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Emerging Influence of the RMB on Currency Markets in a Transpiring Tri-Polar International Monetary System

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Abstract: The up-and-coming influence of the RMB on currency co-movements is examined in this paper, in the context of a transpiring tri-polar international monetary system advocated in prior studies. The study is empirically conducted against the backdrop of a more variable RMB exchange rate regime, which enables the integration of the RMB into the international monetary system. The influence of the RMB is found most evident in Asia, being modest in Latin America while reaching Africa. The RMB co-moves most with the currencies of countries that have large shares in trade with China considerably. Meanwhile, a residual-based instrumental variables model is proposed in this study purposely for dealing with issues of common factor dominance, which prevails in currency co-movements. The emerging influence of the RMB on currency co-movements arises at the time when a multiple-reserve currency system is coming, and the RMB is included as the third largest currency in the SDR basket. It is shored up by the improved infrastructure, strengthened central bank cooperation and expanded networks for cross-border RMB payments and settlements. It is concluded that the RMB has increasingly integrated into the international monetary system as one of the major players, effecting currency market movements actively alongside the US dollar and euro.

Key words: foreign exchange rate, currency market, RMB

JEL codes: F31, F33, C18, C32

1. Introduction

The world has witnessed the growing and phenomenal influence of China on the global economy in the last decade, which has been gradually acknowledged in the recent literature. The moves in China variables have been closely watched while they move global markets more and more emphatically. Signified by the inclusion of the RMB[1] as the third largest currency in the SDR basket on October 1, 2016, the importance of the RMB to the global economy has been accredited (IMF Communications Department 2016). This has echoed recent studies that advocate the emergence of a tri-polar international monetary system. Meanwhile, the central bank, viz. the People's Bank of China (PBOC), has accelerated the reform of the RMB exchange rate regime, shifting towards greater flexibility away from its previous overly bonding to the US dollar. Accompanied by China's enormous economy and rapid growth, phenomenal international trade and momentous overseas investments, the RMB has gradually become responsive to, and influential on, foreign exchange market movements.

Intermittently, various studies have examined and documented the rising influence of the RMB on the currency market regionally and globally, alongside the US dollar, euro and to a lesser extent the Japanese yen and British pound. "China's rise in the global economy is reflected by changes in the international significance of its currency", Arner and Soares (2016) have claimed soon after the inclusion of the RMB in the SDR basket. It is argued by Eichengreen (2012) that a multiple-reserve currency system is coming for another related reason. For decades, the global economy expands faster than the US and consequently the US GDP share in the world has been falling. As a result, the fiscal capacity of the US government has become less likely to backstop the growing volume of foreign dollar claims required by the global economy, which must be shored up by fiscal capacities elsewhere. The euro and RMB

[1] The RMB, renminbi in full, is used for the currency name, while yuan or CNY is used for the quantity or units and in exchange rate expressions. We conform to this practice. Similar examples include sterling and pound, pound sterling v. GBP. e.g., the ECB and BBC quote sterling exchange rates with the symbol of Pound Sterling (GBP).

are the natural candidates. The creation of the euro and a rapidly rising economy of China, together with the US, have made the world tri-polar with three almost equal sized economies. "Their combined fiscal capacity is several times greater than the fiscal capacity of the United States alone… to stand behind government bonds and bank deposits, thereby providing the expanding world economy with an adequate supply of safe assets …" (ibid, p208). This is echoed in Chey (2012). "The dollar's future appears to have become more questionable recently, however, since unlike in the past, there are potential alternatives to it, in particular the euro and maybe also the Chinese renminbi in the longer term" (ibid, p51). Modeling international lending of last resort (ILOLR), Gete and Melkadze (2020) indicate the ability of China to be an ILOLR. "China's lending agreements have multiple goals: facilitate settlement in renminbi, promote trade and also serve as a source of liquidity as a lender of last resort" (ibid, p11).

The economic size and fiscal capacity are the backbone of an international currency, but they do not make an international currency alone and automatically. "An international currency is one that is used and held beyond the borders of the issuing country, not merely for transactions with that country's residents, but also, and importantly, for transactions between non-residents" Kenen (2009, p9). Since 2009, China has taken concrete measures to internationalize the RMB to make the RMB an international currency that is used in invoicing and payments by non-resident entities. Full integration with the international financial institutions (IFIs) under the global financial governance (GFG) architecture is essential, which China has embarked on since 2009 according to Zhang (2021, p15). The period of full integration is signified by the establishment of New Development Bank (NDB), formerly known as BRICS Development Bank, headquartered in Shanghai in 2015. It has been highlighted by the launch of the Beijing based Asian Infrastructure Investment Bank (AIIB) in 2014. Prominent US allies such as the UK, Australia, New Zealand and South Korea joined

AIIB in 2015 as funding members despite the displeasure of the US. “We are wary about a trend toward constant accommodation of China, which is not the best way to engage a rising power”, a senior US administration official was reported as saying (Dyer and Parker 2015). France, Germany and Italy have all announced to join AIIB the following Monday (Parker *et al*. 2015). These have made the institutional ingredients in the essential infrastructure for RMB internalization to promote the use of the RMB in cross-border trade settlements and other financial transactions. The rising, sometimes dominant, role of China in GFG and IFIs points to an increasingly significant influence of its currency, the RMB, on the world stage and regional arenas.

The last financial crisis helped accelerate RMB internationalization and the acceptance of the RMB in settlements and payments. “The current crisis has exposed the vulnerability of China’s financial position under the existing international monetary system, which is characterized by the domination of the US dollar as the international reserve currency” (Gao and Yu 2009, p105). “In 2009, … , China launched the cross-border RMB settlement of the trade in goods based on the economic ties with neighboring countries and regions. … The total amount of cross-border RMB settlement of trade in goods hit another RMB 4 trillion yuan in 2020, second only to the early highs of 2014 and 2015 [of RMB 7 trillion yuan]” (PBOC 2021, p11). “The total amount of cross-border payments and receipts settled in RMB was RMB 28.39 trillion yuan [in 2020], with a year-on-year increase of 44.3%” (ibid, p3). The RMB entered the top five of world payment currencies since November 2014, according to SWIFT (RMB Tracker 2015). One month later, the RMB reached a record high share of 2.17% in global payments by value (ibid). “In May 2022, the RMB has retained its position as the fifth most active currency for global payments by value, with a [stagnated] share of 2.15%” (RMB Tracker 2022, p2). The RMB became the 2nd most used currency in trade finance with a share of 8.66% in October 2013, overtaking the euro (RMB Tracker 2013). “In 2020, the cross-border

RMB settlement accounted for 46.2% of the total cross-border settlement, reaching a record high in history, which was 8 percentage points higher than that of 2019" (PBOC 2021, p5). That is, nearly half of cross-border settlements involving China were settled with the RMB, compared with the RMB's share of 2.15% in global use. This indicates that the use of the RMB is primarily confined to deals between China and the partners, in contrast to the US dollar and euro that are used involving the US and the Eurozone and serving widely as vehicle currencies. As Liu *et al*. (2019) put, "a currency becomes international when it circulates outside of its issuing country, and it becomes an international vehicle currency if it is used by non-residents" (p74). They concur that the global use of RMB is decreasing by distance and the influence of the RMB is largely regional.

Having empirically observed the growing influence of China, McKinnon and Schnabl (2012) proclaim that China have gradually become an anchor for the greater East Asian economy, and a fiscal stabilizer on the world stage since the new millennium. Nevertheless, there are benefits as well as costs associated with increasing and greater influence of the RMB, or RMB internationalization. As Zhang and Tao (2016) point out, "by using the RMB as an invoicing and settlement currency, PRC firms may reduce the exchange risks of international trade and investment, thereby reducing transaction costs (p8). "RMB internationalization would create a great deal of monetary efficiency and integrate the PRC more deeply into the world economy" (ibid, p8), which is the actual cause, rather than the phenomenon, of currency co-movements involving the RMB. On the other hand, "impossible trinity" of an open economy would arise, "that no country can simultaneously reach the policy goals of free capital movement, exchange rate stability, and independent monetary policy" (ibid, p16). Examining China's growing influence with regard to the connectedness in Asia Pacific currency markets, Chow (2021) shows "a number of Asia Pacific currencies… exhibiting tight association with renminbi fluctuations" (p3816). Specifically, McCauley and Shu (2019) study currency co-

movements following the reform of the daily fixing of the RMB in August 2015. The co-movements examined in the study include the currencies of the emerging economies in Asia and Latin America. “Such co-movement is generally interpreted as the renminbi’s influence on other currencies, rather than the other way around” (ibid, p444). Their findings support the claim of Ryan (2015) that the global economy is already close to operating with three exchange rate anchors: the US dollar, the euro and, increasingly, the RMB. The results of Cai (2022) suggest that “since the B&R Initiative, the RMB has made more remarkable progress as an anchor currency in B&R countries than in non-B&R ones” (p7). Similarly, Keddad (2019) looks into the ways in which the RMB co-moves with East Asian currencies, whereas Ito (2017) addresses the prospect for a RMB bloc to emerge, which leads to new financial order in Asia.

It should be noted that foreign exchange markets and foreign exchange rates are bilateral as well as multilateral. Foreign exchange rates are subject to unique constrains other financial instruments and their prices rarely confront to. That is, foreign exchange markets are formed by many triangles of currencies and foreign exchange rates satisfy many triangular constraints. Therefore, currencies are destined to be interrelated and their movements are preordained to be correlated, even for freely floating currencies. Satisfying even one of the many triangular configurations would suggest that a looser connection of one currency with another must go along with a stronger association with the third currency in the triangle. At one extreme are hard pegs where the currency is anchored to one major currency, detaching completely from the rest. At the other extreme, however, freely floating currencies share moderate co-movements between them; they are not quite free to float any magnitude or direction. In between, there are various soft pegs and floating without a “free” tag; their co-movements with leading currencies and with each other would be even less variable. Therefore, studies of currency co-movements should be aware of such systematic embeddedness in interpreting the derived regression coefficients and other results. The contemplated issues

range from estimating currency weights in a currency basket to co-movements between selected currencies.

Bearing the above concern in mind, currency co-movements should be viewed prudently through the lens of regression coefficients in interpreting the effects or weights of specific currencies. Prior and existing econometric approaches to correcting estimation biases are ineffective and inappropriate in dealing with this specific issue in the foreign exchange market. Common factors prevail due to systematic embeddedness. The effect on the dependent variable of the common factor could partly be shifted from the common factor instigator to the common factor bearers mistakenly. Some of the bias correction procedures could introduce double counting in coefficients and weights while correcting coefficient estimates to a certain good extent. The present paper thus probes into the misrepresentation arising from the dominance of common factors. It puts forward a procedure appropriate for bias correction for currency co-movements. Empowered with the new procedure, the paper empirically studies the evolving role of the RMB in moving the global currency market following the US dollar and euro.

The rest of the paper proceeds as follows. The next section reviews the evolution of the RMB exchange rate regime since 2005, which has witnessed the introduction and implementation of a range of regime reforms. The paper then elaborates on the misrepresentation of, and the distortion in, parameter estimates for research on currency co-movements under the dominance of common factors in section 3. It reveals the residual misrepresentation and distortion left over by the conventional procedures for bias corrections in the form of double counting in shifting the effect of the common factor. A new procedure is then proposed to deal with the identified issue, in recognition of the specific snags in assessing currency co-movements. Empirical work is presented in section 4 for examining currency market movements and currency co-movements, where the estimation results are reported and

analyzed for the prospect of a potential tri-polar monetary system involving the US dollar, euro and RMB. Further discussion is undertaken in section 5, reflecting upon the results and findings from a broader perspective. Finally, section 6 summarizes this study.

2. Evolution of the RMB exchange rate regime

The RMB exchange rate was fixed to the US dollar until July 21, 2005, when POBC issued "*Announcement on Improvement on RMB Exchange Rate Regime*", marking the beginning of a series of measures to reform the RMB exchange rate (PBOC 2005). The band of daily fluctuation in the RMB exchange rate vis-à-vis the US dollar was set at 0.3%. Since the reform, the RMB exchange rate against the US dollar on the inter-bank foreign exchange market has been moving up and down by small margins. As of December 31, 2005, the central parity of the RMB against the US dollar stood at ¥8.0702/$. The RMB experienced appreciation against the US dollar on 67 trading days, and the RMB underwent depreciation on 46 trading days. The largest appreciation and depreciation recorded for a single business day was both 0.07%. After the initial adjustment, the RMB exchange rate against the US dollar appreciated accumulatively by 0.49 percent (*cf.* PBOC 2006).

The band of daily fluctuation in the RMB exchange rate against the US dollar was widened to 0.5% from May 21, 2007, announced PBOC on May 18, 2007 (PBOC 2007), which was exceeded previously already, albeit occasionally. Then followed the global financial crisis, there was virtually little fluctuation in the RMB exchange rate against the US dollar from July 2008 until June 2010, to reserve financial stability and safeguard the economy from external shocks. With the global recovery on the horizon, PBOC announced on April 14, 2012 that the band of daily fluctuation was widened again to 1% from April 16, 2012 (PBOC 2012), for the sake of meeting the development needs in the foreign exchange market and enhancing the elasticity in the bi-directional floating of the RMB exchange rate. In less than two years' time,

it was announced on March 15, 2014 that the band of daily fluctuation in the RMB exchange rate against the US dollar was to be broadened to 2% from March 17, 2014 (POBC 2014). Nevertheless, it will be observed that the extent to which the RMB co-moves with currencies other than the US dollar remain largely unchanged, given the band's unique link to the US dollar. RMB behavior and patterns virtually did not change when the band had been widened from 0.3% through to 0.5%, 1% and 2% in a series of band management-based reforms, indicating that the approach is ineffective.

Departing from the US dollar linked band management approaches, a relatively radical new measure was introduced and implemented by PBOC on August 11, 2015 (PBOC 2015), thereby PBOC "improved the quotation mechanism of central parity between the RMB against the US dollar" (POBC 2016, p65). It is the central parity regime of 'closing rate & rate change against a basket of currencies' as summarized by PBOC and China Foreign Exchange Trade System (CFETS). Meanwhile on December 11, 2015, CFETS launched the CFETS RMB Index or the CFETS currency basket. "The sample currency weight is calculated by international trade weight with adjustments of re-export trade factors. The sample currency value refers to the daily CNY Central Parity Rate and CNY reference rate (e.g. THB). The baseline date is 31 Dec 2014. The baseline index value is 100 points. The index is calculated by the geometric mean method" (CFETS 2016a). Increased from the initial 13 currencies included in the basket in 2016, there were 24 currencies in the basket effective on January 1, 2017. The weight of the US dollar was 22.40% and that of the euro 16.34%, (*cf*. CFETS 2016b). The CFETS RMB Index is a kind of trade weighted effective exchange rate, similar to the BIS RMB Index.

The 'closing rate & rate changes in basket currencies' mechanism emphasized that the daily central parity quotes of the RMB-dollar exchange rate should refer to the closing rate on the previous day to reflect the changes of market supply and demand. PBOC Monetary Policy Analysis Group (2016) has explained the mechanism (ibid, p19). Market makers are required

to estimate the expected adjustment in the bilateral RMB-dollar exchange rate before the inter-bank foreign exchange market opens, in line with the previous day's changes in the exchange rates of basket currencies. This estimated magnitude of adjustment is then added to the previous day's closing RMB-dollar exchange rate to produce the RMB-dollar mid-rate for the day. Market makers consider the CFETS basket in quoting the exchange rate and then report their RMB-dollar mid-rates to CFETS. CFETS eliminates the highest mid-rate quote and the lowest mid-rate quote and then works out the weighted average of the remaining mid-rate quotes, with the weights of market makers being decided by CFETS according to their foreign exchange trading volumes and other considerations. The mid-rate will be released at 09:15am. "The central parity regime of the RMB against the US dollar of 'closing rate & rate change against a basket of currencies' has been gradually improved" (PBOC 2017, p67). Against this background of the evolution of the RMB exchange rate regime, we study the evolving role of the RMB in moving the global currency market vis-à-vis the US dollar, euro, Japanese yen and British pound, with the new procedure.

3. Misrepresentation and distortion in parameter estimates

Let us consider a foreign exchange market where there are following currencies. ₲ represents the currencies to be tested for co-movements with currency market movers; they are the dependent variable in the model. The independent variables include the following. Ψ is the dominant currency that plays a role of dominant common factor; it is a common factor instigator. Whereas Θ represents the currencies that are the common factor bearer. Ω represents a group of freely floating currencies. ₣ is the numeraire currency. The exchange rate is expressed as $E_{₲/₣,t}$, $E_{\Psi/₣,t}$, $E_{\Theta/₣,t}$ and $E_{\Omega/₣,t}$ respectively. Changes in exchange rates are employed in estimating co-movements and assessing influence. i.e., logarithmic differences of exchange rates used. They are in the form of:

$$\Delta e_{\mathbb{G}/\mathbb{F},t} = e_{\mathbb{G}/\mathbb{F},t} - e_{\mathbb{G}/\mathbb{F},t-1} = Ln\left(E_{\mathbb{G}/\mathbb{F},t}\right) - Ln\left(E_{\mathbb{G}/\mathbb{F},t-1}\right) \quad (1a)$$

$$\Delta e_{\Psi/\mathbb{F},t} = e_{\Psi/\mathbb{F},t} - e_{\Psi/\mathbb{F},t-1} = Ln\left(E_{\Psi/\mathbb{F},t}\right) - Ln\left(E_{\Psi/\mathbb{F},t-1}\right) \quad (1b)$$

$$\Delta e_{\Theta/\mathbb{F},t} = e_{\Theta/\mathbb{F},t} - e_{\Theta/\mathbb{F},t-1} = Ln\left(E_{\Theta/\mathbb{F},t}\right) - Ln\left(E_{\Theta/\mathbb{F},t-1}\right) \quad (1c)$$

$$\Delta e_{\Omega/\mathbb{F},t} = e_{\Omega/\mathbb{F},t} - e_{\Omega/\mathbb{F},t-1} = Ln\left(E_{\Omega/\mathbb{F},t}\right) - Ln\left(E_{\Omega/\mathbb{F},t-1}\right) \quad (1d)$$

respectively in this paper.

In the following the commonly used two-step regression approach to correcting estimation biases is critically reviewed first, revealing the embedded problems and pointing out the ways forward. Identification issues are addressed subsequently and a residual-based instrumental variables model is proposed accordingly. An additional method is supplemented as well, which, though less ideal, is able to remove double counting, the most serious problem in the two-step regression approach.

3.1. Residuals regression – rationale and issues

This is a two-step regression approach, which appears fairly sensible. It is widely used in research on currency co-movements and currency basket weights, including Cui (2014), Kawai and Pontines (2016), and Fang *et al*. (2012), among others. The idea behind this approach has originated from the concern that two or more of the independent variables in the regression may be highly linearly correlated. They follow the work of Frankel and Wei (2007) and Frankel and Xie (2010) in estimating currency co-movements while recognize the fact that changes in exchange rates can be highly correlated, which produces biased regression coefficients or distorted currency basket weights. Whereas Ito (2017) claims "It [co-movement between the RMB and USD] was indeed a problem in earlier studies" (ibid, p246) and runs a straight regression, as "in recent years, the Chinese authorities increased flexibility against the US dollar, so that a test of separating the RMB and USD became possible with a higher statistical confidence" (ibid, p246). The necessity will need to be found out in further studies.

Regression models with highly linearly correlated, or multi-collinear, regressors can still explain well the outcome or the dependent variable. However they may not produce valid results about individual regressors. i.e., the extent to which the effects on the dependent variable are portioned between the multi-collinear regressors is unknown or ambiguous, or the extent to which individual regressors are redundant with respect to others is unknown or ambiguous. Thus Wang and Wang (2022) have proposed to correct parameter misrepresentation under the dominance of a common factor. Such phenomenon exists widely and persistently in currency co-movements. "The estimation bias problem of common factor dominance is regularly encountered but overlooked in the research on currency interactions and co-movements. …, calling for realistic and sensible currency weight estimations." (ibid, 1416). It poses as a problematic puzzle on the one hand; but it offers a solution to apportioning contributions between regressors on the other hand, applying economic intelligence in individual currencies and market dominance.

The regression setup is to estimate the coefficients or the weights of the currencies in a currency basket for a particular currency. However, due to the influence of the dominant common factor, the effects of certain currencies on the exchange rate changes of other currencies can be misrepresented in regression or other modeling procedures. i.e., the coefficient estimates can be distorted in the following regression:

$$\Delta e_{\mathbb{C}/\mathbb{F},t} = \beta_0 + \beta_\Psi \Delta e_{\Psi/\mathbb{F},t} + \beta_\Omega \Delta e_{\Omega/\mathbb{F},t} + \beta_\Theta \Delta e_{\Theta/\mathbb{F},t} + \varepsilon_t \quad (2)$$

where Ψ is the dominant currency playing a role of dominant common factor, it is a common factor instigator; whereas Θ is the common factor bearer.

In a conventional two-step approach, the first step is to run regression of the common factor bearer on the instigator:

$$\Delta e_{\Theta/\mathbb{F},t} = \alpha_\Theta + \alpha_{\Theta\Psi} \Delta e_{\Psi/\mathbb{F},t} + \nu_{\Theta,t} \quad (3)$$

The residuals from the above regression are subtracted as follows:

$$\nu_{\Theta,t} = \Delta e_{\Theta/\mathrm{F},t} - \alpha_{\Theta} - \alpha_{\Theta\Psi}\Delta e_{\Psi/\mathrm{F},t} \quad (4)$$

In the second step, the residuals of the first step regression are brought in to replace the regressor $\Delta e_{\Theta/\mathrm{F},t}$:

$$\Delta e_{\mathbb{C}/\mathrm{F},t} = \beta'_0 + \beta'_{\Psi}\Delta e_{\Psi/\mathrm{F},t} + \beta'_{\Omega}\Delta e_{\Omega/\mathrm{F},t} + \beta'_{\Theta}\nu_{\Theta,t} + \varepsilon'_t \quad (5)$$

The subsequent process establishes the relationships between the coefficient estimates of equation (2) and that of equation (5). Replacing $\nu_{\Theta,t}$ by its components in equation (4) produces:

$$\Delta e_{\mathbb{C}/\mathrm{F},t} = \beta'_0 + \beta'_{\Psi}\Delta e_{\Psi/\mathrm{F},t} + \beta'_{\Omega}\Delta e_{\Omega/\mathrm{F},t} + \beta'_{\Theta}\left[\Delta e_{\Theta/\mathrm{F},t} - \alpha_{\Theta} - \alpha_{\Theta\Psi}\Delta e_{\Psi/\mathrm{F},t}\right] + \varepsilon'_t$$

$$= \beta'_0 + \beta'_{\Psi}\Delta e_{\Psi/\mathrm{F},t} + \beta'_{\Omega}\Delta e_{\Omega/\mathrm{F},t} + \beta'_{\Theta}\Delta e_{\Theta/\mathrm{F},t} - \beta'_{\Theta}\alpha_{\Theta} - \beta'_{\Theta}\alpha_{\Theta\Psi}\Delta e_{\Psi/\mathrm{F},t} + \varepsilon'_t$$

$$= (\beta'_0 - \beta'_{\Theta}\alpha_{\Theta}) + (\beta'_{\Psi} - \beta'_{\Theta}\alpha_{\Theta\Psi})\Delta e_{\Psi/\mathrm{F},t} + \beta'_{\Omega}\Delta e_{\Omega/\mathrm{F},t} + \beta'_{\Theta}\Delta e_{\Theta/\mathrm{F},t} + \varepsilon'_t \quad (6)$$

Since equation (6) has the same regressors as equation (2), its coefficient estimates must be the same as the corresponding coefficient estimates in equation (2). Therefore, the following equalities hold:

$$\beta'_{\Theta} = \beta_{\Theta} \quad (7a)$$

$$\beta'_{\Omega} = \beta_{\Omega} \quad (7b)$$

$$(\beta'_0 - \beta'_{\Theta}\alpha_{\Theta}) = \beta_0 \quad (7c)$$

$$(\beta'_{\Psi} - \beta'_{\Theta}\alpha_{\Theta\Psi}) = \beta_{\Psi} \quad (7d)$$

$$\varepsilon'_t = \varepsilon_t \quad (7e)$$

Equation (7c) and equation (7d) can be rearranged as:

$$\beta'_0 = \beta_0 + \beta_{\Theta}\alpha_{\Theta} \quad (7c')$$

$$\beta'_{\Psi} = \beta_{\Psi} + \beta_{\Theta}\alpha_{\Theta\Psi} \quad (7d')$$

The above analysis reveals the effects of residuals regression. The intercept increases by $\beta_{\Theta}\alpha_{\Theta}$, which is less important than the next two effects. The coefficient of the freely floating currency is not affected; it remains the same. The most relevant and merited rectification is that the coefficient estimate of the dominant currency, Ψ, increases by $\beta_{\Theta}\alpha_{\Theta\Psi}$, which is attributed to Θ through their bearing of the common factor in equation (2). The most worrying fact is that

the coefficient estimates of the residuals remain exactly the same as the coefficient estimates of the corresponding variables they represent in equation (2). Coefficient estimates reported in Table 3 (under CR and UIRR for every currency) verify the concern in the way in which the change takes place. These two effects constitute a kind of double counting, which must be corrected accordingly.

The above problem brings about an identification issue and is caused by under identification. This residual-based regression mirrors the well-known instrumental variable (IV) regression, the latter utilizing the fitted or predicted values of the first step regression rather than the residuals employed by the former. Therefore, we define identifications for the residual-based regression in reference to the IV method. We name the residual-based two-step regression method the residuals IV (RIV) method, and name the additional regressors employed in the first step regression instruments, instrumental variables or IVs.

Definitions

Under identification: All the regressors used in the first step regression are included in the second step regression.

Just identification: There is one additional variable, i.e., an IV, in each of the first step regressions that is not included in the second step regression.

Over identification: there is more than one additional variable, i.e., IV, in each of the first step regressions that are not included in the second step regression.

The above case has illustrated under identification and its consequences, where all the regressors used in the first step regression are included in the second step regression. A model is sufficiently identifiable with the second and third definitions – just identification and over identification. The next sub-section presents their specification.

3.2. Specification of sufficiently identified residuals regression – RIV method

One specification of residual-based regression or the RIV model is to adopt the just identified model in the first step regression. An additional group of variables Φ that can be a sub-set of Θ, is therefore employed as IVs in the first step regression that is not to be included in the second step regression. Alongside the definitions of currencies in equation (1) earlier, its logarithmic difference form is:

$$\Delta e_{\Phi/\text{F},t} = e_{\Phi/\text{F},t} - e_{\Phi/\text{F},t-1} = Ln\left(E_{\Phi/\text{F},t}\right) - Ln\left(E_{\Phi/\text{F},t-1}\right) \quad (1e)$$

Running regression of the common factor bearer on the instigator and the additional regressor in the first step:

$$\Delta e_{\Theta/\text{F},t} = \alpha_\Theta + \alpha_{\Theta\Psi}\Delta e_{\Psi/\text{F},t} + \alpha_{\Theta\Phi}\Delta e_{\Phi/\text{F},t} + \nu_{\Theta,t} \quad (8)$$

The residuals from the above regression are then subtracted:

$$\nu_{\Theta,t} = \Delta e_{\Theta/\text{F},t} - \alpha_\Theta - \alpha_{\Theta\Psi}\Delta e_{\Psi/\text{F},t} - \alpha_{\Theta\Phi}\Delta e_{\Phi/\text{F},t} \quad (9)$$

The above residuals of the first step regression are brought in to replace the regressor $\Delta e_{\Theta/\text{F},t}$ in the second step regression:

$$\Delta e_{\mathfrak{C}/\text{F},t} = \beta'_0 + \beta'_\Psi\Delta e_{\Psi/\text{F},t} + \beta'_\Omega\Delta e_{\Omega/\text{F},t} + \beta'_\Theta\nu_{\Theta,t} + \varepsilon'_t$$

$$= \beta'_0 + \beta'_\Psi\Delta e_{\Psi/\text{F},t} + \beta'_\Omega\Delta e_{\Omega/\text{F},t} + \beta'_\Theta\left(\Delta e_{\Theta/\text{F},t} - \alpha_\Theta - \alpha_{\Theta\Psi}\Delta e_{\Psi/\text{F},t} - \alpha_{\Theta\Phi}\Delta e_{\Phi/\text{F},t}\right) + \varepsilon'_t$$

$$= \beta'_0 + \beta'_\Psi\Delta e_{\Psi/\text{F},t} + \beta'_\Omega\Delta e_{\Omega/\text{F},t}$$

$$-\beta'_\Theta\alpha_\Theta - \beta'_\Theta\alpha_{\Theta\Psi}\Delta e_{\Psi/\text{F},t} + \beta'_\Theta\left(\Delta e_{\Theta/\text{F},t} - \alpha_{\Theta\Phi}\Delta e_{\Phi/\text{F},t}\right) + \varepsilon'_t \quad (10)$$

The intercept and the coefficient of the dominant currency, Ψ, change by:

$$\beta'_0 = \beta_0 + \beta_\Theta\alpha_\Theta \quad (11a)$$

$$\beta'_\Psi = \beta_\Psi + \beta_\Theta\alpha_{\Theta\Psi} \quad (11b)$$

β'_Θ, also as the coefficient for $\left(\Delta e_{\Theta/\text{F},t} - \alpha_{\Theta\Phi}\Delta e_{\Phi/\text{F},t}\right)$, is the effect of $\Delta e_{\Theta/\text{F},t}$ on the dependent variable net of the effects of the common factor instigator and the rest of the common factor bearers.

3.3. Modification to under identified models

The issues with the under identified residual-based two-step regression are not as dire as in the IV model, and they could be modified to correct the misrepresentation to certain extents. One of the major problems is double counting, when the procedure shifts the part of the effect back to the common factor instigator fairly appropriately while still keeping the misallocated contribution to the common factor bearer. So modification can be carried out accordingly, though not ideally. The modified under identified residuals regression then provides additional assessments, supplementing the main approach in this study.

Given that $\beta_\Theta \alpha_{\Theta\Psi} \Delta e_{\Psi/\mathrm{F},t}$ of $\Delta e_{\Theta/\mathrm{F},t}$ is attributed to $\Delta e_{\Psi/\mathrm{F},t}$, only $(1-\beta_\Theta \alpha_{\Theta\Psi})\Delta e_{\Psi/\mathrm{F},t}$ of $\Delta e_{\Theta/\mathrm{F},t}$ is attributed to $\Delta e_{\Theta/\mathrm{F},t}$ itself. The corrected coefficient estimates of the dominant currency and the common factor bearing currencies, as well as the corrected intercept, are as follows:

$$\beta_0^{\mathrm{c}} = \beta_0 + \beta_\Theta \alpha_\Theta \tag{12a}$$

$$\beta_\Psi^{\mathrm{c}} = \beta_\Psi + \beta_\Theta \alpha_{\Theta\Psi} \tag{12b}$$

$$\beta_\Theta^{\mathrm{c}} = \beta_\Theta (1 - \beta_\Theta \alpha_{\Theta\Psi}) \tag{12c}$$

The residual-based instrumental variables method introduced in 3.2 is applied in the next section to assess the influence of the RMB on currency markets and currency co-movements. The estimation results by the commonly used two-step regression approach, the under identified residuals regression discussed in 3.1 and that by the modified under identified residuals regression in 3.3 are also reported and contrasted.

4. Data sample and empirical results

The data sample starts on August 11, 2015 when PBOC accelerated the reform of the RMB exchange rate regime. The latest measure has shifted the RMB exchange rate arrangement towards greater flexibility away from its previous US dollar linked band management

approaches that were overly bonded to the US dollar. It ends on March 19, 2020. Major emerging market currencies are included in the sample, together with the US dollar, euro and RMB. The data set is in daily frequencies, collected from Eikon databases of Thomson Reuters. The WM/Reuters spot rates are used for all the exchange rates, to minimize additional noise produced from using different sources. The development since the reform of August 11, 2015 has witnessed discernible changes in RMB variability and co-movement behavior, revealed by Table 1 and Table 2. All the SDR currencies and the currencies of BRICS countries are included for a preliminary assessment on the evolving RMB variability and co-movement features. IBAN currency codes are used to symbolize the currencies in all the tables.

Table 1a exhibits the standard deviation of changes in the RMB exchange rate vis-à-vis the US dollar in contrast with exchange rates of major selected currencies vis-à-vis US dollar. Table 1b shows the standard deviation of changes in the RMB exchange rate vis-à-vis major selected currencies other than the US dollar. Considerably low degrees of RMB variability and flexibility are prior to August 11, 2015, Table 1a indicates. The standard deviation of changes in the RMB exchange rate vis-à-vis the US dollar is much smaller than that for the exchange rates between the other currencies and the US dollar – less than ¼ of the latter excluding the Indian IND and Russian RUB. The variability of the RMB in the 1% and 2% band regimes is even lower than and lowered from that in the 0.5% band regime. The RMB in the first 0.5% band period, indicated by 0.5%i, looks to be the most flexible, which doubles the variability in the initial 0.3% band period, but no further improvements in variability are made. In contrast, the standard deviation of changes in the exchange rate between the RMB and the US dollar since the central parity reform, indicated by cp, has doubled or more than doubled that in the previous band management-based regimes. Table 1b shows that the RMB exchange rate vis-à-vis a foreign currency other than the US dollar is as volatile as the exchange rate between the US dollar and that foreign currency. The figures in the corresponding cells of Table 1a and

Table 1b are almost the same. The former is slightly smaller or larger than the latter, depending on positive or negative correlations between changes in the exchange rate of currencies other than the US dollar vis-à-vis the RMB and vis-a-via the US dollar. Table 2 further suggests that the RMB, while closely associated with the US dollar, is rather detached from other currencies during the band management-based regimes. The co-movements measured in correlation coefficients are as low as 0.1 approximately. The extent to which the RMB co-moves with currencies other than the US dollar remain largely unchanged in the end, despite a rise in the 0.5% band period, the co-movements in the seemingly wider 1% and 2% band periods have dropped to the initial reform's level. The latest central parity regime reform has also brought the RMB closer to the currencies other than the US dollar. The co-movements have doubled to approximately 0.2 across the currencies overall.

{Table 1a about here}

{Table 1b about here}

{Table 2 about here}

Having inspected the evolution of RMB variability and co-movement features through stages of RMB exchange rate regime reforms, the extent to which the RMB co-moves with other currencies and drives currency market movements is scrutinized. Major emerging market currencies are chosen for dependent variables, all of them adopting free floating or floating exchange rate arrangements according to *Annual Report on Exchange Arrangements and Exchange Restrictions* (IMF 2019). Adopting IBAN currency codes, they are Indian INR, Indonesian IDR, Philippine PHP, Turkish TRY, Thai THB, South Korean KRW, Malaysian MYR, Kazakhstani KZT and Mongolian MNT in Asia; South African ZRA, Tanzanian TZS, Kenyan KES, Ugandan UGX, Mozambican MZN, Ghanaian GHS and Malawian MWK in

Africa; Brazilian BRL, Mexican MXN, Colombian COP, Argentine ARS, Peruvian PEN and Chilean CLP in Latin America; and Russian RUB, Ukraine UAH, Polish PLN, Romanian RON, Hungarian HUF and Serbian RSD in Europe. They are included in the ₲ group of currencies in the above estimation setting as dependent variables. Whereas the US dollar is Ψ in the system, the euro is the Ω currency, and the RMB is the Θ currency in the specifications in Section 3. The Singaporean dollar, which adopts stabilized arrangements with a composite exchange rate anchor according to IMF (2014, 2017, 2019), is the right candidate chosen for the Φ currency in the specifications. The Swiss franc, ₣, serves as the numeraire currency[2].

Table 3 presents the estimation results for the prospect of a potential tri-polar monetary system involving the US dollar, euro and RMB. Four sets of results are reported for four specifications and 27 currencies. They are RIV, the residual-based instrumental variables method, where the Singaporean dollar is additionally employed in the first step regression alongside the US dollar. CR, conventional regression in one step. UIRR, the under identified residuals regression, where the US dollar is the only regressor in the first step regression. MUIRR, the modified under identified residuals regression where double counting is removed. Table 4 additionally provides a qualitative summary of the results.

{Table 3 about here}

The RMB's influence is most evident in Asia, being modest in Latin America, according to the results by the RIV method. Meanwhile the RMB plays a limited role in effecting currency movements in Africa and Europe. Whereas the CR makes the RMB more powerful than the US dollar in driving currency co-movements with higher significance and

[2] Swiss National Bank (SNB) abandoned the one-sided restriction on its currency movement, the cap of CHF1.2/EUR on January 15, 2015, and the currency resumed floating on the currency market on the day and remains so (SNB 2015).

magnitudes even in the US backyard of Latin America, which seems implausible. Therefore the analysis follows the RIV line, and is supplemented by the MUIRR model and contrasted with the CR method. Specifically, the RMB co-moves most and considerably with the currencies of countries that have large shares in trade with China, reflecting as well shared cultural and customary traits to a certain extent. The co-movements of the RMB are particularly closer with the South Korean KWR, Indonesian IDR and Malaysian MYR. The CNY coefficient in the RIV model is highly significant at 1% level and the magnitude is comparable to that of USD. The RMB has exerted the same power on KWR movements as the US dollar, measured by the size of the USD and CNY coefficients, the former being 0.7693 and the latter 0.7969. The RMB effect is also substantial on IRD, MYR, INR and THB, with the CNY coefficient being highly significant at 1% level and its magnitude being over one quarter to half of the corresponding USD coefficient. The RMB has transcended the euro in impacting currency movements in Asia except Turkey. Turkey spans Asia and Europe and trades much with the EU. The Turkish TRY naturally co-moves with the euro. The EUR coefficient, at 0.8270 and being significant at 1% level, is much higher than the USD coefficient of 0.4880 in magnitude. The Mongolian MNT appears to be exclusively attached to the US dollar, though it is classified as floating in a successive series of *Annual Report on Exchange Arrangements and Exchange Restrictions* (IMF 2014, 2018, 2019). The RMB's co-movements with the Kazakhstani KZT is ambiguous, whereas the euro exerts no effect on the currency.

"An internationalized RMB can be a new opportunity for Latin American countries to diversify their sources of finance. …countries and companies can issue RMB-denominated debt." (Arner and Soares 2016, p6). Echoing such development, the reach of the RMB has stretched beyond Asia to Latin America. The RMB plays a significant role in currency movements of the Chilean CLP, Colombian COP and Peruvian PEN. The CNY coefficient is highly significant at 1% level in the Chilean CLP equation, with a magnitude of 0.3092 that is

more than a third of the USD coefficient of 0.6907 and half of the EUR coefficient of 0.5781. The RMB is less instrumental to the movements of Colombian COP and Peruvian PEN nonetheless. Bear in mind that the CR method can be most misrepresentative in the cases of Latin American currencies. The CNY coefficient is significant at 1% level for all the currencies examined, and it is greater or much greater in magnitude than the USD coefficient except the Peruvian PEN, which does not look plausible. The USD coefficient is even insignificant for the Colombian COP and Chilean CLP.

European currency movements are predominantly influenced by the euro. 19 out of 27 EU member countries are in the Eurozone while Danish krone, though outside the Eurozone, is pegged to the euro. Outside the EU, Serbia also maintains a de facto exchange rate anchor to the euro. Among the six emerging economies in the EU and outside the Eurozone, three adopt floating or free floating exchange rate arrangements that are all included. The non-EU countries that adopt free floating or floating regimes, Russia and Ukraine, are covered in this study. It is evident that the Polish PLN, Romanian RON and Hungarian HUF are exclusively moved by the euro. The EUR coefficient is highly significant at 1% level, and moreover, is more than 10 times of the corresponding USD coefficient in magnitude. The USD coefficient is -0.0623, 0.0182 and -0.0941 for the three currencies, against the overriding EUR figures of 1.1545, 1.0020 and 1.1920. The USD coefficient is negative in the Polish PLN and Hungarian HUF equations, indicating that the two currencies offset the appreciation against the euro with the depreciation against the US dollar, albeit to a miniscule extent; and vice versa. The CNY coefficient is significant at a lower level of 10% for the Romanian RON, with its size being a tiny figure of -0.0326. Further away from the Eurozone, the influence of the euro goes down while that of the US dollar rises. The Ukraine UAH, similar to the Mongolian MNT, turns up to be exclusively connected to the US dollar, though it is classified as floating in a successive

series of *Annual Report on Exchange Arrangements and Exchange Restrictions* (IMF 2014, 2018, 2019).

The RMB, alongside the euro, has reached Africa where the US dollar nonetheless dominates currency movements overall. The USD coefficient is exclusively significant at 1% level for the Tanzanian TZS, Kenyan KES, Ugandan UGX, Mozambican MZN and Malawian MWK. Whereas the EUR and CNY coefficients are insignificant and tiny in size. However, the CNY coefficient is highly significant at 1% level in the Ghanaian GHS equation with a considerable clout. With a figure of 0.2658, it is a quarter of the USD coefficient of 1.0439, while the EUR coefficient is insignificant and tiny. Notwithstanding, the euro is the most powerful force driving the movement of the South African ZAR. South Africa, going through the Portuguese exploration and the Dutch and British colonization, has strong heritage connections to Europe and in particular the Eurozone. The EUR coefficient is highly significant at 1% level and its size, 0.9548, is three times of that of the USD coefficient of 0.3240. With the emerging role of the RMB and euro on the African continent, it can be expected that their influence will grow nearer that of the US dollar over time.

{Table 4 about here}

Let us have a brief look at the results produced by the MUIRR method, together with a cogent comparison between the four of RIV, CR, UIRR and MUIRR, as reported in Table 3 and Table 4. Generally, the RMB is considered to exert effects on the movements of more currencies, assessed by the results of the MUIRR method than the RIV model. In contrast, the alternations of the euro effects are the opposite. The CNY coefficient becomes significant in estimation for additional 10 currencies. It becomes insignificant for the Romanian RON. Out of the 27 currencies, the size of the CNY coefficient changes little, except the Turkish TRY,

South African ZAR, Brazilian BRL, Mexican MXN and Russian RUB. The MUIRR results make the EUR coefficient, which is significant by the RIV, insignificant for three currencies. The MUIRR method does not alter the estimate of the USD coefficient qualitatively from the RIV results. The double counting effect is evident by comparing the UIRR with the CR estimates. For all the 27 currencies, the CNY coefficient, as well as the EUR coefficient, remains exactly the same, whereas the USD coefficient increases by an amount given by equation (7d'), resulting in double counting. The intercept also increases by an amount decided by equation (7c'). In contrast, the CR method, while maintain the patterns for the EUR and CNY coefficients qualitatively, makes the USD coefficient that is significant by the RIV, insignificant for five currencies. More worryingly, the magnitude of the USD coefficient is much smaller than that of the CNY coefficient. Considering the instances where the USD coefficient is significant, the USD coefficient is greater than the CNY coefficient only in the Peruvian PEN case in the US backyard; the former is smaller than the latter in the rest of the Brazilian BRL, Mexican MXN and Argentine ARS. It has been made clear that the CR method misrepresents coefficient estimates beyond the bearable margins and distorts the roles of the currencies fundamentally. Whereas the MUIRR model, after removing double counting in the UIRR model, may be used to supplement the RIV method with caution.

5. Further discussion and reflection

Exchange rate dynamics is associated with trade and settlement. Exchange rate movements have an effect on trade, one of the transmission channels being exchange rate pass-through. Exchange rate changes cause import/export prices to change, which in turn have an effect on imports/exports in corresponding to respective demand elasticities. Moreover, it has been acknowledged that exchange rates and prices are both endogenous variables and will be jointly determined by other shocks. The general implications and findings are that exchange rate

movements respond to shocks to macroeconomic variables, import/export prices being important ones. The larger the import/export volume, the larger the price effect. This builds an intrinsic association between trade and exchange rate movements. The US, Eurozone and China are the three leading and largest trading economies in the world. Over the period 2014 – 2019, their world export share is 12.77%, 24.10% and 12.90% and their world import share is 8.45%, 24.92% and 13.91% respectively, IMF Direction of Trade Statistics show (IMF 2020). Thus the US, Eurozone and China are amongst the largest trade partners of many countries around the world. Table 5 presents the trade profiles of the 27 countries examined in this paper, using the latest updated data retrieved in 2020 from WITS TradeStat Database of World Integrated Trade Solution, the World Bank (WITS 2020). The top five trading partners of these 27 countries are listed and ranked in import and export market shares. It can be observed that China trade massively with most of these countries and dominates the export market in terms of trade share. China is the largest exporter for 16 out of the 27 countries and the second largest for nine of them in terms of import share into these countries; China is the fourth and fifth for the rest two countries: Hungary and Romania. The US is the largest export for two Latin American countries: Mexico and Colombia, and the second largest for six countries, three of them in Latin America: Brazil, Peru and Chile. Whereas the Eurozone is the largest exporter for three European countries: Poland, Romania and Hungary, and the second largest for South Africa and Russia. With regard to export markets of these 27 countries, the spread is rather even. The Eurozone is the largest export destination for nine of them and the second largest for two. China is the largest export destination for eight countries and the second largest for four. While the US is the largest export destination for four countries and the second largest for six. Figure 1 exhibits the scatter charts for the relationships between exchange rate co-movements and trade shares. The overwhelming export of China to these countries would flatten patterns using the measure of export share of the US, Eurozone and China. Therefore the export market

share of the 27 countries in the US, Eurozone and China is used in Figure 1 for trade links. The vertical axis is trade share in percentage and the horizontal axis is exchange rate co-movements by the RIV coefficients. (a), (b) and (c) of Figure 1 show the trade and exchange rate co-movements of the US, Eurozone and China vis-à-vis the 27 countries, while (d) of Figure 1 combines them together. The charts demonstrate certain associations between trade and exchange rate co-movements. There are obvious outliers nonetheless. Nearly 93 percent of exports of Mongolia, which shares the longest border with China, go to China. While there is almost none co-movements in the Mongolian currency with the RMB as well as the euro, which casts doubt on the credibility of the Mongolian MNT being classified as floating. Whereas the Mexican share of exports to the US is particularly large - 76 percent - nearly three times of the second largest of 27 percent share of the Colombian exports to the US. The Eurozone pattern exhibits most conformities, with no particularly bulky shares in trade with these countries. At large, trade is one of the instrumental macroeconomic variables in an endogenous exchange rate pass-through mechanism, setting off exchange rate co-movements between the currencies of trading partners.

{Table 5 about here}

{Figure 1 about here}

Use of a currency is beyond the necessity of trade and settlements. Raes (2018) has pointed out that there are a number of critical success factors necessary for widespread adoption of the RMB, including: pervasive connectivity, optimized products and services, and community engagement and standards (*cf.* RMB Tracker 2018, p3). Empirically, Chey *et al*. (2019) assess RMB internationalization by testing a sample countries' possessions of the three key RMB policy infrastructures: RMB swaps, RMB Qualified Foreign Institutional Investor (RQFII) and RMB clearing banks. Whereas Cai (2022) concludes "the probability of the RMB

being an anchor currency increases with the higher degree of trade integration, higher investment dependence, better RMB infrastructure and closer policy cooperation" (p9). Currency co-movements would be an illusory representation of the actual influence of a currency without achieving a real status of an international currency. The last decade has witnessed the instigation of and growth in cross-border RMB settlements. The RMB had been China's 2nd largest cross-border settlement currency for eight consecutive years by the end of 2018 (PBOC 2019), increasing by 24.1% in 2019 and 44.3% in 2020 on a yearly basis respectively (PBOC 2020, 2021). Despite very rapid growth however, until the most recently, the absolute volumes are much smaller compared with the payments and settlements made in the US dollar and euro, so are the shares of the RMB in total payments and settlements, as RMB Tracker (2022) indicates. The relative significance of the RMB as an international currency vis-à-vis the US dollar and euro is well summarized by International Monetary Institute (2021). The RMB internationalization index (RII), a weighted average of the RMB's shares in the global monetary system as an invoice, settlement, and reserve currency, just reached 5.02 in 2020, in spite of a sharp increase of 54.20% over the previous year. In contrast, the internationalization index values of the US dollar and euro have swung stably, with the latest 2020 figures being 51.27 and 26.17 respectively. Our results by the residual-based instrumental variables method for bias correction are consistent to such a scenario. While acknowledging the emerging influence of the RMB, our results have demonstrated that the tri-polar international monetary system, as advocated optimistically by a number of prior studies, remains at an early stage. It is transpiring.

Meanwhile, the infrastructure for the cross-border use of the RMB has been developed and further improved. RQFII was implemented in 2011 while the Cross-border Interbank Payment System (CIPS) (phase I) was launched in 2015, with CIPS (phase II) following in 2018. "By the end of 2020, the RMB clearing business of CIPS reached out to more than 3,300

corporate bodies of banks in 171 countries and regions around the world through direct and indirect participation" (PBOC 2021, pp20-21). CIPS handled a total of 2.21 million cross-border RMB transactions with an overall volume of RMB 45.27 trillion yuan in 2020, according to PBOC (2021). Significant efforts have been made in central bank cooperation. PBOC signed MOU with overseas central banks or monetary authorities, established RMB clearing arrangements in 25 countries and regions. Since 2008, PBOC signed bilateral local currency swap agreements with central banks or monetary authorities of 40 countries and regions, with a total amount of over ¥3.99 trillion (PBOC 2021). The RMB these countries receive through the swap could be exchanged into other currencies, increasing the acceptance and use of the RMB outside China. All of these have promoted the cross-border RMB use and made the RMB an integrated ingredient in the international monetary system and international settlement. RMB internationalization has traveled a prolonged journey. Since 2005, China's international trade and investment activities have developed enormously, while its international confidence has transpired and grown in a global economic environment that is ripe for RMB internationalization. Arises the influence of the RMB against this backdrop, in driving currency co-movements alongside the US dollar and the euro.

6. Summary

The emerging influence of the RMB on currency co-movements has been examined in this paper, in the context of a transpiring tri-polar international monetary system advocated in prior studies. This study is empirically conducted against the backdrop of a more variable RMB exchange rate regime that has shifted towards greater flexibility away from its previous US dollar linked band management approaches. The shift has helped facilitate the integration of the RMB into the international monetary system. The change has made research on RMB exchange rate co-movements feasible and meaningful.

The influence of the RMB is found most evident in Asia, being modest in Latin America while reaching Africa. The RMB co-moves most and considerably with the currencies of countries that have cultural similarities and large shares in trade with China. The role of the RMB in effecting currency movements is particularly established on the currencies of South Korea, Indonesia and Malaysia, comparable to the US dollar in significance and magnitude. The RMB has transcended the euro in impacting currency movements in Asia overall. The RMB effect has been stretched out beyond Asia to Latin America. The RMB is in force in moving with the currencies of Chile, Colombia and Peru in Latin America. The RMB, alongside the euro, has reached Africa where the US dollar nonetheless dominates currency movements overall. Whereas European currency movements are predominantly influenced by the euro. Evidence is found in one of the African countries, Ghana, where the impact of the RMB is significant with a considerable clout. The role of the RMB in Europe is still fairly marginal.

The above modest assessment on the RMB effect is based on the results of the RIV model developed in this paper. The RMB is considered to exert effects on the movements of more currencies, gauged by the results of MUIRR, a minor modified model. Whereas the CR, conventional regression, makes the RMB more powerful than the US dollar in driving currency co-movements with higher significance and magnitudes even in the US backyard of Latin America, which seems implausible. The three sets of results in contrast reconcile the prior studies that have produced different results regarding the extents to which the RMB moves the currency market. Part of the US dollar effect as common factor instigator is likely attributed to the RMB in some cases. Comparing the results by the different models confirms that common factors prevail in foreign exchange markets due to systematic embeddedness, which should be addressed to arrive at right interpretations.

Hence there is a necessity for taking out the misrepresentation in coefficient estimates arising from the dominance of common factors, which exists in foreign exchange markets as well as in other markets to varied degrees. For this reason a residual-based instrumental variables model has been proposed in this study specifically for dealing with issues of common factor dominance. The model and procedure developed in this paper for bias correction can therefore be applied to studies of currency co-movements, as well as research where there is a noticeable effect of common factor dominance.

The emerging influence of the RMB on currency co-movements is expedited by the mass of China's economy, the country's bulky share in international trade and its momentous overseas investments. It arises at the time when a multiple-reserve currency system is coming, and the RMB is included as the third largest currency in the SDR basket. During this period, China's interaction with IFIs has entered the stage of full integration, evident by the establishment of NDB and AIIB. The rising role of China in GFG and IFIs has shored up the RMB on the world stage and regional arenas. The infrastructure for the cross-border use of the RMB has been developed and further improved. Significant efforts have been made in central bank cooperation while overseas RMB clearing arrangements have been established. The RMB has increasingly integrated into the international monetary system as one of the major players, effecting currency market movements considerably alongside the US dollar and euro.

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Tables

Table 1a. Standard deviations of changes in RMB exchange rates vis-à-vis US dollar in contrast with exchange rates of major selected currencies vis-à-vis US dollar

Regime	CNY/USD	EUR/USD	JPY/USD	GBP/USD	INR/USD	BRL/USD	ZAR/USD	RUB/USD
0.3%	0.000645	0.004688	0.005148	0.004935	0.002920	0.008048	0.008824	0.002200
0.5%i	0.001217	0.004981	0.007182	0.005025	0.003404	0.008728	0.009718	0.002863
0.5%ii	0.001197	0.007126	0.006050	0.005698	0.004685	0.007709	0.010033	0.006300
1%	0.000792	0.004874	0.006295	0.004256	0.006132	0.006920	0.008597	0.005778
2%	0.001153	0.005685	0.004782	0.004296	0.003138	0.009753	0.007192	0.018780
Cp	0.002378	0.004712	0.005650	0.006383	0.003161	0.009692	0.010551	0.009335

IBAN currency codes are used to stand for pertinent currencies

Table 1b. Standard deviations of changes in RMB exchange rates vis-à-vis major selected currencies

Regime	CNY/USD	CNY/EUR	CNY/JPY	CNY/GBP	CNY/INR	CNY/BRL	CNY/ZAR	CNY/RUB
0.3%	0.000645	0.004666	0.005097	0.004909	0.002917	0.008021	0.008791	0.002224
0.5%i	0.001217	0.004943	0.007085	0.005107	0.003569	0.008742	0.009854	0.002949
0.5%ii	0.001197	0.007000	0.006116	0.005636	0.004441	0.007639	0.009910	0.006228
1%	0.000792	0.004856	0.006373	0.004251	0.006069	0.006908	0.008551	0.005710
2%	0.001153	0.005740	0.004788	0.004333	0.003214	0.009776	0.007192	0.018744
Cp	0.002378	0.004845	0.005935	0.006335	0.003327	0.009639	0.010244	0.009277

IBAN currency codes are used to stand for pertinent currencies

Table 2. Correlation coefficients between changes in RMB exchange rate vis-à-vis US dollar and exchange rates of major selected currencies vis-à-vis US dollar

Regime	CNY/USD: EUR/USD	CNY/USD: JPY/USD	CNY/USD: GBP/USD	CNY/USD: INR/USD	CNY/USD: BRL/USD	CNY/USD: ZAR/USD	CNY/USD: RUB/USD
0.3%	0.103529	0.140876	0.105463	0.115088	0.082240	0.086261	0.108533
0.5%i	0.152990	0.163897	0.053485	0.040024	0.058039	-0.050336	0.141350
0.5%ii	0.188061	0.043529	0.156644	0.326270	0.136103	0.162236	0.155549
1%	0.103623	-0.035891	0.099799	0.143829	0.072263	0.103781	0.154376
2%	0.053802	0.115647	0.101638	0.117061	0.038997	0.080242	0.062065
Cp	0.195739	0.087538	0.206161	0.304185	0.145054	0.239960	0.151755

IBAN currency codes are used to stand for pertinent currencies

Table 3. Currency co-movements with US dollar, euro and RMB

Indian INR

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	0.13^{E-3}	8.90^{E-5}	1.4774	8.88^{E-5}	8.69^{E-5}	1.0216	0.13^{E-3}	8.68^{E-5}	1.5244	0.13^{E-3}
USD	0.9346‡	0.0202	46.3340	0.5831‡	0.0387	15.0691	0.9397‡	0.0197	47.7636	0.9397‡
EUR	0.0930‡	0.0337	2.7575	0.0573*	0.0330	1.7367	0.0573*	0.0330	1.7367	0.0573*
CNY	0.2776‡	0.0403	6.8951	0.3942‡	0.0373	10.5786	0.3942‡	0.0373	10.5786	0.2536‡

* significant at 10% level; † significant at 5% level; ‡ significant at 1% level. Apply to all parts of Table 3.

Indonesian IDR

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	0.13^{E-3}	0.11^{E-3}	1.2052	6.71^{E-5}	1.04^{E-4}	0.6438	0.13^{E-3}	1.04^{E-4}	1.2598	0.13^{E-3}
USD	0.8500‡	0.0245	34.7583	0.3326‡	0.0465	7.1601	0.8575‡	0.0236	36.3102	0.8575‡
EUR	0.1678‡	0.0409	4.1036	0.1147‡	0.0396	2.8990	0.1147‡	0.0396	2.8990	0.1147‡
CNY	0.4247‡	0.0488	8.6990	0.5803‡	0.0447	12.9741	0.5803‡	0.0447	12.9741	0.2757‡

Philippine PHP

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	9.05^{E-5}	7.31^{E-5}	1.2386	5.49^{E-5}	7.14^{E-5}	0.7686	9.12^{E-5}	7.14^{E-5}	1.2777	9.12^{E-5}
USD	0.9302‡	0.0166	56.1819	0.6375‡	0.0318	20.0381	0.9344‡	0.0162	57.7331	0.9344‡
EUR	0.0638†	0.0277	2.3062	0.0337	0.0271	1.2448	0.0337	0.027	1.2448	0.0337
CNY	0.2438‡	0.0331	7.3772	0.3283‡	0.0306	10.7160	0.3283‡	0.0306	10.7160	0.2308‡

Turkish TRY

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	$6.91^{E-4\dagger}$	2.96^{E-4}	2.3370	$6.50^{E-4\dagger}$	2.95^{E-4}	2.2040	$6.92^{E-4\dagger}$	2.95^{E-4}	2.3475	$6.92^{E-4\dagger}$
USD	0.4880‡	0.0670	7.2821	0.1519	0.1314	1.1561	0.4921‡	0.0668	7.3681	0.4921‡
EUR	0.8270‡	0.1120	7.3828	0.7979‡	0.1119	7.1285	0.7979‡	0.1119	7.1285	0.7979‡
CNY	0.0786	0.1338	0.5878	0.3761‡	0.1265	2.9735	0.3761‡	0.1265	2.9735	0.2482‡

Thai THB

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	-6.60^{E-5}	7.62^{E-5}	-0.8619	-0.11^{E-3}	7.36^{E-5}	-1.4636	-0.65^{E-4}	7.35^{E-5}	-0.2287	-0.65^{E-4}
USD	0.8600‡	0.0173	49.7996	0.5143‡	0.0328	15.6924	0.8649‡	0.0167	51.9094	0.8649‡
EUR	0.1083‡	0.0289	3.7506	0.0735‡	0.0279	2.6312	0.0735‡	0.0279	2.6312	0.0735‡
CNY	0.2607‡	0.0345	7.5627	0.3876‡	0.0316	12.2830	0.3876‡	0.0316	12.2830	0.2517‡

South Korean KRW

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	8.1^{E-5}	1.37^{E-4}	0.5898	-2.40^{E-5}	1.31^{E-4}	-0.1810	0.83^{E-4}	1.31^{E-4}	0.6330	0.83^{E-4}
USD	0.7693‡	0.0311	24.7177	-0.0926	0.0585	-1.5835	0.7821‡	0.0297	26.2973	0.7821‡
EUR	0.1241†	0.0520	2.3845	0.0333	0.0498	0.6685	0.0333	0.0498	0.6685	0.0333
CNY	0.7969‡	0.0621	12.8266	0.9671‡	0.0563	17.1688	0.9671‡	0.0563	17.1688	0.1212‡

Malaysian MYR

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	9.51^{E-5}	1.12^{E-4}	0.8478	3.34^{E-5}	1.08^{E-4}	0.3097	9.63^{E-5}	1.08^{E-4}	0.8928	9.63^{E-5}
USD	0.8545‡	0.0254	33.6015	0.3470‡	0.0481	7.2179	0.8616‡	0.0244	35.2495	0.8616‡
EUR	0.0726*	0.0425	1.7079	0.0224	0.0410	0.5467	0.0224	0.0410	0.5467	0.0224
CNY	0.3508‡	0.0508	6.9095	0.5689‡	0.0463	12.2886	0.5689‡	0.0463	12.2886	0.2762‡

Kazakhstani KZT

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	7.38^{E-4}†	2.99^{E-4}	2.4631	7.09^{E-4}†	0.30^{E-3}	2.3673	7.38^{E-4}†	0.30^{E-3}	2.4668	7.38^{E-4}†
USD	0.8998‡	0.0679	13.2582	0.6658‡	0.1334	4.9903	0.9032‡	0.0678	13.3168	0.9032‡
EUR	0.0765	0.1135	0.6743	0.0521	0.1137	0.4580	0.0521	0.1137	0.4580	0.0521
CNY	0.2091	0.1355	1.5432	0.2625†	0.1285	2.0435	0.2625†	0.1285	2.0435	0.2002†

Mongolian MNT

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	2.75^{E-4}‡	5.68^{E-5}	4.8402	2.73^{E-4}‡	5.68^{E-5}	4.8030	2.75^{E-4}‡	5.68^{E-5}	4.8417	2.75^{E-4}‡
USD	1.0076‡	0.0129	78.3021	0.9922‡	0.0253	39.2012	1.0078‡	0.0129	78.3201	1.0078‡
EUR	0.0151	0.0215	0.7020	0.0138	0.0216	0.6410	0.0138	0.0216	0.6410	0.0138
CNY	0.0015	0.0257	0.0601	0.0172	0.0244	0.7066	0.0172	0.0244	0.7066	0.0170

South African ZAR

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	2.41^{E-4}	2.87^{E-4}	0.8404	1.52^{E-4}	2.82^{E-4}	0.5371	2.43^{E-4}	2.82^{E-4}	0.8610	2.43^{E-4}
USD	0.3240‡	0.0650	4.9814	-0.4130‡	0.1257	-3.2866	0.3330‡	0.0639	5.2133	0.3330‡
EUR	0.9548‡	0.1087	8.7806	0.8909‡	0.1071	8.3210	0.8909‡	0.1071	8.3210	0.8909‡
CNY	0.1756	0.1299	1.3520	0.8248‡	0.1210	6.8168	0.8248‡	0.1210	6.8168	0.2095‡

Tanzanian TZS

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	7.67^{E-5*}	4.49^{E-5}	1.7082	7.38^{E-5}	4.50^{E-5}	1.6407	7.68^{E-5*}	4.49^{E-5}	1.7099	7.68^{E-5*}
USD	1.0121‡	0.0102	99.4207	0.9876‡	0.0200	49.3282	1.0124‡	0.0102	99.4654	1.0124‡
EUR	-0.0171	0.0170	-1.0030	-0.0197	0.0171	-1.1541	-0.0197	0.0171	-1.1541	-0.0197
CNY	0.0244	0.0203	1.2024	0.0274	0.0193	1.4218	0.0274	0.0193	1.4218	0.0267

Kenyan KES

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	3.50^{E-5}	4.77^{E-5}	0.7328	3.43^{E-5}	4.78^{E-5}	0.7184	3.50^{E-5}	4.77^{E-5}	0.7330	3.50^{E-5}
USD	0.9750‡	0.0108	90.1230	0.9697‡	0.0213	45.5595	0.9751‡	0.0108	90.1155	0.9751‡
EUR	0.0204	0.0181	1.1302	0.0201	0.0181	1.1089	0.0201	0.0181	1.1089	0.0201
CNY	-0.0037	0.0216	-0.1694	0.0060	0.0205	0.2912	0.0060	0.0205	0.2912	0.0059

Ugandan UGX

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	6.21^{E-5}	1.03^{E-4}	0.6014	5.13^{E-5}	1.03^{E-4}	0.4974	6.22^{E-5}	1.03^{E-4}	0.6043	6.22^{E-5}
USD	1.0322‡	0.0234	44.1348	0.9436‡	0.0459	20.5454	1.0334‡	0.0234	44.2555	1.0334‡
EUR	-0.0010	0.0391	-0.0257	-0.0092	0.0391	-0.2359	-0.0092	0.0391	-0.2359	-0.0092
CNY	0.0414	0.0467	0.8873	0.0992†	0.0442	2.2429	0.0992†	0.0442	2.2429	0.0903†

Mozambican MZN

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	4.46^{E-4*}	2.64^{E-4}	1.6889	4.50^{E-4*}	2.65^{E-4}	1.7024	4.50^{E-4*}	2.64^{E-4}	1.6888	4.50^{E-4*}
USD	1.0017‡	0.0599	16.7260	1.0351‡	0.1178	8.7847	1.0016‡	0.0599	16.7199	1.0016‡
EUR	0.0006	0.1001	0.0063	0.0017	0.1004	0.0172	0.0017	0.1004	0.0172	0.0017
CNY	0.0584	0.1196	0.4886	-0.0371	0.1135	-0.3268	-0.0371	0.1135	-0.3268	-0.0383

Ghanaian GHS

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	3.04^{E-4}	1.93^{E-4}	1.5742	2.75^{E-4}	1.93^{E-4}	1.4266	3.04^{E-4}	1.93^{E-4}	1.5777	3.04^{E-4}
USD	1.0439‡	0.0437	23.8748	0.8114‡	0.0860	9.4353	1.0476‡	0.0437	23.9611	1.0476‡
EUR	-0.0977	0.0731	-1.3364	-0.1235	0.0733	-1.6859	-0.1235	0.0733	-1.6859	-0.1235
CNY	0.2658‡	0.0873	3.0452	0.2611‡	0.0828	3.1531	0.2611‡	0.0828	3.1531	0.1994‡

Malawian MWK

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	2.82^{E-4}‡	8.38^{E-5}	3.3686	2.80^{E-4}‡	8.39^{E-5}	3.3316	2.82^{E-4}‡	8.38^{E-5}	3.3686	2.82^{E-4}‡
USD	0.9994‡	0.0190	52.6118	0.9769‡	0.0374	26.1355	0.9998‡	0.0190	52.6135	0.9998‡
EUR	-0.0024	0.0318	-0.0753	-0.0052	0.0318	-0.1640	-0.0052	0.0318	-0.1640	-0.0052
CNY	0.0380	0.0379	1.0023	0.0253	0.0360	0.7030	0.0253	0.0360	0.7030	0.0247

Brazilian BRL

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	3.13^{E-4}	2.75^{E-4}	1.1402	2.62^{E-4}	2.73^{E-4}	0.9582	3.14^{E-4}	2.73^{E-4}	1.1507	3.14^{E-4}
USD	0.6666‡	0.0623	10.7039	0.2435†	0.1217	2.0010	0.6713‡	0.0619	10.8509	0.6713‡
EUR	0.5278‡	0.1041	5.0699	0.4944‡	0.1037	4.7673	0.4944‡	0.1037	4.7673	0.4944‡
CNY	-0.0171	0.1243	-0.1377	0.4730‡	0.1172	4.0364	0.4730‡	0.1172	4.0364	0.2706‡

Mexican MXN

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	3.19^{E-4}	2.25^{E-4}	1.4146	2.70^{E-4}	2.24^{E-4}	1.2096	3.20^{E-4}	2.22^{E-4}	1.4304	3.20^{E-4}
USD	0.7329‡	0.0511	14.3491	0.3360‡	0.0996	3.3733	0.7375‡	0.0506	14.5647	0.7375‡
EUR	0.5834‡	0.0854	6.8327	0.5508‡	0.0849	6.4903	0.5508‡	0.0849	6.4903	0.5508‡
CNY	0.0272	0.1020	0.2664	0.4439‡	0.0959	4.6287	0.4439‡	0.0959	4.6287	0.2657‡

Colombian COP

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	2.81^{E-4}	2.48^{E-4}	1.1330	2.10^{E-4}	2.45^{E-4}	0.8570	2.82^{E-4}	2.44^{E-4}	1.1546	2.82^{E-4}
USD	0.6940‡	0.0562	12.3513	0.1078	0.1089	0.9900	0.7014‡	0.0554	12.6651	0.7014‡
EUR	0.5274‡	0.0939	5.6149	0.4747‡	0.0928	5.1138	0.4747‡	0.0928	5.1138	0.4747‡
CNY	0.2102*	0.1122	1.8742	0.6562‡	0.1049	6.2563	0.6562‡	0.1049	6.2563	0.2667‡

Argentine ARS

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	1.59^{E-3}‡	4.57^{E-4}	3.4795	1.55^{E-3}‡	4.57^{E-4}	3.3891	1.59^{E-3}‡	4.56^{E-4}	3.4855	1.59^{E-3}‡
USD	0.7145‡	0.1036	6.8972	0.3728*	0.2035	1.8316	0.7190‡	0.1035	6.9490	0.7190‡
EUR	0.6522‡	0.1732	3.7666	0.6197‡	0.1734	3.5732	0.6197‡	0.1734	3.5732	0.6197‡
CNY	0.1896	0.2068	0.9167	0.3828*	0.1960	1.9533	0.3828*	0.1960	1.9533	0.2503*

Peruvian PEN

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	8.52^{E-5}	9.28^{E-5}	0.9177	6.16^{E-5}	9.19^{E-5}	0.6670	8.56^{E-5}	9.19^{E-5}	0.9324	8.56^{E-5}
USD	0.8776‡	0.0210	41.7140	0.6834‡	0.0409	16.6972	0.8801‡	0.0208	42.2964	0.8801‡
EUR	0.1858‡	0.0352	5.2821	0.1681‡	0.0349	4.8215	0.1681‡	0.0349	4.8215	0.1681‡
CNY	0.0754*	0.0420	1.7953	0.2174‡	0.0394	5.5178	0.2174‡	0.0394	5.5178	0.1747‡

Chilean CLP

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	1.87^{E-4}	1.79^{E-4}	1.0456	1.19^{E-4}	1.75^{E-4}	0.6764	1.89^{E-4}	1.75^{E-4}	1.0765	1.89^{E-4}
USD	0.6907‡	0.0406	16.9961	0.1250	0.0782	1.6000	0.6983‡	0.0397	17.5745	0.6983‡
EUR	0.5781‡	0.0679	8.5101	0.5244‡	0.0666	7.8743	0.5244‡	0.0666	7.8743	0.5244‡
CNY	0.3092‡	0.0811	3.8111	0.6337‡	0.0753	8.4216	0.6337‡	0.0753	8.4216	0.2705‡

Russian RUB

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	1.82^{E-4}	2.68^{E-4}	0.6809	1.22^{E-4}	2.65^{E-4}	0.4608	1.83^{E-4}	2.65^{E-4}	0.6909	1.83^{E-4}
USD	0.8513‡	0.0607	14.0334	0.3585‡	0.1182	3.0335	0.8568‡	0.0601	14.2599	0.8568‡
EUR	0.3770‡	0.1014	3.7181	0.3377‡	0.1007	3.3531	0.3377‡	0.1007	3.3531	0.3377‡
CNY	-0.0062	0.1211	-0.0510	0.5509‡	0.1138	4.8409	0.5509‡	0.1138	4.8409	0.2764‡

Ukraine UAH

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	2.21^{E-4}	1.79^{E-4}	1.2317	2.18^{E-4}	1.80^{E-4}	1.2153	2.21^{E-4}	1.79^{E-4}	1.2320	2.21^{E-4}
USD	0.8782‡	0.0406	21.6082	0.8559‡	0.0800	10.7041	0.8785‡	0.0406	21.6126	0.8785‡
EUR	0.0790	0.0679	1.1629	0.0770	0.0681	1.1307	0.0770	0.0681	1.1307	0.0770
CNY	0.0066	0.0811	0.0807	0.0251	0.0770	0.3254	0.0251	0.0770	0.3254	0.0245

Polish PLN

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	6.41^{E-5}	8.96^{E-5}	0.7148	4.41^{E-5}	8.90^{E-5}	0.4953	6.44^{E-5}	8.89^{E-5}	0.7249	6.44^{E-5}
USD	-0.0623‡	0.0203	-3.0642	-0.2269‡	0.0396	-5.7262	-0.0602‡	0.0201	-2.9881	-0.0602‡
EUR	1.1545‡	0.0340	33.9909	1.1398‡	0.0338	33.7623	1.1398‡	0.0338	33.7623	1.1398‡
CNY	0.0555	0.0406	1.3694	0.1843‡	0.0381	4.8307	0.1843‡	0.0381	4.8307	0.1536‡

Romanian RON

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	7.80^{E-5*}	4.05^{E-5}	1.9277	7.89^{E-5}	4.06^{E-5}	1.9458	7.80^{E-5}	4.05^{E-5}	1.9246	7.80^{E-5}
USD	0.0182†	0.0092	1.9791	0.0257	0.0181	1.4222	0.0179*	0.0092	1.9535	0.0179*
EUR	1.0020‡	0.0153	65.3537	1.0035‡	0.0154	65.1893	1.0035‡	0.0154	65.1893	1.0035‡
CNY	-0.0326*	0.0183	-1.7822	-0.0086	0.0174	-0.4927	-0.0086	0.0174	-0.4927	-0.0086

Hungarian HUF

	RIV			CR			UIRR			MUIRR
	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef	Std err	*t* stat	Coef
Intercept	1.08^{E-4}	8.31^{E-5}	1.3009	9.42^{E-5}	8.27^{E-5}	1.1383	1.08^{E-4}	8.27^{E-5}	1.3104	1.08^{E-4}
USD	-0.0941‡	0.0188	-4.9948	-0.2083‡	0.0369	-5.6526	-0.0927‡	0.0187	-4.9473	-0.0927‡
EUR	1.1920‡	0.0315	37.8646	1.1823‡	0.0314	37.6490	1.1823‡	0.0314	37.6490	1.1823‡
CNY	0.0205	0.0376	0.5457	0.1278‡	0.0355	3.6025	0.1278‡	0.0355	3.6025	0.1131‡

Table 4. Currency co-movements with US dollar, euro and RMB – qualitative summary

	RIV			CR			UIRR/MUIRR		
	USD	EUR	CNY	USD	EUR	CNY	USD	EUR	CNY
Indian INR	Y‡	Y‡	Y‡	Y‡	Y*	Y‡	Y‡	Y*	Y‡
Indonesian IDR	Y‡	Y‡	Y‡	Y‡	Y‡	Y‡	Y‡	Y‡	Y‡
Philippine PHP	Y‡	Y†	Y‡	Y‡	N	Y‡	Y‡	N	Y‡
Turkish TRY	Y‡	Y‡	N	N	Y‡	Y‡	Y‡	Y‡	Y‡
Thai THB	Y‡	Y‡	Y‡	Y‡	Y‡	Y‡	Y‡	Y‡	Y‡
S. Korean KRW	Y‡	Y†	Y‡	N	N	Y‡	Y‡	N	Y‡
Malaysian MYR	Y‡	Y*	Y‡	Y‡	N	Y‡	Y‡	N	Y‡
Kazakhstani KZT	Y‡	N	N	Y‡	N	Y†	Y‡	N	Y†
Mongolian MNT	Y‡	N	N	Y‡	N	N	Y‡	N	N
S. African ZAR	Y‡	Y‡	N	Y‡	Y‡	Y‡	Y‡	Y‡	Y‡
Tanzanian TZS	Y‡	N	N	Y‡	N	N	Y‡	N	N
Kenyan KES	Y‡	N	N	Y‡	N	N	Y‡	N	N
Ugandan UGX	Y‡	N	N	Y‡	N	Y†	Y‡	N	Y†
Mozambican MZN	Y‡	N	N	Y‡	N	N	Y‡	N	N
Ghanaian GHS	Y‡	N	Y‡	Y‡	N	Y‡	Y‡	N	Y‡
Malawian MWK	Y‡	N	N	Y‡	N	N	Y‡	N	N
Brazilian BRL	Y‡	Y‡	N	Y†	Y‡	Y‡	Y‡	Y‡	Y‡
Mexican MXN	Y‡	Y‡	N	Y‡	Y‡	Y‡	Y‡	Y‡	Y‡
Colombian COP	Y‡	Y‡	Y*	N	Y‡	Y‡	Y‡	Y‡	Y‡
Argentine ARS	Y‡	Y‡	N	Y*	Y‡	Y*	Y‡	Y‡	Y*
Peruvian PEN	Y‡	Y‡	Y*	Y‡	Y‡	Y‡	Y‡	Y‡	Y‡
Chilean CLP	Y‡	Y‡	Y‡	N	Y‡	Y‡	Y‡	Y‡	Y‡
Russian RUR	Y‡	Y‡	N	Y‡	Y‡	Y‡	Y‡	Y‡	Y‡
Ukraine UAH	Y‡	N	N	Y‡	N	N	Y‡	N	N
Polish PLN	Y‡	Y‡	N	Y‡	Y‡	Y‡	Y‡	Y‡	Y‡
Romanian RON	Y†	Y‡	Y*	N	Y‡	N	Y*	Y‡	N
Hungarian HUF	Y‡	Y‡	N	Y‡	Y‡	Y‡	Y‡	Y‡	Y‡

* significant at 10% level; † significant at 5% level; ‡ significant at 1% level.

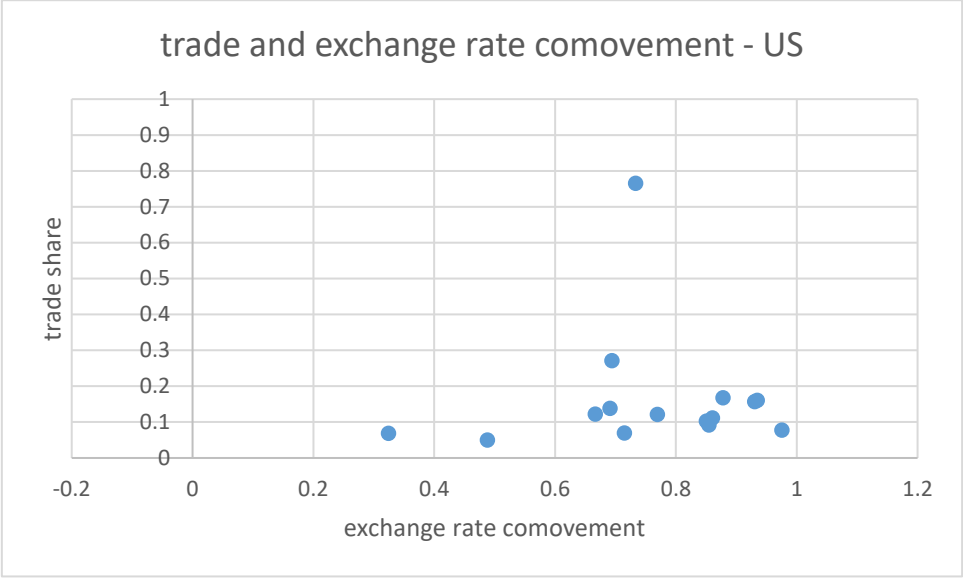
Table 5. Trade share of reporting countries with partners (%)

	Exports to						Imports from				
India	USA	ARE	CHN	HKG	SGP		CHN	USA	SAU	ARE	IRQ
	16.02	8.85	5.08	4.07	3.24		14.63	6.3	5.56	5.2	4.6
Indonesia	CHN	JPN	USA	IND	SGP		CHN	SGP	JPN	THA	USA
	15.05	10.81	10.25	7.62	7.21		24.13	11.36	9.53	5.8	5.41
Philippines	USA	HKG	JPN	CHN	SGP		CHN	KOR	JPN	USA	THA
	15.63	14.16	14.04	12.89	6.27		19.63	10	9.91	7.21	6.91
Turkey	DEU	GBR	ITA	IRQ	USA		RUS	CHN	DEU	USA	UNS
	9.61	6.61	5.69	4.97	4.94		9.86	9.29	9.15	5.55	4.95
Thailand	CHN	USA	JPN	VNM	HKG		CHN	JPN	USA	MYS	ARE
	11.95	11.14	9.88	5.13	4.96		20.05	14.15	6.1	5.36	4.29
S. Korea	CHN	USA	VNM	HKG	JPN		CHN	USA	JPN	SAU	DEU
	26.81	12.08	8.04	7.6	5.05		19.9	11.04	10.2	4.92	3.9
Malaysia	SGP	CHN	USA	HKG	JPN		CHN	SGP	USA	OTH	JPN
	13.94	13.91	9.11	7.47	6.92		19.93	11.72	7.4	7.24	7.24
Kazakhstan	ITA	CHN	NLD	RUS	FRA		RUS	CHN	DEU	ITA	USA
	19.2	10.32	10.12	8.64	6.28		39.33	16	4.87	4.41	3.8
Mongolia	CHN	GBR	RUS	ITA	SGP		CHN	RUS	JPN	KOR	USA
	92.78	2.47	1.23	0.77	0.43		33.51	29.11	9.55	4.47	3.6
S. Africa	CHN	DEU	USA	UUS	GBR		CHN	DEU	USA	SAU	IND
	9.14	7.17	6.79	6.32	5.15		18.45	9.85	5.98	5.84	4.15
Tanzania	RWA	KEN	COD	ZMB	UGA		CHN	IND	ARE	SAU	ZAF
	18.69	9.23	8.48	7.27	5.3		20.7	14.3	10.24	6.67	5.14
Kenya	UGA	PAK	USA	NLD	GBR		CHN	IND	SAU	ARE	JPN
	10.1	9.69	7.72	7.56	6.56		21.07	10.53	9.81	8.38	5.67
Uganda	KEN	ARE	SSD	RWA	COD		CHN	IND	ARE	SAU	KEN
	18.79	18.22	11.52	6.85	6.62		17.6	12.14	11.65	8.99	7.67
Mozambiq	IND	NLD	ZAF	CHN	HKG		ZAF	CHN	ARE	NLD	IND
	27.63	21.23	17.24	5.81	2.39		26.12	11.78	7.65	7.63	7.23
Ghana	IND	CHN	ZAF	CHE	NLD		CHN	USA	BEL	IND	GBR
	21.46	11.88	10.19	9.54	7.19		19.13	8.03	5.82	5.67	5.09
Malawi	BEL	ZAF	TZA	DEU	EGY		ZAF	CHN	IND	ARE	GBR
	21.96	7.81	7.71	5.68	5.55		17.75	14.68	10.92	6.82	5.3
Brazil	CHN	USA	ARG	NLD	CHL		CHN	USA	ARG	DEU	KOR
	26.76	12.16	6.23	5.45	2.66		19.16	16.19	6.1	5.83	4.07
Mexico	USA	UNS	CAN	CHN	DEU		USA	CHN	JPN	DEU	KOR
	76.49	5.48	3.12	1.6	1.57		46.59	17.99	3.92	3.83	3.6
Colombia	USA	CHN	PAN	ECU	TUR		USA	CHN	MEX	BRA	DEU
	27.07	9.7	7.34	4.43	4.04		25.56	20.58	7.71	5.52	4.24
Argentina	BRA	USA	CHN	CHL	VNM		BRA	CHN	USA	DEU	PRY
	18.34	6.95	6.84	4.93	3.41		23.8	18.45	11.76	5.12	3.32
Peru	CHN	USA	IND	KOR	JPN		CHN	USA	BRA	MEX	ECU
	27.64	16.71	5.18	5.14	4.55		23.33	21.27	5.6	4.46	4.46

Chile	CHN	USA	JPN	KOR	BRA		CHN	USA	BRA	ARG	DEU
	33.5	13.79	9.33	5.75	4.49		23.59	18.87	9	4.59	3.93
Russia	CHN	NLD	DEU	BLR	TUR		CHN	DEU	BLR	USA	ITA
	12.41	9.62	7.57	5.05	4.72		21.74	10.62	5.37	5.28	4.4
Ukraine	RUS	POL	ITA	TUR	DEU		RUS	CHN	DEU	BLR	POL
	7.72	6.88	5.55	4.97	4.67		14.15	13.3	10.46	6.62	6.37
Poland	DEU	CZE	GBR	FRA	ITA		DEU	CHN	RUS	ITA	FRA
	28.15	6.36	6.19	5.55	4.6		22.4	11.57	7.34	5.02	3.65
Romania	DEU	ITA	FRA	HUN	GBR		DEU	ITA	HUN	POL	CHN
	22.97	11.43	7.1	4.88	4.25		20.46	9.38	6.86	5.56	5.32
Hungary	DEU	SVK	ITA	ROU	AUT		DEU	AUT	POL	CHN	NLD
	27.27	5.18	5.17	5.13	4.73		25.95	6.1	5.77	5.43	5.12

Sources: World Bank WITS TradeStat Database
ISO Alpha-3 country codes of the ISO 3166-1 international standard are adopted for partner countries

Figures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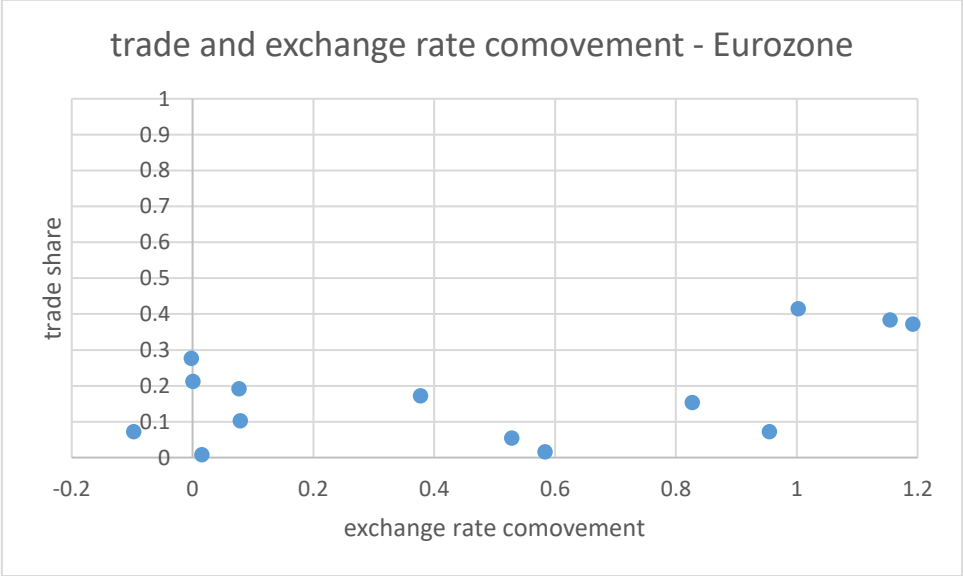
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.2
0
0.2
0.4
0.6
0.8
1
1.2
exchange rate comovement

(a)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0.8
0.7
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0.4
0.3
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0
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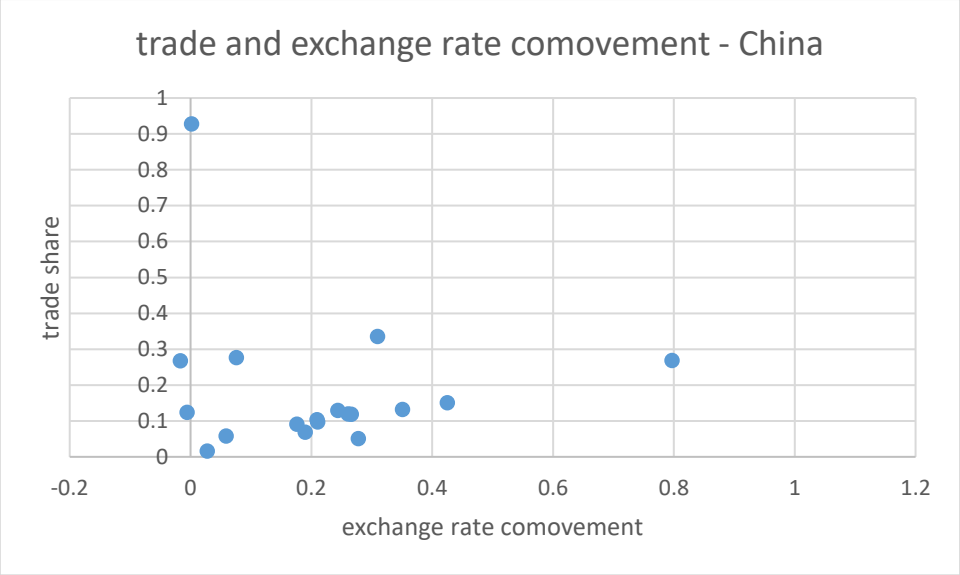
0.4
0.6
0.8
1
1.2
exchange rate comovement

(b)



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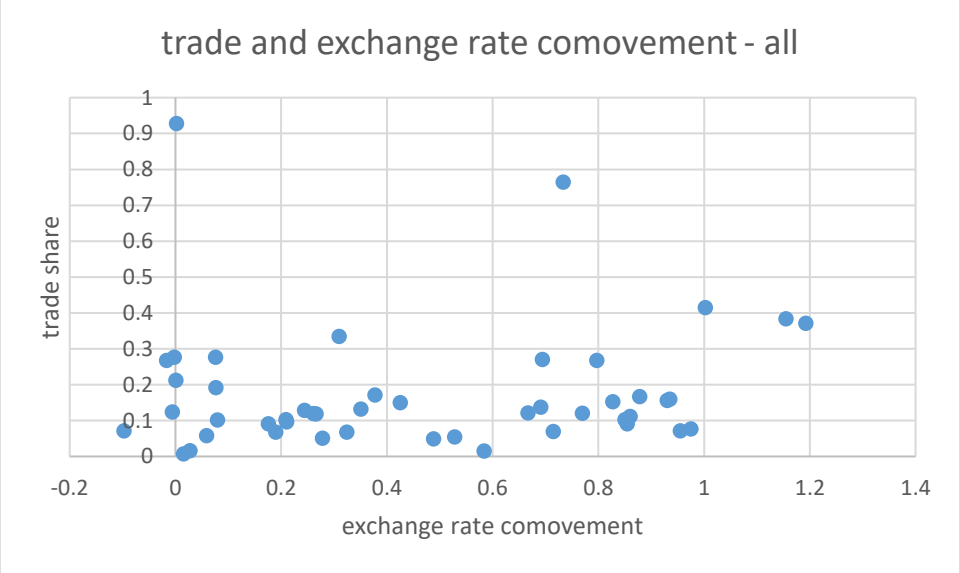

(d)

Figure 1. Trade and exchange rate co-movements