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Pegging or Floating? A Regime-Switching Perspective of Asian Exchange Rate Practices*

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Abstract

We propose a two-state Markov-switching version of the Frankel and Wei (MS-FW) model to assess Asian exchange rate policies during the period from August 2005 to August 2016. We impose coefficient constraints on FW coefficients to detect floating and pegging episodes against the main anchor currencies, such as the U.S. Dollar (USD), Renminbi (RMB), Euro, Japanese Yen and Asian Currency Unit. After estimating episodes where Asian currencies co-move with international currencies, we link the estimated regime probabilities to a set of economic fundamentals of Asian countries to identify the determinants of exchange rate regimes in Asia. We reveal that most Asian countries tend to constantly adjust the weight of their currency basket. When Asian countries loosen their peg against the USD, these currencies tend to increase their correlation with the RMB. However, the soft USD peg regime has a longer duration in most Asian countries, while the regime with a large RMB weight tends to be of shorter duration. Finally, we show that China's trade dependence is a key factor in pegging Asian currencies to RMB, though export similarity with China does not necessarily facilitate the RMB regime.

Keywords: Asian Exchange Rate Policy, Currency Basket, Markov-Switching Model, US Dollar Peg, Renminbi Bloc, Asian Currency Unit
JEL classification: F31, F33, F36, F45

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1. Introduction

As the Chinese economy has grown rapidly, China's global and regional influences have gained considerable attention in the academic and policy arena. China is now well known to be a regional hub of intra-Asian trade, and China's financial influences have also grown significantly. There have been a large number of studies on to what extent the Chinese renminbi (RMB) has been internationalized (Eichengreen and Kawai , 2014; Ito , 2017; Ito et al. , 2018; Shimizu and Sato , 2018). Existing studies have also investigated whether the effect of China's exchange rate policy on regional countries has been growing by estimating the implicit basket weight of each regional currency (Kawai and Pontines , 2015 ; Sato and Shimizu , 2018 ; Keddad , 2019).

A seminal empirical study, Frankel and Wei (1994), demonstrated that Asian currencies were effectively pegged their currencies to the US dollar (USD) up to the early 1990s. This empirical approach to estimate countries' **de facto** exchange rate regime or implicit currency basket weight, which is typically called the "Frankel-Wei (FW) model", has been widely used when evaluating the exchange rate policy or regime of a country in question. Previous studies have attempted to apply the FW regression directly or with modification to reveal whether the RMB has become a major reference currency for regional countries' currency basket or exchange rate policy in Asia. Henning (2012) and Subramanian et al. (2012), for instance, showed that the RMB became a major reference currency for regional countries and hence a RMB bloc had emerged in Asia. In contrast, Kawai and Pontines (2015) revealed that there was weak empirical evidence for a RMB bloc in Asia.

The main purpose of this study is to make rigorous assessment of the comparative role of the USD, RMB, Euro (EUR), Japanese Yen (JPY) or even the Asian Currency Unit (ACU) within the the currency basket of many Asian countries.[1] For this purpose, we use a modified (i.e. non-linear) version of the FW model. Most empirical studies on this research question rely on linear models supposing that exchange rate policy is a linear process. However, our aim is to show that the implicit currency basket weights on which Asian countries peg their currencies are non-linear. This conjecture is motivated by the fact that Asian countries generally adapt their currency regime continuously according to external environment (trade competitiveness, external and domestic shocks, capital flows, inflation).

We use the Markov-Switching model to allow for non-linearity. Markov-switching methods have been already applied to Asian exchange rates but for slightly different purposes. For instance, Keddad (2019) focuses on whether Asian currencies react differently during episodes of RMB appreciation and deprecation against the USD. The results suggests that Asian currencies overreact during phases of RMB depreciation, confirming the existence of a *fear of appreciation* against the RMB. Pontines and Siregar (2012) draw the same conclusions by comparing the Markov probabilities to stay within the appreciating and depreciating regimes against the RMB. Girardin (2011) uses the Markov-switching model to assess structural changes in exchange rate regime over the 1999-2009 period and mainly focuses on the possibility of a *de facto* ACU bloc.

In contrast to these studies, we contribute to the literature by proposing a specific identification scheme under Markov-switching framework to reveal how Asian currencies behave against the international currencies. Although all these papers provide interesting results to characterize Asian exchange rate practices, they do not focus on how domestic and global

[1] See Ogawa and Shimizu (2006) for possible introduction of common currency unit in Asia.

macroeconomic variables influence the decision to adopt a particular exchange rate regime. In this paper, we further examine what macroeconomic factors determine the decision to peg against the USD and the RMB.

The most closely related study to ours is Kim et al. (2012). They propose to impose coefficient restrictions to capture episodes of pegging against the Japanese currency over the post-Asian crisis period (1999-2006). Accordingly, their methodology stands out from our model and most recent versions of the FW model because the authors neglect the role of the RMB and Asian currencies. Although the authors propose an innovative framework, they exclusively focus on the JPY and neglect the role of the RMB and other Asian currencies, without providing a clear assessment of the basket composition of Asian countries. Here, we follow closely Kim et al. (2012) but we go one step further by analyzing the rising role of the RMB and gauging how fluctuations in international and regional currencies, including the JPY, shape Asian exchange rate policies. As detailed later, we propose to estimate five different scenarios in which we impose successively restrictions on each international currencies. The purpose of such exercise is to detect episodes where Asian currencies floated and were attached to each currency (especially the RMB and the USD), and then, to compare their relative influence. Indeed, our model allows to compute and compare for each individual currency (USD, RMB, JPY and ACU), the expected duration of floating and pegged exchange rate regimes, the number of month and the dating of each regime, the transition probabilities from one regime to another, and then the degree of co-movement in the pegged exchange rate regime.

Another issue we need to consider is a possible multi-collinearity when estimating implicit basket weights including both the USD and RMB exchange rates. Following Fratzscher and Mehl (2014) and Kawai and Pontines (2015), we remove USD components from the RMB fluctuations, and the independent fluctuations of the RMB are used for the estimation of our model to make rigorous estimation of RMB weights in Asian country's currency basket.

We reveal that most Asian countries, especially Indonesia, Korea, and Malaysia, tend to adjust the weight of their currency basket continuously, which suggests that their exchange rate regime has alternated between a soft USD peg and floating against the USD. When Asian countries loosen their peg against the USD, these currencies tend to increase their correlation with the RMB. Thus, it is not appropriate to conclude for the existence of a USD bloc or RMB bloc in Asia. However, the soft USD peg regime has a longer duration in most Asian countries, while the regime with a large RMB weight tends to be of shorter duration. We may conclude that the USD remains in the position of the main anchor currency for most Asian countries, even though Asian currencies become more correlated with the RMB during certain periods (excluding of course episodes where the RMB has been pegged to the USD). Finally, we reveal that global fundamentals such as VIX and US shadow policy rate impact positively and negatively the decision to peg against the USD. External debt is also found to play in favor of a US peg. With regard to the RMB, we find that trade dependence on China is a key factor in pegging Asian currencies to RMB. However, estimates on export similarity and business cycle synchronization with China leads to opposite results.

The remainder of this paper is structured as follows. Section 2 elaborates a non-linear version of the FW implicit basket model. Section 3 presents the empirical results. Section 4 empirically investigates what determines the exchange rate regime of Asian countries. Section 5 concludes this study by addressing economic and policy implications.

2. Methodology

2.1. The MS-FW model

In this section, we develop the successive steps of our empirical strategy, which serves two main objectives: First, we propose an original contribution to model the behavior of the Asian exchange rate policies. We impose coefficient constraints on FW coefficients so as to detect floating and pegged regimes against the main anchor currencies, such as USD, RMB, EUR, JPY and ACU. After estimating episodes where Asian currencies co-move with international currencies, we link the estimated regime probabilities to a set of economic fundamentals, in order to identify the factors that encourage a country to peg against the USD and the RMB.

We begin with the simple description of the FW model, which is usually used to model the *de facto* exchange rate policy. Indeed, the main purpose of the FW model is to estimate the relative weights of major currencies (i.e. USD, JPY and EUR) in a domestic country's implicit basket peg. All exchange rates are generally defined in terms of a numeraire currency (i.e. the Swiss Franc, Special Drawing Rights, Australian, the Canadian or New Zealand Dollars), whose fluctuations are supposed to be independent from those of the currencies included in the model. Here, we use the New Zealand Dollar (NZD) as suggested in Kawai and Pontines (2015). The standard FW model is as follows:

$$\Delta e_t^{EA} = \alpha + \beta^1 \Delta e_t^{USD} + \beta^2 \Delta e_t^{EUR} + \beta^3 \Delta e_t^{JPY} + \varepsilon_t \tag{1}$$

where Δe_t is the first difference in the natural logarithm of the respective exchange rates against the independent numeraire. Estimates of β coefficients reflect the respective weight of the right-hand side currencies in the implicit basket peg of the domestic currency. For instance, a β^1 coefficient close to unity implies that the fluctuations of the exchange rate is mainly explained by the movements in the USD. In this case, the USD can be qualified as the main anchor currency because of a high degree of co-movement between the USD and the domestic currency (against the numeraire). If we suppose that movements in the JPY and the EUR are independent from those of the USD, then we should observe that the weights of these currencies will be close to zero. Obviously, many peg configurations are possible depending on the exchange rate policy of each country.

In the Asian context, we have to consider the RMB as a candidate for anchor currency, given its rising role within the region. However, the RMB remains strongly correlated with the USD despite the China's exchange rate policy reforms in July 2005. If both variables appear in the right-hand side of the Eq. (1), it will distort the estimates because of multi-collinearity. This issue has been clearly identified within the literature. In this paper, we follow the auxiliary regression approach to ensure orthogonality between the RMB and the USD. As a first step, we estimate the following equation

$$\Delta e_t^{RMB} = \alpha + \beta^1 \Delta e_t^{USD} + \beta^2 \Delta e_t^{EUR} + \beta^3 \Delta e_t^{JPY} + \zeta_t \tag{2}$$

The Eq. (2) links the fluctuations of the RMB to those of the main international currencies. Accordingly, the residuals of Eq. (2) are a proxy for RMB fluctuations (labelled ζ_t^{RMB}) that are independent from those of the international currencies, in particular the USD.

In the second step, we include ζ_t^{RMB} in the following Markov-FW model:

$$\begin{aligned}\Delta e_t^{EA} &= \alpha_{s_t=1} + \beta^1_{s_t=1}\Delta e_t^{USD} + \beta^2_{s_t=1}\Delta e_t^{EUR} + \beta^3_{s_t=1}\Delta e_t^{JPY} + \beta^4_{s_t=1}\zeta_t^{RMB} + \sigma^2_{s_t=1}\varepsilon_t \quad \text{in state } s_t = 1,\\ &= \alpha_{s_t=2} + \beta^1_{s_t=2}\Delta e_t^{USD} + \beta^2_{s_t=2}\Delta e_t^{EUR} + \beta^3_{s_t=2}\Delta e_t^{JPY} + \beta^4_{s_t=2}\zeta_t^{RMB} + \sigma^2_{s_t=2}\varepsilon_t \quad \text{in state } s_t = 2,\end{aligned} \tag{3}$$

Each equation of the model has its own structure that determines the domestic currency behavior in each state. The switching between each state is governed by an unobservable variable s_t that follows a first-order Markov chain, over the T observations. The behavior of the state variable s_t is governed by the following transition matrix

$$P_{ij} = \mathbb{P}(s_t = i|s_{t-1} = j) = \begin{pmatrix} P_{11} & P_{12} \\ P_{21} & P_{22} \end{pmatrix} \tag{4}$$

with $\sum_{i=1}^{2} P_{ij} = 1$ for all $i, j \in \{1, 2\}$.[2] These transition probabilities are computed as follows:

$$P_{11} = \frac{\exp(\theta_{11})}{1 + \exp(\theta_{11})}, \quad P_{22} = \frac{\exp(\theta_{22})}{1 + \exp(\theta_{22})}, \tag{5}$$

We focus on the following currency set: South Korean Won (KRW), Malaysian Ringgit (MYR), Singapore Dollar (SGD), Indonesian Rupiah (IDR), Philippine Peso (PHP), Thai Bath (THB) and New Taiwan Dollar (TWD). We use monthly data (Pacific Exchange Rate Service) over the period 2005:08 - 2016:08. Note that we favor monthly data over daily data because regime probabilities are less erratic with low frequency data. This avoids too frequent and irrelevant switches in regime probabilities and then improves the identification of regimes. Indeed, it seems highly unlikely that monetary authorities switch exchange rate regime on a daily basis.

Before proceeding to the estimates, we subtract the fluctuations of the Livre Sterling from those of each variable included in the model as suggested by Frankel and Wei (2008). It allows to constrain the weights on the currencies to add up to 1, i.e., $1 = \beta^1_{s_t} + \beta^2_{s_t} + \beta^3_{s_t} + \beta^4_{s_t} + \beta^5_{s_t}$. The coefficient $\beta^5_{s_t}$ corresponds to the implicit weight associated to the Livre Sterling or any other missing currencies in the model. Indeed, we estimate only four parameters, which implies that the addition of the USD, RMB, EUR and JPY coefficients is not necessarily equal to 1. The fifth coefficient could be easily deduced as $1 = \beta^1_{s_t} + \beta^2_{s_t} + \beta^3_{s_t} + \beta^4_{s_t} + \beta^5_{s_t}$.

This assumption seems reasonable for two main reasons: First, Kawai and Pontines (2015) conducted a test of this restriction and found that one cannot reject the null that the sum of these five coefficients is equal to one. Second, Kawai and Pontines (2015) and Frankel and Wei (2008) found that imposing this restriction improves the statistical precision of estimates compared to other approaches. Finally, it seems reasonable to assume that weights sum up to unity when central banks target some reference rate or effective exchange rate, regardless the degree of exchange rate flexibility against any anchor or basket (Frankel and Wei , 2008). As a result, we can interpret within each regime the correlation coefficients as the percentage of the corresponding international currency within the basket.

Assuming that weights sum up to unity does not mean that the dependent currency is fully pegged on the basket value. However, this implies that we need to infer the degree of exchange rate flexibility around this basket value (in each regime). This is done by assuming in Eq. (3) that each regime is characterized by its proper variance as it allows

[2]For instance, the transition probability P_{21} indicates the probability to switch from regime 1 to regime 2.

variance of errors to differ between regimes. Now, assume that regime-dependent errors (ε_t) correspond to non-linear shocks that monetary authorities allow to be partially or fully reflected in the exchange rate (i.e., the difference between the observed exchange rate (y_t) and the estimated central parity against the basket ()), $the variance of errors (\sigma^2_{s_t}\varepsilon_t)$ gives the degree of exchange rate flexibility towards the estimated basket value within each regime (see Frankel and Wei , 2007). Accordingly, the regime where $\sigma^2_{s_t}\varepsilon_t$ is the lowest corresponds to the regime where monetary authorities intervene the most for stabilizing the currency against the basket.[3]

Technically, the Markov-switching model has several advantages: it allows to detect endogenously the structural change of exchange rate fluctuations, without imposing arbitrarily the date of a given breakpoint, or a threshold value. Second, the process describing the evolution of the domestic currency is governed by two distinct distributions. Indeed, each state is defined by a regime-dependent mean (positive if Δe^{EA}_t evolves in a depreciation regime or negative in an appreciation regime), a regime-dependent correlation coefficient associated to major currencies (with a magnitude depending on the strength of the co-movement) and finally, a regime-dependent degree of exchange rate flexibility (high or low). This parametric form is suitable for describing distinct dynamic patterns over different episodes and allows to account for many features of nominal exchange rate (switches between float and managed float regime, adjustment of the currency basket weights, asymmetric degree of exchange rate flexibility toward the central parity, ect.). Allowing switches in parameters is thus particularly suitable when considering that many countries do not perpetually keep a single regime, but rather, switch continuously from one exchange rate regime to another, according to their internal and external environments. In this respect, our methodology departs significantly from those of previous studies which focused on exchange rate co-movements.

2.2. Non-linear Constraints

The Markov-switching model offers the possibility to adjust its parametric form to test for the existence of various scenarios. This could be done by imposing regime-dependent constraints on coefficients.[4] For instance, we can restrict the weight on the USD to be equal to 0 in regime 1, allowing to detect episodes where the domestic currency has fluctuated freely against the USD. This allows in turn to define regime 2 as episodes where the domestic currency has been correlated with the USD, i.e., the synchronization regime as labeled in Kim et al. (2012). One advantage is to remove episodes where there is any co-movement with the USD (or any other major currencies), which sharpens the estimates of currency weights in the implicit basket. This methodology has been originally proposed by Kim et al. (2012) who focused on the JPY only.

In this paper, we propose five relevant scenarios to shed new light on Asian exchange rate policies. These scenarios will provide an interesting basis for comparing the relative influence among the USD, JPY, RMB and local currencies within the region. For each scenario, we estimate an alternative version of the model presented in Eq. (3).

- Scenario 1: Coefficient restriction is $\beta^1_1 = 0$. Accordingly, regime 1 is defined as the floating regime against the USD while regime 2 is defined as the pegged exchange rate regime against the USD. Our measure of correlation

[3]Specifically, we define the degree of flexibility as the square root of the variance in each regime because it is expressed in the same units as the data (log-variation of exchange rates). Accordingly, our measure of the degree of flexibility is expressed in percentage and is interpreted as the monthly average deviations from the estimated central parity against the basket.

[4]Moreover, imposing constraint on parameters allows to avoid any ambiguity on the identification of Markov-states.

with the USD is then $\beta_1^2 \Delta e_t^{USD}$. With estimates related to the duration and frequency of the second regime, it would allow to identify clearly the extent to which the USD continues to shape Asian exchange rate fluctuations.

- Scenario 2: Coefficient restriction is $\beta_1^4 = 0$. Here, regime 2 is defined as the correlation regime with the RMB. This scenario's main goal is to test the hypothesis of a RMB bloc in Asia independent from the USD. Our measure of the RMB as a potential driving currency within the region goes beyond the classic correlation coefficient. Instead, we want to determine also how frequent and persistent are episodes of co-movement with the RMB.

- Scenario 3: Coefficient restriction is $\beta_1^4 = 1$. Unlike the previous scenario, this version of Eq. (3) aims at exploring the existence of a regime where Asian currencies have adopted a single (soft or hard) currency peg against the RMB. Indeed, Asian countries may have temporarily strengthen their RMB peg during episodes where RMB flexibility has increased, so as to mitigate potential spillovers from RMB fluctuations.

- Scenario 4: Coefficient restriction is $\beta_1^3 = 0$. As for the USD and the RMB, this scenario aims at testing the influence of the JPY within the region. Many previous studies have already mentioned the yen influence in Asia but conclusions have produced contradictory findings. This version follows closely the model used in Kim et al. (2012). However, the authors do not include the RMB in their model and then do not account for the effect of the Chinese exchange rate policy reforms after 2005. Here, we propose to extend their estimates over the period 2005-2016 by controlling for the RMB effect.

- Scenario 5: In this scenario, we introduce the ACU in Eq. (3) and restrict the associated coefficient as $\beta_1^5 = 0$. Our goal is to assess to what extent Asian currencies are stabilized against each other without the need of an external anchor. This issue is crucial since many Asian countries have agreed to promote the use of their national currency for regional trade and investments. For each domestic currency, we compute the associated ACU as a basket composed of the six other Asian currencies (excluding the RMB and the JPY) that compose our original sample. Accordingly, we compute seven different ACUs. The weight of each currency in each basket is computed as the share of bilateral trade over the total trade with its six regional partners (over the period 2005-2016).[5] These shares are displayed in Table 1. As for the RMB, we estimate an auxiliary regression to remove from each ACU the effect of international currencies (including the RMB).

Finally, for each scenario we compute the average duration of each regime as well as the number of month over the total period during which the domestic currency has been pegged against the international currency. The duration of each regime is computed as follows:

$$ED_i = \frac{1}{1 - P_{ii}}, \qquad i = \{1, 2\}. \tag{6}$$

Each scenario offers an alternative view and different insights about the practice of exchange rate policy in Asia. There is not one scenario that would be more likely than the others. These scenarios are complementary as they address exchange rate policy from a counter-factual perspective. For each right-hand side currency, we assume that Asian authorities may

[5] Data have been extracted from DOTS-IMF.

switch between floating and (soft or hard) peg regimes. This allows to compare the relative influence of each currency within the basket beyond the simple linear FW regression coefficient and to assess the exact nature of the relationship between Asian and international currencies (or regional in the case of the ACU). One clear limitation of the FW model is that regression coefficients are a mixture of periods with different degree of floating. This implies two things: First, it becomes feasible to detect episodes (even short) where Asian currencies freely float against a given currency. Second, imposing constraints allows to sharpen the estimates of currency weights within the basket because the synchronization regime excludes the episodes where there is any co-movement between currencies.

INSERT TABLE 1

2.3. Estimation Procedure

For each scenario, we constrain the estimation by ignoring the corresponding coefficient in the optimization procedure of the MS-FW model. Here, we briefly details this estimation procedure. The maximum likelihood method is employed to provide estimates of the parameters and the BFGS algorithm is used to perform non-linear optimization.

The conditional likelihood function for the observed data is defined as

$$\begin{aligned} L(\Theta) &= \prod_{t=1}^{T} \sum_{i=1}^{2} \sum_{j=1}^{2} f(y_t | s_t = i, s_{t-1} = j, \Omega_t, \xi_{t-1}; \Theta) \times \mathbb{P}\left(s_t = i, s_{t-1} = j | \Omega_t, \xi_{t-1}; \Theta\right) \\ &= \sum_{t=1}^{T} \ln f(y_t | \Omega_t, \xi_{t-1}; \Theta). \end{aligned} \tag{7}$$

where $\xi_t = (y_t, y_{t-1}, \dots, y_1)$ and $\Omega_t = (X_t', X_{t-1}', \dots, X_1')$ denotes the vector containing observations through date t, and Θ_t the vector of model parameters. Considering the normality assumption, the regime-dependent densities are defined as

$$\begin{aligned} f(y_t | s_t = 1, s_{t-1} = j, \Omega_t, \xi_{t-1}; \Theta) &= \phi\left(\frac{(y_t - \alpha_1 - \beta_1 X_t')}{2\sigma_1^2}\right), \\ f(y_t | s_t = 2, s_{t-1} = j, \Omega_t, \xi_{t-1}; \Theta) &= \phi\left(\frac{(y_t - \alpha_2 - \beta_2 X_t')}{2\sigma_2^2}\right), \\ &. \end{aligned} \tag{8}$$

where ϕ is the standard normal probability density function. The model is estimated using a maximum likelihood estimator for mixtures of Gaussian distributions, which provides efficient and consistent estimates under the normality assumption. Applying the Bayes' rule, the weighting probabilities are computed recursively:

$$\begin{aligned} \mathbb{P}(s_t = i, s_{t-1} = j | \Omega_t, \xi_{t-1}; \Theta) &= \mathbb{P}(s_t = i, s_{t-1} = j; \Theta) \cdot \mathbb{P}(s_{t-1} = j | \Omega_t, \xi_{t-1}; \Theta) \\ &= P_{ij} \cdot \mathbb{P}(s_{t-1} = j | \Omega_t, \xi_{t-1}; \Theta), \\ \mathbb{P}(s_t = i | \Omega_{t+1}, \xi_t; \Theta) &= \frac{\sum_j f(y_t | s_t = i, s_{t-1} = j, \Omega_t, \xi_{t-1}; \Theta) \cdot \mathbb{P}(s_t = i, s_{t-1} = j | \Omega_t, \xi_{t-1}; \Theta)}{f(y_t | \Omega_t, \xi_{t-1}; \Theta)}. \end{aligned} \tag{9}$$

2.4. Determinants of Exchange Rate Regime Probabilities

In the final step, we propose to link the estimated regime probabilities to a set of macroeconomic variables that include economic fundamentals and external relationship of sample countries. Our objective is to capture how and to what extent the exchange rate behavior of Asian countries against the USD and the RMB is explained by domestic and external macroeconomic factors. We set up the following Non-Linear OLS:

$$\mathbb{P}(s_t = i) = \frac{\exp(\omega + \lambda' X_t)}{1 + \exp(\omega + \lambda' X_t)} + \varepsilon_t \tag{10}$$

We choose this specification because the dependent variables are bounded between 0 and 1. Indeed, our dependent variables are the regime probabilities estimated in the first step. We focus on the scenarios 1 and 2. The probability of the USD regime is based on the investigation on the scenario 1 (Figure **??**), and the probability of the RMB regime is on the analysis of the scenario 2 (Figure 2). The vector, X_t, includes explanatory variables for (1) domestic fundamentals, (2) global shock, and (3) external relationship.

(1) Domestic fundamentals include the domestic inflation rate (year-on-year variation in the domestic CPI); financial development (claims on private sector as % of GDP), trade openness (total trade as % of GDP); and external debt (total external debt as % of GDP). (2) Global shock are measured by VIX and the US shadow policy rate (Krippner , 2013).[6] (3) External relationship includes business cycle correlations with the United States and China measured by the year-on-year variation in industrial production index; the trade dependence on the United States, China, and other Asian countries measured by the share in total trade; and the export similarity index to China. All data are monthly, and the sample period ranges from 2005:10 to 2016:08. We take the first log differences in each variable to ensure stationarity. The data sources are IMF-IFS, IMF-DOTS, National Central Banks, Datastream, Joint External Debt Hub Database and UN Comtrade Database.

3. Empirical results

3.1. Non-linear Currency Weights

To begin with, Table 3 presents the estimates of the MS-FW model without coefficient restrictions. Here, we want to give preliminary evidence of the non-linear dynamics of the Asian currencies. Exchange rates are characterized by two regimes that exhibit two very distinct dynamic patterns. The FW weights are clearly non-linear. For each currency, this is confirmed by the LR test. For the IDR, KRW and MYR, we see that the behavior towards the USD is non-linear. In regime 2, the USD weights are significant and positive while insignificant in regime 1. In the second regime, the coefficients are fairly high for IDR, KRW, and MYR, suggesting that these countries alternate between episodes of soft peg and floating against the USD. The difference in USD estimates between two regimes is less obvious for PHP and THB. This conclusion goes beyond the mere affirmation of a USD bloc in Asia as claimed within the literature.

[6] We use shadow rate to account for monetary policy measures beyond the zero lower bound.

We make the same conclusions for the RMB. We find that the magnitude of the correlation coefficients largely differs between regimes. In the weak correlation regime, many coefficients do not exceed 0.25. However, for many currencies, RMB estimates reach much higher values in the other regime. This difference is the most obvious for the MYR. In the case of TWD, the correlation is insignificant in regime 2 but positive and significant in regime 1. Interestingly, we see that the RMB weights increase when monetary authorities loose their peg on the USD. Also, it seems that the notion of a RMB bloc is misleading because Asian countries switch between periods of high and low synchronization with the RMB. For all currency except the KRW and PHP, we find that the regime where they are pegged to the USD is the regime with the longer duration. Conversely, the regime where the RMB weight is the highest has the shortest duration. It implies that the USD remains the main anchor currency for many Asian countries, even if their currencies seem to fluctuate more freely against it during some episodes.

Accordingly, the notion of a USD bloc or RMB bloc is puzzling because Asian countries adjust the composition of their basket continuously. Finally, the EUR and JPY weights remains fairly low. Indeed, we see that the EUR has a non-negligible share for the KRW and the PHP, but only in one regime. This suggests that the role of the EUR is rather limited. Regarding the JPY, the coefficient is insignificant for the IDR, KRW and MYR. For the TWD, THB and SGD, the relationship is significant in one regime, although its value is weak. For the PHP, we observe a negative co-movement in one regime.

Although they provide meaningful information, these results do not allow to describe the exact nature of each regime because there is any identification scheme allowing to define what determines the endogenous switching between the two regimes. In the following sections, we propose different coefficient restrictions to assess the explicit role of each currency within the basket. The findings are summarized in Figure 5(a), 5(b) and 5(c).

INSERT TABLE 2

INSERT TABLE 3

3.1.1. Scenario 1 - The US dollar

Table 4 presents the results of Scenario 1 where correlation with the USD is constrained to be equal to zero in regime 1, while Figure 1 shows the probability of being in the USD peg regime.

First, we find that the USD regime is very persistent. The expected duration of the USD regime is significantly higher than the expected duration of episodes where Asian currencies freely float against the USD. Second, for all currencies, the frequency of the USD regime is the highest when we compare with those of the RMB and JPY regime (scenarios 2and 4 as shown in Figure 5(c)). Third, in the same way, the USD coefficients are the highest compared to those of the other currencies. The share of the RMB is far behind, but always significant. However, the share of the RMB is interestingly high when the Asian currencies freely float against the USD. It suggests that when Asian countries loosen their peg against the USD, they tighten their peg against the RMB.

Moreover, when we compare with the results of the linear model (see Table 2), there is no important differences between the USD coefficients. This is explained by the fact that the floating regime against the USD has a very short duration.

Finally, we can see that the degree of exchange rate flexibility is significantly higher in regime 1 for the IDR, MYR and THB. For instance, the monthly average deviations from the basket value are equal to 3.335% in the regime where the IDR floats against the USD (regime 1). However, when the USD is included within the basket (regime 2), the degree of flexibility falls to 1.061%. This means that regime 2 corresponds to episodes where the IDR has operated as a managed floating currency relatively stable against a currency basket where the USD weight is equal to approximately 75%. However, in regime 1, when the USD is removed from the basket, the IDR is floating more freely. Note that the degree of exchange rate flexibility is rather the same in both regimes for the KRW and SGD, which suggest that including the USD within the basket does not increase the fixity of the exchange rate. However, for the SGD, the standard deviation are much lower in both regimes compared to the KRW, which suggests that the former fluctuates less than the latter.

INSERT TABLE 4

INSERT FIGURE 1

3.1.2. Scenario 2 - The Renminbi ($\beta_1^{rmb} = 0$)

We constrain the model so that correlation with the RMB is equal to zero in regime 1, where Asian currencies freely float against the RMB. Conversely, regime 2 corresponds to the RMB synchronization regime. Note that this corresponds to episodes where the RMB has moved independently from the USD. This allows us to capture episodes where Asian currencies co-move with the RMB (without the USD as an external anchor). The estimates are presented in Table 5 and regime probabilities in Figure 2.

For the IDR, KRW, MYR and THB, we find that the expected duration of the RMB peg regime (i.e., ED2) is shorter compared to the floating regime against the RMB. For the PHP, SGD and TWD, the synchronization regime is more persistent, suggesting that on average, the episodes of co-movement with the RMB last longer than those without co-movement. As a whole, the duration of the synchronization regime ranges between 2 and 10 months. The duration of the synchronization regime is the longest for the THB (10 months) and TWD (9 months) and the shortest for the SGD (2 months).

With regards to RMB coefficients, they are higher compared to the estimates of the linear model (see Table 2). Accordingly, the co-movement appears to be stronger compared with what we observe in the standard FW model. However, we find that the USD coefficients remains higher, even in the pegged regime, than the RMB coefficients for a majority of currencies (i.e. PHP, SGD, THB, TWD). This confirms that the USD plays the main role in shaping Asian exchange rate movements. This is more striking in regime 1 where the USD has a share higher than the EUR and JPY in all cases.

We compute the number of months during which the Asian currencies co-move with the RMB: we find that the TWD is the currency most often pegged to the RMB (113 months), even if the TWD is the currency for which the RMB coefficient is the lowest. Overall, we find that currencies that have the strongest co-movement with the RMB are those that are least often synchronized with the RMB.

Regarding the degree of flexibility towards the basket, it is greater in the RMB synchronization regime for all currencies except SGD. This is mainly explained by the fact that the USD weight is more important when the RMB is not included within the basket. This result tends to confirm those of the previous scenario. Note however, that the degree of exchange rate flexibility in the RMB synchronization regime is quite low for the PHP, SGD and TWD (less than 1.05%), which confirms that the RMB plays an important role for these three currencies.

INSERT TABLE 5

INSERT FIGURE 2

3.1.3. Scenario 3 - The Renminbi ($\beta_1^{rmb} = 1$)

Here, we want to detect the possibility of a hard peg against the RMB (regime 1). We find that there are some episodes during which Asian currencies have been hardly pegged to the RMB. As for the previous scenario, this is especially true for the PHP, SGD and TWD as the degree of exchange rate flexibility towards the RMB single currency peg is very low. Indeed, the average fluctuations towards the RMB are respectively equal to 0.339%, 0.032% and 0.084% for these three currencies. However, the duration of this regime is very weak in all cases as shown by regime probabilities displayed in Figure 3. They do not exceed 3-4 months (see Table 6), while the total number of months during which the Asian currencies have been hardly pegged to the RMB does not exceed 16 months over the sample. Accordingly, this result confirms that there is no RMB bloc in Asia, even if the countries within the region seem to monitor the RMB movements to some extent.

INSERT TABLE 6

INSERT FIGURE 3

3.1.4. Scenario 4 - The Japanese yen

We next constrain the model so that correlation with the JPY is equal to zero in regime 1, and the estimates are presented in Table 7. We find that only two currencies (SGD and TWD) significantly co-move with the Yen, whereas the co-movement with the JPY is significantly negative for KRW and PHP. Overall, the JPY coefficients are quiet low (ranging from -0.34 to 0.24). When comparing the expected duration between the JPY and RMB synchronization regimes, we find that the persistence of the RMB regime is higher for all currencies, excepted the IDR. In addition, the frequency (i.e. the number of months) of the JPY regime (Table 7) is lower than the corresponding frequency of the RMB regime (Table 5), except for the IDR and THB. Thus, the results indicate that the RMB plays a more important role in Asia compared to the JPY.

Comparing with the linear model (see Table 2), the MS-FW estimates bring more accurate results. We find that the JPY coefficients are higher in the MS-FW estimates for the SGD and TWD. Furthermore, the MS-FW model allows to detect that the KRW and PHP negatively co-move with the JPY, while the standard FW linear model indicates a non-significant relationship.

INSERT TABLE 7

3.1.5. Scenario 5 - The Asian Currency Unit

Here, we want to check whether Asian currencies are interlinked with each other. We constrain the ACU coefficient to be equal to zero in regime 1. The second regime is then the pegged regime against the ACU. Table 8 displays the results.

For all currencies, there is a significant and positive relationship between the domestic currency and the ACU. The correlation coefficient ranges from 0.37 to 1.3. Except for KRW, the ACU estimates are higher than 0.5. For IDR, PHP and THB, the number of months during which we observe the peg regime is relatively high compared to the RMB regime (see Table 5). For these currencies except the IDR, the ACU coefficients are higher than those of the RMB. For the other currencies except the KRW, the RMB has a higher share. However, in all cases, the frequency of the ACU regime is lower than that of the USD regime (see Table 4). We find also that the ACU weight is higher than the USD weight in regime 2 except for the MYR and SGD. However, the persistence of the ACU regime is quite low compared to regime 1 except for the case of the THB, suggesting that Asian countries seem to monitor regional currencies on a short-term basis only.

INSERT TABLE 8

INSERT FIGURE 4

3.2. Economic Determinants

The results of the non-linear OLS for the USD regime are presented in Table 9 where coefficients are reported with robust standard errors. First, VIX has a positive and significant effect on the probability to evolve in the USD pegged regime except for Malaysia and Singapore. It means that any increase in US financial market volatility strengthens the probability that these countries peg their currency on the USD. For the US shadow policy rate (SSR), we find a negative coefficient in four cases, suggesting that a decrease in SSR leads Asian countries to loosen their peg against the USD. One explanation relates to the fact that a loosening of US monetary policy may generate important capital inflows within he Asian region and an upward pressure on their currencies.

Domestic inflation is positive and significant in four countries, implying that a positive fluctuation in domestic prices is followed by a higher probability to peg against USD in the next period. This is consistent with the literature. When Asian countries face increased pressure on their domestic prices, they favor a USD peg to gain credibility. With regards to external debt, the estimates provide clear-cut results since the coefficients are positive and significant except for Taiwan. Accordingly, an increase in external debt significantly increases the probability to evolve in the USD peg regime. The traditional explanation is that maintaining a relatively fixed exchange rate to the USD is an implicit insurance mechanism against a rise in the value of the debt denominated in USD. Finally, Financial development and trade openness produce contrasting results as the sign of coefficients is ambiguous.

We now turn on the analysis of bilateral fundamentals. For the USD regime probabilities, we decided to include Chinese variables and intra-regional trade because we can suppose that the decision to adopt an USD peg could be linked to greater regional interdependence. For Indonesia, business cycle (BC) synchronization and export similarity with China is positively linked with the probability to peg against the USD. We find a similar results for the Philippines and Thailand. In addition, for these two countries, an increase in bilateral trade with China leads to the same conclusion. Conversely, Chinese variables impact negatively the probability of a USD peg for Korea, Singapore and Taiwan. When looking at intra-regional trade across our original sample, we find that the impact is negative in all cases when the coefficient is statistically significant.

These results play against the view that a collective USD peg leads to greater intra-regional exchange rate stability, something that becomes desirable as regional trade integration progresses. Indeed, in the aftermath of the 1997-98 crisis, it has been argued that a common implicit USD peg can guarantee to each country an appreciation of their own currency against those of their regional competitors. And this effects would be greater as regional trade flows become more intense. However, our result seem to indicate the opposite over the period 2005-2016. One explanation could be that as regional trade flows intensifies, competition across Asian countries becomes stronger. In this view exchange rate flexibility (against the USD) is considered as a means to preserve trade competitiveness when other countries are likely to intervene on the foreign exchange market to avoid appreciation of their currencies. In others word, the fear of floating would be a fear of appreciation. This may explain why greater intra-regional trade is associated with greater exchange rate flexibility against the USD.

The US variables are in most cases negatively correlated with the probability to peg against USD. The estimates for BC synchronization provide significant and negative coefficients in all countries (except Indonesia). Here, the interpretation refers to the same argument as above. Indeed, US market remains one of the important final destination for Asian finished goods exports, implying that a negative demand shock from US markets spill over into the regional production network. In this view, exchange rate flexibility can be seen as a tool to cope with negative demand shocks from developed countries. For Indonesia and Malaysia, this argument is reinforced by the estimates on US trade, which shows a negative relationship with the probability to be pegged against the USD.

The above findings are supported by results for the RMB regime probabilities (Table 10). First, global factors such as VIX or SSR are most often non-significant. Concerning domestic fundamentals, we do not find any clear-cut evidence of their influence on the decision to peg against the RMB. Indeed, the effect of domestic fundamentals are contradictory according to the country. However, a country-basis assessment offers a different picture. For instance, all variables are significant for Taiwan, but inflation is the only one that impact positively the regime probabilities. Conversely, we do not find any significant results for South Korea. For the original members of the ASEAN-5, external debt and financial development seem to play a role but the impact is not homogenous across countries.

Finally, estimates of bilateral or regional variables seem more relevant. Bilateral trade witch China is positive and significant for Indonesia, Malaysia, the Philippines, and Thailand. This result reveals that trade dependence on China is a key factor in pegging Asian currencies to RMB. For Indonesia and Singapore, we find a similar conclusion in regards to intra-regional trade (excluding China). Interestingly, estimates on export similarity with China leads to opposite results. As trade with China increases, exchange rate stability against the RMB becomes crucial. However, China and its regional partners are also competitors on regional and international markets (proxied by the ESI index), implying that Asian countries may be tempted to keep downward pressure on their currency against the RMB. In the same way, BC synchronization is negatively related to RMB regime probabilities. As production chains become more integrated between China and the neighborhood countries, BC becomes more interrelated and intra-industry trade competition more intense. Keeping exchange rate relatively flexible is therefore crucial for Asian countries in order to preserve their trade competitiveness. These two last results clearly illustrate the coordination failure in choosing an appropriate collective exchange rate arrangement within the region to ensure intra-regional exchange rate stability.

INSERT TABLE 9-10

4. Conclusion

Given China's rapid economic growth and development, it is worth investigating whether the RMB becomes a main reference currency for regional countries' currency basket. Most previous studies, however, used a linear model developed by Frankel and Wei (1994) which fails to consider possible frequent adjustment of currency basket weight by monetary authorities of Asian countries.

In contrast to previous studies, we have employed the MS-FW model to take into consideration possible non-linearity in adapting exchange rate policy or choice of currency basket weights in seven Asian countries. We have presented the estimated results of the MS-FW model for five relevant scenarios by imposing regime-dependent constraints on coefficients. It was revealed that most Asian countries, especially Indonesia, Korea, and Malaysia, tend to adapt the weight of their currency basket continuously, which suggests that their exchange rate regime has alternated between a soft USD peg and floating against the USD. When Asian countries loosened their peg against the USD, these currencies increased their correlation with the RMB. Thus, it is not appropriate to conclude a USD bloc or RMB bloc in Asia. However, the soft USD peg regime has a longer duration in most Asian countries, while the regime with a large RMB weight tends to be of shorter duration.

Although less correlated with the yen, Asian currencies exhibit high correlations with the ACU. The degree of correlations with the ACU becomes higher than the corresponding correlations with the RMB in Indonesia, Singapore, and Thailand. However, the duration of the ACU regime is much shorter than that of the soft USD peg regime. We may say that Asian countries tend to monitor the regional currencies for their exchange rate management even though during short episodes. Based on the above empirical findings, we may conclude that the USD still stays in a position of the main anchor currency for most Asian countries, but Asian currencies become more correlated with the RMB and, possibly, ACU during some periods. The yen is a less important anchor currency than the RMB and ACU.

We have further examined what macroeconomic factors determine the choice to peg against the USD and the RMB. We have revealed that global fundamentals such as VIX and US shadow policy rate impact positively and negatively the decision to peg against the USD. External debt is also found to play in favor of a US peg. With regard to the RMB, we find that trade dependence on China is a key factor in pegging Asian currencies to RMB. However, estimates on export similarity and business cycle synchronization with China leads to opposite results.

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Table 1: Asian Currency Units composition

	IDR	KRW	MYR	PHP	SGD	TWD	THB
ACU-IDR		0.20	0.17	0.04	0.35	0.12	0.12
ACU-KRW	0.20		0.15	0.09	0.23	0.24	0.10
ACU-MYR	0.12	0.13		0.05	0.41	0.12	0.17
ACU-PHP	0.07	0.17	0.12		0.25	0.25	0.13
ACU-SGD	0.24	0.14	0.37	0.06		0.09	0.11
ACU-TWD	0.12	0.29	0.15	0.10	0.23		0.10
ACU-THB	0.16	0.14	0.27	0.08	0.22	0.12	

Notes: Each row equals to 1 (100%).

Table 2: Standard FW linear estimates

	IDR	KRW	MYR	PHP	SGD	THB	TWD
α	0.201	0.053	0.09	-0.093	-0.167**	-0.097	-0.001
	(0.189)	(0.164)	(0.126)	(0.109)	(0.066)	(0.119)	(0.083)
β^{usd}	0.48***	0.34***	0.521***	0.767***	0.439***	0.719***	0.593***
	(0.116)	(0.101)	(0.063)	(0.066)	(0.035)	(0.073)	(0.051)
β^{eur}	0.101	0.279***	0.112	0.077	0.188***	0.058	0.073
	(0.115)	(0.100)	(0.074)	(0.065)	(0.038)	(0.072)	(0.046)
β^{jpy}	-0.003	-0.103	0.077	-0.002	0.129***	0.038	0.096***
	(0.082)	(0.071)	(0.050)	(0.047)	(0.023)	(0.052)	(0.029)
β^{rmb}	0.324***	0.403***	0.311***	0.205***	0.198***	0.238***	0.17***
	(0.073)	(0.064)	(0.058)	(0.042)	(0.028)	(0.046)	(0.031)
LL	-288.547	-272.017	-233.202	-219.61	163.93	-229.735	-180.719

Notes: *,**,*** denote significance at 10, 5 and 1 %, respectively. Standard errors of parameters are reported in parentheses (.).

Table 3: MS-FW estimates without constraints

	IDR	KRW	MYR	PHP	SGD	THB	TWD
σ_1^2	3.336***	1.982***	1.917***	1.155**	0.841***	1.719***	1.314***
	(0.377)	(0.232)	(0.284)	(0.509)	(0.311)	(0.393)	(0.381)
σ_2^2	1.085	0.453***	0.892	0.003***	0.127***	0.562***	0.735*
	(1.315)	(0.101)	(0.619)	(0.000)	(0.014)	(0.143)	(0.421)
α_1	0.276*	-0.062***	0.4***	-0.175*	-0.15*	-0.07**	-0.442***
	(0.154)	(0.005)	(0.156)	(0.105)	(0.077)	(0.035)	(0.160)
α_2	0.18*	0.138	-0.088*	-0.356***	-0.694***	-0.184	0.085
	(0.101)	(0.110)	(0.047)	(0.001)	(0.067)	(0.152)	(0.173)
β_1^{rmb}	0.445*	0.507***	0.772***	0.508***	0.211***	0.331***	0.164**
	(0.245)	(0.098)	(0.175)	(0.000)	(0.029)	(0.090)	(0.081)
β_2^{rmb}	0.22***	0.253***	0.151***	0.168***	0.388***	0.127***	0.248
	(0.052)	(0.038)	(0.039)	(0.039)	(0.027)	(0.049)	(0.260)
β_1^{eur}	0.254	0.068	-0.023	0.122**	0.038	-0.03	0.038
	(0.353)	(0.141)	(0.290)	(0.054)	(0.045)	(0.144)	(0.164)
β_2^{eur}	0.114	0.288***	0.169***	0.232***	0.053*	0.064*	0.056
	(0.081)	(0.063)	(0.054)	(0.001)	(0.027)	(0.036)	(0.067)
β_1^{jpy}	0.12	-0.144	-0.01	0.061	0.043	0.009	0.268*
	(0.269)	(0.090)	(0.175)	(0.044)	(0.031)	(0.082)	(0.153)
β_2^{jpy}	-0.006	-0.088	0.066	-0.532***	0.201***	0.098**	0.063
	(0.056)	(0.063)	(0.058)	(0.001)	(0.014)	(0.044)	(0.038)
β_1^{usd}	-0.079	0.154	0.402	0.76***	0.602***	0.7***	0.354**
	(0.395)	(0.131)	(0.274)	(0.065)	(0.041)	(0.117)	(0.143)
β_2^{usd}	0.766***	0.81***	0.526***	0.977***	0.365***	0.684***	0.644***
	(0.080)	(0.072)	(0.070)	(0.001)	(0.020)	(0.071)	(0.054)
LL	-257.693	-251.095	-213.580	-185.986	-155.462	-215.751	-173.020
LR STAT	61.71	41.85	39.24	67.25	16.94	27.97	15.40
p.value	[0.000]	[0.000]	[0.000]	[0.000]	[0.031]	[0.000]	[0.052]
$P11$	0.859	0.763	0.773	0.936	0.931	0.890	0.715
$P21$	0.141	0.237	0.227	0.064	0.069	0.110	0.285
$P12$	0.946	0.559	0.932	0.923	0.697	0.875	0.929
$P22$	0.054	0.441	0.068	0.077	0.303	0.125	0.071
ED1	7.069	4.220	4.407	15.622	14.569	9.107	3.515
ED2	18.631	2.269	14.603	13.013	3.296	8.020	14.171

Notes: *,**,*** denote significance at 10, 5 and 1 %, respectively. Standard errors of parameters are reported in parentheses (.), while p-values are displayed in brackets [.]. The LR test aims to test whether the MS-FW outperforms the standard FW model. The test statistic is computed as follows: $LR = 2 \times [LL_{MS-FW} - LL_{FW}]$. The null hypothesis is that the unconstrained model does not fit significantly better than the constrained model. ED corresponds to the expected duration of each regime in terms of months. P_{ij} indicates the probability to stay or switch between regimes.

Table 4: Estimates of Scenario 1: $\beta_1^{usd} = 0$

	IDR	KRW	MYR	PHP	SGD	THB	TWD
σ_1^2	11.119***	2.184**	3.935***	0.3*	0.318*	3.965***	0.01**
	(2.107)	(0.894)	(1.260)	(0.158)	(0.166)	(0.917)	(0.005)
σ_2^2	1.126***	1.924***	0.828***	1.013***	0.399***	0.732***	0.554***
	(0.100)	(0.288)	(0.118)	(0.163)	(0.053)	(0.097)	(0.073)
α_1	0.24	1.422***	0.268	0.237	0.552**	0.339	-0.626***
	(0.587)	(0.476)	(0.477)	(0.250)	(0.261)	(0.291)	(0.042)
α_2	0.185	-0.213	-0.079	-0.06	-0.234***	-0.242**	0.009
	(0.119)	(0.142)	(0.099)	(0.100)	(0.063)	(0.107)	(0.070)
β_1^{rmb}	0.4318***	0.9146***	0.919***	1.0292***	0.5109***	0.5194***	0.4564***
	(0.048)	(0.055)	(0.038)	(0.038)	(0.022)	(0.044)	(0.028)
β_2^{rmb}	0.219***	0.308***	0.158***	0.146***	0.158***	0.094**	0.157***
	(0.048)	(0.055)	(0.038)	(0.038)	(0.022)	(0.044)	(0.028)
β_1^{eur}	0.234	-0.274	0.029	0.171	0.374**	0.093	0.1474***
	(0.330)	(0.205)	(0.303)	(0.194)	(0.153)	(0.289)	(0.041)
β_2^{eur}	0.108	0.185*	0.165***	0.054	0.194***	0.112*	0.076*
	(0.075)	(0.101)	(0.058)	(0.058)	(0.036)	(0.057)	(0.041)
β_1^{jpy}	0.084	-0.306***	0.071	0.854	0.224***	0.199	0.417***
	(0.174)	(0.095)	(0.176)	(0.995)	(0.089)	(0.164)	(0.027)
β_2^{jpy}	0.004	0.07	0.068	-0.018	0.125***	-0.001	0.06**
	(0.051)	(0.070)	(0.044)	(0.044)	(0.026)	(0.000)	(0.030)
β_1^{usd}	0	0	0	0	0	0	0
	-	-	-	-	-	-	-
β_2^{usd}	0.748***	0.454***	0.528***	0.805***	0.461***	0.757***	0.639***
	(0.074)	(0.092)	(0.060)	(0.062)	(0.037)	(0.002)	(0.044)
$P11$	0.86	0.61	0.73	0.34	0.58	0.82	0.51
$P21$	0.14	0.39	0.27	0.66	0.42	0.18	0.49
$P12$	0.05	0.07	0.07	0.06	0.05	0.07	0.04
$P22$	0.95	0.93	0.93	0.94	0.95	0.93	0.96
ED1	7.06	2.55	3.67	1.52	2.39	5.56	2.03
ED2	19.71	14.69	14.28	16.97	20.08	14.33	22.54
Degree of Flexibility (%):							
Regime 1	3.335	1.478	1.984	0.548	0.564	1.991	0.100
Regime 2	1.061	1.387	0.910	1.006	0.632	0.856	0.744
Nb. of Months Reg. 2	97 (73.5%)	120 (90.9%)	114 (86.4%)	124 (93.9%)	119 (90.2%)	99 (75%)	123 (93.2%)

Notes: This table shows the estimates of the MS-FW models with the constraint $\beta_{usd}^1 = 0$. Regime 1 thus corresponds to episodes where there is no correlation with USD. Regime 2 captures episodes where Asian currencies have been pegged to USD. *,**,*** denote significance at 10, 5 and 1 %, respectively. Standard errors of parameters are reported in parentheses (.), while p-values are displayed in brackets [.]. ED corresponds to the average duration of each regime in terms of months. P_{ij} indicates the probability to stay or switch between regimes.

Table 5: Estimates of Scenario 2: $\beta_1^{rmb} = 0$

	IDR	KRW	MYR	PHP	SGD	THB	TWD
σ_1^2	1.691***	1.591***	0.776***	0.567***	0.467***	0.878***	0.074***
	(0.235)	(0.300)	(0.141)	(0.142)	(0.115)	(0.148)	(0.029)
σ_2^2	10.369***	3.706***	2.757***	1.109***	0.328***	2.938***	0.818***
	(2.961)	(0.874)	(0.586)	(0.245)	(0.072)	(0.618)	(0.115)
α_1	-0.007	-0.443**	-0.08	-0.243*	-0.145	-0.375***	0.373***
	(0.143)	(0.179)	(0.124)	(0.134)	(0.131)	(0.115)	(0.095)
α_2	0.82	0.191	0.355	0.088	-0.076	0.194	-0.155
	(0.647)	(0.334)	(0.279)	(0.164)	(0.091)	(0.289)	(0.093)
β_1^{rmb}	0	0	0	0	0	0	0
	-	-	-	-	-	-	-
β_2^{rmb}	0.617***	0.568***	0.648***	0.384***	0.316***	0.459***	0.208***
	(0.247)	(0.108)	(0.105)	(0.059)	(0.032)	(0.096)	(0.035)
β_1^{eur}	0.243***	0.327***	0.22***	-0.013	0.336***	0.2***	0.124**
	(0.084)	(0.104)	(0.061)	(0.067)	(0.067)	(0.064)	(0.055)
β_2^{eur}	0.091	0.201	0.021	0.183*	0.093*	-0.023	0.047
	(0.363)	(0.197)	(0.185)	(0.096)	(0.051)	(0.265)	(0.056)
β_1^{jpy}	-0.012	0.146*	0.026	-0.013	0.118**	0.025	-0.045
	(0.063)	(0.086)	(0.049)	(0.049)	(0.050)	(0.049)	(0.039)
β_2^{jpy}	0.355	-0.314**	0.017	-0.046	0.104***	0.038	0.111***
	(0.266)	(0.154)	(0.123)	(0.069)	(0.035)	(0.157)	(0.040)
β_1^{usd}	0.831***	0.626***	0.57***	0.77***	0.447***	0.72***	0.898***
	(0.082)	(0.108)	(0.066)	(0.069)	(0.071)	(0.065)	(0.047)
β_2^{usd}	-0.402	0.323	0.454**	0.747***	0.469***	0.716***	0.514***
	(0.395)	(0.199)	(0.186)	(0.105)	(0.054)	(0.203)	(0.055)
$P11$	0.95	0.86	0.88	0.49	0.78	0.95	0.50
$P21$	0.05	0.14	0.12	0.51	0.22	0.05	0.50
$P22$	0.19	0.19	0.20	0.49	0.15	0.10	0.12
$P12$	0.81	0.81	0.80	0.51	0.85	0.90	0.88
ED1	19.17	7.05	8.03	1.97	4.58	19.65	1.99
ED2	5.25	5.37	4.88	2.06	6.59	9.74	8.41
Degree of Flexibility (%):							
Regime 1	1.300	1.136	0.881	0.753	0.683	0.937	0.272
Regime 2	3.220	1.925	1.660	1.053	0.573	1.714	0.904
Nb. of Months Reg. 2	27 (20.45%)	45 (34.1%)	38 (28.79%)	57 (43.18)	85 (64.39)	40 (30.3%)	113 (85%)

Notes: This table shows the estimates of the MS-FW models with the constraint $\beta_{rmb}^1 = 0$. Regime 1 thus corresponds to episodes where there is no correlation with RMB. Regime 2 captures episodes where Asian currencies have been pegged to RMB. *,**,*** denote significance at 10, 5 and 1 %, respectively. Standard errors of parameters are reported in parentheses (.), while p-values are displayed in brackets [.]. *ED* corresponds to the expected duration of each regime in terms of months. P_{ij} indicates the probability to stay or switch between regimes.

Table 6: Estimates of Scenario 3: $\beta_1^{rmb} = 1$

	IDR	KRW	MYR	PHP	SGD	THB	TWD
σ_1^2	9.1	4.894**	1.548***	0.115**	0.001*	1.27**	0.007*
	(9.712)	(2.333)	(0.554)	(0.056)	(0.000)	(0.531)	(0.004)
σ_2^2	2.326***	1.79***	0.884***	1.213***	0.375***	0.921***	0.539***
	(0.368)	(0.255)	(0.126)	(0.162)	(0.049)	(0.112)	(0.074)
α_1	5.805	1.3*	0.693**	-0.425***	0.147***	-1.005**	-0.996***
	(4.885)	(0.765)	(0.329)	(0.147)	(0.016)	(0.486)	(0.047)
α_2	0.105	-0.227	-0.027	-0.106	-0.152***	-0.077	0.061
	(0.144)	(0.143)	(0.100)	(0.107)	(0.059)	(0.112)	(0.070)
β_1^{rmb}	1	1	1	1	1	1	1
	-	-	-	-	-	-	-
β_1^{rmb}	0.251***	0.3111***	0.182***	0.1558***	0.199***	0.0962***	0.184***
	(0.067)	(0.054)	(0.035)	(0.040)	(0.023)	(0.039)	(0.028)
β_1^{eur}	-0.961	-0.016	0.112	-0.424	0.022***	-0.479	0.135***
	(0.828)	(0.390)	(0.198)	(0.340)	(0.006)	(0.499)	(0.039)
β_1^{eur}	0.162*	0.161*	0.128**	0.081	0.171***	0.097	0.054
	(0.089)	(0.093)	(0.058)	(0.058)	(0.034)	(0.059)	(0.043)
β_1^{jpy}	1.597	-0.316	0.031	0.739	-0.034***	0.480	0.07**
	(1.487)	(0.255)	(0.147)	(0.735)	(0.013)	(0.365)	(0.030)
β_1^{jpy}	0.063	0.1	0.071	-0.001	0.133***	-0.021	0.419***
	(0.066)	(0.072)	(0.044)	(0.000)	(0.024)	(0.044)	(0.032)
β_1^{usd}	-1.82	0.367	0.206	0.079	-0.491	0.025	1.173
	(2.002)	(0.341)	(0.196)	(0.081)	(0.317)	(0.248)	(0.742)
β_1^{usd}	0.66***	0.476***	0.517***	0.771***	0.455***	0.791***	0.617
	(0.095)	(0.100)	(0.061)	(0.048)	(0.034)	(0.057)	(0.045)
$P11$	0.47	0.71	0.63	0.61	0.38	0.42	0.57
$P21$	0.53	0.29	0.37	0.39	0.62	0.58	0.43
$P22$	0.03	0.06	0.08	0.04	0.04	0.12	0.03
$P12$	0.97	0.94	0.92	0.96	0.96	0.88	0.97
ED1	1.88	3.41	2.71	2.57	1.60	1.71	2.30
ED2	32.83	17.58	12.68	27.94	24.86	8.31	39.90
Degree of Flexibility (%):							
Regime 1	3.017	2.212	1.244	0.339	0.032	1.127	0.084
Regime 2	1.525	1.338	0.940	1.101	0.612	0.960	0.734
Nb. of Months Reg. 1	4 (3.03%)	13 (9.85%)	16 (12.12%)	13 (9.85%)	8 (6.06%)	13 (9.85%)	8 (6.06%)

Notes: This table shows the estimates of the MS-FW models with the constraint $\beta_{rmb}^1 = 1$. Regime 1 thus corresponds to episodes where Asian currencies have been hardly pegged to RMB. *,**,*** denote significance at 10, 5 and 1 %, respectively. Standard errors of parameters are reported in parentheses (.), while p-values are displayed in brackets [.]. *ED* corresponds to the expected duration of each regime in terms of months. P_{ij} indicates the probability to stay or switch between regimes.

Table 7: Estimates of Scenario 4: $\beta_1^{jpy} = 0$

	IDR	KRW	MYR	PHP	SGD	THB	TWD
σ_1^2	1.132***	2.42***	0.808***	0.766***	0.389***	0.461***	0.499***
	(0.111)	(0.315)	(0.125)	(0.130)	(0.055)	(0.104)	(0.090)
σ_2^2	11.141***	0.003**	3.542***	0.545***	0.006**	3.212***	1.179***
	(2.225)	(0.001)	(0.932)	(0.150)	(0.002)	(0.548)	(0.327)
α_1	0.184	-0.048	-0.114	-0.179	-0.166***	-0.112	0.112
	(0.119)	(0.145)	(0.101)	(0.110)	(0.063)	(0.133)	(0.103)
α_2	0.253	0.407***	0.436	-0.097	-0.206***	0.024	-0.476*
	(0.591)	(0.022)	(0.399)	(0.167)	(0.026)	(0.254)	(0.266)
β_1^{rmb}	0.219***	0.302***	0.135***	0.105***	0.17***	0.158***	0.139***
	(0.048)	(0.055)	(0.037)	(0.041)	(0.023)	(0.048)	(0.040)
β_2^{rmb}	0.442*	0.471***	0.264***	0.376***	0.3***	0.2931***	0.267***
	(0.229)	(0.010)	(0.082)	(0.052)	(0.011)	(0.087)	(0.098)
β_1^{eur}	0.108	0.277***	0.195***	-0.028	0.258***	0.016	0.078
	(0.073)	(0.084)	(0.056)	(0.062)	(0.034)	(0.061)	(0.054)
β_2^{eur}	0.244	0.29***	-0.05	0.281***	0.209***	0.246	0.012
	(0.333)	(0.010)	(0.273)	(0.097)	(0.020)	(0.189)	(0.137)
β_1^{jpy}	0	0	0	0	0	0	0
	-	-	-	-	-	-	-
β_2^{jpy}	0.125	-0.34***	0.039	-0.338***	0.246***	-0.016	0.226**
	(0.246)	(0.007)	(0.164)	(0.112)	(0.011)	(0.123)	(0.101)
β_1^{usd}	0.752***	0.415***	0.582***	0.719***	0.571***	0.789***	0.704***
	(0.061)	(0.072)	(0.046)	(0.048)	(0.027)	(0.043)	(0.044)
β_2^{usd}	-0.084	0.569***	0.38	0.979***	0.403***	0.632***	0.381***
	(0.322)	(0.011)	(0.267)	(0.113)	(0.019)	(0.171)	(0.125)
$P11$	0.95	0.93	0.93	0.60	0.90	0.87	0.90
$P21$	0.05	0.07	0.07	0.40	0.10	0.13	0.10
$P22$	0.14	0.71	0.22	0.89	0.79	0.15	0.26
$P21$	0.86	0.29	0.78	0.11	0.21	0.85	0.74
ED1	19.74	14.17	13.54	2.52	9.83	7.65	10.27
ED2	7.01	1.42	4.55	1.13	1.26	6.68	3.81
Degree of Flexibility (%):							
Regime 1	1.064	1.556	0.899	0.875	0.624	0.679	0.706
Regime 2	3.338	0.055	1.882	0.738	0.077	1.792	1.086
Nb. of Months Reg. 2	34 (25.76%)	16 (12.12%)	23 (17.42%)	28 (21.21%)	18 (13.64%)	55 (41.67%)	20 (15.15%)

Notes: This table shows the estimates of the MS-FW models with the constraint $\beta_{jpy}^1 = 0$. Regime 1 thus corresponds to episodes where there is no correlation with JPY. Regime 2 captures episodes where Asian currencies have been pegged to JPY. *,**,*** denote significance at 10, 5 and 1 %, respectively. Standard errors of parameters are reported in parentheses (.), while p-values are displayed in brackets [.]. *ED* corresponds to the average duration of each regime in terms of months. P_{ij} indicates the probability to stay or switch between regimes.

Table 8: Estimates of Scenario 5: $\beta_1^{ACU} = 0$

	IDR	KRW	MYR	PHP	SGD	THB	TWD
σ_1^2	1.09***	1.788***	0.79***	0.508***	0.508***	0.281***	0.55***
	(0.100)	(0.253)	(0.125)	(0.099)	(0.081)	(0.091)	(0.084)
σ_2^2	8.863***	6.128***	2.751***	1.616***	0.165***	2.118***	0.001
	(1.827)	(1.927)	(0.671)	(0.271)	(0.027)	(0.555)	(0.000)
α_1	0.207*	-0.192	-0.106	-0.251**	-0.069	-0.154	0.008
	(0.116)	(0.157)	(0.101)	(0.100)	(0.091)	(0.146)	(0.075)
α_2	0.051	0.954	0.358	-0.045	-0.281***	-0.176	-0.546***
	(0.517)	(0.677)	(0.319)	(0.161)	(0.049)	(0.174)	(0.007)
β_1^{rmb}	0.217***	0.312***	0.157***	0.21***	0.199***	0.152***	0.162***
	(0.047)	(0.055)	(0.040)	(0.037)	(0.031)	(0.048)	(0.033)
β_2^{rmb}	0.373*	0.584**	-0.623	-0.520	-0.285	-0.321	0.247***
	(0.203)	(0.271)	(0.415)	(0.350)	(0.251)	(0.219)	(0.012)
β_1^{eur}	0.107	0.134	0.151***	-0.056	0.201***	-0.072	0.066
	(0.077)	(0.104)	(0.059)	(0.063)	(0.052)	(0.099)	(0.051)
β_2^{eur}	0.447	0.678	0.155	0.161*	0.122***	0.073	0.081
	(0.300)	(0.484)	(0.194)	(0.092)	(0.035)	(0.133)	(0.064)
β_1^{jpy}	0.002	0.071	0.059	0.011	0.136***	0.143**	0.025
	(0.080)	(0.069)	(0.044)	(0.045)	(0.039)	(0.063)	(0.041)
β_2^{jpy}	-0.059	-0.494**	-0.053	0.027	0.129***	0.014	-0.034***
	(0.226)	(0.227)	(0.141)	(0.066)	(0.026)	(0.077)	(0.007)
β_1^{usd}	0.75***	0.479***	0.546***	0.652***	0.433***	0.678***	0.67***
	(0.089)	(0.096)	(0.059)	(0.071)	(0.052)	(0.049)	(0.048)
β_2^{usd}	0.224	0.644**	0.046	0.511***	0.35***	0.599***	0.31***
	(0.308)	(0.329)	(0.209)	(0.086)	(0.003)	(0.123)	(0.004)
β_1^{ACU}	0	0	0	0	0	0	0
	-	-	-	-	-	-	-
β_2^{ACU}	0.52***	0.369*	1.298***	0.772***	0.593***	0.703***	0.535***
	(0.182)	(0.212)	(0.390)	(0.139)	(0.048)	(0.261)	(0.013)
$P11$	0.95	0.97	0.95	0.96	0.98	0.92	0.87
$P21$	0.05	0.03	0.05	0.04	0.02	0.08	0.13
$P22$	0.14	0.12	0.11	0.05	0.04	0.05	0.84
$P21$	0.86	0.88	0.89	0.95	0.96	0.95	0.16
ED1	19.25	36.02	20.46	23.22	51.32	11.94	7.98
ED2	7.36	8.45	9.01	19.70	25.96	20.39	1.19
Degree of Flexibility (%):							
Regime 1	1.044	1.337	0.889	0.713	0.713	0.530	0.742
Regime 2	2.977	2.475	1.659	1.271	0.406	1.455	0.032
Nb. of Months Reg. 2	37 (28.03%)	17 (12.88%)	28 (21.21%)	70 (53.03%)	64 (48.48%)	86 (65.15%)	18 (13.64%)

Notes: This table shows the estimates of the MS-FW models with the constraint $\beta_{ACU}^1 = 0$. Regime 1 thus corresponds to episodes where there is no correlation with ACU. Regime 2 captures episodes where Asian currencies have been pegged to JPY. *,**,*** denote significance at 10, 5 and 1 %, respectively. Standard errors of parameters are reported in parentheses (.), while p-values are displayed in brackets [.]. *ED* corresponds to the average duration of each regime in terms of months. P_{ij} indicates the probability to stay or switch between regimes.

Table 9: Estimates of economic determinants for the USD regime probabilities

	Indonesia	Korea	Malaysia	The Philippines	Singapore	Taiwan	Thailand
C	1.156	1.941***	-0.02	10.174**	15.942**	1.039	-0.309
	(1.237)	(0.743)	(0.873)	(4.302)	(6.640)	(1.104)	(0.866)
INF	0.755***	0.071	0.014	5.257***	6.057***	0.627*	-0.093
	(0.135)	(0.391)	(0.149)	(1.174)	(2.011)	(0.378)	(0.100)
FD	0.167	-0.126	-0.112**	26.027***	-1.26***	0.668***	-0.029
	(0.175)	(0.084)	(0.045)	(3.498)	(0.408)	(0.223)	(0.031)
DEBT	0.504***	0.662***	0.272**	5.698***	3.295***	-0.031	0.646***
	(0.102)	(0.197)	(0.110)	(0.912)	(1.073)	(0.019)	(0.183)
OPEN	0.171***	-0.022	-0.085***	1.711***	-0.04	-0.191***	0.034*
	(0.045)	(0.035)	(0.030)	(0.266)	(0.062)	(0.072)	(0.017)
CORR US	-0.006	-1.161**	-1.547***	-4.871***	-4.114***	-1.168**	-0.211*
	(0.254)	(0.474)	(0.467)	(1.416)	(1.347)	(0.479)	(0.115)
TRADE US	-0.457*	0.621	-1.245***	16.468***	4.201*	0.63	-0.204
	(0.275)	(0.736)	(0.408)	(2.570)	(2.136)	(0.612)	(0.202)
TRADE ASIA	-0.478**	-1.651***	0.223	0.652	-3.906***	0.037	-0.042
	(0.188)	(0.619)	(0.177)	(1.082)	(1.339)	(0.165)	(0.181)
TRADE CHINA	-0.169	-2.989**	-0.589**	4.992***	-10.309***	0.33	0.622**
	(0.301)	(1.201)	(0.279)	(1.073)	(3.233)	(0.398)	(0.286)
CORR CHINA	1.964***	-4.983***	0.67*	9.444***	-25.784***	-1.321**	0.663***
	(0.592)	(1.321)	(0.382)	(2.836)	(8.912)	(0.548)	(0.197)
ESI	0.135***	-0.321***	-0.08**	0.769***	-1.23***	-0.199	0.033**
	(0.051)	(0.093)	(0.039)	(0.107)	(0.432)	(0.179)	(0.016)
VIX	0.087**	0.091**	0.059	0.492***	-0.258	0.109*	0.074*
	(0.033)	(0.039)	(0.038)	(0.122)	(0.186)	(0.060)	(0.043)
SSR	0.045	-2.345***	-0.787*	-19.42***	-24.155***	1.93*	0.305
	(0.448)	(0.825)	(0.473)	(3.836)	(8.064)	(1.034)	(0.470)

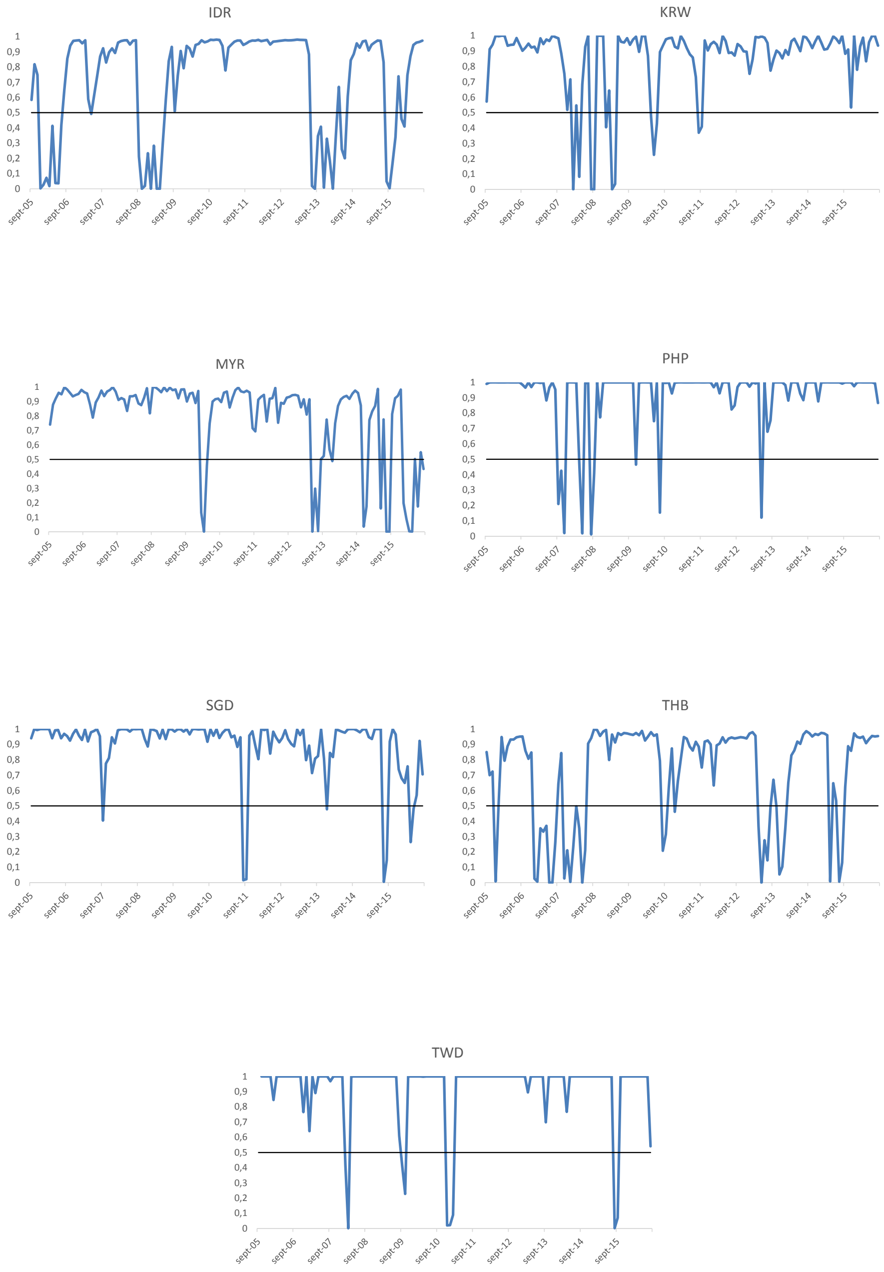
Notes: *,**,*** denote significance at 10, 5 and 1 %, respectively. Standard errors of parameters are reported in parentheses (.).

Table 10: Estimates of economic determinants for the RMB regime probabilities

	Indonesia	Korea	Malaysia	The Philippines	Singapore	Taiwan	Thailand
C	-0.708	-0.663	-0.391	-1.262**	1.217***	1.483***	0.069
	(1.080)	(0.577)	(0.396)	(0.515)	(0.358)	(0.417)	(0.521)
INF	0.905***	0.14	-0.084	0.047	-0.035	0.75***	-0.044
	(0.155)	(0.175)	(0.068)	(0.067)	(0.081)	(0.198)	(0.082)
FD	-0.054	-0.014	-0.02	0.107***	-0.002	-0.224***	-0.028
	(0.166)	(0.017)	(0.019)	(0.030)	(0.017)	(0.076)	(0.027)
DEBT	0.704***	-0.052	-0.096**	-0.034	0.145***	-0.044***	-0.621***
	(0.137)	(0.060)	(0.037)	(0.030)	(0.036)	(0.015)	(0.113)
OPEN	-0.253***	0.015	0.018*	-0.008	0.009**	-0.072**	-0.022
	(0.046)	(0.019)	(0.010)	(0.018)	(0.004)	(0.030)	(0.015)
ASIA TRADE	0.311*	0.002	0.05	-0.022	0.365*	0.044	-0.013
	(0.178)	(0.110)	(0.085)	(0.117)	(0.192)	(0.066)	(0.145)
CHINA TRADE	0.554**	0.175	0.898***	1.034***	-0.035	-0.124	0.343*
	(0.262)	(0.191)	(0.233)	(0.270)	(0.136)	(0.182)	(0.198)
CHINA CORR	-2.029***	-0.057	-0.069	-0.175*	-0.318***	0.128	-0.725***
	(0.532)	(0.339)	(0.282)	(0.094)	(0.102)	(0.105)	(0.162)
ESI	-0.302***	0.07***	0.018	0.005	-0.032***	0.282***	-0.05***
	(0.057)	(0.022)	(0.019)	(0.012)	(0.011)	(0.079)	(0.017)
VIX	0.062*	0.009	-0.005	0.05**	-0.007	0.014	-0.022
	(0.033)	(0.016)	(0.017)	(0.024)	(0.013)	(0.021)	(0.021)
SSR	-0.234	0.045	0.313	-0.25	0.373	-0.216	-0.096
	(0.410)	(0.300)	(0.372)	(0.318)	(0.318)	(0.612)	(0.423)

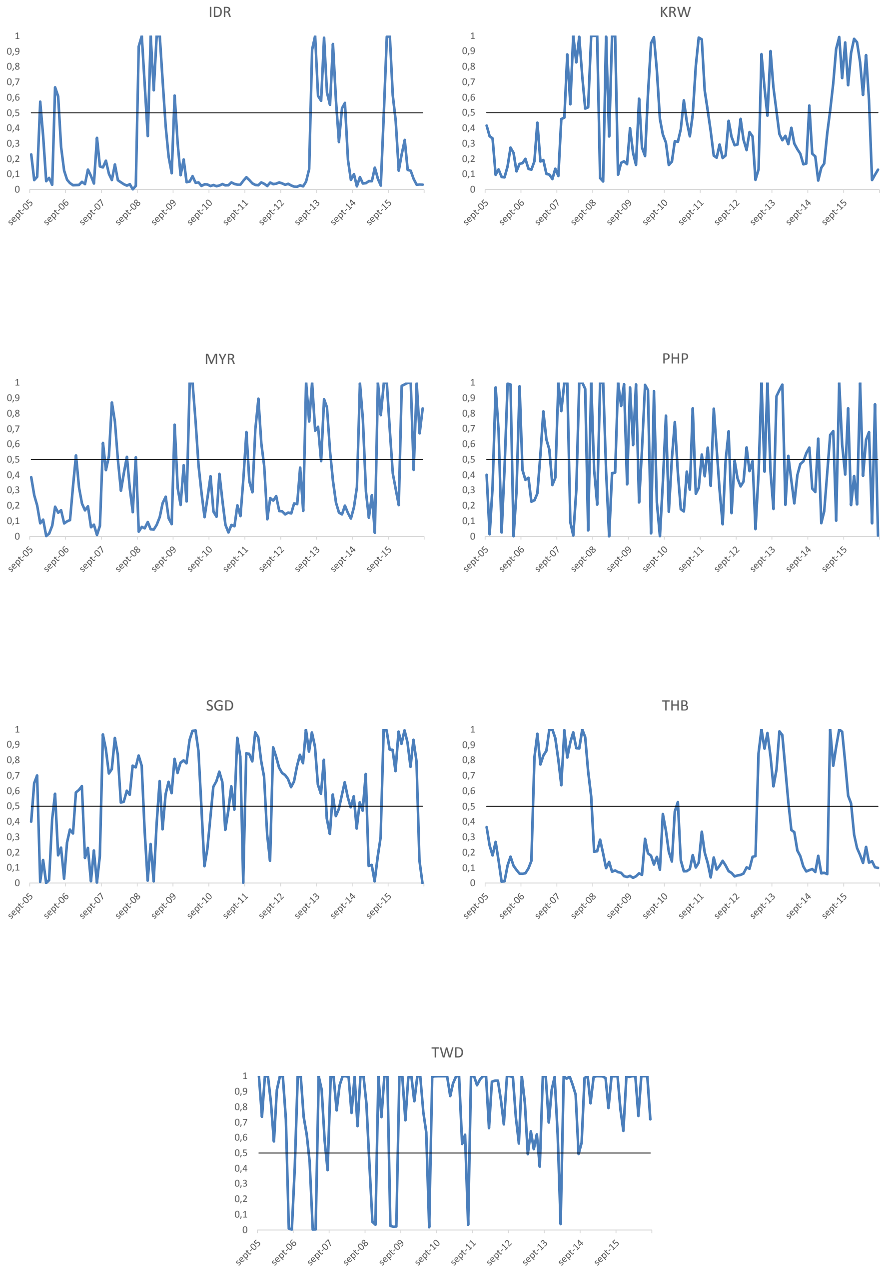
Notes: *,**,*** denote significance at 10, 5 and 1 %, respectively. Standard errors of parameters are reported in parentheses (.).

Figure 1: Regime probabilities of being in the USD synchronization regime



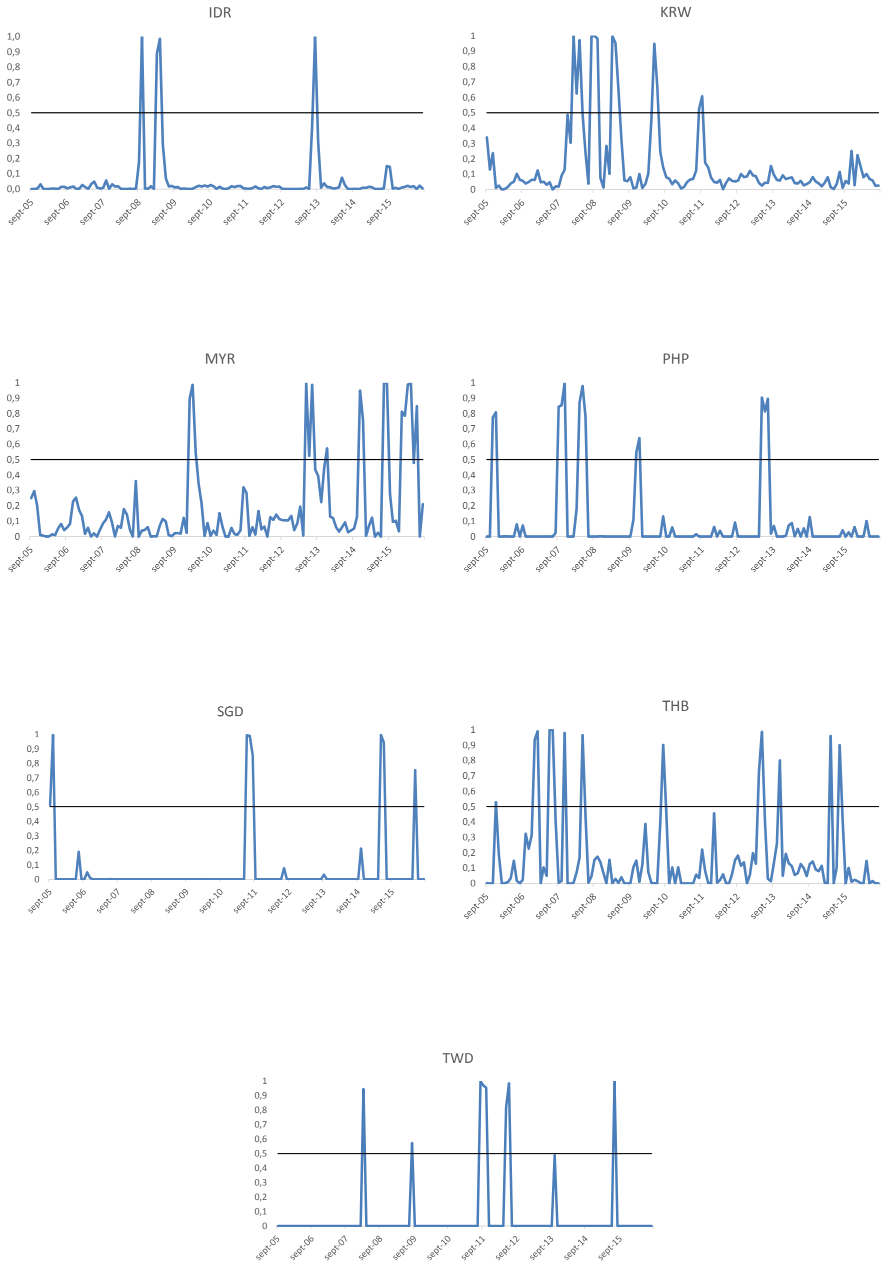
Note: When regime probabilities are higher than 0.5, the dependent variables are more likely to evolve in regime 2. Notice that regime 1 corresponds to episodes where there is no correlation with USD ($\beta_1^{usd} = 0$.)

Figure 2: Regime probabilities of being in the RMB synchronization regime



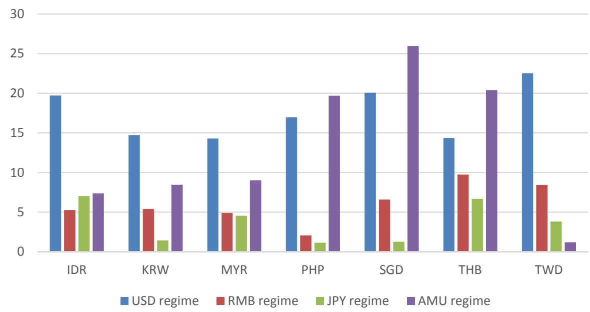
Note: When regime probabilities are higher than 0.5, the dependent variables are more likely to evolve in regime 2. Notice that regime 1 corresponds to episodes where there is no correlation with RMB ($\beta_1^{rmb} = 0$).

Figure 3: Regime probabilities of being in the hard peg RMB regime

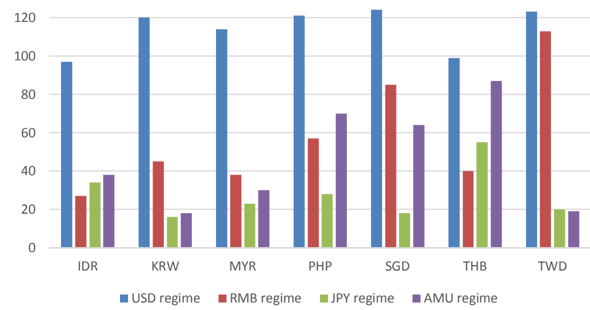


Note: When regime probabilities are higher than 0.5, the dependent variables are more likely to evolve in regime 1. Notice that regime 1 corresponds to episodes where $\beta_1^{rmb} = 1$.

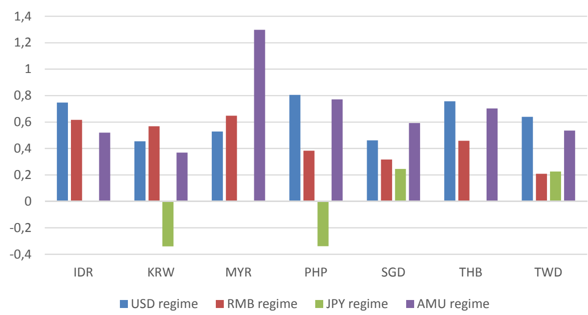
Figure 4: Comparison across indicators



(a) Expected Duration



(b) Nb. of Months



(c) Correlation Coefficient