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CURRENCY CO-MOVEMENTS IN ASIA-PACIFIC:
THE REGIONAL ROLE OF THE RENMINBI

by Daniela Marconi*

Abstract

The economic and political influence of China in the Asia-Pacific region is growing; the internationalization of the Chinese currency, the renminbi (RMB), add an additional channel of influence. This paper assesses the evolution of exchange rate co-movements against the US dollar within the region and finds that the RMB has been exerting a growing influence. The degree of influence varies considerably across currencies. On the one hand, the Indonesian rupiah, the Korean Won, the Malaysian ringgit, the Singaporean dollar, and the Taiwanese dollar show very strong co-movements with the RMB, while, on the other hand, the Australian dollar and the New Zealand dollar are not affected. Furthermore, the study confirms that Asian currencies move as if driven by an objective to stabilize the effective exchange rate, avoiding excessive appreciation against the USD.

JEL Classification: F31, F33.
Keywords: exchange rates, Asia-Pacific, renminbi, China.

Contents

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1. Introduction

Since the Asian financial crisis of 1997-98, the array of exchange rates within the Asia-Pacific (AP) region has changed considerably. Many currencies once strictly anchored to the US dollar have become progressively more flexible. According to the latest IMF assessment (IMF, 2015), a large share of exchange rate arrangements in the AP region are currently of the floating kind; just a handful of countries, including China, Malaysia, Singapore, and above all Hong Kong maintain more tightly managed arrangements (Table 1).

Table 1: Asia-Pacific: *de facto* exchange rate arrangements

	Currency Board	Stabilized arrangement	Crawl-like arrangement	Other managed arrangement	Floating	Free floating
China			X			
Australia						X
Hong Kong	X					
India					X	
Indonesia					X	
Japan						X
Korea					X	
Malaysia				X		
New Zealand					X	
Philippines					X	
Singapore		X				
Taiwan					X	
Thailand					X	

Source: IMF: Annual report on exchange rate arrangements and exchange restrictions 2014.

China's exchange rate regime has also been reformed repeatedly over the last ten years, moving towards greater flexibility. In the summer of 2005 China abandoned its strict peg with the US dollar, allowing a limited fluctuation around a central parity fixed on a daily basis, and since then exchange rate flexibility has gradually increased.

This paper investigates whether the growing economic influence of China in the AP region is reflected in currency co-movements against the US dollar. The growing use of the RMB to settle trade transactions within the region in association with higher exchange rate flexibility, may have increased the sensitivity of AP exchange rates to RMB movements against the US dollar. This greater sensitivity may either be policy-driven, as policymakers seek to stabilize relative competitiveness and to reduce currency risks, or market-driven, as international traders increasingly take RMB movements into account when they trade other AP currencies.

This study contributes to the existing literature by proposing an identification strategy which makes it possible to draw a clearer distinction between the global, regional and RMB factors that drive AP daily exchange rate returns.

When controlling for the main global and regional factors, it is found on average that, since the 2005 exchange rate reform in China, regional currencies have been co-moving with the RMB against the US dollar. Furthermore, results indicate that:

1) When the US dollar tends to depreciate globally, daily exchange rate returns within the region tend to be more (positively) correlated among themselves and with the RMB and less correlated to other major global currencies. On the contrary, when the US dollar tends to appreciate globally, AP exchange rate returns follow the global depreciation trend against the US dollar more closely; in these instances the RMB plays little or no role. The evidence suggests that AP currencies move as if driven by the aim of stabilizing the effective exchange rate, thereby avoiding excessive appreciation; a similar interpretation was also suggested by Ho et al. (2005) and Rajan (2012).
2) The degree of correlation with the RMB varies considerably across currencies. At one end of the spectrum, the correlation is zero throughout the period for the Australian and New Zealand dollars. At the other end, the Indonesian rupiah, the Korean Won, the Malaysian ringgit, the Singaporean dollar and the Taiwanese dollar show a very strong correlation with the RMB.

The paper is organized as follows. Section 2 briefly describes the basis of China's economic influence in the AP region. Section 3 reviews the relevant literature on the topic of RMB co-movements with other Asian currencies. Section 4 describes the data and the empirical strategy used. Section 5 presents the results of the analysis. Section 6 concludes the paper.

2. The regional role of China and its currency

Following the Asian financial crisis of 1997-98, and especially after the global financial crisis of 2008-09, China has been taking on a leadership role in promoting intra-regional integration. In response to the US-led *Trans-Pacific Partnership* (TPP) agreement, which excludes China but includes a number of AP countries, China has been promoting the creation of a regional *Free-Trade Area of the Asia-Pacific* (FTAAP).

Regional trade integration has grown dramatically over the last decade, and for many AP countries intra-regional trade has come to account for more than 60 per cent of their total external trade (Table 2). China has exerted a pivotal role in this process, thanks to its central position in the region's production network (IDE-JETRO and WTO, 2011; Baldwin, 2011). Since 2002, the share of trade with China has nearly doubled in almost all countries, mainly at the expense of Japan.

Table 2: Trading weights display increasing intra-regional integration, driven by the growing weight of trade with China.

Weights for:	Share of intra-AP trade (1)		*of which*: Share of trade with China		*of which*: Share of trade with Japan	
	2002-04	**2011-13**	**2002-04**	**2011-13**	**2002-04**	**2011-13**
Australia	50.1	56.6	12.0	23.9	14.5	9.5
Taiwan	57.0	63.6	15.6	28.5	21.6	14.1
Hong Kong	61.9	63.3	13.4	21.0	12.6	15.8
India	32.5	42.0	8.2	19.6	6.5	8.7
Indonesia	61.4	70.2	8.1	19.4	19.1	5.1
Japan	47.0	57.8	20.0	31.0	-	-
Korea	53.6	59.6	17.7	30.0	20.1	14.8
Malaysia	57.3	65.3	9.9	21.0	15.8	14.0
New Zealand	59.7	64.0	10.0	20.7	14.1	11.7
Philippines	57.7	68.0	7.7	17.1	21.9	9.0
Singapore	60.0	65.3	10.8	19.3	13.8	17.4
Thailand	60.8	68.0	10.4	20.5	23.8	9.2

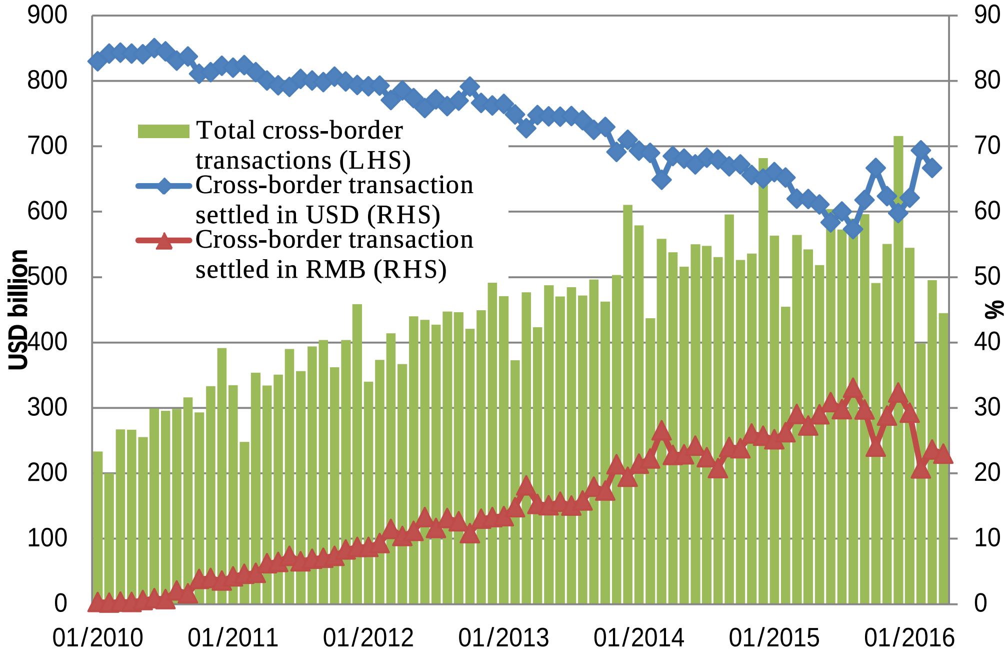
Source: BIS. (1) AP includes the countries reported in the first column and China.

In July 2009, China's State Council introduced a pilot scheme for RMB trade settlement. Since then the Chinese authorities have proactively encouraged the internationalization of the RMB with the aim of reducing its reliance on the US dollar as a medium of exchange and store of value. The eligible transactions allowed to be settled in RMB have been progressively enlarged to include all current account transactions and some financial account transactions.[1] In 2010 a RMB market was established in Hong Kong, allowing for trading the RMB offshore at a fully flexible exchange rate. Following the introduction of the offshore market, the daily trading band of the onshore exchange rate against the US dollar has been widened repeatedly (up to 2% on April 2014), although the persistence of capital controls has caused the emergence of a differential between the onshore and the offshore exchange rates; the differential has usually remained modest, showing occasional spikes when market pressures, in either direction, became stronger.

[1] For an overview of the RMB internationalization process see Eichengreen and Kawai, 2014 and Marconi et al., 2016.

The use of the RMB as a trade settlement currency has grown significantly: the share of Chinese transactions regulated in domestic currency peaked at 30% in the first half of 2015 (up from zero at the beginning of 2010; Fig. 1). At the global level, according to Swift data, the RMB ranks fifth as a world payment currency, accounting for about 2.5% of global payments by value at the beginning of 2016, lagging behind the Japanese yen.[2]

Fig. 1. Banks' cross-border payments and receipts on behalf of clients



Source: CEIC.

The AP region accounts for more than half of China's total trade in goods and for about 80% of cross-border RMB payments (PBC, 2015). In order to encourage the use of the RMB, the People's Bank of China (PBoC) has signed bilateral currency swap agreements with many central banks in the region (Australia, New Zealand, South Korea, Hong Kong, Malaysia, Indonesia, Singapore and Thailand), and allowed for the creation of multiple offshore centers for RMB trading, after Hong Kong, Singapore, Seoul, Sidney, Kuala Lumpur, Bangkok, Taipei and Macau all became clearing centers for offshore RMB operations.

In addition to trade agreements, China is also seeking to extend its regional economic and political influence by sponsoring new ambitious projects, such as the "New Silk Road" plan, aimed at building transportation and energy infrastructures connecting South and Southeast Asia to Europe[3], and establishing new inter-governmental regional development institutions, such as the Asian

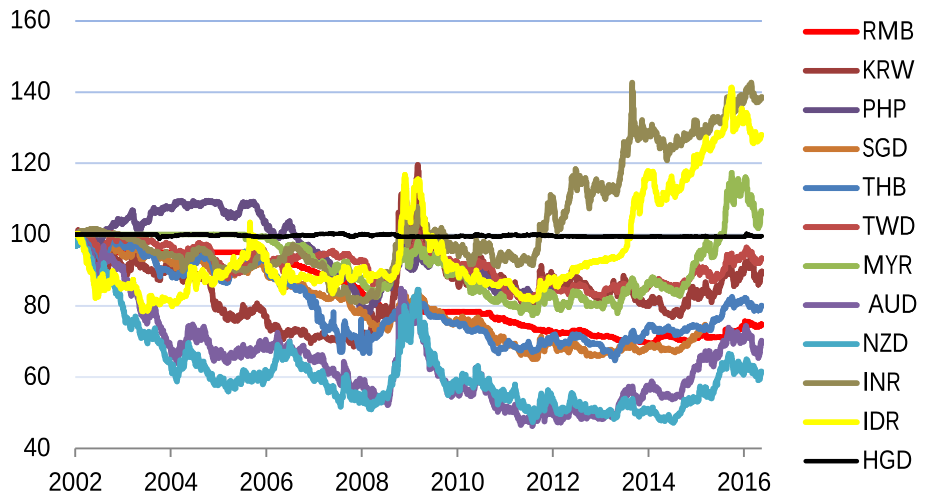
[2] http://www.swift.com/products_services/renminbi_reports
[3] http://news.xinhuanet.com/english/2015-04/14/c_134149910.htm

Infrastructure Investment Bank (AIIB)[4]. Almost all Asian countries, excluding Japan, have joined the AIIB as founding members.

Intra-region financial integration, while still lagging behind relative to trade integration, is progressing. According to Lane (2013): "*A key structural trend that would have a major influence on the nature of cross-border flows in Asia is the internationalisation of the yuan.*[5] […] *the current concentration* [in Asia] *of foreign asset positions in dollar reserves will be replaced by a more balanced mixture, with regional financial integration set to grow more quickly than extra-regional financial linkages*". (p.9)[6]

This study looks at whether the RMB exchange rate against the US dollar (USD) has come to play a role in influencing AP currencies' exchange rates against the USD. The study considers eleven currencies in the AP region (Fig. 3).

Fig. 3: AP daily exchange rates to USD
(Jan 2002=100)



Source: Thomson Reuters Datastream.

Figure 3 displays certain co-movements in daily exchange rates against the USD, with some outliers, such as the Indian Rupee (INR) and the Indonesian Rupiah (IDR), on the one hand, and the Australian dollar (AUD) and the New Zealand dollar (NZD), on the other hand. The question is whether AP's exchange rates have become more sensitive to the RMB/USD daily returns, in consideration of the growing role of the RMB as invoicing currency within the region and the

[4] http://news.xinhuanet.com/english/business/2014-10/24/c_133740149.htm
[5] The official name of the Chinese currency is 'renminbi', 'yuan' is the unit of account.
[6] The debate on whether the RMB is ready to become a global reserve currency has been intensifying recently, also in anticipation of the inclusion of the RMB in the basket of currencies composing the Special Drawing Rights (SDR) issued by the IMF, which was eventually decided in the fall 2015. This issue is beyond the scope of this paper; for a review of the discussion see Eichengreen and Kawai (2015).

increasing flexibility of the Chinese currency. Such sensitivity may be either policy driven, as governments seek to stabilize relative competitiveness and reduce currency risks, or market driven, as international currency traders increasingly take into account RMB movements when they price other currencies in the AP region, as competitiveness vis-à-vis China is an increasingly important element of each currency's fundamentals.

3. Literature review

An increasing body of literature has started to look at the role of the RMB in the exchange rate configuration of the AP region. Most of the research has focused on determining whether the RMB has begun to appear in the implied currency baskets against which markets and/or policymakers tend to stabilize the currencies of other Asian economies, e.g. Fratzcher and Mehl (2013); Henning (2012); Subramanian and Kessler (2012) and Kawai and Pontines (2014). A common feature of the empirical strategy is to estimate a Frenkel-Wei equation (Frenkel and Wei, 1994) of the following type:

$$\Delta \log\left(\frac{E_i}{CHF}\right) = \alpha_i + \beta_1 \Delta \log\left(\frac{USD}{CHF}\right) + \beta_2 \Delta \log\left(\frac{EUR}{CHF}\right) + \beta_3 \Delta \log\left(\frac{JPY}{CHF}\right) + \beta_4 \Delta \log\left(\frac{GBP}{CHF}\right) + \beta_4 \Delta \log\left(\frac{RMB}{CHF}\right) + \epsilon_{it} \quad (1)$$

where $\Delta \log\left(\frac{E_i}{CHF}\right)$ is the change of the log of the exchange rate (E) of country i, vis-à-vis the Swiss franc (CHF); USD, EUR, JPY and GBP denote US dollar, euro, Japanese yen, pound sterling. All exchange rates are expressed vis-à-vis the Swiss franc (but another currency too could be chosen as *numéraire:* for instance, Fratzcher and Mehl (2013) chose the SDR while Kawai and Pontines (2014) chose the New Zealand dollar).

The evidence based on this approach is mixed. On the one hand, Henning (2012) and Subramanian and Kessler (2012) conclude that a RMB bloc has emerged in East Asia; on the other hand, Fratzcher and Mehl (2013) and Kawai and Pontines (2014) find a more limited effect. This ambiguity essentially arises from two main problems. First, much of the difficulties in assessing the degree of co-movements with the RMB arise as a result of the choice of the *numéraire*. The USD is not only the dominant currency in the international monetary system, it is also the main reference currency in the RMB basket. Whenever a currency other than the USD is chosen as the *numéraire*, and both the USD and the RMB are included on the right hand side, multicollinearity problems arise. A second problem is due to omitted variables, in that exchange rate changes may be driven by common factors, both at the global and regional level. Not accounting for these factors may cause the RMB to take on a larger role. Fratzscher and Mehl (2013) suggest to overcome collinearity problems using orthogonal explanatory variables, taking the USD/SDR exchange rate as the exogenous one; to control for the omitted variable problems, they introduce a set of global variables, including oil prices, a proxy for global liquidity conditions and a proxy for risk aversion.[7] Kawai and Pontines (2014) use a two-step estimation approach and conclude that the importance of the RMB in the currency basket of many East Asian economies has grown in recent years, but the USD still remains the most important anchor currency in the region. Fratzscher and Mehl (2013) reached a very similar conclusion.

Another approach is to choose the USD itself as the *numeraire*. This choice is set to focus on the degree of exchange rate co-movements against the USD. Using this approach, Shu et al. (2014) found significant, though differentiated, co-movements of AP currencies with the RMB.

To summarize, existing evidence points to: (i) an increasing role of the RMB in explaining exchange rate movements in Asia (ii) an even larger role after the global financial crisis; (iii) the magnitude varies across studies, also depending on the specification.

4. Data and estimation strategy

In this section we assess the response of daily exchange rate returns against the USD of eleven AP currencies to developments of the RMB/USD daily exchange rate. The USD is chosen as the *numeraire*, thereby overcoming one possible source of collinearity; along with the RMB/USD exchange rate, explanatory variables include global and regional factors. The basic specification is the following:

$$\Delta \log\left(\frac{E_{it}}{USD_t}\right) = \alpha_i + \beta_{GD}\Delta\log(GD_t) + \beta_{REG}\Delta\log(REG_{it}) + \beta_{RMB}\Delta\log\left(\frac{RMB_t}{USD_t}\right) + \gamma_1\Delta\log(GSCI_t) + \gamma_2\Delta SOVX_t + \gamma_3\Delta VIX_t + \delta_1\Delta REPO_t + \epsilon_{it} \quad (2)$$

The dependent variable is the two-day (non-overlapping) return for the nominal (spot) exchange rate expressed in units of the *i-th* national currency per USD; *i* indicates the *i-th* AP currency. Variables on the right hand side include: the two-day log change of an outside-region global dollar index (GD); the two-day return of a regional exchange rate index (REG); the two-day return of the

[7] The study carried out by Fratzscher and Mehl (2013) proposes many different specifications to test the China's dominance hypothesis. The reference here is to the specification reported in Table 4 (p.1361).

RMB/USD exchange rate.[8] Other global variables included are: a commodity price index (GSCI); the emerging market sovereign spread index (SOVX), to capture the degree of stress on global financial markets; and the Chicago Board Options Echange Volatilty Index (VIX), to capture global risk aversion. To account for any additional effect stemming from liquidity conditions in China, we also include the Chinese 1-week interbank repo rate (REPO). β_{RMB} is the parameter of interest, it measures the degree of response of daily returns to the RMB/USD exchange rate.

The GD index is the trade-weighted exchange value of the USD versus six major free floating currencies.[9] The GD index is invariant across the countries included in the sample. An increase of GD indicates an average appreciation of the USD with respect to major international currencies. It intends to capture the 'non-regional' fraction of the 'global dollar' factor proposed by Verdelhan (2015). The regional fraction is in turn captured by the variable REG[10]; this variable is country-specific and corresponds to a trade-weighted average index of the bilateral AP exchange rates against the USD, excluding currency *i* itself:

$$REG_{it} = \sum_{s \neq i} \frac{E_{st}}{USD_t} * w_s^i \; ; \; i \in AP; s \in AP \; ; \; \sum_{s \neq i} w_s^i = 1 \; . \qquad (3)$$

where w_s^i indicates the trade weight (for country *i*) assigned to the currency of trading partner *s*. A more detailed description of the variables and the list of the currencies included is reported in Table A1 in the Appendix.

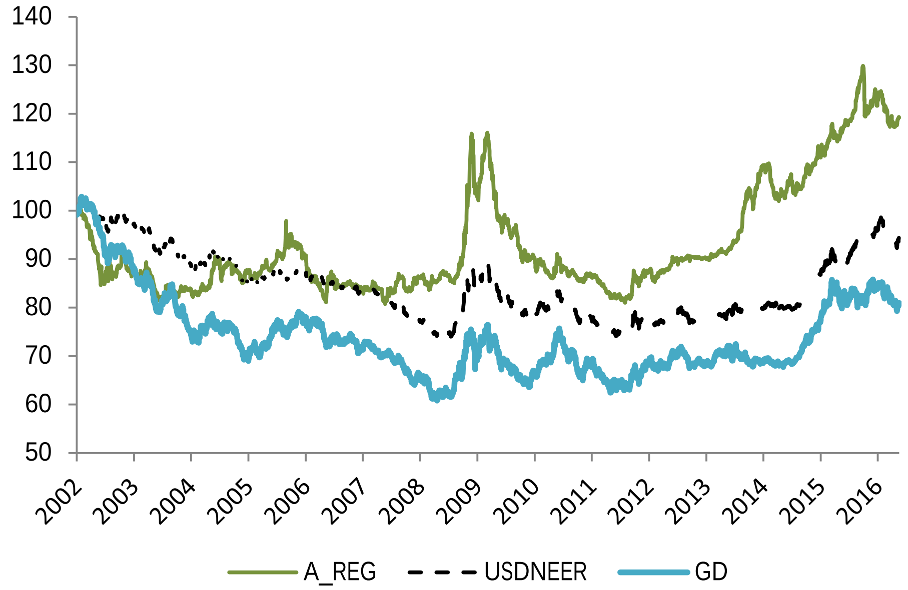
Figure 4 reports the GD index, as well as a simple average of the eleven country-specific REG indexes, and the USD broad nominal effective exchange rate index (NEER). Since 2003 GD and REG have been diverging, the distance between the two variables increased following the 2008-09 global financial crisis. Since then, the gap has tended to increase in periods of sustained USD depreciation and to narrow in periods of USD appreciation.

8 It is standard in the literature to use two-day non-overlapping exchange rate returns to account for possible non-overlapping trading zones affecting global variables and to avoid spurious correlations if two-day returns were overlapping.

9 The index, computed by the Federal Reserve, it includes the Canadian dollar, the Euro, the Japanese yen, the Swiss franc, the UK pound, and the Swedish krona.

10 In Verdelhan (2015) the global dollar factor corresponds to the average change in the exchange rate between the US dollar and all other currencies, excluding currency *i* itself. Hence, in Verdelhan the global dollar factor is country-specific. Here we split Verdelhan's global dollar factor into two parts: an outside-region part, common across the currencies considered, and a regional part, which is country-specific. Fratzscher and Mehl (2011, 2013) too consider a regional currency factor similar to ours, however in their specification the regional factor for Asia includes the RMB, hence the RMB effect is not distinguished from the regional one (see Table 6 on page 35, in Fratzscher and Mehl, 2011); similarly, when they single out the RMB effect, they do not include the regional factor (see Table 7 on page 36, in Fratzscher and Mehl, 2011).

Fig. 4: Global dollar; Regional factor and USD nominal effective exchange rate



Source: Thomson Reuters Datastream and author's calculations.
Note: An increase indicates a dollar effective appreciation against the group of currencies considered. A_REG is the average of country-specific REG_{it} *computed in (3); GD is the USD index against 6 major currencies; USDNEER is the daily USD effective exchange rate index.*

5. Empirical results

5.1 Panel regressions

We use daily data running from 1 January 2002 to 16 May 2016. This time span provides a sufficient perspective to assess the evolution of exchange rate co-movements in the AP region, since it encompasses both periods of RMB hard peg to the US dollar, for which β_{RMB} should take on a zero value, and periods of higher RMB flexibility.

Table 3 reports panel estimates for equation (2), using different estimators: pooled OLS estimator (column 1), fixed effect estimator (FE, column 2), panel-corrected standard error estimator (PCSE), and a fixed effect estimator based on orthogonal variables.[11] Different estimators give the same results in terms of both the magnitude and the significance of the estimated parameters, hence I choose to rely on the fixed-effect estimator with non-orthogonal variables. Turning on the coefficients, a first element to point out is their relative magnitude, as the largest impact comes from the GD factor, followed by the REG factor; the RMB factor retains the smallest impact, though statistically very significant.

[11] Orthogonal variables may be useful in case of highly collinear variables. Pairwise correlation coefficients indicate very low correlations between GD, REG and RMB.

Table 3: Basic panel regressions comparing different estimators

	OLS	FE	PCSE	FE_ORTH
	(1)	(2)	(3)	(4)
GD	0.27***	0.27***	0.27***	0.27**
REG	0.20***	0.20***	0.20***	0.20***
RMB	0.17***	0.17***	0.17***	0.17**
SOVX	0.01***	0.01***	0.01***	0.01***
GSCI	-0.02***	-0.02***	-0.02***	-0.02*
VIX	0.01***	0.01***	0.01***	0.01**
REPO	0	0	0	0
N	20614	20614	20614	20614
r2	0.23	0.23	0.23	0.23

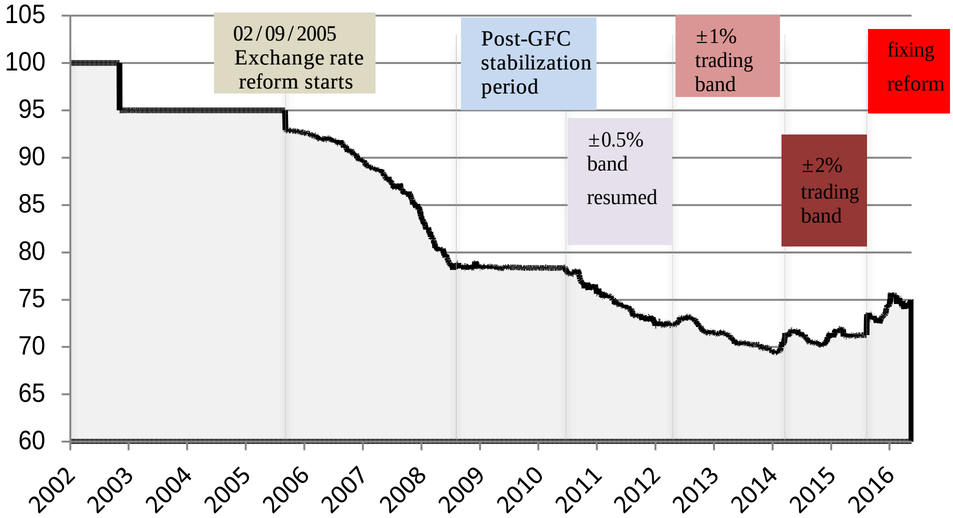
*Note: *p<0.05; ** p<0.01; *** p<0.001. FE= fixed effect, with robust standard errors; PCSE= panel-corrected standard error model. ORTH = orthogonalized variables. Variable ordering for orthogonalization: GD, VIX, SOVX, GSCI, REG, RMB, REPO.*

Looking at the RMB/USD exchange rate it is possible to identify seven sub-periods.

- Period 1 (01/01/2002 - 02/09/2005): strict peg to the dollar;
- Period 2 (05/09/2005 - 01/08/2008): introduction of the crawling-peg regime, with a maximum daily trading band against the US dollar of ±0.5%;
- Period 3 (02/08/2008 - 18/06/2010): restoration of a stricter peg to the dollar;
- Period 4 (21/06/2010 - 13/04/2012): return to flexibility, within a daily trading band of ±0.5%;
- Period 5 (16/04/2012 - 14/03/2014): daily trading band widens to ±1%;
- Period 6 (15/03/2014 - 10/08/2015): daily trading band widens to ±2.0%;
- Period 7 (from 11/08/2015-): new mechanism of determination of daily central parity

Fig. 2: RMB/US$; daily exchange rate

(Jan 2002=100)



Source: Thomson Reuters, Datastream.

Table 4 reports the results from regressions based on different specifications and run on the seven sub-periods identified.

We consider the following alternative specifications:

$$\Delta\log\left(\frac{E_{it}}{USD_t}\right) = \alpha_i + \beta_{EUR}\Delta\log\left(\frac{EUR_t}{USD_t}\right) + \beta_{YEN}\Delta\log\left(\frac{JPY_t}{USD_t}\right) + \beta_{RMB}\Delta\log\left(\frac{RMB_t}{USD_t}\right) + \gamma_1\Delta\log(GSCI_t) + \gamma_2\Delta SOVX_t + \gamma_3\Delta VIX_t + \delta_1\Delta REPO_t + \epsilon_{it} \quad \text{(I)}$$

$$\Delta\log\left(\frac{E_{it}}{USD_t}\right) = \alpha_i + \beta_{GD}\Delta\log(GD_t) + \beta_{RMB}\Delta\log\left(\frac{RMB_t}{USD_t}\right) + \gamma_1\Delta\log(GSCI_t) + \gamma_2\Delta SOVX_t + \gamma_3\Delta VIX_t + \delta_1\Delta REPO_t + \epsilon_{it} \quad \text{(II)}$$

$$\Delta\log\left(\frac{E_{it}}{USD_t}\right) = \alpha_i + \beta_{GD}\Delta\log(GD_t) + \beta_{REG}\Delta\log(REG_{it}) + \beta_{RMB}\Delta\log\left(\frac{RMB_t}{USD_t}\right) + \gamma_1\Delta\log(GSCI_t) + \gamma_2\Delta SOVX_t + \gamma_3\Delta VIX_t + \delta_1\Delta REPO_t + \epsilon_{it} \quad \text{(III)}$$

Results show that $\hat{\beta}_{RMB}$ not only varies considerably depending on the controls included in the regression, but also across the seven sub-periods. Nonetheless a common feature of all the specifications is that $\hat{\beta}_{RMB}$ has started being statistically significant since the early reform period in 2005, carrying a positive sign. During the post-GFC stabilization period the coefficient becomes statistically insignificant, as expected. Interestingly, the coefficients drops and is less significant, or not different from zero, in the 2%-band period. It is worth noting that, in this time span, despite the wider trading band, the RMB displayed very low volatility and the USD tended to appreciate globally. We will come back to the issue of asymmetric correlation later on.

Table 4: $\hat{\boldsymbol{\beta}}_{\boldsymbol{RMB}}$ from alternative specifications and on different sub-periods

Period	I	II	III
All sample	0.23***	0.24***	0.17***
Pre-sept.2005	0.0	-0.01	-0.01
Post-Sep.2005	0.34***	0.35***	0.25***
Early-reform period	0.27***	0.30***	0.23***
Post-GFC stabilization period	-0.32	-0.04	-0.15
0.5%-band period	0.31***	0.33***	0.25***
1%-band period	0.36***	0.36***	0.28**
2%-band period	0.14*	0.18**	0.05
Post- fixing reform period	0.38***	0.39***	0.28***

*Note: based on fixed-effect regressions, robust standard errors. *p<0.05; ** p<0.01; *** p<0.001. Specification tests run on country-specific regressions indicate that if we exclude GD and REG from the model the null hypothesis of no specification errors is rejected. On the contrary, when the two variables are included, we fail to reject the null hypothesis of no specification error.*

Given the degree of trade integration and competition within the region, as well as the role of the global dollar factor in explaining bilateral exchange rate movements (Verdelhan, 2015), controlling for global and regional factors appears to be key: if these two variables are excluded from the regression and replaced with EUR/USD and JPY/USD (as done in many studies), the RMB effect appears larger; restricting the sample to post-2005 and including GD and REG reduces $\hat{\beta}_{RMB}$ from 0.34 to 0.25 (Table 4, 'Post-Sep.2005' row).[12] Specification tests run on country-specific regressions confirm that by excluding GD and REG the model is not correctly specified (results are available from the author upon request).[13]

Table 5 displays full results from panel regressions run on the seven sub-periods of the RMB regime. As previously noted, $\hat{\beta}_{RMB}$ is not significantly different from zero in three occasions: the pre-reform period and the stabilization period, as one would expect, as well as the 2%-band period (15/03/2014 - 10/08/2015). In all those instances, both $\hat{\beta}_{GD}$ and $\hat{\beta}_{REG}$ remain highly significant and fairly stable in magnitude. $\hat{\beta}_{RMB}$ is higher between June 2010 and March 2014, which corresponds also to a period of rapid increase in the use of the currency within the region, and in the post-fixing reform period, when the volatility of the Chinese currency increased considerably and the RMB tended to depreciate against the USD.

Table 5. Fixed-effect panel regressions with global, regional and RMB factors

	All sample	Pre-reform	Early reform	Post-GFC stabilization	0.5% band	1% band	2% band	Post-fixing reform
GD	0.27***	0.25***	0.27***	0.32***	0.24***	0.28***	0.26***	0.34***
REG	0.20***	0.17***	0.22***	0.15***	0.22***	0.21***	0.20***	0.23***
RMB	0.17***	-0.01	0.23***	-0.15	0.25***	0.28**	0.05	0.28***
SOVX	0.01***	0.00***	0.01***	0.00***	0.01***	0.01***	0.01**	0.01***
GSCI	-0.02***	0	0	-0.03***	-0.05***	-0.02	-0.02	-0.01
VIX	0.01***	0.00*	0.00***	0.02***	0.01***	0	0.00**	0.02***
REPO	0	0.02	-0.02	-0.05	-0.02	0.07***	0.02	-0.11
N	20614	5258	4180	2695	2607	2750	2013	1100
r2	0.23	0.18	0.16	0.27	0.35	0.2	0.19	0.38

*Note: * p<0.05; ** p<0.01; *** p<0.001. Robust standard error.*

[12] This can explain why Shu et al. (2014) find very large RMB coefficients.
[13] Provided the GD factor is included, the EUR and the YEN variables have no additional explanatory power. Including these two factors along with the GD factor do not affect the coefficients of REG and RMB, while the GD coefficient changes accordingly. The full set of regressions are available from the author upon request.

Results are confirmed and reinforced if we exclude from the sample the Australian dollar (AUD), the New Zealand dollar (NZD) and the Hong Kong dollar (HGD) (Table 6). The first two are excluded because AUD and NZD are truly free floating currencies and likely more affected by fluctuations in commodity prices; HGD can be excluded because it is a currency-board regime. The effect of these exclusions is to reduce the role of GD and to increase that of the RMB. In the 2%-band period the RMB exerts again a positive and statistically significant influence on AP's daily exchange rate returns, though of a lower magnitude compared to previous and the latest sub-period.

Table 6. Fixed-effect panel regressions with global, regional and RMB factor; excl. AUD, NZD and HGD

	All sample	Pre-reform	Early reform	Post-GFC stabilization	0.5% band	1% band	2% band	Post-fixing reform
GD	0.19***	0.15***	0.16***	0.23***	0.18***	0.24***	0.19***	0.29***
REG	0.21***	0.17***	0.27***	0.14***	0.24***	0.25***	0.22***	0.23***
RMB	0.22***	-0.02	0.25***	0.25	0.30***	0.31**	0.15*	0.35***
SOVX	0.01***	0.00*	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***
GSCI	-0.01***	0.01	0.01	0	-0.03***	-0.02	-0.01	0
VIX	0.01***	0	0	0.01***	0.00**	0	0.00**	0.01***
REPO	0	-0.12	-0.01	0.08	-0.03	0.06**	0	0.12
N	14992	3824	3040	1960	1896	2000	1464	800
r2	0.21	0.15	0.15	0.25	0.36	0.2	0.21	0.41

*Note: * $p<0.05$; ** $p<0.01$; *** $p<0.001$. Robust standard error.*

Tables 5 and 6 reveal a certain instability of $\hat{\beta}_{RMB}$. In order to better understand the behavior of $\hat{\beta}_{RMB}$ in relation to $\hat{\beta}_{GD}$ and $\hat{\beta}_{REG}$, the sample period is now divided according to the appreciation and depreciation phases of the USD against other major international currencies (Table 7). Doing so it is possible to detect a clear pattern: when the USD depreciates globally (i.e. GD tends to decrease), AP currencies co-move less with the GD factor and more with both the REG and the RMB factors (column 2, Table 7); on the contrary, when the USD appreciates globally (i.e. GD tend to increase) daily returns co-move more with GD and less with both REG and RMB. This suggests that the AP currencies move "as if" driven by an objective to stabilize the effective exchange rate, avoiding excessive appreciations against the USD, an interpretation in line with that suggested by Ho et al. (2005) and Rajan (2012).[14]

Table 7. Fixed effects panel regressions based on USD phases of appreciation/depreciation			
Variable	USD depreciation	USD appreciation	USD stability
GD	0.24***	0.31***	0.26***
REG	0.25***	0.17***	0.21***
RMB	0.27***	0.09	0.30***
SOVX	0.01***	0.00***	0.01***
GSCI	0.0	-0.03***	-0.02***
VIX	0.01***	0.01***	0.01***
REPO	-0.02	0.01	0.01
N	4323	4070	6930
r2	0.20	0.25	0.28

*Note: * p<0.05; ** p<0.01; *** p<0.001. Robust standard error. The depreciation period includes: 10/03/2006-18/04/2008; 10/03/2009-25/11/2009; 09/06/2010-29/04/2011. The appreciation period includes: 19/04/2008-09/03/2009; 26/11/2009-08/06/2010; 01/07/2014-16/03/2015. The stability period includes: 05/09/2005-09/03/2006; 30/03/2011-30/06/2014; 17/03/2015-16/05/2016.*

5.2 Country-specific rolling regressions

Country-specific rolling-window regressions are important when checking for parameter changes, particularly when structural breaks are expected. In order to grasp all the information stemming from the increasing flexibility of the RMB, I perform a reverse recursive analysis, using the end date of 16/05/2016. The starting date is advanced by 100 working days while the minimum window size is set to 290. Excluding the pre-reform period, our dataset has observations numbered 960-3460. We start from 960 (corresponding to 5/09/2005), the first regression is run using observations 960-3750, the second is run on observation 1060-3750, and so on, finishing with a regression using the last 290 observations (06/04/2015-16/05/2016)

Figure 5 shows the country-specific recursive coefficients for the RMB (red line). Dashed lines indicate the confidence interval (95%) around the estimated coefficient[15]. Countries are ordered according to the degree of correlation of their respective currencies with the RMB. As expected, the AUD and the NZD are uncorrelated with the RMB throughout the different sample periods; the

[14] Results are confirmed also by interacting GD, REG and RMB with dummy variables that identify the appreciation and depreciation periods. Results are reinforced if we exclude Australia, New Zealand and Hong Kong from the sample. Results are available from the author upon request.
[15] Estimates for β_{GD} and β_{REG} are reported in Appendix B.

HGD and the INR display a very weak correlation.[16] The Indian Rupiah shows a certain sensitivity after the end of 2014. On the contrary, the currencies of Indonesia, Korea, Malaysia Singapore and Taiwan, display strong and significant co-movements with the RMB throughout the sampling periods. The Philippine peso and the Thailand bath lie somewhere in between in terms of correlation.

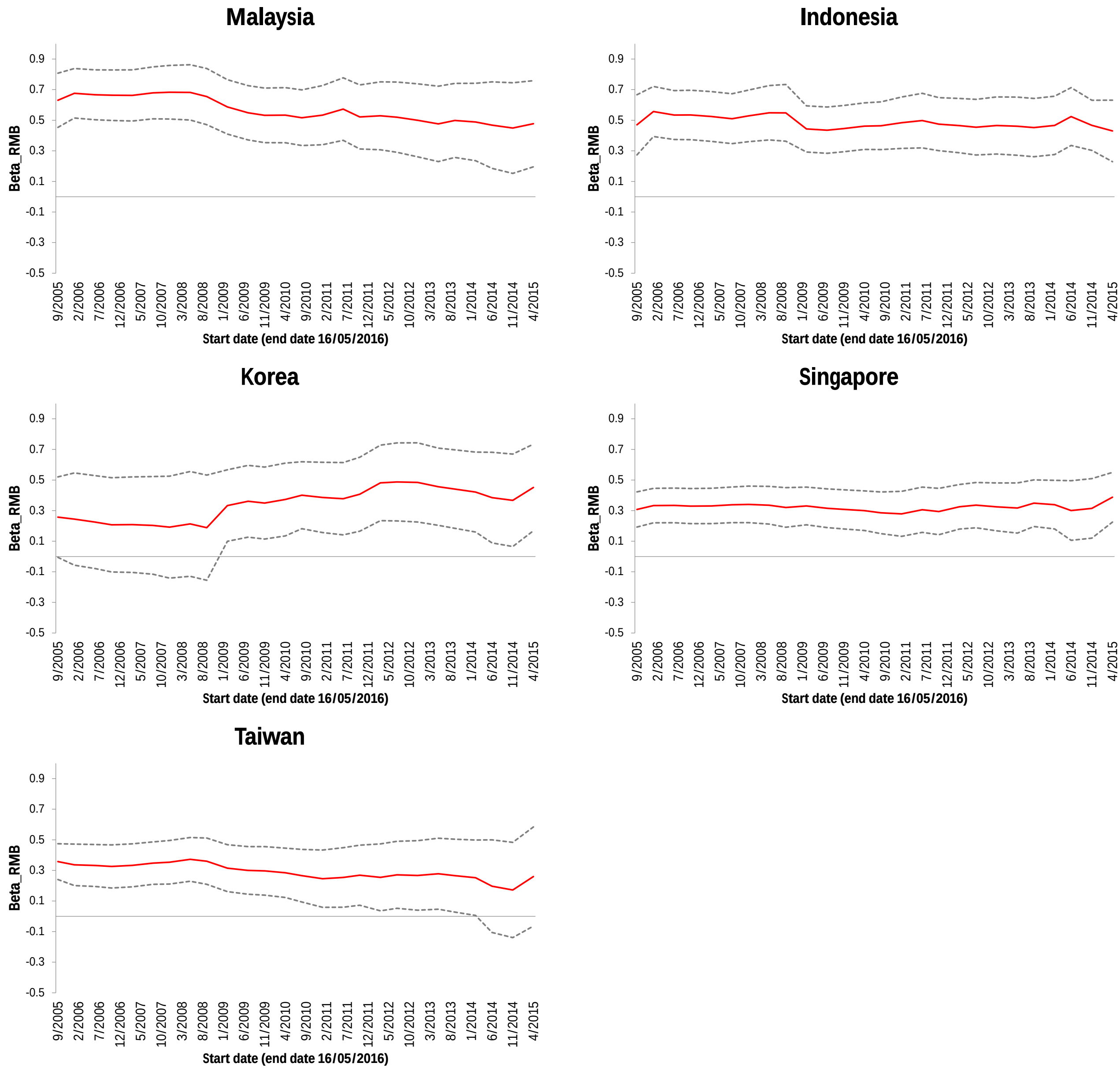
Figure 5: Rolling estimates of RMB coefficients

(a) Uncorrelated currencies

(b) Slightly correlated currencies

[16] The HGD is on a currency board with the USD, hence it records very little daily movements against the US dollar, nonetheless, occasionally the currency show a certain sensitivity to daily RMB movements.

Figure 5 'ctd.: estimated RMB coefficient from rolling-window estimation: (c) Highly correlated currencies



Note: The figures display country-specific rolling coefficient estimates of RMB and their 95% confidence intervals. The rolling estimates are based on reverse-recursive rolling samples. Holding fix the end date, the starting date is advanced by 100 observations and the minimum window size (i.e. the last sample period) is set to 290 observations. The whole sample period is from 5 September 2005 to 16 May 2016. The dates shown in x-axis are the starting date of the rolling samples; all samples end on 16 May 2016.

5.3. Robustness checks

This section provides additional checks. The first check is to consider the role of the offshore RMB exchange rate, henceforth indicated with the label CNH. The CNH is a freely floating exchange rate, accessible to all market participants. Although the onshore (henceforth labelled CNY) and offshore RMB are exchanged at par, the trading between CNY and CNH is restricted to current account transactions, foreign direct investments and portfolio transactions within the quota limits. These restrictions generate a segmentation between the onshore and offshore exchange rate markets which may result in differences in the value of the two exchange rates in terms of foreign currencies. When the onshore rate deviates significantly from market valuations then the divergence between CNY and CNH tends to become larger, indicating the direction of the market pressures. Since its introduction daily spreads have remained quite modest, indicating that the CNH tend to track quite closely the CNY (Table 8).

Table 8. Summary statistics for CNY and CNH

Variable	Obs	Mean	Std.	Min	Max
CNY	1,361	6.28	0.14	6.04	6.6
CNH	1,361	6.29	0.14	6.02	6.7
CNY-CNH	1,361	-0.0046	0.022	-0.14	0.063

Note: Observations from 28 February 2011 to 16 May 2016. sRMB is the difference between the daily (closing) spot rate CNY/USD and daily (closing) spot rate CNH/USD.

Table 9 compares the estimated coefficients obtained when the RMB/USD in eq. (2) is set equal to CNH, as opposed to RMB/USD equal to CNY as done so far. In order to make a comparison, the initial date of the sample period is fixed to 28 February 2011, when daily rates for the CNH/USD became available. The estimated coefficients for CNY and CNH confirm that the two rates carry exactly the same information, exerting the same degree of influence on AP's currencies.

Table 9. Fixed-effect panel regressions onshore (CNY) vs offshore (CNH) RMB

	Onshore RMB (CNY)	Offshore RMB (CNH)	Onshore RMB Excluding AUD, NWD and HGD (CNY)	Offshore RMB Excluding AUS, NWZ and HKG (CNH)
GD	0.26**	0.26**	0.19*	0.20*
REG	0.20**	0.22***	0.23**	0.24**
CNY	0.27***		0.32***	
CNH		0.27***		0.32**
SOVX	0.01***	0.01***	0.01**	0.01**
GSCI	-0.03*	-0.03*	-0.02	-0.02
VIX	0.01*	0.01*	0.00*	0.00*
REPO	0.02	0.02	0.02	0.02
N	7480	7491	5440	5448
r2	0.28	0.27	0.29	0.28

*Note: * p<0.05; ** p<0.01; *** p<0.001. Robust standard error.*

The second check is to regress the (onshore) RMB/USD on GD and REG, including all the controls considered in eq. (2). Results reported in Table 10 shows that GD does not exert a significant influence on RMB/USD daily returns, while REG exerts a very mild effect, though stronger since the second half of 2010. The very low level of the r-squared indicates that the model has almost no explanatory power for the RMB/USD exchange rate.

Table 10. OLS regressions for RMB/USD exchange rate

$$\Delta \log\left(\frac{RMB}{USD_t}\right) = \alpha_i + \beta_{GD}\Delta \log(GD_t) + \beta_{REG}\Delta \log(REG_{RMBt}) + \gamma_1\Delta\log(GSCI_t) + \gamma_2\Delta SOVX_t + \gamma_3\Delta VIX_t + \delta_1\Delta REPO_t + \epsilon_{it}$$

	Full sample period 05/09/2005-16/03/2016	Post GFC-stabilization period 21/06/2010-16/05/2016
GD	0.02*	0.01
REG	0.04***	0.10***
SOVX	0.0	0.0
GSCI	-0.01**	-0.02**
VIX	0.0	0.0
REPO	0.01	0.01
N	1396	770
r2	0.05	0.09

** p<0.05; ** p<0.01; *** p<0.001. Robust standard error; regressions include a constant term.*

The third check consists in estimating eq.(2) using monthly data instead of daily data. There is plenty of evidence that the Asian currencies remain heavily managed, both against the USD and against a basket of currencies (Rajan, 2012). The reaction function of policymakers can have lags that may be difficult to capture at high frequencies, hence lower frequency data may better reflect the influence stemming from our three factors GD, REG and RMB. Results reported in Table 11 show the estimated coefficients based on monthly data. The first regression is based on the full sample, starting from September 2005; the second regression excludes the AUD, the NZD and HGD; the third is based on observations from June 2010 to May 2016 (excluding AUD, NZD and HGD). Results are very similar to those obtained from regressions on daily data. In particular, the influence of the RMB grows larger as the three currencies are excluded and the RMB becomes more flexible. It is interesting to note that, in regression III the RMB effects seem to capture the entire regional effect as REG is not statistically significant. Similar results are obtained considering CNH instead of CNY.

Table 11. Fixed-effect panel regressions on monthly data			
Variable	I	II	III
GD	0.35**	0.29**	0.23**
REG	0.21***	0.21***	0.17
RMB	0.22**	0.28**	0.37**
SOVX	0.01**	0.01*	0.02**
GSCI	0	0.02	0.03
VIX	0.01*	0.01	0.0
REPO	-0.01	0.03	0.13
N	1419	1032	568
r2	0.41	0.41	0.41

** p<0.05; ** p<0.01; *** p<0.001. Robust standard error.*
All regressions include a constant term.

Finally, using monthly data to regress RMB/USD on GD and REG (including all the other controls) does not deliver any meaningful result, indicating that at lower frequencies feedback influence is not yet visible either from global currencies or from AP currencies on RMB changes against the USD.

6. Conclusions

This study looks at whether the RMB exchange rate against the USD has come to exert an influence on Asia-Pacific currencies. The economic and political influence of China in the Asia-Pacific region has grown considerably in recent years, particularly since the 2008-09 global financial crisis. The internationalization of the Chinese currency has the potential to increase the regional influence of the RMB on exchange rate movements. This paper assesses the progress made by the RMB along this path by looking at the evolution of exchange rate co-movements in the Asia-Pacific region. Controlling for the main global and regional factors, it is found that on average, since the 2005 exchange rate reform in China, regional currencies have been increasingly co-moving with the RMB against the US dollar. The degree of correlation with the RMB varies considerably across currencies. At one end of the spectrum, the correlation is zero throughout the period for the Australian and New Zealand dollars. At the other end, the Indonesian rupiah, the Korean won, the Malaysian ringgit, the Singaporean dollar and the Taiwanese dollar show very strong correlations with the RMB. Results are robust to different specifications and to different frequencies.

Furthermore, we find evidence that AP currencies move as if driven by the aim of stabilizing the effective exchange rate, thereby avoiding excessive appreciation against the USD.

Appendix A

Table A1: Description of Variables

Variable	Description	Additional information
$\frac{E_{it}}{USD_t}$	*i-th* currency to US$ exchange rate	i= Australian dollar, Hong Kong dollar, Indian rupiah, Indonesian rupee, Korean won, Malaysian ringgit, New Zealand dollar, Philippines peso, Singaporean dollar, Thailand dollar, Taiwan dollar
$\frac{RMB_t}{USD_t} = \frac{CNY_t}{USD_t}$	onshore Chinese RMB to US$ exchange rate	
$\frac{CNH_t}{USD_t}$	offshore Chinese RMB to US$ exchange rate	
GSCIt	S&P GSCI Commodity Total Return	
SOVXt	JPM EMBI GLOBAL	composite - stripped spread
REPOt	CHINA REPO 1 WEEK	middle rate
VIX	Volatility index	Chicago Board Options Echange Volatilty Index
REGit	Trade-weighted dollar exchange rate index against a basket of AP currencies	$REG_{it} = \sum_{s \neq i} e_{st} * w_s^i$; $i \in AP; s \in AP$ $\sum_{s \neq i} w_s^i = 1$. An increase indicates a dollar appreciation with respect the basket of AP currencies considered (excluding JPY and RMB).
GDt	Trade-weighted dollar exchange rate index against a basket of six major global currencies	Trade-weighted dollar exchange rate with respect to: Canadian dollar; Euro; Japanese yen; Swedish krona; Swiss franc; UK pound. An increase indicates a dollar appreciation against the basket of six major currencies.

Note: All data are sourced from *Thomson Reuters Datastream* at daily frequencies.

Appendix B: additional estimates

Fig. B1: Country-specific rolling-window estimates for the Regional Factor

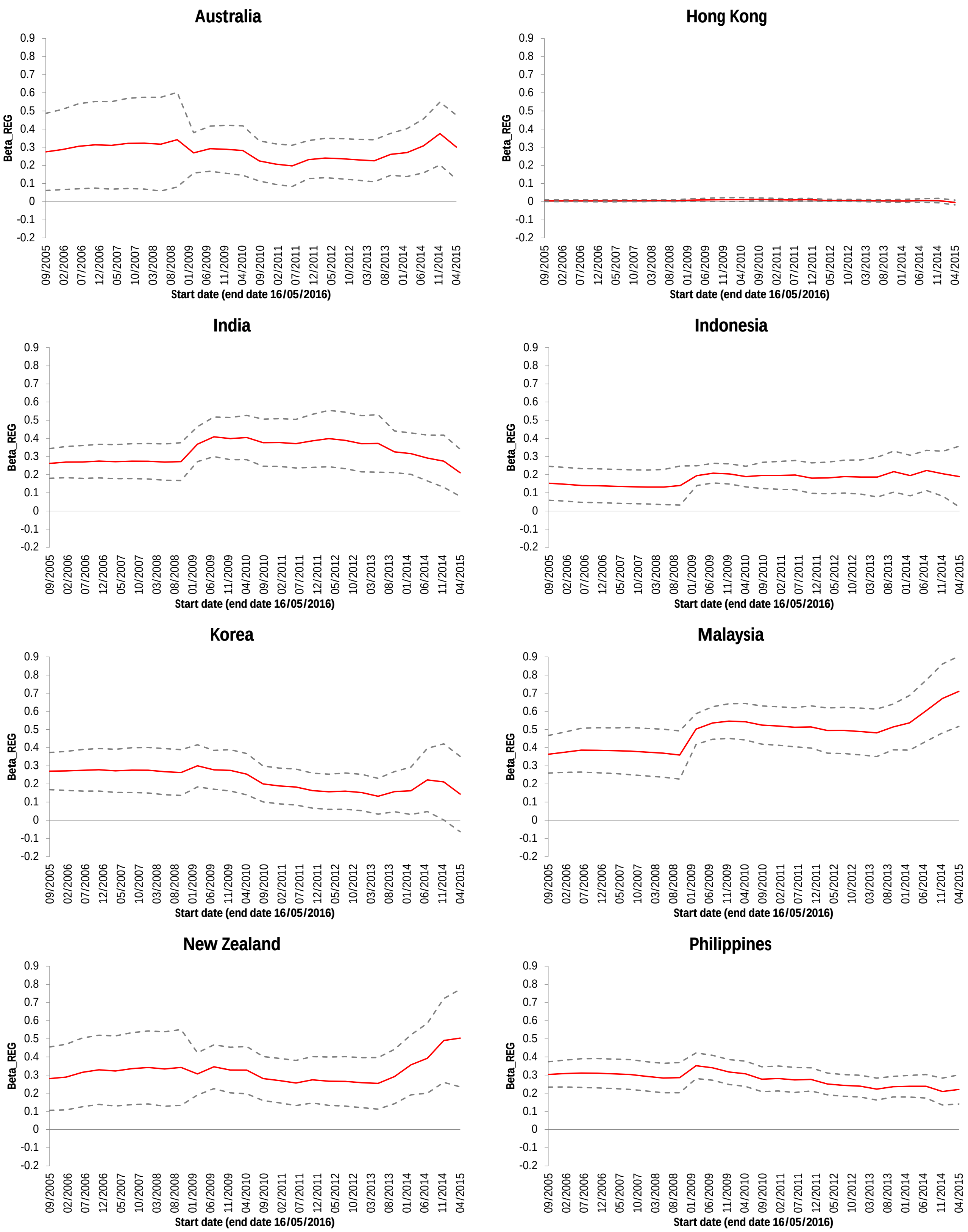
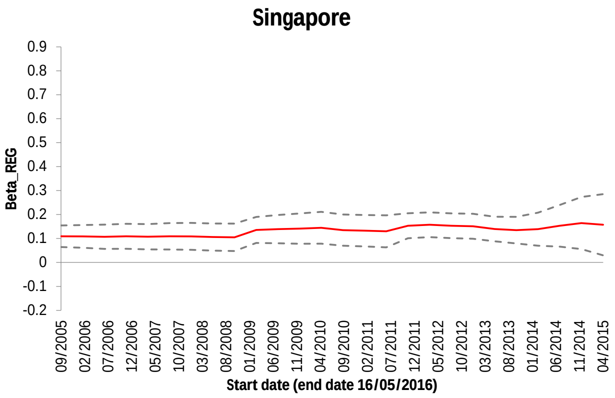
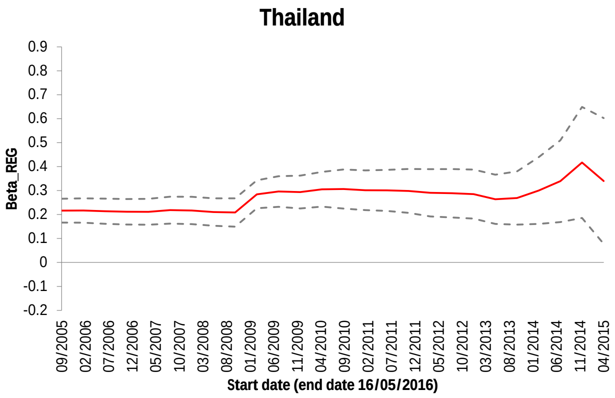


Fig. B1 'ctd.: Country-specific rolling-window estimates for the Regional Factor





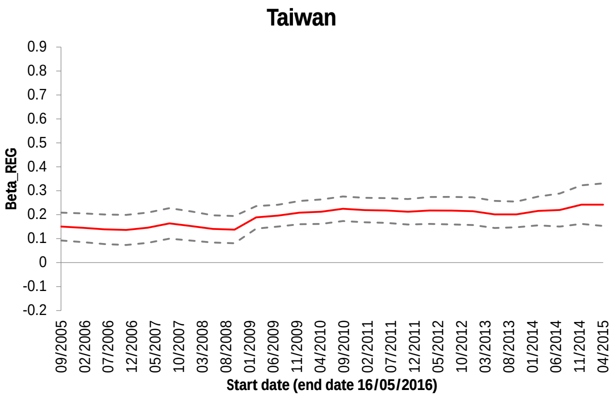


Fig B2: Country-specific rolling-window estimate for the Global Factor

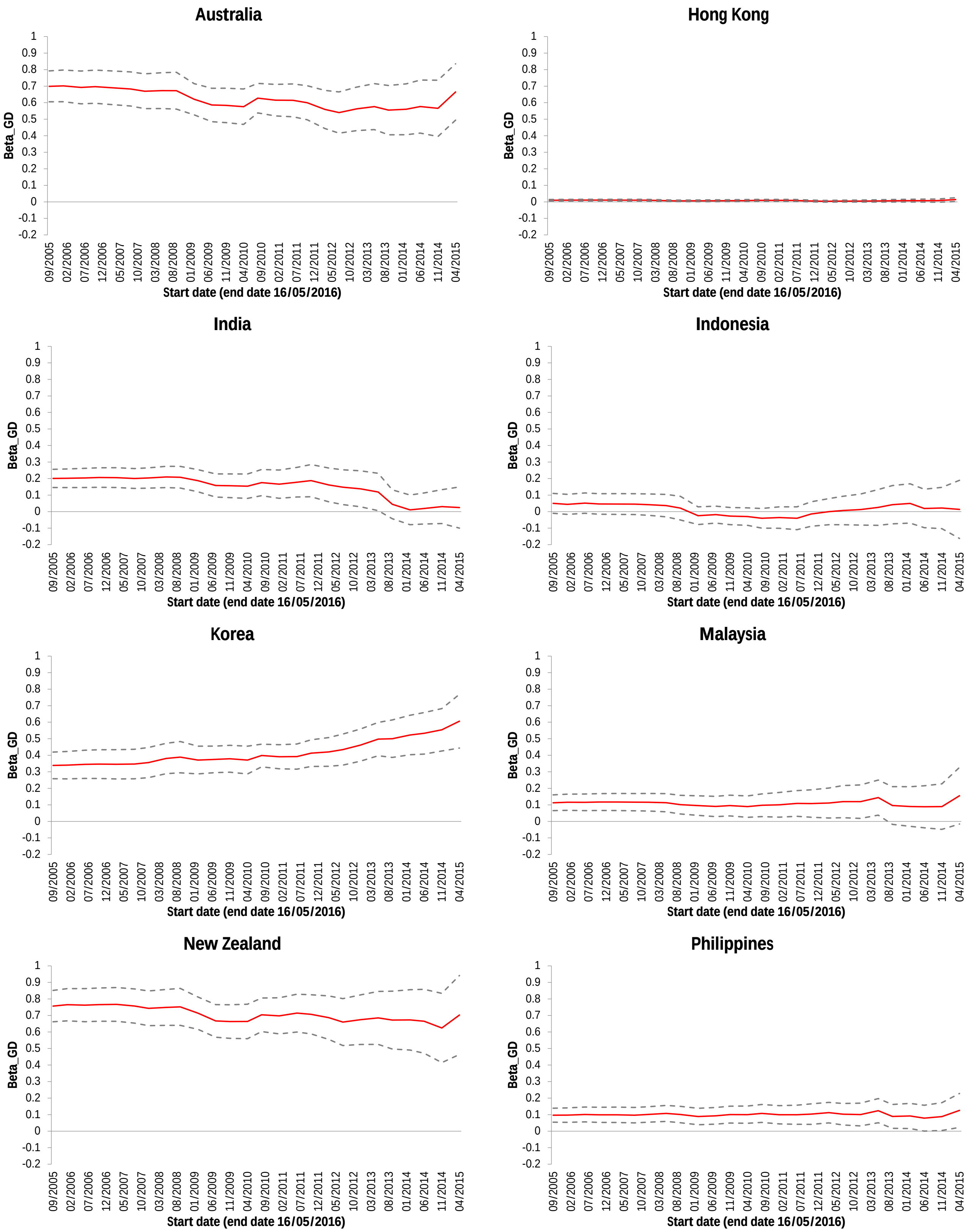
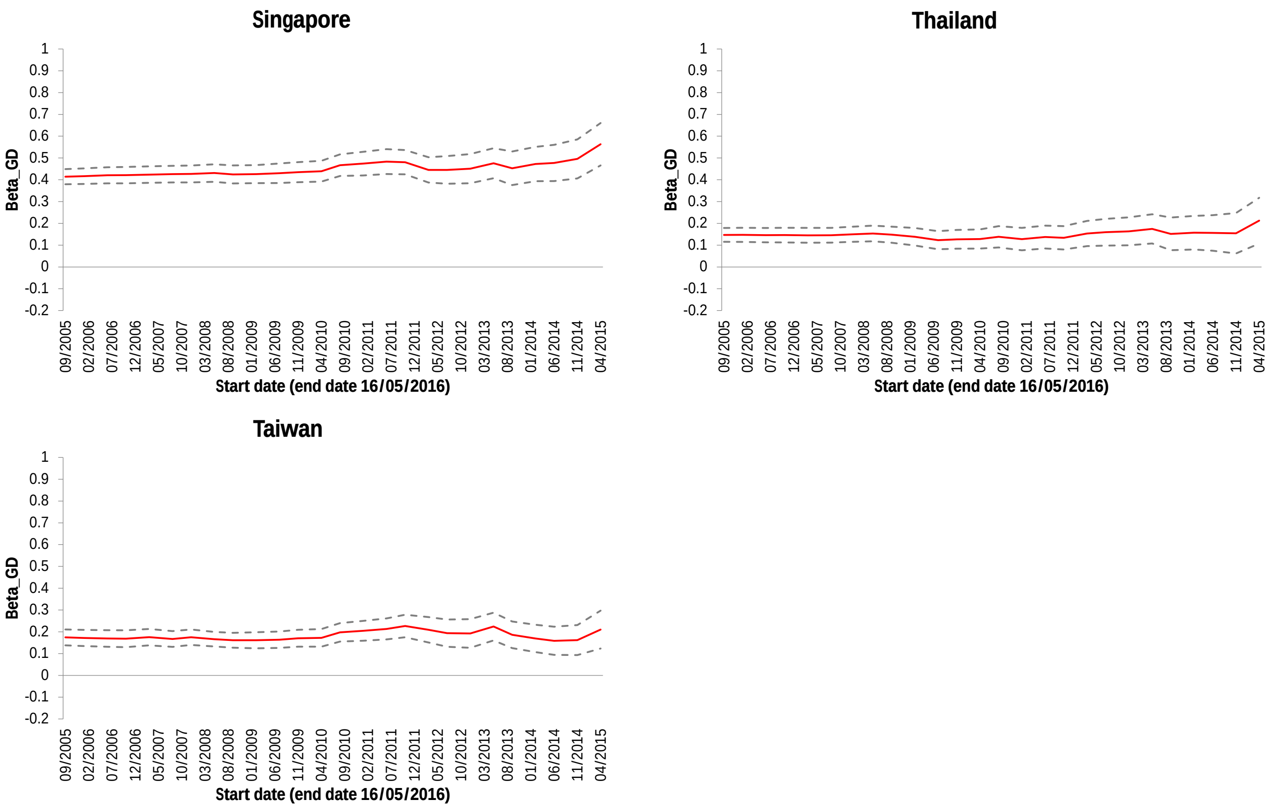


Fig B2 ‘ctd.: Country-specific rolling-window estimate for the Global Factor



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