4: Estimation Results Using the New Method, with Renminbi Spot Rate

Period: 21 July 2005–21 July 2008 (Period of relative flexibility of the RMB)

	US dollar	Euro	Yen	Pound sterling	RMB	R^2
PRC RMB	0.934*** [0.009]	0.044*** [0.013]	0.028*** [0.007]	-0.017 [0.013]	-----	0.979
Korean won	0.686*** [0.055]	0.140** [0.067]	-0.036 [0.055]	0.096 [0.070]	0.112*** [0.023]	0.730
NT dollar	0.737*** [0.027]	0.076** [0.032]	0.079*** [0.020]	0.042 [0.031]	0.064*** [0.014]	0.908
Hong Kong dollar	0.980*** [0.002]	0.007 [0.005]	0.010*** [0.002]	0.001 [0.004]	0.000 [0.001]	0.998
Singapore dollar	0.562*** [0.022]	0.196*** [0.024]	0.078*** [0.019]	0.049* [0.025]	0.113*** [0.013]	0.925
Cambodian riel	0.964*** [0.035]	0.037 [0.080]	-0.015 [0.027]	0.005 [0.065]	0.007 [0.020]	0.822
Indonesian rupiah	0.664*** [0.081]	0.087* [0.048]	0.008 [0.042]	0.127** [0.059]	0.113*** [0.024]	0.631
Cambodian kip	1.032*** [0.023]	-0.073* [0.043]	0.004 [0.015]	0.008 [0.026]	0.027 [0.021]	0.920
Malaysian ringgit	0.752*** [0.029]	0.068 [0.042]	0.021 [0.025]	0.042 [0.042]	0.114*** [0.018]	0.879
Indian rupee	0.804*** [0.030]	0.058* [0.034]	-0.023 [0.023]	0.080** [0.036]	0.079*** [0.021]	0.866
Mongolian togrog	1.028*** [0.035]	-0.011 [0.021]	-0.018 [0.012]	0.012 [0.031]	-0.010 [0.014]	0.883
Philippine peso	0.801*** [0.041]	0.044 [0.046]	-0.021 [0.034]	0.059 [0.045]	0.115*** [0.022]	0.779
Thai baht	0.681*** [0.035]	0.038 [0.041]	0.140*** [0.025]	0.057* [0.032]	0.082*** [0.023]	0.815
Viet Nam dong	1.014*** [0.010]	0.006 [0.009]	-0.005 [0.009]	-0.013* [0.007]	-0.002 [0.004]	0.980

PRC = People's Republic of China, RMB = renminbi.

Notes:

(a) The estimates for the PRC RMB are obtained from the first regression equation below and those for other currencies are obtained from the following two-step regressions:

$$\Delta \log \left(\frac{\text{RMB}}{\text{NZD}}\right) = \phi_0 + \phi_1 \Delta \log \left(\frac{\text{USD}}{\text{NZD}}\right) + \phi_2 \Delta \log \left(\frac{\text{EURO}}{\text{NZD}}\right) + \phi_3 \Delta \log \left(\frac{\text{JPY}}{\text{NZD}}\right) + \phi_4 \Delta \log \left(\frac{\text{GBP}}{\text{NZD}}\right) + \omega,$$

$$\Delta \log \left(\frac{x}{\text{NZD}}\right) - \hat{\omega} = \gamma_0 + \gamma_1 \left[\Delta \log \left(\frac{\text{USD}}{\text{NZD}}\right) - \hat{\omega}\right] + \gamma_2 \left[\Delta \log \left(\frac{\text{EURO}}{\text{NZD}}\right) - \hat{\omega}\right] + \gamma_3 \left[\Delta \log \left(\frac{\text{JPY}}{\text{NZD}}\right) - \hat{\omega}\right] + \gamma_4 \left[\Delta \log \left(\frac{\text{GBP}}{\text{NZD}}\right) - \hat{\omega}\right] + v,$$

where $\hat{\omega} = \Delta \log \left(\frac{\text{RMB}}{\text{NZD}}\right) - [\hat{\phi}_0 + \hat{\phi}_1 \Delta \log \left(\frac{\text{USD}}{\text{NZD}}\right) + \hat{\phi}_2 \Delta \log \left(\frac{\text{EURO}}{\text{NZD}}\right) + \hat{\phi}_3 \Delta \log \left(\frac{\text{JPY}}{\text{NZD}}\right) + \hat{\phi}_4 \Delta \log \left(\frac{\text{GBP}}{\text{NZD}}\right)]$.

(b) Asterisks, *, **, ***, indicate statistical significance at the 10%, 5%, and 1% level, respectively. The values in brackets are the estimated robust standard errors.

Source: Authors' computation.

Table A.5: Estimation Results Using the New Method, with Renminbi Spot Rate

Period: 21 June 2010–31 July 2013 (Period of relative flexibility of the RMB)

	US dollar	Euro	Yen	Pound sterling	RMB	R^2
PRC RMB	0.941*** [0.009]	0.034*** [0.008]	0.006 [0.006]	0.001 [0.011]	-----	0.981
Korean won	0.620*** [0.044]	0.062* [0.034]	-0.048 [0.032]	0.045 [0.049]	0.319*** [0.029]	0.538
NT dollar	0.832*** [0.021]	0.060*** [0.017]	-0.006 [0.014]	-0.008 [0.024]	0.122*** [0.016]	0.904
Hong Kong dollar	0.983*** [0.003]	0.001 [0.002]	-0.003* [0.002]	0.002 [0.003]	0.016*** [0.002]	0.998
Singapore dollar	0.461*** [0.027]	0.158*** [0.026]	0.034** [0.017]	0.097*** [0.029]	0.248*** [0.022]	0.821
Cambodian riel	0.977*** [0.019]	-0.011 [0.024]	-0.004 [0.011]	0.032* [0.019]	0.005 [0.012]	0.887
Indonesian rupiah	0.826*** [0.033]	0.054* [0.029]	-0.021 [0.022]	0.043 [0.038]	0.096*** [0.024]	0.720
Lao PDR kip	0.920*** [0.039]	0.106** [0.041]	-0.031 [0.026]	-0.000 [0.047]	0.004*** [0.017]	0.829
Malaysian ringgit	0.702*** [0.036]	0.094*** [0.026]	-0.065*** [0.023]	0.033 [0.036]	0.234*** [0.020]	0.734
Indian rupee	0.599*** [0.042]	0.144*** [0.031]	-0.064** [0.029]	0.032 [0.045]	0.288*** [0.026]	0.577
Mongolian togrog	1.010*** [0.029]	0.003 [0.030]	0.007 [0.018]	-0.041 [0.040]	0.018 [0.024]	0.803
Philippine peso	0.754*** [0.036]	0.090*** [0.025]	-0.052** [0.021]	0.047 [0.035]	0.159*** [0.018]	0.806
Thai baht	0.696*** [0.027]	0.106*** [0.019]	0.030* [0.018]	0.040* [0.023]	0.125*** [0.015]	0.872
Mongolian dong	0.981*** [0.029]	0.014 [0.012]	0.015 [0.020]	-0.026 [0.015]	0.014* [0.014]	0.894

Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China, RMB = renminbi.

Notes:

(a) The estimates for the PRC RMB are obtained from the first regression equation below and those for other economies are obtained from the following two-step regressions:

$$\varDelta \log\left(\frac{\text{RMB}}{\text{NZD}}\right) = \phi_0 + \phi_1 \varDelta \log\left(\frac{\text{USD}}{\text{NZD}}\right) + \phi_2 \varDelta \log\left(\frac{\text{EURO}}{\text{NZD}}\right) + \phi_3 \varDelta \log\left(\frac{\text{JPY}}{\text{NZD}}\right) + \phi_4 \varDelta \log\left(\frac{\text{GBP}}{\text{NZD}}\right) + \omega,$$

$$\varDelta \log\left(\frac{x}{\text{NZD}}\right) - \widehat{\omega} = \gamma_0 + \gamma_1\left[\Delta \log\left(\frac{\text{USD}}{\text{NZD}}\right) - \widehat{\omega}\right] + \gamma_2\left[\varDelta \log\left(\frac{\text{EURO}}{\text{NZD}}\right) - \widehat{\omega}\right] + \gamma_3\left[\varDelta \log\left(\frac{\text{JPY}}{\text{NZD}}\right) - \widehat{\omega}\right]$$
$$+ \gamma_4\left[\varDelta \log\left(\frac{\text{GBP}}{\text{NZD}}\right) - \widehat{\omega}\right] + v,$$

where $\widehat{\omega} = \varDelta \log\left(\frac{\text{RMB}}{\text{NZD}}\right) - [\hat{\phi}_0 + \hat{\phi}_1 \varDelta \log\left(\frac{\text{USD}}{\text{NZD}}\right) + \hat{\phi}_2 \varDelta \log\left(\frac{\text{EURO}}{\text{NZD}}\right) + \hat{\phi}_3 \varDelta \log\left(\frac{\text{JPY}}{\text{NZD}}\right) + \hat{\phi}_4 \varDelta \log\left(\frac{\text{GBP}}{\text{NZD}}\right)]$.

(b) Asterisks, *, **, ***, indicate statistical significance at the 10%, 5%, and 1% level, respectively. The values in brackets are the estimated robust standard errors.

Source: Authors' computation.