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# No More Clubbing

## The Evolution of Exchange Rate Behaviour in the ASEAN-5 Countries

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*This paper examines exchange rate behaviour in the ASEAN-5 countries (Indonesia, Malaysia, the Philippines, Singapore, and Thailand). It finds that for the last ten years, there is no evidence that their central banks target particular exchange rate levels against any currency or basket. Thus, contrary to some assertions, they do not belong to a dollar club, a yen club, a renminbi club, or an ASEAN club. At the same time, they clearly try to smooth short-term volatility, particularly vis-à-vis the U.S. dollar. The degree of smoothing declined noticeably after the Asian Financial Crisis and less obviously after the Global Financial Crisis, with heterogeneity across countries. Short-term smoothing without level targeting does not interfere with monetary policies aimed at price stability.*

**Keywords:** Exchange rate regimes; exchange rate volatility; fear of floating; currency blocks; ASEAN.

### 1. Introduction

Exchange rate policies of the ASEAN-5 countries have been subject to considerable scrutiny.[1] The reasons for the scrutiny include: implications of the exchange rate regime for the conduct of monetary policy; concerns about (some of) these countries gaining competitive advantage by undervaluing their currencies; and the view of currency alignment as a reflection of global power structures (Henning 2012).

Heavily managed exchange rate regimes are believed to have contributed to the accumulation of vulnerabilities that resulted in the Asian Financial Crisis (AFC) (Goldstein 1999). Post-crisis, most emerging markets professed greater exchange rate flexibility. However, as documented in the large literature on the "fear of floating" pioneered by Calvo and Reinhart (2002), many of them continued intervening in foreign exchange markets. At the same time, the increasing use of

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exchange rate adjustment as a shock absorber has been noted by many observers (e.g., Shambaugh 2015).

Despite considerable attention, the characterization of exchange rate policies in the ASEAN-5 remains somewhat contentious. Officially, the monetary policy frameworks of these countries center on price stability.[2] Indonesia, the Philippines and Thailand are inflation targeters and profess floating exchange rates, while Malaysia and Singapore "monitor" the value of their currencies against undisclosed baskets.[3] Singapore relies on the exchange rate to conduct its monetary policy, whereas the other four countries use a short-term interest rate as the main policy instrument. All ASEAN-5 have fairly open capital accounts, which makes it challenging to control domestic monetary conditions and the exchange rate at the same time.

The authorities in the ASEAN-5 countries generally acknowledge that they intervene, at least occasionally, in foreign exchange markets. They maintain that intervention is aimed at smoothing excess volatility rather than targeting a specific level of the exchange rate, but some acknowledge that external competitiveness may be a consideration.[4] Many analysts note patterns in observed exchange rate behaviour and reserve movements inconsistent with pure floating or pure short-term smoothing.

Among those analysts, the question as to what is the relevant anchor or reference currency remains unsettled. Some have heralded the emergence of a "renminbi bloc" (Subramanian and Kessler 2013). Others maintain that the U.S. dollar (USD) continues to be the dominant anchor currency in the region, even though the renminbi (RMB) has taken on increasing importance in recent years (Kawai and Pontines 2014). Still others suggest that a synthetic regional currency — to which several East and Southeast Asian economies peg their currencies along the lines advocated by Williamson (1999; 2005) — has in fact already emerged (Girardin 2011).

These studies largely rely on various versions of an econometric approach pioneered by Frankel and Wei (1994, 2008), where bilateral currency movements against a certain numeraire currency are regressed on movements of other currencies against the same numeraire and, in some versions, an index of exchange market pressure. In particular, Girardin (2011) embeds the Frankel-Wei equation in a Markov switching process and includes a synthetic Asian currency on the right-hand side. Subramanian and Kessler (2013) focus on the relative weights of the USD and the RMB in these regressions and note that for most East Asian currencies — including all ASEAN-5 currencies — the latter exceeded the former during the period July 2010 – July 2013. This leads them to assert that the RMB has become the dominant reference currency in the region. Kawai and Pontines (2014) take issue with that finding, pointing out a high degree of collinearity between the USD and RMB movements against any numeraire because the RMB has been managed tightly against the USD, and suggesting a two-step procedure to get around that problem. Based on their approach, Kawai and Pontines (2014) conclude that the USD remains the dominant anchor currency in the region.

The main contribution of our paper is that in studying the exchange rates in the ASEAN-5, we draw a distinction between short-term and long-term behaviour. We argue that while there is evidence that central banks intervene in foreign exchange markets to smooth currency movement in the short term, post-AFC, the ASEAN-5 no longer target specific levels of their exchange rates with respect to other currencies. Therefore, contrary to what some analysts have suggested, there is no dollar club, yen club, RMB club or ASEAN club. The studies mentioned above fail to make that distinction between the extent to which the authorities limit day-to-day volatility in the exchange rate and the degree to which parities are allowed to drift over longer horizons. Our perspective allows us to shed a useful light on the role the RMB plays in the region. Another distinguishing feature is that our research employs a variety of approaches, including observation of the levels of exchange rates and their volatility as well as several econometric techniques — unit root tests, cointegration tests, and multiple regression. As discussed in more detail in section 4, the

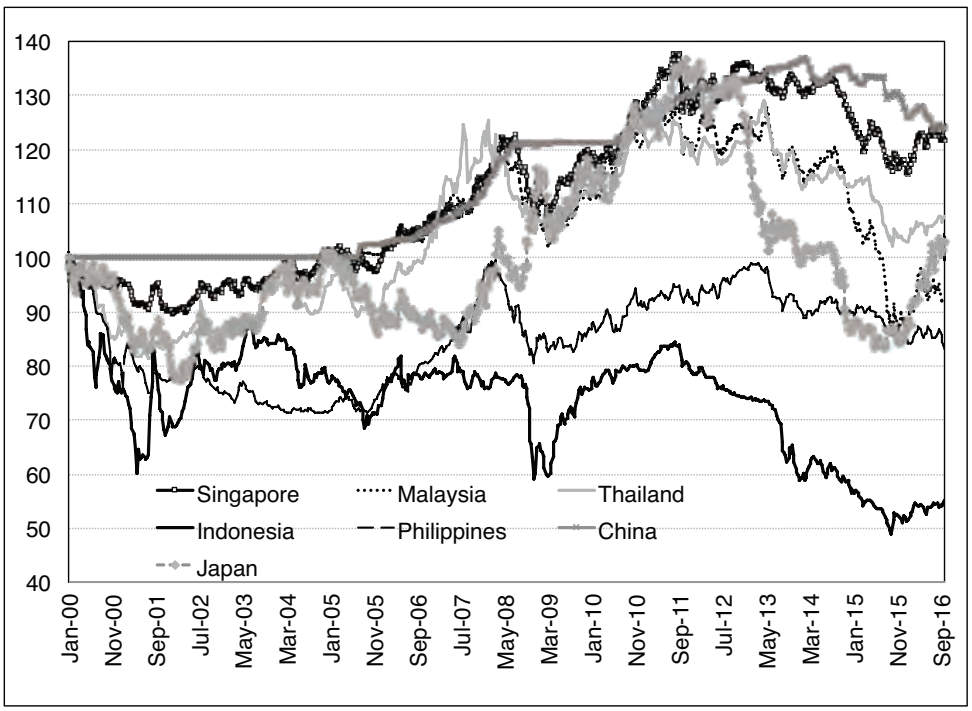
Frankel-Wei approach makes it possible to recover weights in a basket peg if a country follows one rather strictly (including the case of a hard single-currency peg), but the interpretation of results in other regimes is more challenging. Thus, attacking the issue from different angles and applying techniques suitable for an analysis of long-term movements and those appropriate for studying short-term fluctuations allows us to draw a comprehensive picture.

This paper is organized as follows: section 2 provides a big picture view of long-term exchange rate levels; section 3 looks at short-term volatility; section 4 provides the results of our regression analysis using the Frankel-Wei approach; and section 5 concludes.

## 2. Long-Term Exchange Rate Levels

In this section, we review the long-term exchange rate levels and find no evidence of ASEAN-5 countries pegging their exchange rates. Figure 1 shows the evolution of the ASEAN-5 exchange rates against the USD since the beginning of this century.[5] It also shows the paths of the Japanese yen (JPY) and the Chinese RMB. With the obvious exception of the Malaysian ringgit (MSR) peg to the USD until July 2005, the graph depicts very large variation in all ASEAN-5 currencies over this fifteen-year period, with broad trends emerging and disappearing, occasional sharp turns, and quite a few ups and downs. The ASEAN-5 trajectories do not look qualitatively

FIGURE 1
Exchange Rates Against the USD
(2000w1=100; increase = appreciation)



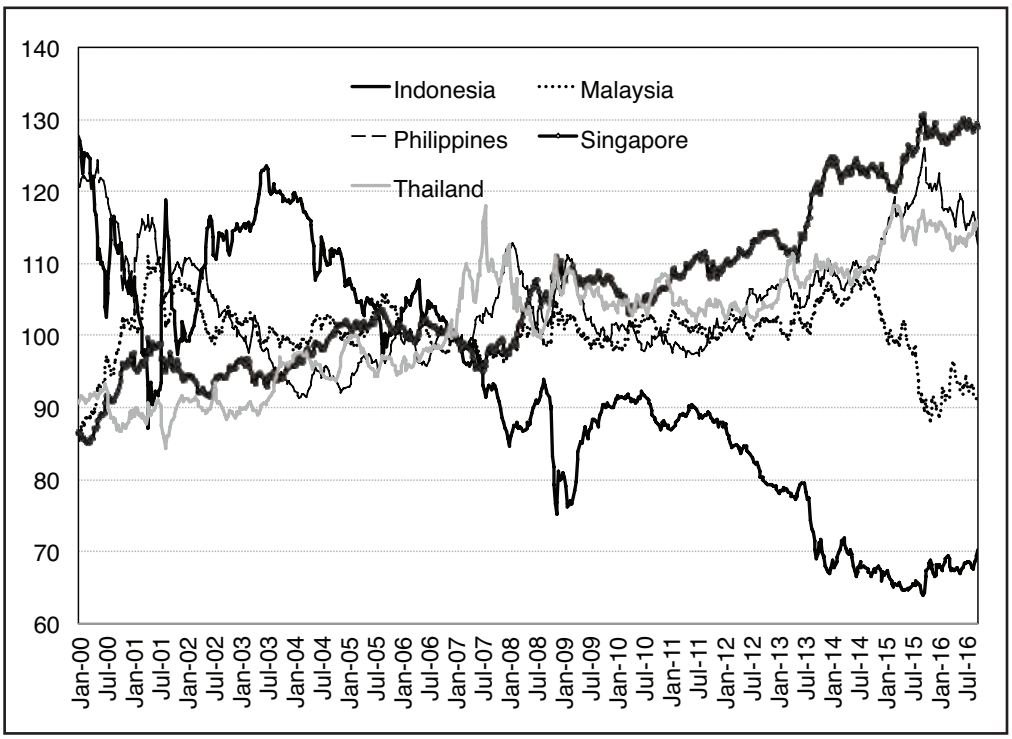

SOURCE: Haver Data Analytics; and authors' calculations.

different from that of a freely floating currency (the JPY), and they look quite different from the heavily managed RMB.[6]

One can notice broad co-movements among various subsets of the ASEAN-5 currencies over certain periods, which is not surprising given that they are neighbours, trading partners and competitors. At the same time, the magnitudes of exchange rate changes and the turning points differ across countries, and the groups of currencies moving together differ across periods. Thus, it is hard to make the case that the ASEAN-5 currencies or a subset thereof are bound together in a tight "club". This is evident in Figure 2, which shows the evolution of each ASEAN-5 currency against the equally weighted basket of the other four currencies.[7] In the same vein, it is hard to talk about an RMB club or a yen club (see Figures A3 and A4 for ASEAN-5 exchange rates against the RMB and against the JPY, respectively, since July 2005). There is no denying that the movements in the RMB or the JPY have an impact on the ASEAN-5 currencies. But it is patently not the case that any of the ASEAN-5 countries maintains a stable parity against the RMB or the JPY.

Formal econometric tests support these observations. If a currency is pegged to another currency or is only allowed to move in a fairly narrow band, the exchange rate between those two currencies should be stationary. This can be

FIGURE 2
Exchange Rates Against Other ASEAN-4 Average
(1/1/2007=100; increase = appreciation)




SOURCE: Haver Data Analytics; and authors' calculations.

checked using a standard augmented Dickey-Fuller test (ADF) unit root test.

To be clear, we are referring to a *conventional* peg with a fixed parity or a quasi-peg where the central bank may not announce a specific rate that it targets but in fact does not allow the exchange rate to deviate too far from a certain (constant) number. This should not be confused with a *crawling* peg or a crawling band. Under a crawling peg, the exchange rate would change at predetermined intervals by a predetermined amount. Over time, this would result in the exchange rate drifting from the original parity. Thus, under a crawling peg, the exchange rate would not be stationary. However, it would be *trend-stationary* (which means that deviations of the exchange rate from a linear trend are stationary), and a simple modification of the ADF test can reveal that fact.[8]

Stationarity and cointegration tests have been used widely in the literature to study the properties of exchange rates. For instance, Froot and Rogoff (1995) summarize a voluminous literature on using unit root tests, including the ADF test, to test the stationarity of real exchange rate (an implication of the purchasing power parity hypothesis). A recent example of applying unit root and cointegration tests to test currency stationarity is Wang (2015). Appendix II provides theoretical justification for the use of these techniques.

The AFC and the Global Financial Crisis (GFC) were two watershed events where exchange rate regimes broke down at least temporarily as evidenced by large depreciations and currency volatility during those episodes. Moreover, the regimes may have changed after the crises. Thus we exclude the volatile crisis periods from our sample, and we apply econometric approaches to four periods: pre-AFC (January 1990 – December 1996); inter-crisis I (January 1999 – June 2005, when the RMB and the MSR were pegged to the USD); inter-crisis II (August 2005 – June 2008); and post-GFC (June 2010 – December 2015).

Table 1 shows *p*-values from the ADF tests for the logs of various exchange rates for the four periods. We test for unit roots in the exchange rates of the ASEAN-5 currencies against the USD, the JPY, and the RMB, as well as against one another — since the existence of an ASEAN-5 club would imply that member currencies move together against third currencies, and thus should be stationary against one another.[9]

A detailed discussion of these results can be found in Appendix III. The key takeaway is that apart from the pre-2008 MSR peg to the USD (and, indirectly, to the RMB), we do not find solid evidence of the ASEAN-5 countries targeting the levels of their currencies with respect to the USD, the RMB, the JPY, or one another after the AFC.

Cointegration tests provide a complementary perspective on the same issue. Rather than examining whether the exchange rate between two currencies is stationary, we can check whether they move together against third currencies. If they do, their exchange rates against third currencies should form a stationary linear combination. The existence of such a combination can be tested using a cointegration test. In addition, in principle a cointegration test can be used to discover more complex relationships involving more than two currencies, such as basket pegs. The choice of the numeraire currency is not very material as long as the exchange rates of the currencies we focus on vis-à-vis that numeraire are non-stationary. We use for that purpose the New Zealand dollar (NZD), which is a free-floating currency whose exchange rates against the USD, the RMB and all the ASEAN-5 currencies are non-stationary in all four periods under consideration.

Appendix IV contains a detailed discussion of the extensive cointegration tests that we have conducted and their results. The results confirm the findings from the unit root tests. Apart from the 1999–2005 MSR peg to the USD, it does not appear that the ASEAN-5 central banks are targeting the levels of their currencies to any specific parities with respect to one another or any major currencies or combinations of currencies, including the RMB.

## 3. Short-term Volatility

The absence of targeting a specific exchange rate level does not imply the lack of intervention in the foreign exchange market, especially for short-

TABLE 1
*P*-values for Unit Root Tests for Cross Exchange Rates

*Pre-AFC : Year 1990–96*

| | *USD* | *RMB* | *JPY* | *IDR* | *MSR* | *PLP* | *SGD* | *THB* |
|---|---|---|---|---|---|---|---|---|
| *IDR* | 0.71 | 0.62 | 0.43 | * | 0.78 | 0.61 | 0.44 | 0.57 |
| *MSR* | 0.61 | 0.73 | 0.50 | 0.78 | * | *0.04* | 0.50 | 0.47 |
| *PLP* | 0.05 | 0.77 | 0.23 | 0.61 | *0.04* | * | 0.10 | *0.04* |
| *SGD* | 0.49 | 0.72 | 0.71 | 0.44 | 0.50 | 0.10 | * | 0.67 |
| *THB* | *0.04* | 0.69 | 0.52 | 0.57 | 0.47 | *0.04* | 0.67 | * |

*Inter-crisis I : Year 1999–2005*

| | *USD* | *RMB* | *JPY* | *IDR* | *MSR* | *PLP* | *SGD* | *THB* |
|---|---|---|---|---|---|---|---|---|
| *IDR* | 0.24 | 0.24 | 0.13 | * | 0.24 | 0.26 | 0.23 | 0.10 |
| *MSR* | **0.00** | **0.00** | 0.36 | 0.24 | * | 0.49 | 0.25 | 0.27 |
| *PLP* | 0.49 | 0.49 | 0.59 | 0.26 | 0.49 | * | 0.72 | 0.77 |
| *SGD* | 0.25 | 0.26 | 0.15 | 0.23 | 0.25 | 0.72 | * | 0.32 |
| *THB* | 0.27 | 0.28 | 0.13 | 0.10 | 0.27 | 0.77 | 0.32 | * |

*Inter-crisis II : Year 2005–08*

| | *USD* | *RMB* | *JPY* | *IDR* | *MSR* | *PLP* | *SGD* | *THB* |
|---|---|---|---|---|---|---|---|---|
| *IDR* | 0.21 | 0.87 | 0.47 | * | 0.79 | 0.74 | 0.93 | 0.61 |
| *MSR* | 0.89 | 0.45 | 0.22 | 0.79 | * | 0.33 | 0.90 | 0.35 |
| *PLP* | 0.54 | 0.48 | 0.27 | 0.74 | 0.33 | * | 0.54 | 0.18 |
| *SGD* | 0.99 | 0.47 | 0.30 | 0.93 | 0.90 | 0.54 | * | 0.52 |
| *THB* | 0.55 | 0.52 | 0.35 | 0.61 | 0.35 | 0.18 | 0.52 | * |

*Post-GFC : Year 2010–16*

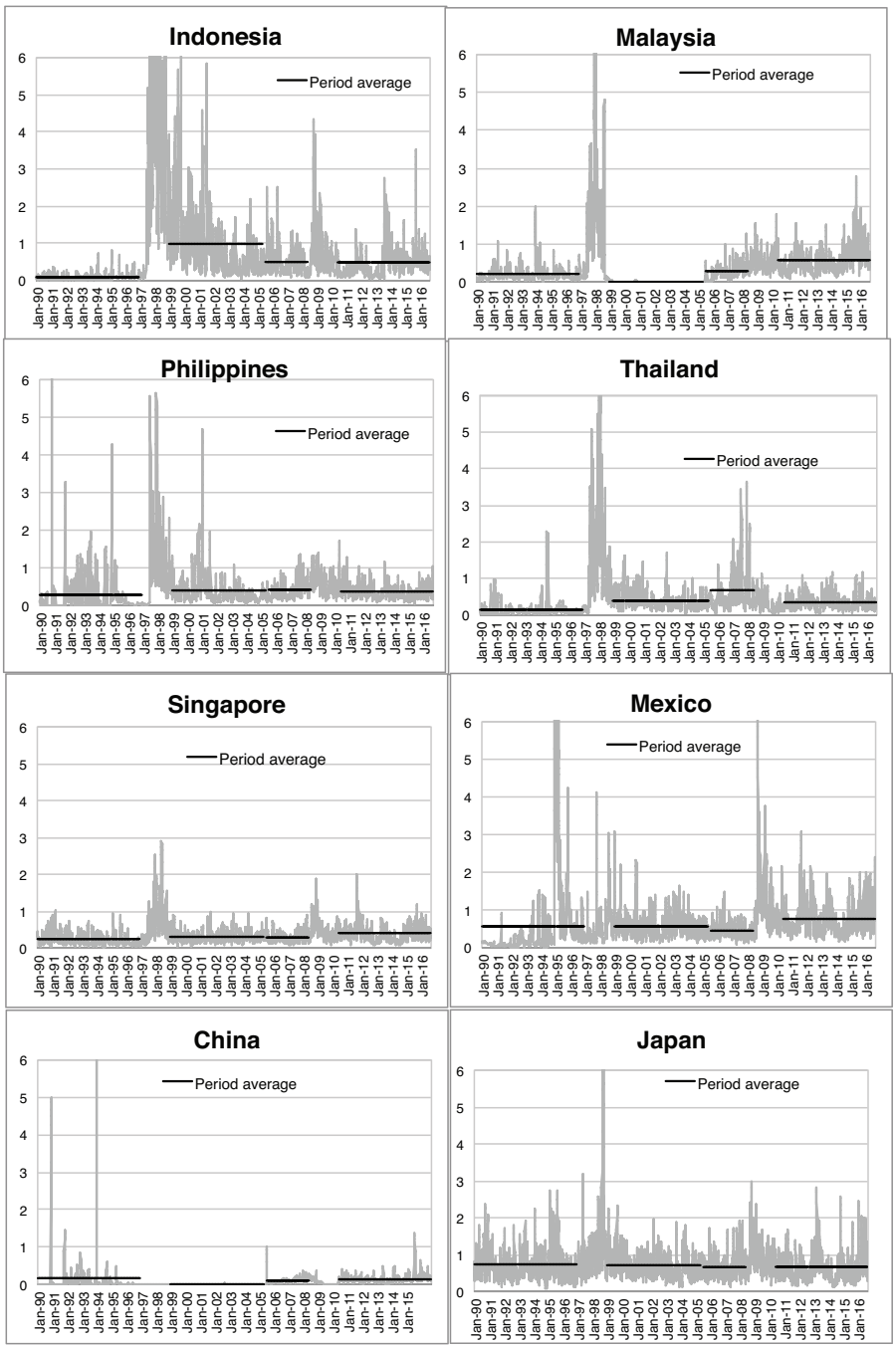
| | *USD* | *RMB* | *JPY* | *IDR* | *MSR* | *PLP* | *SGD* | *THB* |
|---|---|---|---|---|---|---|---|---|
| *IDR* | 0.98 | 0.93 | 0.06 | * | 0.56 | 0.85 | 0.79 | 0.81 |
| *MSR* | 1.00 | 0.99 | 0.59 | 0.56 | * | 0.98 | 0.99 | 0.91 |
| *PLP* | 0.43 | 0.60 | 0.83 | 0.85 | 0.98 | * | 0.07 | 0.32 |
| *SGD* | 0.48 | 0.68 | 0.82 | 0.79 | 0.99 | 0.07 | * | 0.24 |
| *THB* | 0.98 | 0.89 | 0.81 | 0.81 | 0.91 | 0.32 | 0.24 | * |

NOTES: *P*-values smaller than 0.1 are highlighted. Those below 0.01 are shown in boldface.

term smoothing. As noted in the introduction, Singapore uses the exchange rate path as the instrument of monetary policy, while the other ASEAN-5 central banks admit openly that they intervene occasionally to avoid excessive currency movements. This section explores whether ASEAN-5 tolerance to exchange rate volatility has changed over time.

The most direct way to observe the evolution of exchange rate volatility is to plot the rolling coefficient of variation.[10] Figure 3 shows this coefficient taken over a ten-working-day window

FIGURE 3
Coefficient of Variation of Exchange Rates Against the USD




NOTE: Daily exchange rates. Rolling ten-day window.
SOURCE: Haver Data Analytics; and authors' calculations.

for the exchange rates of ASEAN-5 and three comparator countries against the USD.

Looking at these figures one can make the following observations. First, unsurprisingly, there is a noticeable spike in exchange rate volatility for the ASEAN-5 countries during the periods of the AFC and the GFC (with the former considerably larger in scale).

Second, except for Singapore, there is a perceptible difference in volatility between the periods preceding and following the AFC, but the differences are not the same for all the countries.[11] The THB and the IDR exchange rates clearly became more variable, the latter by a very wide margin. The PLP moved from stop-and-go policies of near-pegs followed by step devaluations or revaluations to relative flexibility. The MSR, on the other hand, was pegged to the USD until July 2005. After de-pegging, its volatility increased gradually and eventually exceeded the level observed in the years before the AFC.

Third, there might be a slight uptick in volatility after the GFC, but it is less pronounced than the change after the GFC, except for Malaysia (and maybe Indonesia) in the most recent period. It is too early to tell whether these swings reflect exceptionally large shocks or signal a regime shift.

Fourth, exchange rate variability against the USD in ASEAN-5 after the AFC remained lower than that in freer floating currencies such as the Mexican peso or the JPY (even though one might expect the peso to be closely linked to the dollar given the extensive trade and financial linkages between Mexico and the United States), suggesting that ASEAN-5 central banks do not allow their currencies to fluctuate freely against the USD — confirming the residual fear of floating.[12]

Plotting ASEAN-5 currency volatility against the JPY (Figure 4) confirms that the USD occupies a special place — ASEAN-5 currencies are allowed to fluctuate much more against the yen than against the dollar, even though trade and financial linkages between ASEAN-5 and Japan are at least as large as those between ASEAN-5 and the United States.[13]

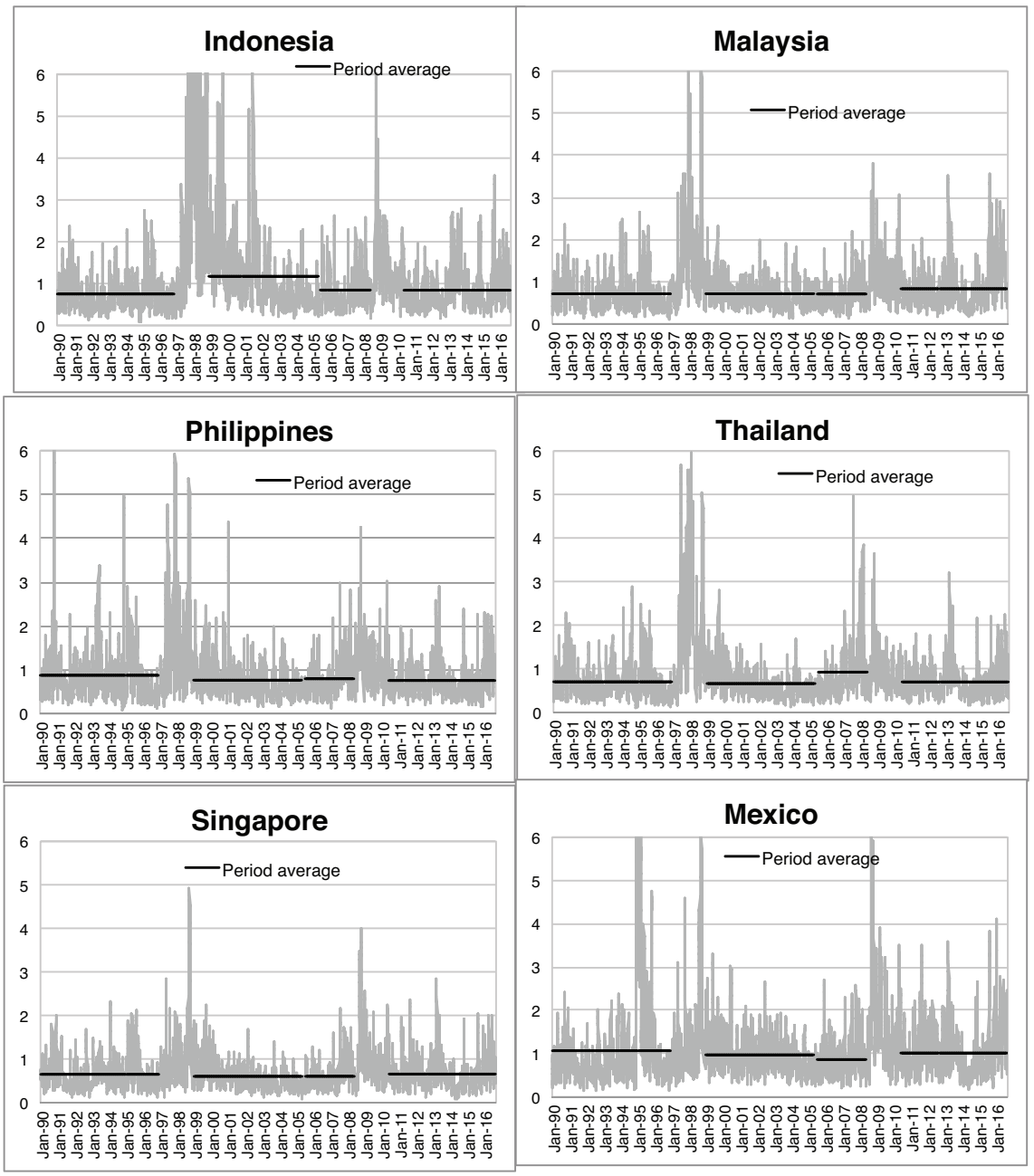
A clear pattern among different lines in Figure 5 shows that the variability of the ASEAN-5 exchange rates against the USD increases with time horizon. The picture would look different if the authorities tried to keep those rates within a fairly narrow band. These graphs are consistent with the notion that the authorities try to dampen day-to-day volatility of their currencies against the USD, but allow them to move substantially over longer periods. One cannot necessarily conclude, however, that the authorities do not resist lasting shocks and trends at all. Notably, the JPY has larger volatility against the USD than the ASEAN-5 currency at every horizon.[14]

## 4. Regression Analysis

### *4.1 Original Approach*

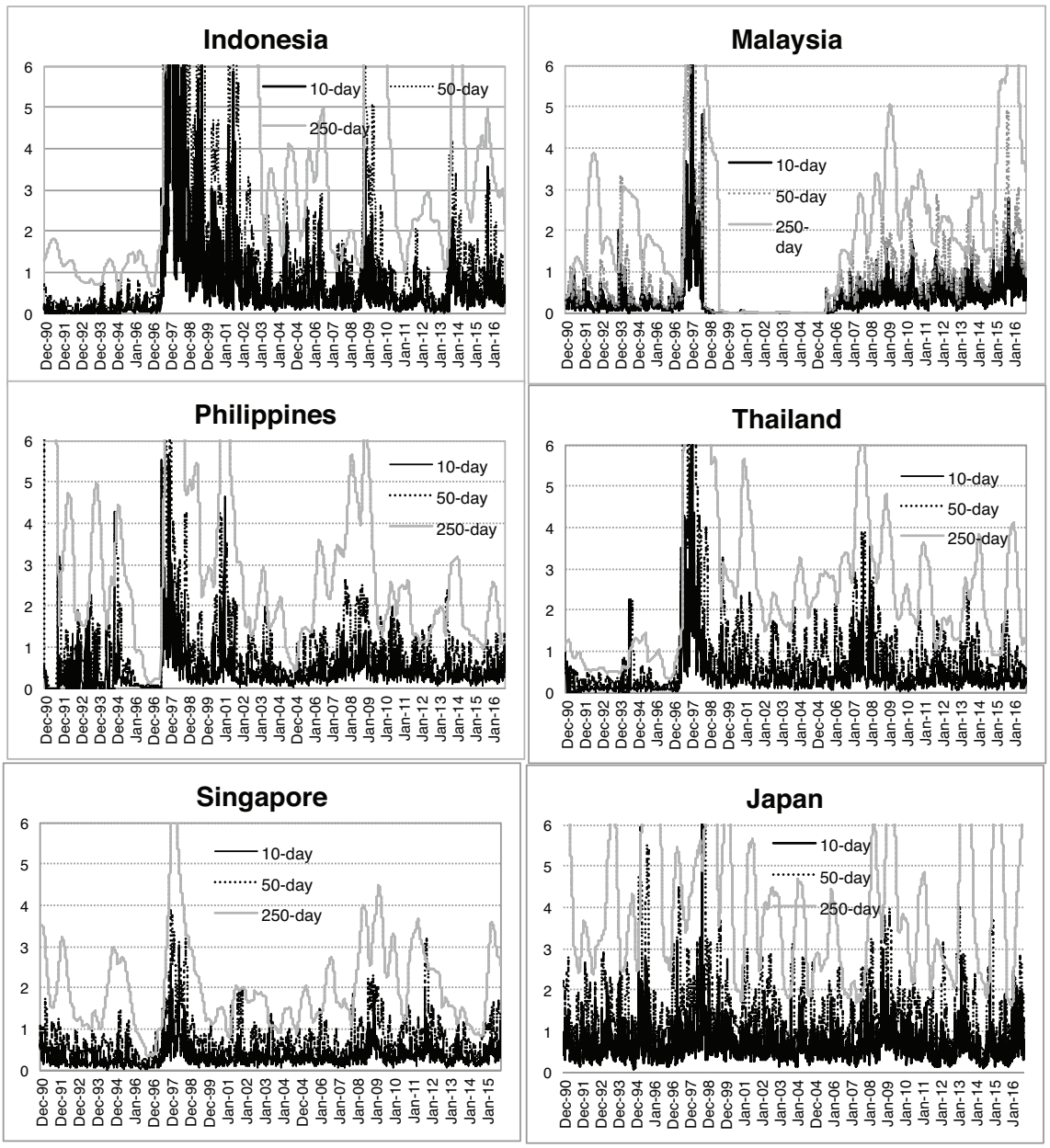
Finally, we use multiple regression analysis to move beyond the somewhat impressionistic examination of the volatility of ASEAN-5 exchange rates against a single currency conducted above. Following Frankel and Wei (1994), we regress changes in an ASEAN-5 currency (the Thai baht in the example below) against a numeraire currency (the New Zealand dollar in the example) on a constant and on changes in several other currencies against the same numeraire. The idea is that if the baht is pegged to one of those currencies (or a basket), then it will move against third currencies as much as the currency it is pegged to does (or, in the case of a basket peg, as much as a linear combination of the currencies in the basket). Thus, if the baht is pegged to one of the currencies in the equation, the coefficient on that currency will be very close to one and highly statistically significant, while all other coefficients will not be significant, and the *R*-squared will be close to one. In case of a basket peg, if all the currencies in the basket are represented on the right-hand side of the equation, the coefficients on those currencies will equal their weights in the basket (and thus add up to one), all other coefficients will equal zero, and the *R*-squared will again be close to one. The constant is introduced to accommodate a crawling peg.

FIGURE 4
Coefficient of Variation of Exchange Rates against the JPY




NOTE: Daily exchange rates. Rolling ten-day window.
SOURCE: Haver Data Analytics; and authors' calculations.

FIGURE 5
Coefficient of Variation of Exchange Rates Against the USD at Different Horizons




SOURCE: Haver Data Analytics; and authors' calculations.

$$\ln\frac{\left(NZD/THB\right)_t}{\left(NZD/THB\right)_{t-1}} = \beta_0 + \beta_{USD}\ln\frac{\left(NZD/USD\right)_t}{\left(NZD/USD\right)_{t-1}} + \beta_{JPY}\ln\frac{\left(NZD/JPY\right)_t}{\left(NZD/JPY\right)_{t-1}} + \beta_{EUR}\ln\frac{\left(NZD/EUR\right)_t}{\left(NZD/EUR\right)_{t-1}} + \beta_{GBP}\ln\frac{\left(NZD/GBP\right)_t}{\left(NZD/GBP\right)_{t-1}} + \varepsilon_t$$

If a country does not literally follow a peg, but still manages its exchange rate fairly tightly against some currency or a basket, the equation above can help reveal that fact. The coefficients would reflect the roles of different partner currencies if the baht is managed against a basket, and their statistical significance as well as the overall *R*-squared would indicate the tightness of the exchange rate regime.

We put different combinations of currencies on the right-hand side. In our basic specification we include only the four major currencies shown in the equation.[15] To test the hypotheses of an RMB club or an ASEAN club, we then add the RMB and the ASEAN-5 currencies to the equation. The results are shown in Table 2 and Table A1.

In the six years before the AFC, the ASEAN-5 countries, except for the Philippines, followed fairly tight pegs, primarily against the USD, as indicated by *R*-squared close to 0.9 and coefficients on the USD that were close to one and highly statistically significant. Singapore is shown to pursue a basket peg in which the USD plays a dominant role, but the JPY and the Deutsche mark have a weight of about 10 per cent each. After the AFC, the IDR became considerably more volatile, while at the opposite edge of the spectrum the MSR was pegged to the USD. Singapore appears to have shifted some weight from the USD to the JPY in its basket without changing materially the degree of regime tightness. Thailand seems to have moved to targeting a combination of the dollar, the yen, and possibly the euro, with the dominant weight still on the dollar, and to have allowed a little more flexibility. Finally, the PLP shifted from intervals of stability occasionally interrupted by sharp movements before the AFC (which explains the low *R*-squared) to a fairly soft tie to the USD.

After the RMB and MSR pegs to the USD were broken, the Malaysian currency moved more freely but retained a fairly strong link to the greenback. The IDR and the PLP maintained rather large and statistically significant coefficients on the USD, but the *R*-squared remained relatively low. There was no notable change in the THB behaviour.

Finally, after the GFC, the goodness of fit remained unchanged for the THB and the PLP and declined for the other three currencies, most notably for the MSR. It is too early to tell whether this shift is due to a more volatile environment or to a change in policy reaction, but most likely both explanations have an element of truth.[16]

Over the last decade the question has been raised on the role of the RMB in ASEAN-5 exchange rate policies since China has emerged as a major trading partner and competitor for the regional economies, even though the USD is the traditional anchor currency. It is difficult to answer the question unequivocally.

Given that the RMB had been managed very tightly against the USD until very recently, at short horizons there was very little difference between linking one's currency to the RMB and to the USD. As the last two columns of Table 2 show, adding the RMB to the right-hand side of the regressions has virtually no impact on their fit. The addition shifts some weight from the USD to the RMB without affecting the other coefficients (except for the intercept).[17] Taken at face value, the results suggest that, particularly in recent years, the RMB has started playing a role comparable to that of the USD in ASEAN-5 central banks' approach to managing currency volatility. This is an interesting finding, but we would not overemphasize its significance. For all practical purposes, in the short run limiting the movements of a currency against the USD is equivalent to limiting its movements against the RMB, and given the near multicollinearity, linear regression is not the best way to distinguish which one the policymakers are really interested in.[18] Figure 6 shows the instability in the USD and RMB coefficients resulting from near collinearity using Singapore as an example. These two rolling coefficients vary widely while the other coefficients are considerably more stable

TABLE 2
Regression Results

| *Indonesian rupiah* | *Pre-AFC* | *Inter-I* | *Inter-II* | *Post-GFC* | *Inter-II* | *Post-GFC* |
|---|---|---|---|---|---|---|
| USD | ***1.00*** | ***0.89*** | ***0.88*** | ***0.74*** | ***0.70*** | ***0.42*** |
| | (0.01) | (0.06) | (0.05) | (0.046) | (0.18) | (0.12) |
| JPY | –0.01 | ***0.18*** | ***–0.13*** | –0.01 | ***–0.13*** | –0.01 |
| | (0.00) | (0.05) | (0.04) | (0.03) | (0.04) | (0.03) |
| EUR | *0.01* | –0.05 | 0.10 | –0.02 | 0.10 | –0.01 |
| | (0.01) | (0.06) | (0.07) | (0.03) | (0.07) | (0.03) |
| GBP | –0.01 | –0.13 | 0.04 | ***0.13*** | 0.05 | ***0.13*** |
| | (0.01) | (0.08) | (0.05) | (0.05) | (0.05) | (0.05) |
| RMB | | | | | 0.19 | 0.33 |
| | | | | | (0.19) | (0.11) |
| Sample size | 1,793 | 1,696 | 760 | 1,435 | 760 | 1,433 |
| *R*-squared | ***0.93*** | ***0.30*** | ***0.62*** | ***0.58*** | ***0.62*** | ***0.58*** |

| *Malaysian ringgit* | *Pre-AFC* | *Inter-I* | *Inter-II* | *Post-GFC* | *Inter-II* | *Post-GFC* |
|---|---|---|---|---|---|---|
| USD | ***0.86*** | ***1.00*** | ***0.87*** | ***0.66*** | 0.27 | ***0.27*** |
| | (0.01) | (0.00) | (0.02) | (0.04) | (0.15) | (0.09) |
| JPY | ***0.05*** | 0.00 | –0.03 | –0.06 | –0.03 | –0.06 |
| | (0.01) | (0.00) | (0.02) | (0.02) | (0.02) | (0.02) |
| EUR | ***0.06*** | 0.00 | 0.05 | 0.03 | 0.04 | 0.03 |
| | (0.01) | (0.00) | (0.04) | (0.03) | (0.04) | (0.03) |
| GBP | 0.00 | 0.00 | 0.04 | ***0.16*** | 0.05 | ***0.15*** |
| | (0.01) | (0.00) | (0.04) | (0.03) | (0.04) | (0.03) |
| RMB | | | | | ***0.61*** | ***0.39*** |
| | | | | | (0.15) | (0.09) |
| Sample size | 1,826 | 1,696 | 756 | 1,435 | 756 | 1,433 |
| *R*-squared | **0.80** | **1.00** | **0.87** | **0.61** | **0.88** | **0.62** |

| *Philippine peso* | *Pre-AFC* | *Inter-I* | *Inter-II* | *Post-GFC* | *Inter-II* | *Post-GFC* |
|---|---|---|---|---|---|---|
| USD | ***0.98*** | ***0.95*** | ***0.87*** | ***0.90*** | ***0.74*** | ***0.48*** |
| | (0.06) | (0.03) | (0.03) | (0.02) | (0.16) | (0.08) |
| JPY | 0.02 | ***0.09*** | 0.01 | –0.03 | 0.01 | –0.03 |
| | (0.05) | (0.03) | (0.03) | (0.02) | (0.03) | (0.02) |
| EUR | 0.01 | 0.01 | *0.10* | 0.00 | *0.10* | 0.00 |
| | (0.02) | (0.03) | (0.04) | (0.02) | (0.04) | (0.02) |
| GBP | ***–0.04*** | –0.06 | –0.04 | ***0.06*** | –0.04 | 0.06 |
| | (0.02) | (0.04) | (0.05) | (0.02) | (0.05) | (0.02) |
| RMB | | | | | 0.13 | ***0.43*** |
| | | | | | (0.16) | (0.08) |
| Sample size | 1,763 | 1,668 | 758 | 1,425 | 758 | 1,423 |
| *R*-squared | **0.30** | **0.70** | **0.79** | **0.81** | **0.79** | **0.82** |

| *Singapore dollar* | *Pre-AFC* | *Inter-I* | *Inter-II* | *Post-GFC* | *Inter-II* | *Post-GFC* |
|---|---|---|---|---|---|---|
| USD | ***0.85*** | ***0.70*** | ***0.65*** | ***0.47*** | ***0.39*** | ***0.27*** |
| | (0.02) | (0.02) | (0.02) | (0.02) | (0.10) | (0.07) |
| JPY | ***0.07*** | ***0.19*** | ***0.06*** | ***0.04*** | ***0.06*** | ***0.04*** |
| | (0.01) | (0.01) | (0.02) | (0.01) | (0.02) | (0.01) |
| EUR | ***0.05*** | ***0.05*** | ***0.16*** | ***0.17*** | ***0.15*** | ***0.17*** |
| | (0.01) | (0.01) | (0.03) | (0.02) | (0.03) | (0.02) |
| GBP | –0.01 | 0.00 | 0.03 | ***0.11*** | 0.03 | ***0.11*** |
| | (0.01) | (0.01) | (0.03) | (0.02) | (0.03) | (0.02) |
| RMB | | | | | ***0.27*** | ***0.21*** |
| | | | | | (0.10) | (0.07) |
| Sample size | 1,826 | 1,696 | 762 | 1,435 | 762 | 1,433 |
| *R*-squared | **0.74** | **0.90** | **0.92** | **0.82** | **0.92** | **0.83** |

| *Thai baht* | *Pre-AFC* | *Inter-I* | *Inter-II* | *Post-GFC* | *Inter-II* | *Post-GFC* |
|---|---|---|---|---|---|---|
| USD | ***0.96*** | ***0.78*** | ***0.78*** | ***0.74*** | ***0.45*** | ***0.55*** |
| | (0.01) | (0.02) | (0.03) | (0.02) | (0.13) | (0.05) |
| JPY | ***0.02*** | ***0.17*** | ***0.10*** | 0.01 | ***0.10*** | 0.01 |
| | (0.01) | (0.02) | (0.02) | (0.01) | (0.02) | (0.01) |
| EUR | 0.01 | 0.03 | 0.02 | ***0.07*** | 0.01 | ***0.07*** |
| | (0.01) | (0.02) | (0.04) | (0.02) | (0.04) | (0.02) |
| GBP | 0.00 | –0.02 | 0.04 | 0.05 | 0.05 | 0.05 |
| | (0.01) | (0.02) | (0.03) | (0.02) | (0.03) | (0.02) |
| RMB | | | | | ***0.34*** | ***0.20*** |
| | | | | | (0.13) | (0.05) |
| Sample size | 1,826 | 1,696 | 762 | 1,435 | 762 | 1,433 |
| *R*-squared | **0.87** | **0.80** | **0.85** | **0.84** | **0.85** | **0.85** |

NOTE: Standard errors in parentheses. Italic indicates the coefficient is significant at 5 per cent level. Italic and bold significant at 1 per cent level. Based on HAC standard errors. Daily observations.

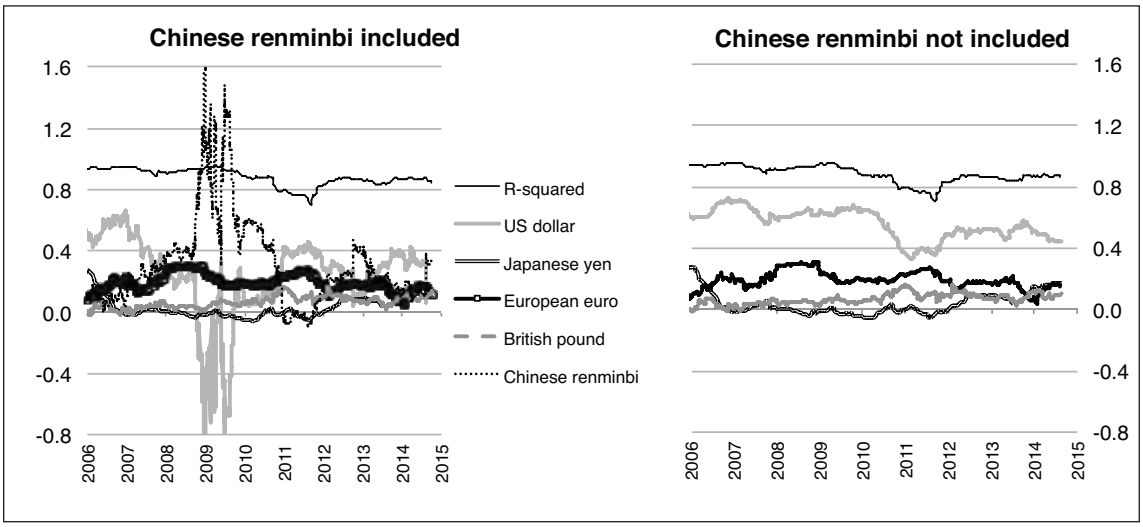
and neither they nor the *R*-squared are affected by the introduction of the RMB in the regression.

Over the longer run, the RMB moved materially against the USD in the second inter-crisis period and after the GFC. Thus, a USD peg and an RMB peg would look very different at horizons exceeding several months. However, at such horizons, neither regime appears to be a fair representation of the exchange rate policy for any of the ASEAN-5 currencies after July 2005 — as we saw above, their exchange rates against both the USD and the RMB are non-stationary.

What about the ASEAN club? Adding the four ASEAN partner currencies to the regressions in the last two periods improves the goodness of fit by a few percentage points, and many coefficients come out statistically significant (Table A1). This could be consistent with the notion that the ASEAN-5 central banks react to the behaviour of their ASEAN-5 partners and competitors. On the other hand, these correlations could reflect common shocks. We are leaning towards the latter interpretation and plan to explore the issue further in future work.

Regressions at different horizons (weekly and monthly changes) and using alternative currencies as numeraire (SDR, Swiss franc, Mexican peso) confirm these findings.

FIGURE 6
Rolling Regression Coefficients and *R*-squared for Singapore




NOTE: Daily observations. 260-day window.
SOURCE: Haver Data Analytics; and authors' calculations.

*4.2 Augmented Approach*

As an additional robustness check, we augment the regressions with an exchange market pressure (EMP) variable as suggested by Frankel and Wei (2008). EMP is calculated as the sum of percentage changes in the exchange rate and in reserves over the same period of time (typically a month):

$$\text{EMP}_t = \Delta E_t/E_{t-1} + \Delta R_t/R_{t-1}$$

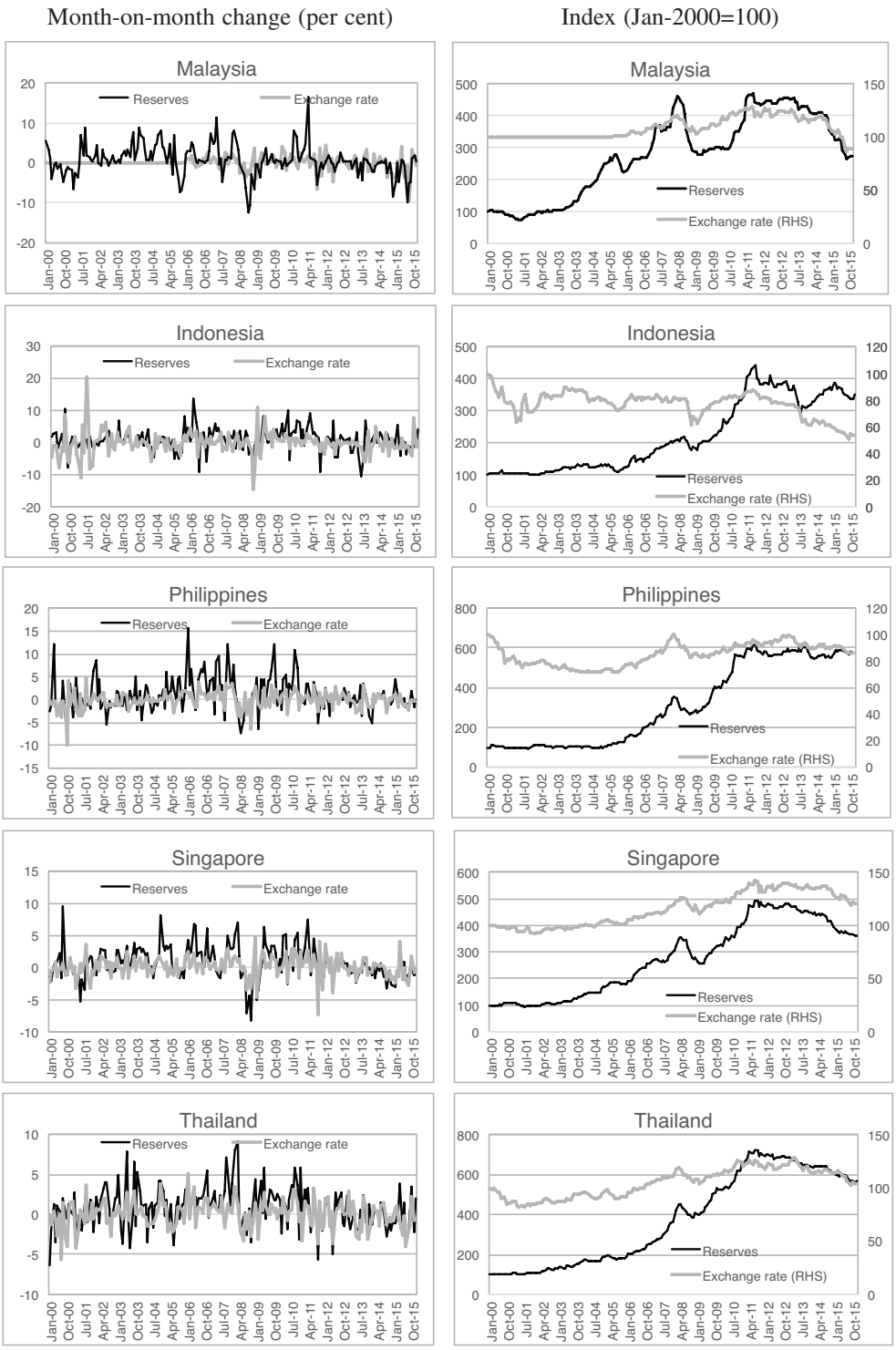
It is designed to capture various shocks exerting pressure on the exchange rate, to which the central bank can react by allowing the exchange rate to adjust or by intervening (e.g., by purchasing reserves to stave off appreciation pressure). The augmented regression will take the following form:

$$d\ln\left(\frac{NZD}{THB}\right)_t = \beta_0 + \beta_{USD} d\ln\left(\frac{NZD}{USD}\right)_t + \beta_{JPY} d\ln\left(\frac{NZD}{JPY}\right)_t + \ldots + \delta\left[d\ln\left(\frac{NZD}{THB}\right)_t + d\ln R_t\right] + \varepsilon_t$$

In case of a hard peg to another currency or a basket, the exchange rate will move little compared to reserves (which play the role of a shock absorber), so the coefficient δ on the EMP variable will be close to zero (reserve movements do not help explain changes in the exchange rate with respect to an arbitrary numeraire). In case of a pure float, reserves do not change materially, so the EMP variable nearly equals the change in the exchange rate.[19] With the dependent variable essentially represented on the right-hand side of the equation, the coefficient on EMP will be close to one, and so will be the *R*-squared. In the intermediate cases such as managed float or adjustable peg, δ will be between zero and one, and the *R*-squared will be below one.

Figure 7 (left panel) shows that the value of ASEAN-5's international reserves has generally been more volatile than the value of their currencies in USD, with changes in both usually going in the same direction. This suggests that shocks have been accommodated through a combination of exchange rate movements and intervention,

FIGURE 7
Exchange Rates Against the USD and Reserves in USD




SOURCE: Haver Data Analytics; and authors' calculations.

although valuation changes likely account for some of the correlation.[20] Plotting reserves and exchange rates in levels (Figure 7, right panel) reveals a long period of reserve accumulation, from the early 2000s through 2011, temporarily interrupted by the GFC. These episodes of mostly one-sided intervention may suggest that even though the ASEAN-5 central banks did not target a particular exchange rate level, they did try to prevent their currencies from appreciating "too much" even in the long term rather than intervening only to smooth volatility. Of course, that policy also helped build up reserves for self-insurance purposes — which was particularly important in the years following the AFC.

Table 3 contains the results of regressions at monthly frequency with the EMP variable. Before the AFC, the EMP coefficients were close to zero, except for Singapore, indicating a large extent of intervention. After the Asian crisis, the coefficients have become bigger, with the exception of Singapore and, during the ringgit peg to the USD, Malaysia. However, the coefficients never got anywhere near one, except maybe for Indonesia during the first inter-crisis period.[21] This suggests that the ASEAN-5 currencies are quite far from a pure float. Thus the EMP regressions confirm our finding that after the AFC the ASEAN-5 other than Singapore have decreased the amount of intervention aimed at smoothing fluctuations in their currency values, but have not fully abandoned that policy.

### *4.3 Discussion*

We would like to make a few observations to relate these results to our analysis in earlier sections as well as to the literature which, as we mention in the Introduction, is largely built around the Frankel-Wei approach. First of all, while the coefficient on the EMP term in the augmented regression is meant to capture the degree of exchange rate flexibility, it does so imperfectly. As noted above, reserves can move even without intervention because of valuation changes. Thus, even in the case of a pure float $\delta$ is likely to be different from one. At the same time, in the case of a hard peg, the term in the square brackets would not necessarily be dominated by movements in reserves, since the exchange rate there is taken with respect to the numeraire, not the anchor currency, and thus it will move as well. Hence, the coefficient on the EMP term will be different from zero even for a hard peg.[22] Thus while the values of *R*-squared and d convey important information about the exchange rate regime, there are no established benchmarks that would allow one to classify the regime definitively on the basis of these parameters. Moreover, while the relative values of these parameters between two countries or two periods may be suggestive of the relative degree of exchange rate flexibility, the comparison should not be regarded as watertight since these parameters are affected not only by exchange rate policy but also by shocks prevalent over the sample period. Even more broadly, while the Frankel-Wei approach allows the researcher to recover weights in a strict basket or single-currency peg, the interpretation of results in other regimes is more challenging. The equation may no longer be well specified, which accounts, for example, for the counterintuitive statistically significant negative coefficients in regressions with relatively low *R*-squared.

For these reasons, we use the Frankel-Wei approach as supplementary rather than making it a cornerstone of our analysis. With caveats noted above, we do take the *R*-squared of the regression without the EMP term and $\delta$ in the regressions with the EMP term as indicative of the degree of exchange rate flexibility, and we look at the coefficients on right-hand-side currencies as reflecting their importance in the country's exchange rate policy. However, given the short time horizon of exchange rate movements considered (a day or at most a month), we consider these coefficients to be reflecting short-term smoothing policies rather than long-term targeting.[23] Thus, there is no contradiction between these regression results showing some (varying) degree of smoothing exchange rate fluctuations against major currencies, particularly the USD, and our finding that the ASEAN-5 have not been targeting specific long-term levels of their exchange rates after the AFC.

This differentiation between short-term and long-term anchoring distinguishes our work from

TABLE 3
Regression Results with EMP Variable

| *Indonesian rupiah* | *Pre-AFC* | *Inter-I* | *Inter-II* | *Post GFC* |
|---|---|---|---|---|
| Constant | –0.003 | –0.004 | –0.003 | –0.006 |
| USD | ***0.95*** | ***0.42*** | ***0.80*** | ***0.80*** |
| JPY | –0.01 | –0.13 | 0.01 | –0.06 |
| EUR | –0.01 | 0.05 | –0.25 | –0.07 |
| GBP | 0.01 | –0.20 | 0.03 | –0.09 |
| EMP | –0.01 | ***0.78*** | ***0.29*** | ***0.29*** |
| *R*-squared | 0.93 | 0.87 | 0.79 | 0.80 |

| *Malaysia ringgit* | *Pre-AFC* | *Inter-I* | *Inter-II* | *Post GFC* |
|---|---|---|---|---|
| Constant | 0.001 | 0.000 | 0.001 | –0.004 |
| USD | ***0.87*** | ***1.00*** | ***0.86*** | ***0.53*** |
| JPY | 0.08 | 0.00 | –0.10 | –0.07 |
| EUR | 0.04 | 0.01 | 0.17 | –0.19 |
| GBP | 0.00 | –0.02 | –0.14 | 0.23 |
| EMP | 0.00 | 0.01 | ***0.14*** | ***0.30*** |
| *R*-squared | 0.62 | 1.00 | 0.91 | 0.79 |

| *Singaporean dollar* | *Pre-AFC* | *Inter-I* | *Inter-II* | *Post GFC* |
|---|---|---|---|---|
| Constant | –0.003 | –0.002 | 0.000 | 0.000 |
| USD | ***0.56*** | ***0.58*** | ***0.70*** | ***0.47*** |
| JPY | 0.01 | ***0.11*** | –0.03 | 0.03 |
| EUR | ***0.07*** | 0.05 | 0.06 | 0.04 |
| GBP | 0.00 | –0.03 | –0.02 | 0.00 |
| EMP | ***0.31*** | ***0.22*** | ***0.22*** | ***0.29*** |
| *R*-squared | 0.94 | 0.92 | 0.96 | 0.93 |

| *Philippine peso* | *Pre-AFC* | *Inter-I* | *Inter-II* | *Post GFC* |
|---|---|---|---|---|
| Constant | –0.004 | –0.005 | 0.000 | –0.001 |
| USD | ***0.91*** | ***0.56*** | ***0.98*** | ***0.58*** |
| JPY | 0.01 | 0.01 | 0.00 | –0.01 |
| EUR | 0.02 | 0.10 | –0.03 | –0.01 |
| GBP | –0.07 | –0.03 | –0.28 | 0.05 |
| EMP | 0.06 | ***0.28*** | ***0.22*** | ***0.27*** |
| *R*-squared | 0.33 | 0.80 | 0.93 | 0.93 |

| *Thai baht* | *Pre-AFC* | *Inter-I* | *Inter-II* | *Post GFC* |
|---|---|---|---|---|
| Constant | –0.001 | –0.006 | –0.006 | –0.002 |
| USD | ***0.77*** | ***0.64*** | ***0.76*** | ***0.66*** |
| JPY | ***0.08*** | 0.00 | –0.14 | ***–0.10*** |
| EUR | ***0.05*** | 0.01 | –0.22 | ***–0.13*** |
| GBP | 0.01 | –0.16 | 0.23 | –0.03 |
| EMP | ***0.05*** | ***0.42*** | ***0.43*** | ***0.54*** |
| *R*-squared | 0.96 | 0.84 | 0.96 | 0.96 |

NOTES: Italic indicates the coefficient is significant at 5 per cent level. Italic and bold significant at 1 per cent level. Based on HAC standard errors. Monthly observations.

the rest of the literature. For example, based on a graph similar to our Figure 1, Subramanian and Kessler (2013) claim to observe a pattern of East Asian currencies broadly following the RMB, even though the ASEAN-5 currencies have fluctuated very widely against both the USD and the RMB over the period they consider (2004–13). Having made that broad and, we dare say, unwarranted observation, the authors do not pursue level analysis any further. They proceed directly to Frankel-Wei type regressions, focusing on a comparison between correlation coefficients on the USD with the RMB. The authors do not explicitly discuss whether the "reference currency" role they seek to uncover pertains to the long run or the short run, but the language they use ("tracking") seems to suggest that the answer is "both", even though their results can hardly support such a claim. Indeed, with *R*-squared around 0.8 at daily frequency (the authors report *R*-squared in the Appendix but do not discuss those numbers in the text), the exchange rates can move very far from the purported anchor over several months. Other analyses, such as Girardin (2011) and Kawai and Pontines (2014), also rely on Frankel-Wei regressions without being specific as to what time horizon their findings pertain to.

Related to this are attempts to differentiate between anchoring roles of the USD and the RMB, complicated by the fact that the latter has been managed tightly against the former for many years. Subramanian and Kessler (2013) look at the periods when the RMB was on a steady appreciating path against the USD (July 2005 – August 2008 and July 2010 – July 2013) to get around the problem of multicollinearity. However, even though the RMB/USD exchange rate changed considerably over each of these periods, at the daily frequency changes were minimal, unidirectional, and predictable, resulting in a very high correlation between overnight movements of any currency against the USD and its movements against the RMB. And while Subramanian and Kessler assert that multicollinearity is not so high as to cause any estimation problems, some of their results look counterintuitive (e.g., near-zero or even negative coefficients on the USD for four of the ASEAN-5 currencies in the latter period). In our view, the fact that adding the RMB to regressions containing the USD increases massively that coefficient's standard error (with the standard errors for both coefficients much larger than the standard error for their sum) while barely moving the *R*-squared, and the instability of the USD and RMB coefficients in regressions including them both (as demonstrated in Figure 6) show that multicollinearity remains a serious issue.

We thus support the criticism of Subramanian and Kessler's findings by Kawai and Pontines (2014). However, we do not embrace the alternative proposed by the latter authors. Kawai and Pontines apply a two-step procedure, where in the first stage they regress changes in the RMB/NZD exchange rates on movements in the four major currencies against NZD, and in the second stage they use the residual from that regression in place of the RMB/NZD exchange rate on the right-hand side. While appealing on the surface, this approach has two major problems. First of all, it attributes all co-movements between the RMB and the USD (ignoring the yen, the euro and the pound for the moment for simplicity) exclusively to the RMB following the USD. While hardly anyone would suspect reverse causality (USD following RMB), there are common shocks (including those to the numeraire currency) to which the RMB and the USD may react similarly, and their impact would be misattributed to the RMB shadowing the USD. Moreover, if the RMB is replaced by the residual in the Frankel-Wei regression, the combination of variables on the right-hand side no longer represents a currency basket, and one can show that the coefficients will no longer sum to one even for a country that truly follows a basket consisting of the four major currencies and the RMB. For these two reasons, the Kawai-Pontines procedure overestimates the weight on the USD, casting doubt on their results.

While critical of both Subramanian and Kessler's and Kawai and Pontines's findings, we do not offer an alternative. Instead we point out the importance of clarifying the time horizon to which the question about the relative roles of the USD and the RMB in anchoring ASEAN-5 currencies

pertains. As we noted above, at short horizons the question is (or at least was for most of the period under consideration) almost meaningless given the tight link between the RMB and the USD. Over the long term, the RMB and the USD have diverged quite a bit, so the question becomes important and answerable — and the answer is "neither", as we have shown above. There may be a different answer at intermediate horizons — we leave this to future research.

## 5. Conclusion

The monetary and exchange rate frameworks of the ASEAN-5 currencies have evolved over time. Singapore has been the most consistent in its approach, using a crawling peg with an undisclosed basket and parameters[24] as the instrument of its monetary policy directed at price stability. The other four countries have undergone a variety of transitions, eventually settling on inflation-targeting frameworks with floating exchange rates in Indonesia, the Philippines and Thailand and a managed float in Malaysia.

These changes have been reflected in the behaviour of the ASEAN-5 exchange rates. Before the AFC, particularly in the two years preceding the onset of the crisis, their currencies were tightly managed against the USD. After the AFC, the exchange rates have become significantly more flexible, with the exception of a period through July 2005 when the Malaysian ringgit was pegged to the USD.

Direct observation and a variety of econometric tests make it clear that the ASEAN-5 no longer target specific levels of their exchange rates with respect to other currencies — be it the USD, the yen, the RMB, other ASEAN currencies, or a combination thereof. Thus, contrary to what some analysts have suggested, there is no dollar club, yen club, RMB club, or ASEAN club. This does not necessarily mean that the authorities do not try to influence the strength of their currencies beyond the short term. That statement cannot be proved or disproved solely on the basis of observed exchange rate behaviour, but prolonged periods of mostly one-sided intervention suggests that the ASEAN-5 central banks have tried to moderate trend shifts in their currencies. What is true, however, is that this did not amount to defending a particular parity.

At the same time, the fear of floating is not completely gone. Our analysis suggests that the central banks intervene in foreign exchange markets to smooth currency movements — which officials generally acknowledge. They primarily try to reduce the volatility of their exchange rates vis-à-vis the USD — which also smoothes movements against the RMB, since in the short run the RMB is tightly managed against the USD. As a result, in the short term, the variation of the ASEAN-5 currencies with respect to the USD is considerably smaller than against other currencies including the yen — despite Japan's geographic proximity and the large role it plays in trade and FDI flows to the ASEAN-5. It is also smaller than the volatility of freer floating currencies, such as the yen, the Australian dollar, the New Zealand dollar, and the Mexican peso, with respect to the US dollar. At the same time, regression analysis indicates that these countries — most notably Singapore, in line with its basket peg — do pay some attention to currencies other than the USD in managing their exchange rate volatility.

The degree of smoothing short-term currency fluctuations declined noticeably after the AFC in Indonesia and Thailand as well as — compared to the immediate pre-AFC period — in the Philippines. The change in Singapore was less pronounced, and in Malaysia it did not take place until the ringgit was taken off the US dollar peg in July 2005. One can also discern an increase in exchange rate volatility after the GFC, although Malaysia is the only ASEAN-5 country where this change is pronounced.

Given that currency intervention is directed at reducing short-term exchange rate fluctuations rather than defending a particular level, the exchange rate policies of the ASEAN-5 central banks are not inconsistent with their mandates for domestic macroeconomic stability.

What will the future bring? On the one hand, there seems to be a trend towards increased exchange rate flexibility among emerging markets, and our analysis suggests that this trend may apply

to the ASEAN-5 countries as well. On the other hand, despite some slowdown, China's weight and importance in the region will continue to grow, and we may see increasing evidence that ASEAN-5 central banks, to the extent they intervene in the market, will seek to smooth the movements of their currencies against the RMB, particularly with increasing internationalization of the RMB (and its inclusion in the SDR basket). As market forces are allowed to play a bigger role in determining RMB parity against the USD, smoothing volatility against the latter will no longer be equivalent to smoothing volatility against the former, so the smoothing central banks will have a decision to make — and researchers will be able to make inferences on the basis of observed behaviour. At the same time, increasing economic and financial integration under the aegis of the ASEAN Economic Community (AEC) could lead to and be facilitated by some coordination of monetary policy and exchange rate stability among the ASEAN members. These are decisions for the regional policymakers to make. We would note that the AEC hardly satisfies key criteria for an optimal currency area (symmetric shocks; high labour mobility across countries; compensating fiscal transfers). Thus we believe that each country would be better served by an independent monetary policy and a flexible exchange rate, with intervention limited to smoothing short-term volatility.

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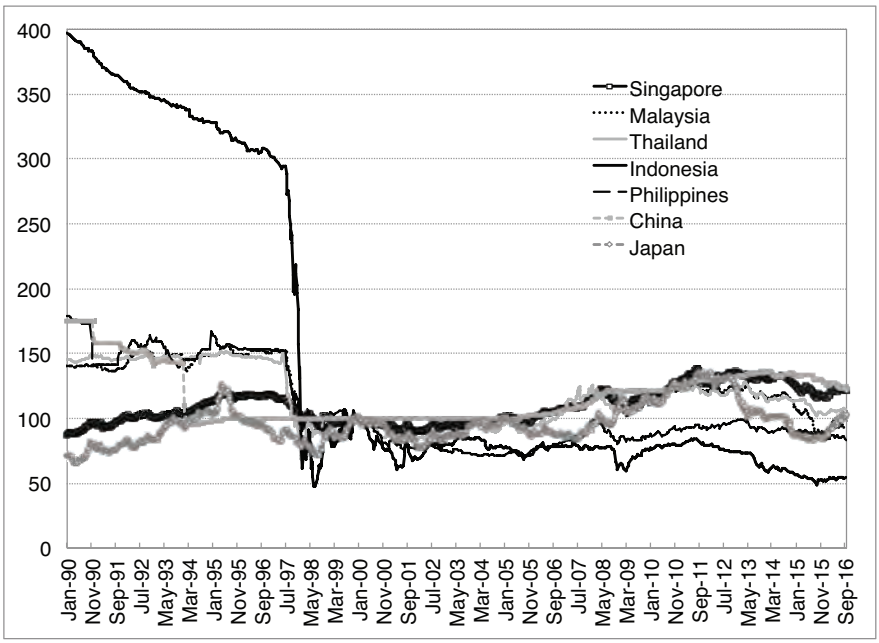
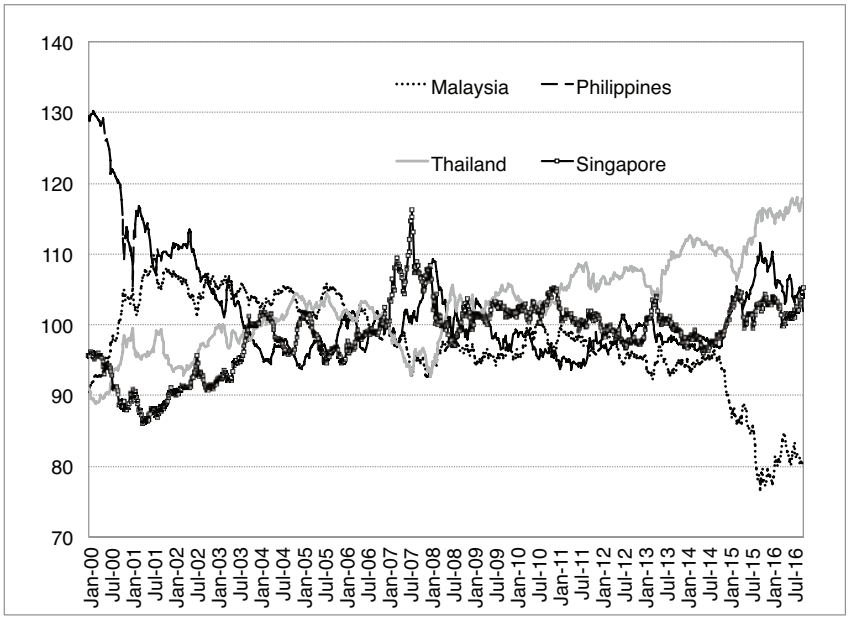
## APPENDIX I
## Additional Tables and Graphs

FIGURE A1
Exchange Rates Against the U.S. Dollar
(2000w1=100; increase = appreciation)



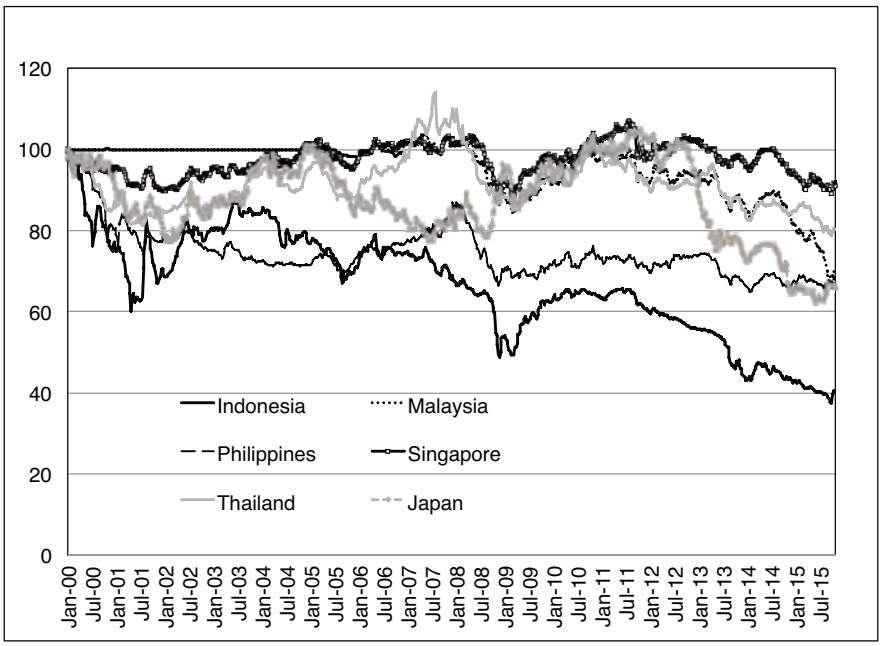

SOURCE: Haver Data Analytics; and authors' calculations.

FIGURE A2
ASEAN-4 Exchange Rates Against Average of the Rest
(2000w1=100; increase = appreciation)



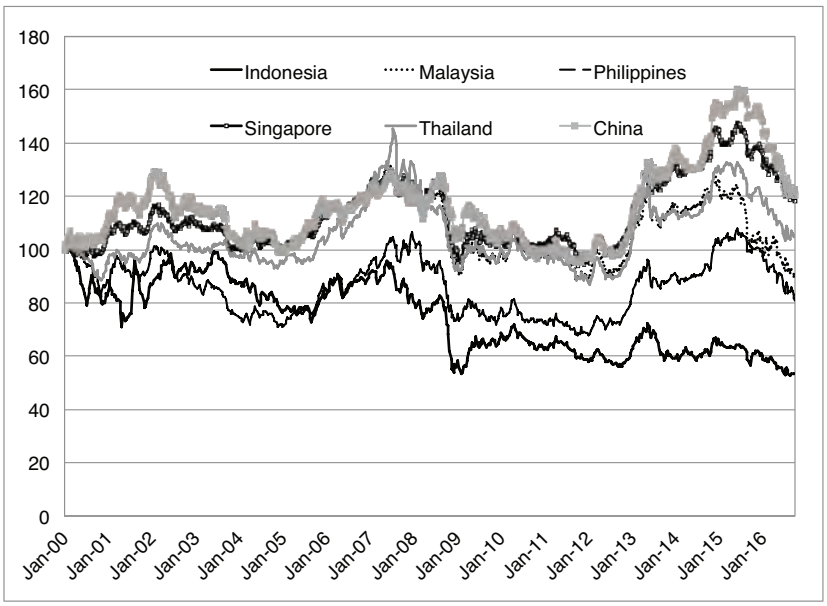

SOURCE: Haver Data Analytics; and authors' calculations.

FIGURE A3
Exchange Rates Against the Renminbi
(2000w1=100; increase = appreciation)



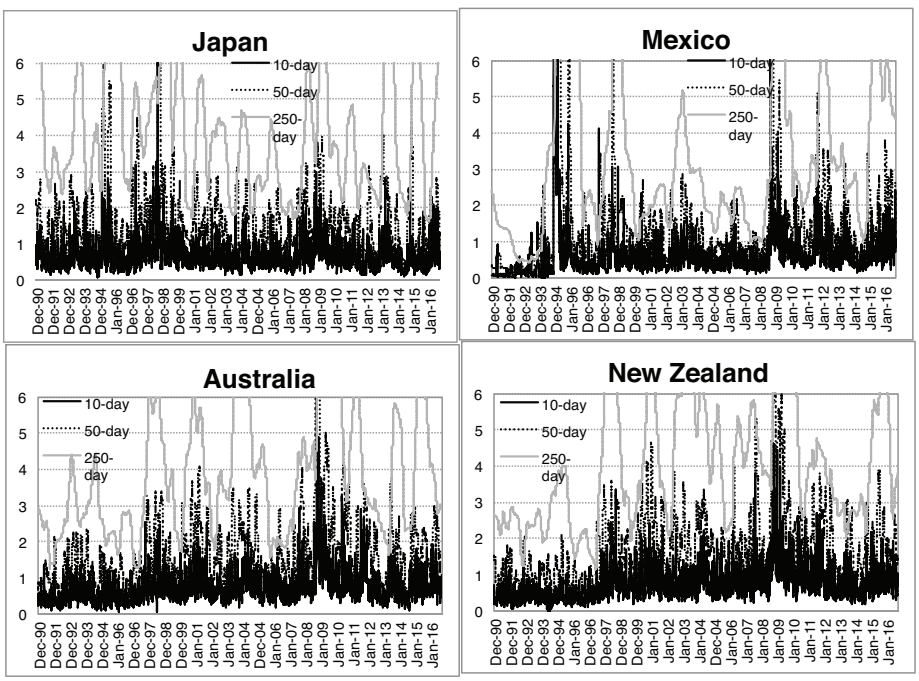

SOURCE: Haver Data Analytics; and authors' calculations.

FIGURE A4
Exchange Rates Against the Yen
(2000w1=100; increase = appreciation)




SOURCE: Haver Data Analytics; and authors' calculations.

FIGURE A5
Coefficient of Variation of Exchange Rates Against the U.S. Dollar at Different Horizons




SOURCE: Haver Data Analytics; and authors' calculations.

TABLE A1
Regression Results

| | *Inter-II* | | | | *Post-GFC* | | | |
|---|---|---|---|---|---|---|---|---|
| | *4 majors* | *4M+ RMB* | *4M+ ASEAN-4* | *4M+ RMB+ ASEAN-4* | *4 majors* | *4M+ RMB* | *4M+ ASEAN-4* | *4M+ RMB+ ASEAN-4* |
| *Indonesian rupiah* | | | | | | | | |
| Constant | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| USD | ***0.88*** | 0.70 | 0.03 | 0.26 | ***0.74*** | ***0.42*** | ***0.26*** | 0.14 |
| JPY | ***–0.13*** | ***–0.13*** | –0.16 | –0.16 | –0.01 | –0.01 | –0.01 | –0.01 |
| EUR | 0.10 | 0.10 | 0.00 | 0.01 | –0.02 | –0.01 | ***–0.09*** | ***–0.09*** |
| GBP | 0.04 | 0.05 | 0.01 | 0.01 | ***0.13*** | ***0.13*** | 0.05 | 0.05 |
| RMB | | 0.19 | | –0.25 | | ***0.33*** | | 0.13 |
| THB | | | ***0.12*** | ***0.13*** | | | ***0.26*** | ***0.26*** |
| MSR | | | 0.46 | 0.47 | | | ***0.25*** | ***0.25*** |
| SGD | | | ***0.35*** | ***0.35*** | | | ***0.30*** | ***0.29*** |
| PLP | | | 0.16 | 0.16 | | | –0.02 | –0.03 |
| *R*-squared | 0.62 | 0.62 | 0.68 | 0.68 | 0.58 | 0.58 | 0.64 | 0.64 |
| *Malaysia ringgit* | | | | | | | | |
| Constant | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| USD | ***0.87*** | ***0.27*** | ***0.27*** | ***–0.13*** | ***0.66*** | ***0.27*** | *–0.14* | ***–0.22*** |
| JPY | –0.03 | –0.03 | –0.05 | –0.05 | *–0.06* | *–0.06* | ***–0.08*** | ***–0.08*** |
| EUR | 0.05 | 0.04 | –0.06 | –0.06 | 0.03 | 0.03 | ***–0.10*** | ***–0.10*** |
| GBP | 0.04 | 0.05 | 0.03 | 0.04 | ***0.16*** | ***0.15*** | 0.03 | 0.03 |
| RMB | | 0.61 | | 0.44 | | ***0.39*** | | 0.08 |
| THB | | | 0.03 | 0.02 | | | ***0.27*** | ***0.27*** |
| IDR | | | 0.10 | 0.10 | | | ***0.14*** | ***0.14*** |
| SGD | | | 0.47 | 0.45 | | | ***0.65*** | ***0.65*** |
| PLP | | | 0.20 | 0.20 | | | ***0.22*** | ***0.21*** |
| *R*-squared | 0.87 | 0.88 | 0.91 | 0.92 | 0.61 | 0.62 | 0.74 | 0.74 |
| *Singapore dollar* | | | | | | | | |
| Constant | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| USD | ***0.65*** | 0.39 | 0.28 | 0.23 | ***0.47*** | ***0.27*** | ***0.18*** | 0.11 |
| JPY | ***0.06*** | ***0.06*** | ***0.06*** | ***0.06*** | ***0.04*** | ***0.04*** | ***0.05*** | ***0.05*** |
| EUR | ***0.16*** | ***0.15*** | ***0.14*** | ***0.14*** | ***0.17*** | ***0.17*** | ***0.15*** | ***0.15*** |
| GBP | 0.03 | 0.03 | 0.01 | 0.01 | ***0.11*** | ***0.11*** | ***0.06*** | ***0.06*** |
| RMB | | 0.27 | | 0.06 | | ***0.21*** | | 0.07 |
| THB | | | ***0.10*** | ***0.10*** | | | ***0.13*** | ***0.13*** |
| IDR | | | ***0.04*** | ***0.04*** | | | ***0.05*** | ***0.05*** |
| MSR | | | 0.27 | 0.27 | | | ***0.22*** | ***0.21*** |
| PLP | | | 0.01 | 0.01 | | | 0.02 | 0.02 |
| *R*-squared | 0.92 | 0.92 | 0.94 | 0.94 | 0.82 | 0.83 | 0.87 | 0.87 |
| *Philippine peso* | | | | | | | | |
| Constant | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| USD | ***0.87*** | 0.74 | 0.37 | 0.54 | ***0.90*** | ***0.48*** | ***0.60*** | ***0.31*** |
| JPY | ***0.01*** | ***0.01*** | 0.03 | 0.03 | –0.03 | –0.03 | –0.02 | –0.02 |
| EUR | 0.10 | 0.10 | 0.05 | 0.06 | 0.00 | 0.00 | –0.03 | –0.03 |
| GBP | –0.04 | –0.04 | –0.06 | –0.07 | ***0.06*** | 0.06 | 0.02 | 0.02 |
| RMB | | 0.13 | | –0.18 | | ***0.43*** | | ***0.32*** |
| THB | | | ***–0.01*** | ***0.00*** | | | ***0.24*** | ***0.23*** |
| IDR | | | 0.08 | 0.08 | | | *–0.01* | *–0.01* |
| MSR | | | 0.46 | 0.47 | | | ***0.16*** | ***0.15*** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| SGD | | | *0.05* | *0.05* | | | 0.05 | 0.04 |
| *R*-squared | 0.79 | 0.79 | 0.83 | 0.83 | 0.81 | 0.82 | 0.84 | 0.84 |
| *Thai baht* | | | | | | | | |
| Constant | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| USD | ***0.78*** | 0.45 | 0.49 | 0.29 | ***0.74*** | ***0.55*** | ***0.41*** | ***0.38*** |
| JPY | ***0.10*** | ***0.10*** | ***0.09*** | ***0.09*** | 0.01 | 0.01 | 0.02 | 0.02 |
| EUR | 0.02 | 0.01 | –0.04 | –0.05 | ***0.07*** | ***0.07*** | *0.04* | *0.04* |
| GBP | 0.04 | 0.05 | 0.03 | 0.03 | 0.05 | 0.05 | 0.00 | 0.00 |
| RMB | | 0.34 | | 0.22 | | 0.20 | | 0.03 |
| IDR | | | ***0.05*** | ***0.05*** | | | ***0.06*** | ***0.06*** |
| MSR | | | 0.05 | 0.03 | | | ***0.12*** | ***0.12*** |
| SGD | | | ***0.32*** | ***0.32*** | | | ***0.18*** | ***0.18*** |
| PLP | | | ***0.00*** | ***0.00*** | | | ***0.14*** | ***0.14*** |
| *R*-squared | 0.85 | 0.85 | 0.86 | 0.86 | 0.84 | 0.85 | 0.88 | 0.88 |

NOTES: Italic indicates the coefficient is significant at 5 per cent level. Italic and bold significant at 1 per cent level. Based on HAC standard errors. Daily observations.

## APPENDIX II
## Exchange Rate Pegs and Stationarity Tests

A process is said to be covariance-stationary or weakly stationary if its mean and all autocovariances do not depend on time (Hamilton 1994).

For a strict peg, $E_t = E$, where $E$ is a constant. Clearly, the mean equals $E$ and all the autocovariances are zero, so the exchange rate is stationary according to the above definition. In a less strict regime, such as an exchange rate band or a quasi-peg, the exchange rate may vary, but the central bank limits its deviations from a certain parity. Thus again the unconditional mean of the exchange rate will equal that parity, and autocovariances will likely be positive (if the central bank allows persistent small deviations from the central parity) but would not depend upon time unless the central bank changes its policies. Hence, for pegs and bands, the exchange rates are stationary.

Non-stationary processes are said to have a unit root. Thus, a unit root test is a way to test stationarity of a series. The most common among those is the augmented Dickey-Fuller test (ADF; Dickey and Fuller 1979). Under the ADF test, the null hypothesis is the presence of a unit root. If the null cannot be rejected, this is evidence that the process is likely non-stationary. In our particular application, a failure to reject the null hypothesis would indicate that the exchange rate is not pegged, even rather loosely, to another currency because a peg would produce a stationary exchange rate — contradicting the result of the ADF test. Of course, as is always the case with econometric tests, such evidence is suggestive rather than conclusive.

If a currency is pegged to a basket rather than a single currency, it can be non-stationary against individual currencies in the basket, but a linear combination of those exchange rates will be stationary. Indeed, a basket peg means maintaining a constant value of one's currency against a fixed basket of other currencies.

In a hypothetical example, suppose that Thailand pegs its currency to a combination of the USD and the EUR with weights $a$ and $(1 - a)$, respectively. Let $x$ and $y$ be the amounts of USD and EUR, respectively, in a basket whose value $V$ is one baht. We can write:

$$V = x\left(\frac{THB}{USD}\right)_t + y\left(\frac{THB}{EUR}\right)_t = 1$$

Suppose now that the exchange rate between the dollar and the euro changes. Then the baht will also be realigned against those two currencies, but in such a way that the value of the basket remains unchanged. This implies the following (using $d$ to indicate differentiation):

$$dV = xd\left(\frac{THB}{USD}\right)_t + yd\left(\frac{THB}{EUR}\right)_t = x\left(\frac{THB}{USD}\right)_t \frac{d\left(\frac{THB}{USD}\right)_t}{\left(\frac{THB}{USD}\right)_t} + y\left(\frac{THB}{EUR}\right)_t \frac{d\left(\frac{THB}{EUR}\right)_t}{\left(\frac{THB}{EUR}\right)_t} =$$

$$= ad\ln\left(\frac{THB}{USD}\right)_t + (1-a)\,d\ln\left(\frac{THB}{EUR}\right)_t = 0$$

The penultimate equality holds because the amount of dollars in a basket times the number of baht per dollar equals the baht equivalent of dollars in that basket; and since the value of the basket is one baht, the baht value of those dollars equals the dollar share in that basket ($a$); and similarly for the euro. The last equality is due to the fact that the value of the basket should not change after the realignment.

Integrating the last equation, we obtain:

$$a\ln\left(\frac{THB}{USD}\right)_t + (1-a)\ln\left(\frac{THB}{EUR}\right)_t = c,$$

where $c$ is a constant.

Thus, the logs of the exchange rates of the Thai baht against the USD and against the euro would form a stationary liner combination if the Thai baht followed a basket peg against those two currencies. We can also rewrite that relationship in a different form, introducing a numeraire currency (e.g., the New Zealand dollar) that is not part of the basket:

$$c = a \ln\left(\frac{THB}{USD}\right)_t + (1-a)\ln\left(\frac{THB}{EUR}\right)_t = a \ln \frac{\left(\frac{NZD}{USD}\right)_t}{\left(\frac{NZD}{THB}\right)_t} + (1-a)\ln \frac{\left(\frac{NZD}{EUR}\right)_t}{\left(\frac{NZD}{THB}\right)_t} =$$

$$= a \ln\left(\frac{NZD}{USD}\right)_t + (1-a)\ln\left(\frac{NZD}{EUR}\right)_t - \ln\left(\frac{NZD}{THB}\right)_t$$

Or:

$$\ln\left(\frac{NZD}{THB}\right)_t - a \ln\left(\frac{NZD}{USD}\right)_t - (1-a)\ln\left(\frac{NZD}{EUR}\right)_t = -c$$

Thus, the logs of the exchange rates of the Thai baht, the USD and the euro against the New Zealand dollar would form a stationary linear combination. In fact, in the case of a strict basket peg the linear combination would be not just stationary, but actually a constant. In a looser basket peg, $c$ could vary, but would have a limited range and would still remain stationary. If non-stationary variables form a stationary linear combination, they are by definition cointegrated. Hence, we can use a standard cointegration test, such as the Johansen test, to reveal a basket peg if one exists. It is also important to note that a basket peg would imply not just any cointegrating relationship, but one where the normalized coefficients (after the first one is set to one) are all negative and add up to minus one.

## APPENDIX III
## Unit Root Test Results

For the pre-AFC period, the hypothesis of no unit root is rejected at the 5 per cent significance level for the Thai baht (THB) and the Philippine peso (PLP) exchange rates against the USD. This confirms the narrative of quasi-dollar-pegs in Southeast Asia before the AFC.[25] In addition, the unit root hypothesis is rejected for the PLP exchange rates against the MSR and the THB (at the 5 per cent significance level) and against the SGD (at the 10 per cent significance level).

During the first inter-crisis period, the unit root test unequivocally picks up the ringgit peg to the USD (and, indirectly, to the RMB). No other ASEAN currency appears linked to any major currency. However, the *p*-value for the baht-rupiah exchange is borderline at 10 per cent. Mechanically this reflects the fact the baht and the rupiah both moved down against the USD at the beginning of that period, then up, and then down again in a broadly synchronous fashion. However, it is hard to suspect that the policymakers intentionally tried to maintain the baht-rupiah rate within a narrow range. Most likely, the result reflects common or co-incidental shocks — after all, at the 10 per cent significance level, 10 per cent is the probability of rejecting the null hypothesis even if it is true.

There are no stationary currency combinations during the second inter-crisis period.

Finally, after the GFC the ASEAN-5 currencies remained non-stationary against the USD. The ADF tests suggest that the IDR-JPY and the SGD-PLP exchange rates might have been stationary after the GFC.[26] The former result likely reflects primarily the steep declines in both currencies that started in 2011. While simultaneous, to a large extent these declines can be attributed to country-specific factors — QE in Japan and domestic vulnerabilities in Indonesia. As for the Singapore dollar and the Philippine peso, both currencies underwent the same broad up and down arc as the other ASEAN-5 (and many other emerging market) currencies in the post-GFC period. The size of the swings against the US dollar was relatively small for these two currencies, probably reflecting their political stability and low commodity dependence as well as fairly small trade linkages with China for the Philippines and a managed exchange rate regime for Singapore. Those forces likely held these two currencies relatively close to one another.

## APPENDIX IV
## Cointegration Tests

Given the history of hard and soft pegs to the US dollar as well as the hypotheses of an RMB club and an ASEAN club, we first test bilateral cointegration of the ASEAN-5 exchange rates with the USD, the RMB, and one another. For the pre-AFC period, the Johansen test finds only one co-integrating relationship at the 10 per cent significance level — between the THB and the USD, with the cointegrating vector [1, –0.98], confirming the quasi-peg revealed by the unit root test. No cointegration has been found between any of the ASEAN-5 currencies and the RMB. For several currency pairs *p*-values exceed 10 per cent, but the purported cointegrating vectors are quite close to [1, – 1] hinting at loose pegs to the USD and (via the USD) to one another.[27]

During the first inter-crisis period, the MSR is found to cointegrate with the USD and the RMB at 1 per cent significance level and cointegrating vector [1, –1] in both cases. This comes as no surprise since the MSR and the RMB were pegged to the USD during that period. At the 5 per cent significance level, the SGD is found to cointegrate with the USD (as well as the RMB and the MSR) with the vector [1, –0.87]. Mechanically, such a relationship could suggest a basket peg with at an 87 per cent weight on the USD and a 13 per cent weight on the numeraire currency (see Appendix V). While there is hardly a reason to believe that Singapore included the NZD in its target basket, over the period in question the NZD was highly correlated with the EUR, which is a reasonable candidate for the Singapore basket. This may explain why there is no unit root in the SGD/USD exchange rate even though the two currencies are cointegrated. As in the pre-AFC period, several pairs of ASEAN-5 currencies are found to have putative cointegrating vectors close to [1, –1] even though the *p*-values are too high for the hypothesis of no cointegration to be rejected.

During the second inter-crisis period, no cointegration is found between any of the ASEAN-5 currencies and the USD, the RMB, or any of the other ASEAN-5 currencies. Moreover, unlike in the previous two periods, the putative cointegrating vectors are quite far from [1, –1], and often the two components even have the same sign. This confirms the results of the unit root tests for that period.

Finally, after the GFC, no cointegration is found between any of the ASEAN-5 currencies and the USD. Bilateral cointegration tests between individual ASEAN-5 currencies and the RMB do not suggest an RMB peg for the pre-GFC or post-GFC periods.[28]

This analysis confirms the results in Appendix III regarding targeting the level of a specific exchange rate.[29] As the next step, we conduct cointegration tests involving more than two variables.

The first series of tests explores the possibility of a basket peg for the ASEAN-5 currencies to a combination of the four major currencies. For the pre-AFC period, only one cointegrating relationship is found. It is between the Thai baht and the four major currencies, with most weight on the USD.[30] So while the bilateral cointegration test is indicative of a THB peg to the USD, this multivariable test suggests the possibility of a basket peg (the weights add up to one), with the USD playing the dominant role.

During the first inter-crisis period, the Johansen test finds two cointegrating relationships among the major currencies — one between the euro and the pound and another one involving also the USD and the JPY. For that reason, during that period we only keep the USD and the JPY in the test as likely the most relevant currencies for the ASEAN-5 region. With that, we find two relationships — a very strong one between the MSR and the USD, reflecting the peg; and a weaker one between the SGD, the USD and the JPY.[31] The latter relationship implies that Singapore followed a basket peg at the time.[32]

No cointegrating relationship is found in the second inter-crisis period. Post-AFC, at the 10 per cent level only one test indicates cointegration — the maximum eigenvalue test for the THB. However, the combination of positive and negative weights in the cointegrating vector does not suggest exchange rate targeting.

Thus, the tests involving individual ASEAN-5 countries and the major currencies reveal a THB peg to a basket heavily dominated by the USD in the pre-AFC period; a hard MSR peg to the USD and a softer SGD peg to a USD-dominated basket during the first inter-crisis period; and no level targeting against the major currencies since 2005.

If we throw the RMB into the mix, things get complicated. The Johansen test finds one cointegrating relationship between some of the ASEAN-5 currencies, the four major currencies, and the RMB during the second inter-crisis period or the post-GFC period (or both) at the 5 per cent significance level. However, in none of those cases does the cointegrating vector suggest a basket peg, with the negative coefficients on the non-ASEAN-5 currencies adding up to about minus one when the coefficient on the ASEAN-5 member is normalized to one. Instead, the non-ASEAN-5 coefficients tend to be large and have different signs. Most prominently, the largest in absolute value coefficients are on the USD and the RMB (on the order of 10), and they have opposite signs. This does not look like a basket peg. Thus, we do not find evidence of ASEAN-5 currencies tracking a combination of the four major currencies and the RMB.[33]

Finally, the hypothesis of a cointegrating relationship among the five ASEAN-5 currencies is rejected. This suggests that an ASEAN-5 club, or a subset thereof, does not exist.[34]

## APPENDIX V
## Interpreting the Cointegration Vector

Suppose the log of the EUR/SGD exchange rate is cointegrated with the log of the EUR/USD exchange rate, with a cointegrating vector $[1, -\beta]$, where $0 < \beta < 1$. This means that a following relationship holds:

$$\log\left(\frac{EUR}{SGD}\right)_t = \alpha + \beta \log\left(\frac{EUR}{USD}\right)_t + \varepsilon_t,$$

where $\varepsilon_t$ is stationary. Switching to any different numeraire (e.g., the SDR) we can obtain:

$$\log\left(\frac{SDR}{SGD}\right)_t = \log\left(\frac{SDR}{EUR}\right)_t + \log\left(\frac{EUR}{SGD}\right)_t = \log\left(\frac{SDR}{EUR}\right)_t + \alpha + \beta \log\left(\frac{EUR}{USD}\right)_t + \varepsilon_t =$$

$$= \log\left(\frac{SDR}{EUR}\right)_t + \alpha + \beta\left[\log\left(\frac{SDR}{USD}\right)_t - \log\left(\frac{SDR}{EUR}\right)_t\right] + \varepsilon_t =$$

$$\alpha + \beta \log\left(\frac{SDR}{USD}\right)_t + (1 - \beta) \log\left(\frac{SDR}{EUR}\right)_t + \varepsilon_t$$

Econometrically, this means that the SDR/SGD exchange rate is cointegrated with the SDR/USD and SDR/EUR exchange rates. Economically, this would suggest that the Singapore dollar follows a basket consisting of the U.S. dollar and the euro with the weights $\beta$ and $(1 - \beta)$, respectively.

More broadly, if a cointegration tests suggest a cointegrating relationship where one currency in the units of a certain numeraire is a linear combination of other currencies with weights adding up to less than one, it may indicate a basket peg with the numeraire currency belonging to the basket (and making up the missing weight).

NOTES

1. The group comprises Indonesia, Malaysia, the Philippines, Singapore, and Thailand — the founding members of the Association of Southeast Asian Nations (ASEAN).
2. Price stability is the primary objective of the Bank Negara Malaysia (BNM), the Bangko Sentral ng Pilipinas (BSP), and the Monetary Authority of Singapore (MAS). The Bank Indonesia (BI) Act states that its ultimate objective is to achieve and maintain the stable value of the rupiah, which has two aspects: a stable price of goods and services (internal price); and a stable exchange rate (external price). The Bank of Thailand (BOT) Act states its objectives as "maintaining monetary stability, stability of the financial system, and stability of the payments system". Thus, BI's and BOT's mandates do not stipulate the primacy of price stability — but they do not rule it out either, and in practice price stability can be expected to be the top priority since the BI and the BOT have adopted inflation targeting.
3. The IMF (2015) classifies Indonesia, the Philippines and Thailand as floaters. Malaysia's exchange rate regime has been classified as "other managed" since BNM's adoption on 21 July 2005 of a managed float with the exchange rate of the ringgit monitored against an undisclosed trade-weighted basket of currencies. MAS monitors the value of the Singapore dollar against an undisclosed basket of currencies and intervenes in the market to maintain this value within an undisclosed target band. The parameters of the band (its central parity, the width, and the crawl rate) are subject to change, with the direction but not magnitude of changes announced to the public. The IMF's classification of Singapore's de facto regime varies with the actual path of the exchange rate. In the last few years it has been variably characterized as "other managed", "crawl-like" and "stabilized" arrangement.
4. See, for example, the description of Thailand's exchange rate regime at <https://www.bot.or.th/English/MonetaryPolicy/MonetPolicyKnowledge/Pages/ExchangeRate.aspx>.
5. Appendix Figure A1 shows that evolution starting from 1990.
6. The graphs of the JPY and the RMB are shown for visual comparison, since there is no obvious theoretical benchmark for how volatile a floating currency should be, and comparing ASEAN-5 currencies with actual currencies falling into free float and managed category helps the reader form an impression.
7. If there were a tight ASEAN-5 club, the figure would show five nearly straight lines. If there was only one outsider (Indonesia clearly stands out), the other four lines would move all together. This is not the case. Figure A2 excludes Indonesia.
8. We do not conduct that modified test since this hypothesis (that ASEAN-5 currencies follow a crawling peg against one of the major currencies) has not been advanced in the literature, and direct observation does not suggest it (under a crawling peg the exchange rate would follow a straight or an exponential line with little variation around it).
9. To emphasize, all cross-rates among the club members should be stationary.
10. The coefficient of variation is the ratio of the standard deviation to the mean over a sample period, expressed in percent.
11. Volatility appears to have increased for Singapore, but the difference is marginal.
12. Use of the Mexican peso as a comparator is motivated by the fact that the country is an emerging market with close economic and financial linkages to the U.S. economy. Thus, in the absence of intervention, the ASEAN-5 currencies could be expected to be more volatile against the U.S. dollar than the Mexican peso.
13. Which is not the case for Mexico, giving a plausible explanation as to why the Mexican peso fluctuates more against the yen than against the dollar. This does not rule out, of course, that the Bank of Mexico might intervene to smooth oscillations against the dollar.
14. Figure A5 shows the coefficient of variation of the Australian dollar, the New Zealand dollar, and the Mexican peso against the USD at the same horizons. The volatility of these currencies is similar to that of the Japanese yen and higher than that of the ASEAN-5 currencies.
15. The U.S. dollar, the Japanese yen, the euro and the British pound. These are four traditional global reserve currencies, and this combination is a starting point for most analyses in the Frankel-Wei tradition, including Frankel and Wei (2008). Pre-AFC, the Deutsche mark is used in place of the euro.
16. In similar regressions for the Mexican peso, the coefficient on the U.S. dollar is close to one (and highly statistically significant) and the *R*-squared is close to 0.7 in both inter-crisis periods. After the GFC, the coefficient on the dollar drops 0.43 and the *R*-squared falls to 0.35, indicating a large decrease in the degree of comovement between the Mexican peso and the U.S. dollar vis-à-vis the New Zealand dollar.
17. This remains true if the sample period is limited to 2015 only, even though the course of the RMB may have become less predictable lately.

18. This question may not even have an answer since the policymakers do not have to make that choice, even in their minds.
19. In reality, reserves can move even without intervention because of valuation changes. An alternative, which also has conceptual challenges, is to use the overall balance of payments, but that data is typically available only at quarterly frequency. Another question is how to scale reserve changes, which is our measure of intervention. In the literature, they have been scaled by their own size (thus looking at percent change, as in the equation above), or relative to the monetary base. We have tried different measures without material difference to the results.
20. For example, a broad USD depreciation would both strengthen the exchange rates of ASEAN-5 currencies vis-à-vis the USD and boost the USD value of their reserves if they are partially held in non-USD currencies. It should be noted, however, that, say, a 1 per cent USD depreciation against all other currencies would raise ASEAN-5 exchange rates against the USD by 1 per cent and increase the USD value of their reserves by less than that. Hence, valuation changes alone are unlikely to account for the fact that reserves volatility tends to be higher than exchange rate volatility in the ASEAN-5.
21. All the coefficients are statistically different from 1 at the 1 per cent significance level. The *p*-value for the coefficient on the IDR during the first inter-crisis period is 0.006, and all the others are much smaller.
22. Frankel and Wei (2008) state that when the exchange rate is purely fixed, the left-hand-side variable never changes value, which would make δ (or any other coefficient on the right- hand side for that matter) zero. They seem to forget, though, that the exchange rate on the left-hand side is defined with respect to a numeraire different from the anchor, so it does move.
23. Of course, a very high *R*-squared of the regression would suggest anchoring over long horizons as well, as it does for the ringgit peg.
24. The rate of crawl and the width of the band.
25. One may wonder why the other three countries have not been picked by the test. Indonesia had a de facto crawling peg against the U.S. dollar. If a trend is included in the test, the *p*-value drops to 0.11. The ringgit and the Singapore dollar moved within narrow ranges against the U.S. dollar from the late 1994 but exhibited more variation in the earlier years — resulting in non-stationarity for the whole period 1990–96.
26. The unit root hypothesis is rejected at the 10 per cent significance level, but not at 5 per cent.
27. Such pairs include (PLP, USD) — consistent with the unit root found in the PLP/USD exchange rate — as well as (MSR, USD), (MSR, PLP), (MSR, THB), and (PLP, THB). If the Swiss franc is used as the numeraire, the trace test finds a cointegrating relationship between the PLP and the USD at the 10 per cent significance level, while the maximum eigenvalue test rejects the relationship.
28. Only one cointegrating relationship is found (between the MSR and the RMB in the post-GFC period with *p*-value close to 5 per cent for both the trace and the maximum eigenvalue tests), but the cointegrating vector does not suggest a peg (both components have the same size, suggesting the two currencies tend to move in opposite directions with respect to the NZD).
29. We also tested for cointegration between the rupiah and the yen in the post-GFC period, given that the ADF test rejects a unit root in the rupiah/yen exchange rate at the 10 per cent significance level (though not at 5 per cent). The Johansen test found no cointegration.
30. The weights are 0.85 for the USD, 0.07 for the JPY, 0.06 for the GBP, and 0.03 for the Deutsche Mark (DM).
31. *P*-value of 0.056 for the trace test and 0.054 for the maximum eigenvalue test.
32. The coefficients are 0.70 on the USD and 0.22 on the JPY. As discussed in Appendix V, this implies a 0.08 weight on the NZD in the basket. It is, of course, unlikely that Singapore would have such a high weight (if any) on the NZD, and more plausibly 0.08 is the combined weight on the euro and the pound (which happened to track closely one another and the NZD during that period).
33. The Phillips-Ouliaris test, which looks at whether the residuals from the regressions of the ASEAN-5 currencies on the USD, JPY, EUR, GBP, and RMB (all vis-à-vis the NZD) have unit roots, rejects cointegration for all the ASEAN-5 currencies for both periods at the 5 per cent level.
34. If a cointegrating relationship existed among some of the ASEAN-5 currencies, a test involving all of them should have discovered it. In fact, if N of the five currencies were pegged to one another (including via some synthetic aggregate), the test should have found N-1 cointegrating relationships.

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