Growing Regional Influences of the Chinese Renminbi?

Convergence and Dynamics of Industry-Specific Real Exchange Rates*

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August 2024

Abstract

The internationalization of the Chinese Renminbi (RMB) has been a focal point of China's economic strategy, aiming to establish the RMB as a key regional currency. This study investigates whether the RMB has achieved this status by examining real exchange rate (RER) convergence in the machinery sectors of Asian countries. Unlike previous research that primarily explored trade invoicing and other international currency use, our study employs a dynamic factor model (DFM) to analyze industry-specific RERs based on the Producer Price Index (PPI) across three critical industries: general machinery, electric machinery, and transport equipment. Our findings reveal that although the speed of RER convergence towards the RMB has increased, particularly following key exchange rate reforms, the overall impact remains limited. The analysis shows that RER convergence in Asia is primarily driven by country-specific factors, reflecting the region's diverse economic conditions and policies. In contrast, European countries exhibit strong alignment in RER convergence with significant regional influence, underscoring robust intra-European economic linkages. Our results suggest that while the RMB's status has been enhanced, it has not yet reached the level of a dominant regional key currency. This study contributes to the ongoing discourse on currency internationalization and regional economic stability, highlighting the complexities and challenges of RMB internationalization in a diverse and evolving economic landscape.

Keywords: Economic integration; real exchange rate convergence; Chinese RMB; dynamic factor model

JEL Codes: C32, F15, F33, F36

* This work is financially supported by JSPS KAKENHI Grant Numbers JP19H01504, JP23H00836, 23K25533, and JP23K17550.

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1. Introduction

Rapid economic growth and development in Asia have been significantly driven by China through intra-regional trade. China occupies a central position in global value chains (GVCs), and its economic influence on regional economies has substantially increased (Ong and Sato, 2018; Thorbecke, 2019; Baldwin and Okubo, 2019). Additionally, as the second-largest and fastest-growing economy, the Chinese government is actively working to internationalize its currency, the Renminbi (RMB). According to the International Monetary Fund (IMF)'s Currency Composition of Official Foreign Exchange Reserves (COFER) survey, the share of RMB reserves held by central banks in 2023Q4 was 2.29%, making it the fourth most held currency after the U.S. dollar (USD, 58.41%), the euro (19.98%), and the Japanese yen (JPY, 5.7%).

The internationalization of the RMB is a key component of China's long-term development strategy, driven by the quest for greater independence in international monetary affairs and further economic reform and opening. Achieving significant international status for the RMB or establishing it as a regional key currency necessitates ongoing reform and openness. Figure 1 illustrates the RMB/USD exchange rate from 2001 to 2023, showing the evolution of China's exchange rate policy over this period. Before 2005, China pegged the RMB against the USD through foreign exchange market interventions. In July 2005, the Chinese government allowed the RMB to gradually appreciate from 8.28 RMB per USD, although the RMB/USD exchange rate has never been fully flexible and has always been managed to prevent excessive fluctuations or appreciations and depreciations against the USD (see Shimizu and Sato, 2018; Ong and Sato, 2023).

In contrast, the exchange rate policies of neighboring emerging economies—such as Taiwan, South Korea, and the Southeast Asian countries of Thailand, Malaysia, and Indonesia—have closely tracked the USD, aiming to avoid excessive appreciation or depreciation. Given that this region is China's largest trading partner, there is an expectation that the acceptance of the RMB will progressively improve. From a geographical perspective, the process of currency internationalization involves three stages: peripheralization, regionalization, and internationalization (Ly, 2020). As the RMB moves through these stages, it is anticipated that its role as a regional currency will naturally evolve into that of an international currency. The RMB plays multiple roles in the internationalization process, functioning as a settlement currency, investment currency, and reserve currency. Through this multifaceted approach and geographical expansion, China aims to rapidly broaden the RMB's

regional influence. Therefore, a critical question arises: Has the Chinese RMB increased its regional influences on Asia, or does the USD continue to dominate the region? This study seeks to address this question by investigating real exchange rate (RER) convergence in the machinery sectors of Asian countries, providing insights into the RMB's regional influence and its potential status as a key currency.

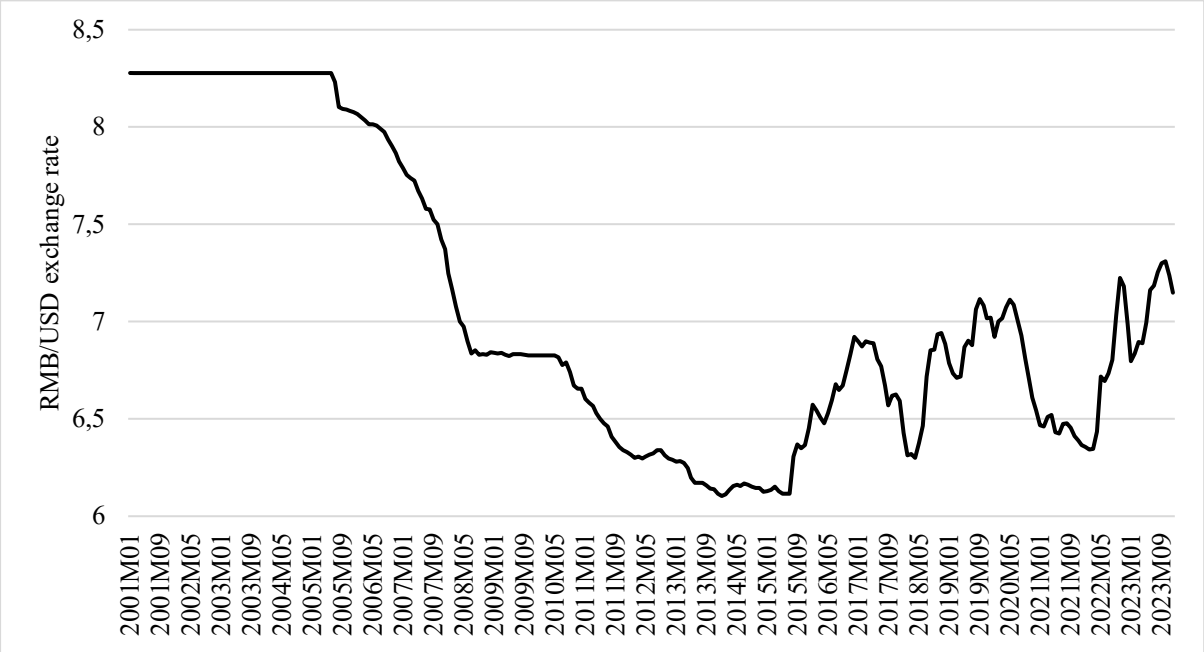

Figure 1. Historical Nominal RMB/USD exchange rate (RMB per USD), 2001-2023.
Source: International Monetary Fund International Financial Statistics (IMF IFS)

While previous studies such as those by Ito and Kawai (2016), Ito (2017), and Sato and Shimizu (2018) have explored various aspects of RMB internationalization, including trade invoicing, exchange risk management, and exchange rate policy, these works have not comprehensively addressed the dynamics of RER convergence across different sectors.[4] Our study fills this gap by analyzing the RER convergence in specific machinery industries—general machinery, electric machinery, and transport equipment—across Asian and European countries. The focus on machinery industries is driven by the rapid growth of machinery trade in Asia, propelled by global production sharing and the deepening integration of East Asian countries into global production networks (Athukorala, 2012; Ng and Yeats, 2003). The

[4] For the study of RER dynamics in the Euro area, see Coudert et al. (2013), Huang and Yang (2015), and Börger and Kempa (2024). Kawasaki and Sato (2021) applied the generalized purchasing power parity (G-PPP) model to the RER of Asian currencies to assess the degree of regional economic integration in Asia.

formation of these networks has transformed the spatial patterns of international trade, particularly within Asia, leading to significant cross-border trade in parts and components. This phenomenon has created a new division of labor among countries in the region based on skill differences, wages, and improved communication and transport infrastructure. Given that China plays a central role in these networks, particularly as a major assembly hub, it is crucial to understand how the RMB's influence as a regional currency impacts the dynamics of these production networks.

In this context, the use of the Producer Price Index (PPI) instead of the Consumer Price Index (CPI) is more suitable for investigating RER convergence. The PPI measures the average changes in prices received by domestic producers for their output, which is directly tied to the production costs and prices in the machinery sectors (Sato et al., 2013), the focus of our research. The PPI reflects the prices of goods at the production stage, providing a more accurate picture of the machinery sector's price dynamics. In contrast, the CPI measures the average change in prices paid by consumers for a basket of goods and services, including many non-tradable items. This makes the CPI less relevant for analyzing the machinery sectors specifically, as it includes prices that do not directly impact the production and export of machinery goods. Additionally, the PPI excludes non-tradable goods and services, focusing solely on the prices relevant to production and trade, making it a better indicator for evaluating the RER in the context of international trade and machinery sectors. Moreover, the PPI reflects the prices at the producer level, which are influenced by production costs, supply chain dynamics, and other factors directly relevant to the machinery sectors. This provides a clearer view of the economic conditions affecting the production and pricing of machinery goods.

By employing industry-specific RERs based on the PPI and utilizing a state space model, we provide a detailed examination of the influences from global, regional, and country-specific factors. This approach offers a more granular understanding of the RMB’s influences on regional economies and its impact on economic integration, which has not been sufficiently covered in previous literature.

Our study reveals significant differences in the RER convergence dynamics between Asian and European countries, highlighting the varied regional influence of the Chinese RMB. For Asian countries, the speed of RER adjustment towards the RMB increased notably during China’s transition to a more market-oriented exchange rate regime, indicating improved regional integration. However, the majority of RER convergence in Asia is driven by country-specific factors, reflecting diverse economic conditions and policies. In contrast, European countries show strong RER convergence with the Deutsche Mark (DEM), underscoring robust

regional economic linkages within the Eurozone. These findings suggest that while China's reforms have enhanced the RMB's status, it has not yet achieved the same level of regional influence as the Euro, with the RMB's impact remaining limited compared to the entrenched economic integration in Europe.

The remainder of this paper is structured as follows. Section 2 provides a description of the data and empirical methods. Section 3 presents the results of the empirical analysis. Finally, Section 4 concludes this study.

2. Empirical Analysis

2.1 Data

This study uses the bilateral RER of the sample country's currency for empirical investigation. We collected monthly series of bilateral nominal exchange rates (NER) and PPI data from January 2001 to October 2023 to construct the RER dataset. Our sample includes a total of 24 economies: nine Asian economies (China, Indonesia, Japan, South Korea, Malaysia, the Philippines, Singapore, Taiwan, and Thailand) and 15 European countries (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom).

Bilateral NER data for all economies were sourced from the IMF International Financial Statistics (IFS). The Eurozone started in January 1999 with nine member countries: Austria, Belgium, Finland, France, Germany, Ireland, Italy, the Netherlands, and Spain.[5] Greece joined the Eurozone in January 2001. For these 10 countries, individual bilateral NER series were extended synthetically to the end of the investigation period using the euro conversion rate.[6]

We first conduct a comprehensive analysis where all exchange rates are expressed against the USD, providing a standardized benchmark for comparison and facilitating the analysis of global trends. Subsequently, we perform an additional analysis focusing on data

[5] Portugal and Luxembourg are not included in our analysis because the industry-breakdown producer price data is unavailable for these two countries.

[6] The euro conversion rate against each member currency is irrevocably fixed and is the only exchange rate to be used for conversion between the euro and individual member currency unit. Specifically, according to the euro conversion rate, one euro is equal to 40.3399 for Belgian franc; 340.750 for Greek drachma; 6.55957 for French franc; 1936.27 for Italian lira; 2.20371 for Dutch guilder; 1.95583 for Deutsche Mark; 166.386 for Spanish peseta; 0.787564 for Irish pound; 13.7603 for Austrian schilling; 5.94573 for Finnish markka. The information on the euro conversion rate was obtained from the website of the European Central Bank (http://www.euro.ecb.int/en/section/conversion.html), accessed on February 20, 2013.

against the respective regional key currencies for comparison. Specifically, the data are transformed for European currencies into exchange rates against the DEM. For Asian countries, individual bilateral exchange rate series against the USD are converted into exchange rates against the Chinese RMB and the JPY.

Next, we calculate the RER for each currency by industry. Industry-specific PPI data for the 24 economies in our study are obtained from Sato et al. (2013, 2020), who constructed the industry-specific real effective exchange rate (I-REER) series for 13 industries based on the two-digit level of the ISIC.Rev.3 classification (see Appendix Table A1 in Kawasaki and Sato (2021) for details). Our empirical analysis focuses on three prominent manufacturing industries: General Machinery (ISIC.Rev.3 code 29), Electrical Industry (codes 30–32), and Transport Equipment (codes 34–35). This choice of industries aligns with the classifications used in the I-REER construction by Sato et al. (2013, 2020), ensuring consistency and comparability in our analysis. These selected industries play crucial roles in regional and global supply chains, making them apt choices for investigating economic integration dynamics.

2.2 Development of Hypotheses

Intuitively, the role of a regional key currency is similar to that of a currency union: it mitigates excessive RER volatility resulting from shocks to the nominal exchange rate, thereby stabilizing member countries' RERs around their equilibrium levels. This stabilization is enhanced by the increasing integration of product markets and greater price transparency, which promote regional arbitrage and price adjustments (Baharumshah and Ariff, 1997).

According to the theory of purchasing power parity (PPP), exchange rates between any two currencies adjust to reflect changes in the price levels of the two countries. This implies that a currency's purchasing power is equalized across countries, at least in the long run. Price convergence through exchange rate adjustment is crucial for evaluating the progress and viability of regional integration from a macroeconomic perspective. Therefore, if a currency functions as a regional key currency, it should be widely used to facilitate increased exchange rate convergence.

Additionally, the Optimum Currency Area (OCA) theory suggests that the suitability of a common currency depends on the economic linkages between countries. These linkages are assessed using criteria such as the symmetry of shocks, factor mobility, wage flexibility, trade and financial integration, and political integration (Mundell, 1961). Much of the literature focuses on the criterion of similarity of shocks because countries experiencing similar

disturbances are likely to respond with similar policies, making them better candidates for forming a monetary union. Therefore, if countries are integrated with a regional key currency, we should observe common regional components influencing the time-varying patterns of RER adjustment across these countries.

Based on these theoretical foundations, we form the following hypothesis: If the Chinese RMB is becoming a regional key currency, there should be significant convergence of RERs towards the RMB. This convergence should be reflected in increased exchange rate stability and reduced RER volatility among Asian countries, indicating the RMB's growing central role in regional economic integration. The Dynamic Factor Model (DFM) will help disentangle global, regional, and country-specific influences on this convergence, providing a nuanced view of the RMB's prominence as a regional anchor currency.

2.3 Methodology

2.3.1 Industry-Specific Real Exchange Rate (RER)

Firstly, we calculate industry-specific RER for each specified industry using the corresponding PPI data. Let $Q_{i,t}$ represent the industry i's bilateral RER of the sample country's currency against the selected reference currencies (DEM/JPY/RMB/USD), E_t the bilateral NER of the sample country's currency against the DEM/JPY/RMB/USD, $P_{i,t}$ the home (sample country's) PPI for industry i, and $P_{i,t}^*$ the foreign (Germany/Japan/China/United States) PPI for the corresponding industry i. The formula for calculating the industry-specific RER is given by:

$$Q_{i,t} = \frac{E_t P_{i,t}^*}{P_{i,t}}$$

Taking the natural log, $q_{i,t} = e_t + p_{i,t}^* - p_{i,t}$, where lowercase letters indicate natural log-transformed variables. Hence, an increase in the RER indicates a real depreciation of the country i's currency vis-à-vis the reference currency.

2.3.2 Real Exchange Rate Decomposition

The analysis commenced with a permanent-transitory decomposition of the RER:

$$q_{i,t} = q_{i,t}^P + q_{i,t}^T$$

where $q_{i,t}^P$ and $q_{i,t}^T$ represent, respectively, the permanent and transitory components of the RER of country i's currency against the reference currency. The permanent component is construed as a measure of RER equilibrium, commonly known as the Permanent Equilibrium

Exchange Rate (PEER). The PEER is a statistical concept assuming that nominal or real rigidities contributing to RER disequilibria will dissipate in the longer run. Classic overviews of the PEER and related concepts for calculating equilibrium exchange rates are provided by MacDonald (2000) and Driver and Westaway (2005).

To estimate the PEER, we apply the unobserved components model of Kim and Nelson (1999). The RER is decomposed into two independent components: a permanent component and a transitory component:

$$q_{i,t}^{P} = \delta_i + q_{i,t-1}^{P} + \varepsilon_{i,t}^{P}$$

$$q_{i,t}^{T} = \phi_{1,i} q_{i,t-1}^{T} + \phi_{2,i} q_{i,t-2}^{T} + \varepsilon_{i,t}^{T}$$

where $\varepsilon_{i,t}^{P}, \varepsilon_{i,t}^{T} \sim i.i.d.\, N(0, \sigma_i^2)$. The model is estimated using the Kalman smoothing approach.

2.3.3 Country-Specific RER Convergence Speeds

The second step involves measuring country-specific RER convergence speeds towards their respective long-run equilibrium levels. This is achieved by employing a time-varying parameter error-correction model (TVP-ECM) to detect potential shifts in the duration of RER misalignments over time. The TVP-ECM representation is given by:

$$\Delta q_{i,t} = \alpha_i + \Delta q_{i,t}^{P} + \lambda_{i,t} q_{i,t-1}^{T} + \upsilon_{i,t}$$

where $\Delta q_{i,t}$ denotes the monthly rate of change of the RER, α_i is a country-specific intercept capturing unobserved persistent country characteristics, and $\nu_{i,t}$ is a heteroscedastic disturbance term, $\nu_{i,t} \sim N(0, \sigma_{\nu_{i,t}}^2)$. The time-varying error-correction parameter, $\lambda_{i,t}$, quantifies the speed of RER adjustment between periods $t-1$ and t, where convergent dynamics require $\lambda_{i,t} < 0$. The error-correction term is modeled as a random walk process:

$$\lambda_{i,t} = \lambda_{i,t-1} + \eta_{i,t}$$

where $\eta_{i,t} \sim N(0, \sigma_{\eta_{i,t}}^2)$. $\lambda_{i,t}$ is estimated following Kim and Nelson's (1989) application of the time-varying parameter model.

To interpret the results, λ represents the error-correction term in the TVP-ECM. It quantifies the speed at which deviations from the long-run equilibrium RER are corrected over time. A negative λ indicates that when the RER is above its equilibrium value, the exchange rate adjusts downward (appreciates) to restore equilibrium, and vice versa. The negativity of λ ensures that the system is stable and converges towards equilibrium, implying that deviations from equilibrium will be corrected over time. The magnitude of λ indicates the speed of adjustment: larger absolute values of λ imply faster adjustment speeds, while smaller absolute values indicate slower adjustments.

2.3.4 Dynamic Factor Model (DFM)

Finally, a TVP-DFM is employed to extract both a common global component and a regional component from the estimated speeds of RER convergence. The DFM is structured as follows:

$$\lambda_{i,t} = \alpha_{i,t} + \beta_{i,t}^{W} f_t^{W} + \beta_{i,t}^{r_i} f_t^{r_i} + e_{i,t}$$

where $\lambda_{i,t}$ is the vector of the estimated time-varying adjustment parameters for the 24 bilateral exchange rates of our sample, $\alpha_{i,t}$ is a country-specific intercept, and f_t^{W} and $f_t^{r_i}$ capture the RER convergence dynamics at the world and regional levels, respectively. The coefficients $\beta_{i,t}^{W}$ and $\beta_{i,t}^{r_i}$ are the respective factor loadings, where all countries load on the world factor, but only the region-area countries load on the regional factor (Asian and European regions in our study). Finally, $e_{i,t}$ is a country-specific error term reflecting idiosyncratic factors determining RER adjustment that are more industry-specific.

The dynamics of the factor loadings follow a random walk without drift:

$$\beta_{i,t}^{k} = \beta_{i,t-1}^{k} + \sigma_{\varepsilon_i^k} \varepsilon_{i,t}^{k}$$

where k represents world or region, $\varepsilon_{i,t}^{k}$ is an i.i.d. innovation $\varepsilon_{i,t}^{k} \sim N(0,1)$ and is independent from each other.

Since all factors are latent, the data-generating process for factors and the idiosyncratic term assumes an autoregressive process of order p:

$$f_t^{W} = \phi_1^{W} f_{t-1}^{W} + \phi_2^{W} f_{t-2}^{W} + \cdots + \phi_p^{W} f_{t-p}^{W} + u_t^{W}$$

$$f_{i,t}^{r_i} = \phi_{i,1}^{r_i} f_{i,t-1}^{r_i} + \phi_{i,2}^{r_i} f_{i,t-2}^{r_i} + \cdots + \phi_{i,p}^{r_i} f_{i,t-p}^{r_i} + u_{i,t}^{r_i}$$

$$e_{i,t} = \psi_{i,1} e_{i,t-1} + \psi_{i,2} e_{i,t-2} + \cdots + \psi_{i,p} e_{i,t-p} + u_{i,t}$$

The innovation terms $\left[u_t^{W} \quad u_{i,t}^{r_i}\right]' \sim N(0,1)$ are independent across countries. Another innovation term $u_{i,t} = \sigma_i \eta_{it}$, where σ_i is the standard deviation of $e_{i,t}$ and $\eta_{it} \sim N(0,1)$, is independent across countries. All these innovation terms are assumed to be mutually independent.

We then estimate all the posterior distributions of the unobserved factors, factor loadings, idiosyncratic terms, and parameters through a Bayesian Gibbs sampling approach by successive iteration of the following steps, given appropriate prior distributions and arbitrary starting values for the parameters of the model, as detailed in Del Negro and Otrok (2008):

Step 1: Conditional on each country's speeds of RER convergence $\lambda_{i,t}$ and all the parameters of model, generate the posterior distributions for all unobserved factors $\{f_t^W, f_{i,t}^{r_i}\}$ and idiosyncratic error terms $\{e_{i,t}\}$.

Step 2: Conditional on each country's speeds of RER convergence $\lambda_{i,t}$ and unobserved factors $\{f_t^W, f_{i,t}^{r_i}\}$, generate the posterior distributions for all unknown parameters.

The method of Markov Chain Monte Carlo (MCMC) is used to estimate the model, as detailed in Chib and Greenberg (1996). This study uses 20,000 draws and discards the first 2,000 in the actual implementation of the Gibbs sampler.

Later, we apply time-varying variance decomposition to the dynamic factor model to calculate the time-varying country's speeds of RER convergence measures for every country. As the global, regional, and idiosyncratic country-specific latent factors are by construction orthogonal to each other, the relative contribution of these three components to variations in the country's speeds of RER convergence in each country can be estimated:

$$var(\lambda_{i,t}) = (\alpha_{i,t})^2 var(f_t^W) + (\beta_{i,t})^2 var(f_t^{r_i}) + var(e_{i,t})$$

The share of the variance $\lambda_{i,t}$ for country i accounted for by variation in the factor $k =$ {world, region}, say the world factor can be written as:

$$\frac{(\alpha_{i,t})^2 var(f_t^W)}{var(\lambda_{i,t})}$$

To interpret the results, if a country exhibits a large value of the share accounted for by the global common factor, then its exchange rate movement is largely synchronized with global trends. This indicates that a global common monetary policy would be more effective in responding to disturbances. If a country exhibits a large value of the share accounted for by the regional common factor, then its exchange rate movement is largely synchronized with regional trends. This suggests that a regional common monetary policy would be more effective in addressing disturbances. However, if a country shows a smaller value for the share accounted for by the global and regional common factors, and a larger value for the share accounted for by the country-specific factor, it indicates that the country needs to rely more heavily on its own independent counter-cyclical monetary policy.

3. Results

Tables 1a and 1b present the descriptive statistics for the variables, including the nominal exchange rate and the producer prices indices for the three machinery industries, for

Asian and European countries, respectively. The sample period ranges from January 2001 to October 2023.

Focusing on the exchange rate, most Asian countries in our sample maintain a relatively stable exchange rate with the USD, with the notable exceptions of Indonesia and Korea. Similarly, most European countries exhibit stable exchange rates with the USD, except for Greece and Italy. The high standard deviations in the NERs for these countries likely reflect the combined effects of economic crises, political instability, and global economic shocks, such as the global financial crisis around 2008 and the sovereign debt crisis around 2009.

The prices for the three machinery industries are comparatively stable for all countries, with the exception of Indonesia. For most countries, the standard deviations are mainly around or less than 20, indicating low volatility in industry-specific prices.

Table 1a. Descriptive Statistics for Nominal Exchange Rates and Machinery Industry Prices in Asian Countries

Country	**Variable**	**Mean**	**Median**	**Maximum**	**Minimum**	**Std. Dev.**
China	NER	7.1	6.8	8.3	6.1	0.8
	General	104.8	106.4	110.4	95.3	4.5
	Electric	96.2	96.0	117.9	86.3	6.8
	Transport	99.4	99.3	112.0	93.9	3.4
Indonesia	NER	11369.4	10284.4	15867.4	8235.8	2374.4
	General	140.8	139.8	189.2	85.0	34.1
	Electric	170.1	180.7	237.1	81.7	50.1
	Transport	149.2	153.3	213.3	81.2	39.8
Japan	NER	109.0	109.9	149.5	76.8	14.8
	General	105.5	103.6	121.3	99.4	5.1
	Electric	87.3	80.6	125.9	73.3	13.9
	Transport	101.4	100.8	108.9	97.9	2.3
Korea	NER	1143.0	1142.1	1462.0	915.9	108.4
	General	116.6	122.4	145.0	93.7	14.3
	Electric	79.6	70.8	169.9	58.7	24.3
	Transport	110.9	110.5	127.7	98.8	8.7
Malaysia	NER	3.8	3.8	4.7	3.0	0.4
	General	112.4	115.7	121.3	93.5	7.7
	Electric	104.0	103.1	122.8	93.5	5.7
	Transport	106.7	105.3	127.7	92.9	6.0
Philippines	NER	49.2	49.8	58.8	40.7	4.5
	General	79.4	77.2	113.8	55.2	16.9
	Electric	97.8	91.9	149.5	74.2	19.0
	Transport	96.6	97.0	109.3	84.2	6.5
Singapore	NER	1.4	1.4	1.8	1.2	0.2

	General	91.1	87.4	116.5	82.1	8.6
	Electric	80.4	73.3	123.6	59.6	17.2
	Transport	107.0	109.4	125.6	95.5	7.1
Thailand	NER	35.0	33.8	45.6	29.1	4.2
	General	104.7	105.2	115.2	91.5	6.5
	Electric	98.5	97.4	108.3	95.3	3.0
	Transport	106.4	108.2	113.9	96.9	4.8
Taiwan	NER	31.5	31.4	35.1	27.7	1.8
	General	106.5	106.1	117.2	99.0	4.8
	Electric	83.2	72.5	144.7	59.9	21.8
	Transport	106.1	107.3	114.9	98.1	4.1

Table 1b. Descriptive Statistics for Nominal Exchange Rates and Machinery Industry Prices in European Countries

Country	**Variable**	**Mean**	**Median**	**Maximum**	**Minimum**	**Std. Dev.**
Austria	NER	11.6	11.5	16.1	8.7	1.5
	General	109.1	108.5	134.9	98.8	8.6
	Electric	99.1	98.7	109.5	95.7	2.8
	Transport	108.0	110.5	124.5	97.0	7.0
Belgium	NER	34.0	33.6	47.3	25.6	4.5
	General	111.7	111.1	148.7	94.2	13.0
	Electric	116.7	116.7	153.8	94.2	13.5
	Transport	99.3	98.9	107.3	91.1	3.3
Switzerland	NER	1.1	1.0	1.8	0.8	0.2
	General	103.0	103.8	112.0	95.8	3.4
	Electric	97.6	96.8	109.2	90.4	5.6
	Transport	99.0	98.4	105.4	93.8	2.9
Germany	NER	1.6	1.6	2.3	1.2	0.2
	General	113.5	113.8	149.7	94.3	13.0
	Electric	89.7	81.7	122.1	79.1	13.5
	Transport	105.0	105.1	123.1	94.7	6.0
Denmark	NER	6.3	6.2	8.7	4.7	0.8
	General	113.1	115.6	137.2	92.9	11.4
	Electric	106.7	106.1	120.8	96.7	5.4
	Transport	111.2	114.1	139.7	90.6	11.2
Spain	NER	140.2	138.5	195.0	105.5	18.4
	General	111.1	113.1	136.5	90.8	10.7
	Electric	105.7	105.4	118.2	99.5	3.9
	Transport	104.9	106.0	119.6	94.3	5.4
Finland	NER	5.0	5.0	7.0	3.8	0.7
	General	111.9	111.3	147.3	95.8	11.8
	Electric	110.9	109.9	140.7	99.2	9.2
	Transport	115.2	116.9	146.7	95.7	12.7
France	NER	5.5	5.5	7.7	4.2	0.7

	General	114.1	116.4	144.5	95.0	12.0
	Electric	100.3	100.7	108.7	96.6	2.7
	Transport	108.0	107.4	138.3	98.1	8.6
Greece	NER	287.2	283.7	399.4	216.1	37.7
	General	107.6	108.6	118.5	98.5	5.0
	Electric	122.3	128.9	150.5	90.6	17.0
	Transport	115.0	120.7	143.7	86.2	12.9
Ireland	NER	0.7	0.7	0.9	0.5	0.1
	General	100.1	100.0	103.4	98.0	0.7
	Electric	95.9	90.4	166.2	64.9	23.3
	Transport	95.6	95.9	101.6	88.1	3.4
Italy	NER	1631.8	1612.1	2269.5	1227.8	214.4
	General	112.3	113.1	142.1	95.0	11.1
	Electric	103.4	103.3	117.4	97.8	4.1
	Transport	108.7	109.9	129.1	93.5	8.5
Netherland	NER	1.9	1.8	2.6	1.4	0.2
	General	112.5	113.5	149.1	91.2	12.9
	Electric	112.6	113.9	146.6	93.2	11.9
	Transport	113.4	113.9	147.5	93.5	12.5
Norway	NER	7.4	7.0	11.0	5.1	1.5
	General	126.3	125.6	186.5	87.5	24.1
	Electric	106.0	101.8	149.2	95.0	10.7
	Transport	113.5	112.4	158.2	94.3	14.1
Sweden	NER	8.1	8.1	11.1	5.9	1.3
	General	119.4	117.0	178.3	93.9	18.9
	Electric	116.2	114.9	169.9	95.8	15.1
	Transport	113.5	110.6	153.0	97.4	12.2
United Kingdom	NER	0.7	0.6	0.9	0.5	0.1
	General	118.8	117.7	166.5	95.4	18.0
	Electric	107.9	105.2	129.2	98.8	7.2
	Transport	111.3	111.0	135.4	96.9	10.8

To effectively analyze the influence of the Chinese RMB as a regional key currency, the full sample period from 2001 to 2023 has been segmented into three distinct sub-periods corresponding to significant shifts in China's exchange rate regime: (1) 2001 to July 2005: This period captures the era of the fixed exchange rate regime, where the RMB was pegged to the USD. It provides a baseline for RER dynamics prior to major reforms. (2) August 2005 to August 2015: This period encompasses the managed float regime initiated in July 2005, during which the RMB was allowed to appreciate gradually within a controlled band, reflecting China's initial steps towards exchange rate liberalization. (3) September 2015 to October 2023: This period corresponds to the era of enhanced market-orientation following the August 2015

reform. The RMB's exchange rate mechanism was further liberalized during this time, allowing for more significant market influence and periodic government interventions.

We first present the results of the average speed of adjustment (λ) over different time periods. To summarize, if multiple countries' RERs are converging towards the RMB, it implies that the RMB is becoming central to the region's economy, thereby functioning as a regional key currency. Following this, we then present the variance decomposition results of the DFM. Our DFM helps disentangle the factors influencing RER convergence, distinguishing between global, regional, and country-specific influences.

Table 2 presents the average speed of adjustment of the RER for various machinery sectors (General Machinery, Electric Machinery, and Transport Equipment) across different time periods (2001 to July 2005, August 2005 to August 2015, September 2015 to October 2023) and currency benchmarks (USD, RMB, DEM, and JPY).

For Asian countries, the average speed of adjustment for the three machinery industries against the RMB is lowest (below -0.70) when China had a fixed exchange rate regime. This indicates a slower adjustment speed and potentially less convergence towards the RMB during this period. However, during the managed float and enhanced market-orientation periods, the speed of adjustment against the RMB generally increased over time, indicating robust RER convergence. As China's exchange rate policy becomes more flexible, the RER convergence towards the RMB improves. This aligns with expectations since a more market-oriented regime should theoretically enhance the adjustment process and integration. On the other hand, the speed of adjustment for the three machinery industries against the JPY was relatively stable across the time periods, fluctuating around -0.7 to -0.8, indicating consistent RER convergence with Japan throughout the periods. The stable adjustment speed towards the JPY reflects consistent economic linkages with Japan. The speed of adjustment for the three machinery industries against the USD showed a slight reduction over the period, which could imply a weakening of RER convergence towards the USD over time. This could also indicate changing economic dynamics or reduced dependency on the USD as a benchmark currency.

For European countries, the speed of adjustment for the three machinery industries against the USD was low, mostly less than -0.8. The low speed of adjustment towards the USD suggests that the European machinery industries are less aligned with the USD. However, towards the DEM, the speed of adjustment for the three machinery industries was very high, exceeding -0.9, especially during the latest period. This suggests strong RER convergence with the DEM, indicating a significant alignment with the Eurozone economic conditions. The high

speed of adjustment towards the DEM indicates strong economic integration within the Eurozone, which is expected given the common currency and shared economic policies.

Table 2. Average speed of adjustment (λ) over different time periods

	USD		RMB and DEM		JPY and DEM	
	Asia	**Europe**	**Asia**	**Europe**	**Asia**	**Europe**
General Machinery						
2001.4-2005.7	-0.75	-0.36	-0.61	-0.73	-0.68	-0.73
2005.8-2015.8	-0.82	-0.70	-0.86	-0.94	-0.81	-0.94
2015.9-2023.10	-0.78	-0.78	-0.87	-0.91	-0.79	-0.91
Electric Machinery						
2001.4-2005.7	-0.74	-0.47	-0.68	-0.84	-0.78	-0.84
2005.8-2015.8	-0.81	-0.75	-0.83	-0.91	-0.78	-0.91
2015.9-2023.10	-0.81	-0.82	-0.84	-0.90	-0.81	-0.90
Transport Equipment						
2001.4-2005.7	-0.75	-0.60	-0.62	-0.73	-0.67	-0.73
2005.8-2015.8	-0.86	-0.72	-0.85	-0.92	-0.81	-0.92
2015.9-2023.10	-0.76	-0.79	-0.84	-0.93	-0.79	-0.93

Table 3 presents the results of the DFM, which decomposes the speed of RER convergence into contributions from global, regional, and country-specific factors. This analysis covers the same industries and time periods as in Table 2, with separate examinations for Asian and European countries.

In Asia, most RER convergence is primarily driven by country-specific factors across most periods. This finding aligns with the diverse economic conditions and policies across Asian countries. Asia consists of a mix of developing and developed economies with different industrial bases, monetary policies, and levels of integration with the global economy. However, an exception is observed during the period from September 2015 to October 2023. In this period, for the general and electric machinery industries, the influence of global factors becomes dominant when the USD is considered. Additionally, during this same period, the regional factor exerts a particularly strong influence on the transport equipment industry. This shift suggests an increased interconnectedness and global integration for certain sectors in the recent past, possibly reflecting broader economic trends and policy changes affecting these industries.

For European countries, the factors influencing RER convergence vary depending on the currency benchmark. When exchange rates are measured against the USD, the global factor is consistently significant for the general and electric machinery industries across all periods.

This could be because European countries are highly integrated with the global economy, particularly through trade in machinery. Similarly, the regional factor maintains a consistently high influence on the transport equipment industry throughout the entire period. In contrast, when exchange rates are measured against the RMB and DEM, the regional factor has a moderate influence on the general machinery and transport equipment industries, while the country-specific factor is notably strong for the electric machinery industry. Furthermore, when exchange rates are evaluated against the JPY and DEM, the country-specific factor becomes particularly significant, especially in the latter two periods. This suggests that while some sectors are more influenced by regional or global trends, others remain largely driven by domestic economic conditions and policies.

Table 3. Variance Decompositions

	Asia			Europe		
	Global	**Regional**	**Country**	**Global**	**Regional**	**Country**
USD						
General Machinery						
2001.4-2005.7	25.8	15.5	58.7	86.2	7.7	6.2
2005.8-2015.8	18.9	11.3	69.8	85.9	7.5	6.6
2015.9-2023.10	86.6	7.6	5.8	86.6	7.6	5.8
Electric Machinery						
2001.4-2005.7	21.5	17.1	61.4	87.5	2.2	10.3
2005.8-2015.8	11.3	16.6	72.1	88.4	1.6	10.0
2015.9-2023.10	88.2	1.6	10.3	88.2	1.6	10.3
Transport Equipment						
2001.4-2005.7	24.2	29.3	46.5	44.8	50.9	4.3
2005.8-2015.8	25.5	17.5	57.1	38.0	59.6	2.4
2015.9-2023.10	35.6	62.3	2.2	35.6	62.3	2.2
RMB and DEM						
General Machinery						
2001.4-2005.7	23.8	16.1	60.2	32.5	55.1	12.4
2005.8-2015.8	22.1	13.7	64.2	32.8	55.9	11.4
2015.9-2023.10	13.3	12.1	74.6	33.0	55.3	11.7
Electric Machinery						
2001.4-2005.7	38.0	40.4	21.6	21.0	23.5	55.5
2005.8-2015.8	26.2	24.1	49.6	18.8	13.1	68.1
2015.9-2023.10	22.2	26.2	51.6	15.6	8.1	76.4
Transport Equipment						
2001.4-2005.7	11.6	43.2	45.2	12.8	79.9	7.3
2005.8-2015.8	13.2	24.2	62.5	14.0	77.9	8.1
2015.9-2023.10	2.9	26.5	70.6	13.2	79.4	7.4
JPY and DEM						

General Machinery						
2001.4-2005.7	27.5	27.7	44.8	31.3	41.7	27.0
2005.8-2015.8	25.4	34.4	40.2	26.5	25.5	48.0
2015.9-2023.10	10.7	28.2	61.0	19.8	28.4	51.8
Electric Machinery						
2001.4-2005.7	10.2	21.5	68.3	27.0	33.4	39.6
2005.8-2015.8	4.7	22.3	73.0	11.5	28.8	59.8
2015.9-2023.10	1.9	24.4	73.7	12.3	18.6	69.1
Transport Equipment						
2001.4-2005.7	16.9	22.4	60.7	21.2	49.7	29.2
2005.8-2015.8	12.8	18.4	68.9	10.5	34.6	54.9
2015.9-2023.10	4.4	20.8	74.7	13.0	25.2	61.8

Notes: Figures are expressed in percentage terms.

4. Conclusion

With the efforts of the Chinese government to internationalize the RMB, a common question arises: Is the RMB now a key regional currency? To examine this question, we follow established approaches in the literature. A key regional currency should play a similar role to a currency union, potentially reducing the incidence of RER misalignments by eliminating nominal exchange rate shocks. Recent studies also suggest that currency unions may quicken the convergence of member countries' RERs towards their equilibrium levels. In this paper, we estimate and compare the emergence of RER misalignments and the variation in the speed of RER adjustment for Asian countries during different periods of China's exchange rate reforms. We also compare these results with those from European countries, considering a model where RER adjustment speed is influenced by global, regional, and country-specific shocks.

Our findings indicate that although the speed of RER convergence for the RMB has increased over time, particularly following several key reforms, the overall impact remains limited. The DFM results show that RER convergence in Asia is predominantly driven by country-specific factors, reflecting the region's diverse economic conditions and policies. This suggests that while currency reforms have bolstered the RMB's standing, their effects have not been substantial enough to establish the RMB as a dominant regional key currency.

The results for Asian countries are understandable given the complexities of managing exchange rates in the region. The Asian financial crisis of 1997 highlighted diverse responses among countries, with some adopting inflation-targeting frameworks to stabilize their currencies and others facing tensions between central banks and finance ministries regarding exchange rate strength. These national-level policy decisions contribute to the divergence in exchange rate movements and RER across Asia.

In contrast, European countries exhibit strong alignment between their RER convergence and DFM results. The speed of convergence is high, and the regional factor is consistently influential, underscoring strong intra-European economic linkages. This difference highlights that despite the RMB reforms, it has not achieved the same level of regional influence as the currencies within the Eurozone, where economic integration is more pronounced.

In conclusion, as suggested by Lai (2021), there is a long-term demand for an alternative reserve currency outside the USD, particularly within the euro-bloc. If the RMB could become a regional key currency, it could lead to more stability in the international monetary system. With continuous efforts to open its financial system, improve its institutional quality, and enhance its legal system, the prospect of the RMB becoming a regional key currency is not impossible.

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