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A Synthetic Chinese Renminbi: Uncovering the Anchor Currencies

Michael Kunkler[1] [a]

[1] Department of Economics, University of Reading, United Kingdom

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We investigate the *de facto* exchange rate arrangements of the Chinese renminbi. A recently enhanced methodology is used to estimate a *synthetic* Chinese renminbi to uncover any *anchor currencies*. We find two anchor currencies, namely the US dollar and the Singapore dollar. However, the average R-squared is only 43.6%. Thus, the Chinese renminbi is less anchored to the US dollar. This implies that future research can classify the Chinese renminbi as a potential anchor currency.

I. Introduction

The motivation for this study is driven by the rise of the Chinese renminbi in the global exchange rate system (see Ilzetzki et al., 2019). For example, in a multipolar global exchange rate system, the Chinese renminbi is expected to be an anchor currency in Asia (Eichengreen, 2011). However, in recent research, the Chinese renminbi was not considered an anchor currency because of its anchor to the US dollar (Ilzetzki et al., 2019). In August 2015, the exchange rate policy of the Chinese renminbi changed in an attempt to transition to a more market-oriented currency. In this study, we test whether the *de facto* exchange rate arrangements of the Chinese renminbi in the post-August 2015 period reflect this change in exchange rate policy.

For three consecutive days, beginning on the 11th of August 2015, the Chinese renminbi experienced a series of devaluations. The devaluations signified a change in the exchange rate regime of the Chinese renminbi from a soft peg to the US dollar to a more market-oriented currency, while remaining as a managed float (Lu et al., 2022). A driving factor behind the regime change was preparation for the inclusion of the Chinese renminbi in the Special Drawing Right of the International Monetary Fund, which occurred in October 2016 (Feng et al., 2022).

The exchange rate regimes of many currencies are explicitly reported through official policy, which represents *de jure* exchange rate arrangements (Ilzetzki et al., 2019). However, many central banks have a *fear of floating*, which can result in their intervention in the exchange rate market to limit extreme fluctuations (Calvo & Reinhart, 2002). For example, a central bank can intervene in the exchange rate market to restrict the fluctuations of their currency around another single currency, or a basket of currencies, which are known as *anchor currencies*. The US dollar is the most important anchor currency, with the Eurozone euro ranked as a distant second (Ilzetzki et al., 2019).

Researchers often evaluate the *de jure* exchange rate arrangements of a currency by estimating a *de facto* (actual) exchange rate (Ilzetzki et al., 2019; Levy-Yeyati & Sturzenegger, 2005; Reinhart & Rogoff, 2004). Methods for estimating *de facto* exchange rates consist of regression analyses, volatility analyses, and central bank reserve analyses (see Frankel & Wei, 1994; Ilzetzki et al., 2019).

The focus of this study is on regression analyses, where the Frankel-Wei regression framework is typically used in the literature. The Frankel-Wei regression framework measures the movements in one currency against the movements in one, or more, other currencies, and assumes that all currencies share a *common numéraire* (Frankel & Wei, 1994). The *common numéraire* is either another currency (*single-currency numéraire*) or a basket of currencies (*multicurrency numéraire*). Recent research on the *choice of numéraire* in the Frankel-Wei regression framework recommends the use of *multicurrency numéraires*, rather than *single-currency numéraires* (Kunkler, 2021).

A recent addition to the regression analysis toolbox for evaluating *de facto* exchange rate arrangements is the concept of synthetic money. A *synthetic currency* is an optimal portfolio of *other* currencies that mimics a *target currency*, without the portfolio having a position in the target currency (Hovanov et al., 2007). For example, a synthetic Chinese renminbi is an optimal portfolio of other currencies that mimics the Chinese renminbi, without holding a Chinese renminbi position. To enforce a zero position in the target currency, the optimal portfolio *must* be subject to a budget constraint such that the portfolio weights sum to zero (Kunkler, 2022).

The objective of this paper is to investigate the *de facto* exchange rate arrangements of the Chinese renminbi in the post-August 2015 period, together with a comparison to

a Corresponding author email: m.kunkler@pgr.reading.ac.uk

the pre-August 2015 period. The investigation involves estimating a *synthetic* Chinese renminbi for a group of ten trading partner currencies to test whether the Chinese renminbi is less anchored to the US dollar in the post-August 2015 period, as well as uncovering any other *anchor currencies*. The synthetic Chinese renminbi is estimated with a *constrained* Frankel-Wei regression model, where the regression coefficients sum to zero and the *common numéraire* is an equally-weighted *multicurrency numéraire* (see Kunkler, 2022).

This study has similarities to Kunkler (2021), which reported that the relationship between the US dollar and the Chinese renminbi had reduced for the two years from 2018 to 2019 when compared to a pre-2016 period. In contrast, this study uses multiple regression variables, as well as the sum-to-zero constraint on the regression coefficients. In addition, the data sample includes another two years of data.

II. Methodology

We first introduce some notations associated with bilateral exchange rates. This is followed by an overview of the decomposition of a system of bilateral exchange rates into a system of relative currency rates, which are multilateral exchange rates. Subsequently, we provide an overview of the estimation of a *synthetic* Chinese renminbi.

A. The price of a currency

A bilateral exchange rate for the ith currency in terms of the jth currency is the price at which the ith currency can be exchanged for the jth currency. A system of N_S bilateral exchange rates (S) with respect to the numéraire $(0th)$ currency can be decomposed into a set of $N_S + 1$ relative currency rates (C) to give:

$$p_{S,t}^{i/0} = p_{C,t}^{i} - p_{C,t}^{0} \tag{1}$$

where $i = 1, \ldots, N_S$, $t = 1, \ldots, T$; $p_{S,t}^{i/0}$ is the $ith/0th$ bilateral exchange rate for the ith currency in terms of the numéraire $(0th)$ currency; $p_{C,t}^{i}$ is the ith relative currency rate; and $p_{C,t}^{0}$ is the $0th$ (numéraire) relative currency rate (see Kunkler & MacDonald, 2015).

A relative currency rate is a unique tradable price of each currency, given by:

$$p_{C,t}^{i} = \frac{1}{N_S + 1} \sum_{j=0}^{N_S} p_{S,t}^{i/j} \tag{2}$$

where $i = 0, \ldots, N_S$, $t = 1, \ldots, T$; $p_{C,t}^{i}$ is the ith relative currency rate; and $p_{S,t}^{i/j}$ is the ith/jth bilateral exchange rate, with:

$$p_{S,t}^{i/j} = p_{S,t}^{i/0} - p_{S,t}^{j/0} = p_{C,t}^{i} - p_{C,t}^{j} \tag{3}$$

The relative currency rate for the ith currency is the price of the ith currency relative to all the currencies in the group of currencies: an equally weighted basket of currencies.

For example, the Chinese renminbi/US dollar bilateral exchange rate can be decomposed into a relative currency rate for the Chinese renminbi and a relative currency rate for the US dollar to give:

$$p_{S,t}^{CNY/USD} = p_{C,t}^{CNY} - p_{C,t}^{USD} \tag{4}$$

where $t = 1, \ldots, T$; $p_{S,t}^{CNY/USD}$ is the Chinese renminbi/US dollar exchange rate; $p_{C,t}^{CNY}$ is the relative currency rate for the Chinese renminbi; and $p_{C,t}^{USD}$ is the relative currency rate for the US dollar.

B. Synthetic Chinese renminbi

In logarithm terms at time t, a synthetic Chinese renminbi is given by:

$$s_{C,t}^{CNY} = \sum_{j=0}^{N_S} I_{(j \neq CNY)} w_{C,t}^{CNY,j} p_{C,t}^{j} \tag{5}$$

subject to a budget constraint such that the portfolio weights sum to zero:

$$\overline{w}_{C,t}^{CNY} = \sum_{j=0}^{N_S} I_{(j \neq CNY)} w_{C,t}^{CNY,j} = 0 \tag{6}$$

where $i = 0, \ldots, N_S$; $t = 0, \ldots, T$; $s_{C,t}^{CNY}$ is the synthetic Chinese renminbi that mimics the relative currency rate of the Chinese renminbi (target currency); $I_{(j \neq CNY)}$ is an indicator function that equals one when $j \neq CNY$ and zero when $j = CNY$; $w_{C,t}^{CNY,j}$ is the portfolio weight of the jth relative currency rate; $p_{C,t}^{j}$ is the jth relative currency rate; and $\overline{w}_{C,t}^{CNY}$ is the sum of the portfolio weights. It should be noted that any sum-to-x budget constraint $(x = \overline{w}_{C,t}^{CNY} \neq 0)$ unintentionally creates a synthetic Chinese renminbi with a non-zero position in the Chinese renminbi (see Kunkler, 2022). The synthetic Chinese renminbi in Eq. (5) is typically estimated with a constrained Frankel-Wei regression model, where the logarithm returns of the Chinese renminbi relative currency rate are regressed on the logarithm returns of the *other* relative currency rates, subject to the sum-to-zero budget constraint in Eq. (6). More sophisticated time-series regression models are possible, but are beyond the scope of the current study, and left to future research.

III. Data

The data sample is sourced from Bloomberg and consists of ten exchange rates $(N_S = 10)$ against the US dollar (11 currencies) from the 1st of August 2005 to the 31st of December 2021. The data sample begins on the 1st of August 2005 since the Chinese renminbi was hard-pegged to the US dollar prior to the 21st of July 2005. The eleven currencies are the Chinese renminbi (CNY), the Australian dollar (AUD), the British pound (GBP), the Canadian dollar (CAD), the Eurozone euro (EUR), the Japanese yen (JPY), the Korean won (KRW), the Malaysian ringgit (MYR), the Singaporean dollar (SGD), the Thailand baht (THB), and the US dollar (USD).

Figure 1 displays the US dollar/Chinese renminbi (USD/CNY) exchange rate over the whole data sample for the Chinese renminbi (CNY) relative to the US dollar (USD). An increase (decrease) in the USD/CNY exchange rate represents a depreciation (appreciation) of the Chinese renminbi against the US dollar. The series of devaluations for three consecutive days in August 2015 is circled. The value of the

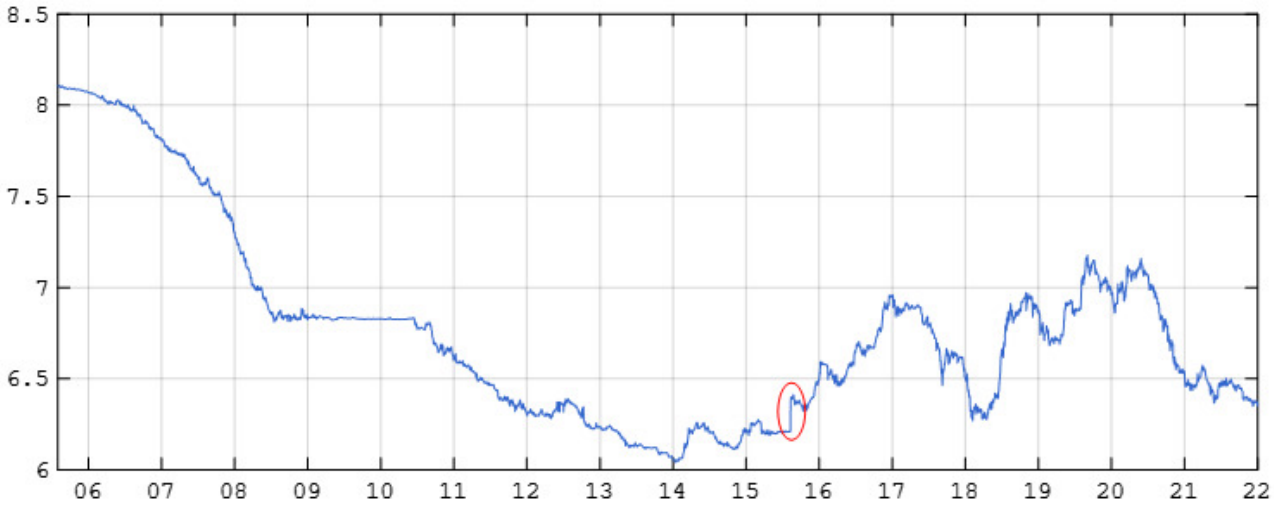

Figure 1. US dollar/Chinese renminbi exchange rate

Notes: The plot displays the US dollar/Chinese renminbi exchange rate from the 1st of August 2005 to the 31st December 2021.

USD/CNY exchange rate moves from a little over 6.2 to approximately 6.4 three days later. In the post-August 2015 period, the level of the USD/CNY exchange at the end of the data sample remains relatively unchanged at around 6.4 from the post-devaluation level in August 2015.

IV. Results

We estimate a synthetic Chinese renminbi in both the pre-August 2015 and the post-August 2015 periods for three frequencies of data, namely daily, weekly, and monthly. We use a constrained Frankel-Wei regression model subject to a sum-to-zero constraint on the portfolio weights (regression coefficients) (see Kunkler, 2022). Table 1 reports the estimated portfolio weights of the synthetic Chinese renminbi. Table 2 reports the annualised contributions to total risk for the Chinese renminbi, where the Total row represents the *R*-squared statistic for the constrained regression model. Table 3 reports the annualised volatilities for each currency, including the Chinese renminbi (CNY).

In the pre-August 2015 period, the single anchor currency of the Chinese renminbi is the US dollar, which is the only currency with a positive average portfolio weight. The US dollar (USD) has the largest average portfolio weight of 0.729 and the largest average percentage contribution to total risk of 73.28%. Furthermore, the average *R*-squared is 92.47%, which demonstrates that only 7.53% of the movements in the Chinese renminbi are specific to the Chinese renminbi. Thus, the Chinese renminbi was significantly anchored to the US dollar in the pre-August 2015 period. This result validates the decision in Ilzetzki et al. (2019) not to consider the Chinese renminbi as an anchor currency because of its own anchor to the US dollar, where the data sample spanned from 1946 to 2016.

In the post-August 2015 period, the two anchor currencies of the Chinese renminbi are the US dollar and the Singapore dollar, which are the only two currencies with positive average portfolio weights. The US dollar (USD) has the largest average portfolio weight of 0.361 and has the largest average percentage contribution to total risk of 27.68%. In contrast, the Singapore dollar (SGD) has the second largest average portfolio weight of 0.314, but has a low average percentage contribution to total risk of only 2.65%, which is approximately one tenth of the average percentage contribution to total risk for the US dollar. The reason behind the small average percentage contribution to total risk is that the Singapore dollar has the smallest average annualised volatility of 1.62% (see Table 3). Interestingly, the Australian dollar (AUD) has the second largest average *negative* portfolio weight of -0.122 and the second largest percentage contribution to total risk of 8.54%. More importantly, the average *R*-squared is 43.59%, which shows that over 56.41% of the movements in the Chinese renminbi are specific to the Chinese renminbi.

V. Conclusion

We measured a *de facto* foreign exchange rate of the Chinese renminbi with a *synthetic* Chinese renminbi in both the pre- and the post-August 2015 periods. We found that the two main anchor currencies of the Chinese renminbi are the US dollar and the Singapore dollar. On average, the US dollar still dominates the systematic movements in the Chinese renminbi with approximately 63% attributed to the US dollar. However, the average *R*-squared is 43.59%, which shows that over half of the movements in the Chinese renminbi are specifically attributed to the Chinese renminbi. Thus, the Chinese renminbi has become significantly less anchored to the US dollar in the post-August 2015 period. Consequently, the Chinese renminbi can now be a potential anchor currency in future research.

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Table 1. Portfolio weights of the synthetic Chinese renminbi

	Pre-August 2015				Post-August 2015			
	Daily	Weekly	Monthly	Average	Daily	Weekly	Monthly	Average
USD	0.729	0.721	0.738	0.729	0.447	0.449	0.188	0.361
SGD	-0.052	-0.042	0.012	-0.027	0.115	0.276	0.552	0.314
KRW	-0.094	-0.103	-0.138	-0.112	0.009	-0.063	-0.075	-0.043
THB	-0.071	-0.074	-0.105	-0.083	-0.027	-0.121	-0.066	-0.072
MYR	-0.083	-0.081	-0.055	-0.073	-0.136	-0.121	-0.133	-0.130
EUR	-0.071	-0.073	-0.032	-0.059	-0.055	-0.099	-0.105	-0.086
CAD	-0.091	-0.079	-0.104	-0.091	-0.085	-0.072	-0.078	-0.078
GBP	-0.090	-0.085	-0.121	-0.099	-0.078	-0.048	0.007	-0.040
JPY	-0.084	-0.089	-0.098	-0.091	-0.109	-0.096	-0.108	-0.104
AUD	-0.093	-0.095	-0.096	-0.095	-0.080	-0.105	-0.182	-0.122
Total	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes: This table reports the estimated portfolio weights of the synthetic Chinese renminbi, together with the average weight across all data frequencies.

Table 2. Percentage contributions to total risk

	Pre-August 2015				Post-August 2015			
	Daily	Weekly	Monthly	Average	Daily	Weekly	Monthly	Average
USD	72.08	73.85	73.92	73.28	35.13	36.20	11.71	27.68
SGD	-0.46	-0.48	0.06	-0.30	1.09	2.10	4.77	2.65
KRW	6.35	7.37	11.41	8.38	-0.16	1.02	0.65	0.50
THB	-3.34	-3.58	-3.29	-3.40	-0.75	-1.26	0.15	-0.62
MYR	-0.83	-0.76	-0.26	-0.61	0.60	1.53	1.22	1.11
EUR	3.52	3.28	1.51	2.77	0.74	1.49	0.75	0.99
CAD	4.02	3.88	3.84	3.91	2.14	1.60	1.78	1.84
GBP	3.24	3.83	1.14	2.74	3.59	1.09	0.12	1.60
JPY	-5.59	-6.63	-6.24	-6.15	-0.80	-1.31	0.00	-0.70
AUD	11.63	12.28	11.68	11.86	5.04	7.72	12.85	8.54
Total	90.61	93.03	93.77	92.47	46.61	50.17	34.00	43.59

Notes: This table reports the percentage contribution to total risk, together with the average contribution to total risk across all data frequencies. The Total row represents the r-squared statistic for the constrained regression model.

Table 3. Annualised volatilities

	Pre-August 2015				Post-August 2015			
	Daily	Weekly	Monthly	Average	Daily	Weekly	Monthly	Average
CNY	5.09	5.00	5.71	5.26	3.73	3.98	3.72	3.81
USD	5.29	5.31	5.95	5.52	4.51	4.68	4.64	4.61
SGD	2.78	2.51	2.35	2.55	1.94	1.63	1.30	1.62
KRW	9.46	8.33	8.87	8.89	5.31	5.09	5.11	5.17
THB	4.74	4.96	4.70	4.80	3.78	3.87	4.01	3.89
MYR	4.57	4.32	3.91	4.27	5.14	5.14	4.97	5.08
EUR	6.55	6.40	6.59	6.52	4.82	4.32	4.13	4.42
CAD	7.19	6.73	6.80	6.91	5.15	4.99	4.91	5.01
GBP	6.84	7.35	6.42	6.87	7.25	6.76	6.78	6.93
JPY	10.80	10.79	9.72	10.43	7.69	7.75	6.84	7.43
AUD	10.12	9.83	9.23	9.73	6.40	6.53	6.47	6.47

Notes: This table reports the annualised volatilities, together with the average annualised volatilities across all data frequencies.

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