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Could Renminbi Hedge against Risk?

—Evidence from Vector Auto-regression Model

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Abstract: This study attempts to evaluate whether offshore RMB(CNH) is a hedging asset. Current research in this field is few and far between, so the introduction of more data and models would be helpful to enrich relevant studies. We use data that covers the period from 2010 to 2021. Various means of analysis, including vector auto-regression(VAR) model, impulse response function, and heterogeneity test, are deployed to answer our research question. In line with prior research, we found RMB's inability to function as a safe-haven asset. Nevertheless, we found preliminary evidence that the Renminbi is going global. Another unanticipated result is that inefficiency in the foreign exchange market is observed in terms of two-way trading of RMB to JPY.

Keywords: Renminbi, Hedging asset, Safe-haven currencies, Vector Auto-regression Model, Impulse response function.

1. Introduction

In times of stormy weather, ships seek out the save-haven of a port or harbor to ride out the storm. Therefore, a safe-haven asset must be some asset that holds its value in 'stormy weather' or adverse market conditions[1]. The weather for the world economy in 2022 is far from sunny, as "American inflation, Europe's energy crisis, and China's Omicron outbreak threaten the world economy with a downturn"(The Economic, April 2022). Therefore, investors must discern which asset is safe in the face of uncertainty.

The interest in "safe-haven assets" has been rising in scholars and policy-making terms. Traditionally, gold, as well as scarce metals, are considered to be safe-haven assets. One research[1] examined gold's role in the global financial system and found different results for different markets. Some of the major currencies are also regarded as a safe-haven assets. This characteristic has drawn a degree of scholarly interest: [2] concluded that the Swiss franc and Japanese yen "have significant safe-haven characteristics and move inversely with international equity markets and FX volatility."

It is essential for researchers and investors to know whether RMB is a good safe-haven asset as it is playing an increasingly significant role in the world. However, researches in this field are sparse: Using a regime switching model and the data between 2005 and 2019, [3] found that RMB is not a good hedge in times of market volatility. The result above seems to contradict the phenomenon

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observed by some people that RMB depreciates domestically and appreciates externally. To answer this question, we would deploy more analysis methods using more recent data.

The aims of this study are as follows: First, to examine the capability of RMB to hedge risks and uncertainties during the period between Jan/01/2010 and Dec/12/2021; a separation point is set at Jan/01/2017, short after Oct/01/2016, when RMB is included into the SDR basket. Second, to examine whether there is a lag effect between market volatility and appreciation/depreciation of RMB. Third, if there is a lag effect, we would explore the details of such an effect. If not, namely, the extent of market volatility synchronizes with the relative value of RMB, we would explore the linear relationship between the two and consider the extreme cases when there is a grave market panic. And finally, to compare RMB's performance in the two periods.

2. Literature Review

There is growing scholarly and political interest in so-called "safe assets," which are especially valuable during financial market stress as their par value holds. In contrast, the value of other assets usually declines[4]. Studies on safe assets can generally be divided into two strands: one examines whether scarce metals, like gold, could hedge risks, and the other examines whether some major currencies could yield the same result.

The first strand of studies usually find that precious metals could act as good safe assets for investors during risks: Some[1] report gold as a solid safe-haven for most developed markets during the peak of the recent financial crisis, but this is not the case for Australia, Canada, Japan and large emerging markets such as the BRIC countries. For geopolitical risks, particularly Precious metals, gold and silver mainly, display consistent safe-haven properties; conversely, stocks and bonds respond negatively to geopolitical risk and geopolitical threats[5].

The second strand is more extensive regarding the number of papers and the methods used. Details are as follows.

2.1. Evaluation of major currencies

To begin witt, a study[2] concluded that of the major currencies, the Swiss franc and Japanese yen are the safest and that these safe-haven properties materialize over different time granularity (from a few hours to several days). The former view is not challenged or questioned by later studies but fortified[6] by a study that also found the Japanese yen to be the safest currency regardless of the prevailing level of uncertainty by deploying a non-temporal threshold analysis.

In addition to reviewing the safe-haven currencies, some researchers[7] studied what makes a safe-haven currency. They concluded that the size of net foreign asset position, whether currencies have been a good hedge(performance in the past) or inertia[4], and whether the currencies come from large, less financially open economies are some of the only few factors determining a safe-haven status.

2.2. Evaluation of RMB

Papers specifically asking whether RMB could act as a safe-haven asset are scarce. To sum up, all documents in this field agree that RMB is not a safe-haven asset to a different degree. One paper[8] using the Chicago Board Options Exchange (CBOE) Volatility Index (VIX)the as the primary indicator of global risk finds that the RMB only exhibitor minor degree of hedging capability(safer than the GBP and euro but less safe than USD and JPY during part of the sample period. Another study covering a broader period from 2005 to 2019 and adopting a more complicated method, i.e., the Regime-switching models, also found that RMB is not a safe-haven asset: it is not a good hedge in times of market volatility. It is unable to hedge against stock market crashes.

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3. Research Methodology

3.1. Our Hypothesis and Research Objectives

We hypothesize that RMB, specifically offshore RMB(CNH), is a hedging asset. A hedging asset is defined as an asset that appreciates as market volatility increases. Our objectives are as follows:

1) to assess the contemporaneous linear relationship between the relative value of CNH and market volatility indices using multiple linear regression(MLR).

2) to assess whether there is a lag effect between them; for example, a rise in the market volatility indices would cause CNH to change(up or down) only on the same day but also on the second, or third day.

3) to perform a heterogeneity test: we would set Jan/01/2017, not long after RMB's inclusion into the SDR basket, as a separation point and evaluate the performance of CNH in the two periods(2010 to 2017 and 2017 to 2021).

3.2. Data

The data we used comes from Wind and covers the period from Jan/01/2010 and Dec/12/2021. Specifically, it includes the exchange rate of CNH against USD(our dependent variable) and the exchange rate of CNH against JPY(our dependent variable for the robustness test). Following previous research[8], we use market volatility indices to measure risks. We selected three indices for market volatility: VXJGI[1] , VIXGI[2] , and VXJGI[3] , and they[4] should be representative of the overall volatility in Japan, America, and China markets, respectively. In aggregate, the three indices would roughly be representative of the global market . All outliers(those less than P0.5 and higher than P99.5) in variables are winsorized.

The direct quotation method is used in this paper, meaning a rise in the RMB rate indicates a depreciation in RMB.

For heterogeneity test purposes, a separation point is set on Jan/01/2017, not long after Oct/01/2016, when RMB is included in the SDR basket.

[1] Osaka University Center for the Study of Finance and Insurance near-term implied volatility measure of Nikkei 225 index options

[2] Chicago Board Options Exchange (CBOE) Volatility Index

[3] CBOE China ETF Volatility Index, which is a measure of near-term implied volatility based on the iShares China Large-Cap ETF

[4] VXO (the CBOE measure of near-term implied volatility of S&P 100 index options) is not available on Wind and thus not included

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3.3. Descriptive Statistics of Variables.

Table1: Descriptive Statistics of Variables.

	N	Mean	min	max	p5	p95
dlnUSDCNH	2355	0	-0.015	.03	-.004	.004
dlnJPYCNH	2355	0	-0.066	.051	-.009	.009
dlnVXJGI	2916	0	-0.369	.578	-.097	.111
dlnVIXGI	2916	0	-0.351	.768	-.113	.131
dlnVXJGI	2916	0	-0.369	.578	-.097	.111
Dummy1	2917	.007	0.000	1	0	0
Dummy2	2917	.204	0.000	1	0	1

The dependent variable(Y) is set as the first order logarithmic difference of the relative value of CNH, namely the rate of return of CNH. We take(first-order logarithmic differences of) VXJGI, VIXGI, VXJGI as our independent variables. Take dlnVXJGI for an example; if dlnVXJGI(t)=0.01, it means the closing value of VXJGI at day t is 1% higher than its opening value at day t.

Dummy variables: Dummy1 and Dummy2 are set to denote regional and global panic: when there is a worldwide market panic, meaning all the three indices higher than the threshold, Dummy1 has a value of 1; When there is a regional market panic in any equity market of China, America and Japan market, Dummy2 equals to 1;

3.4. Multiple Linear Regression model

To test if RMB is a safe-haven asset, we use a short-run linear regression model to explore the relationship between the relative value of CNH and market indices, taking the effect of regional and global market panic into account. Presumably, a positive relationship would indicate that CNH could not hedge against risks because it depreciates as markets become unstable.

In this part, we selected the highest 5 percent of the three indices(P95) to represent market panic days. Our model is as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_5 D_1 + \beta_6 D_2 \quad (1)$$

where

Y: First order logarithmic difference of CNH's relative value against USD or JPY

X1: First order logarithmic difference of Osaka University Center for the Study of Finance and Insurance near-term implied volatility measure of Nikkei 225 index options

X2: Chicago Board Options Exchange (CBOE) Volatility Index

X3: CBOE China ETF Volatility Index, which is a measure of near-term implied volatility based on the iShares China Large-Cap ETF

D1: Dummy variable, D1(t)=1 means on day t, there is an "extreme" global market panic, and the values of the three indices are no less than their respective 95% percentile(P95) at the same time.

D2: Dummy variable, D2(t)=1 means in day t there is a regional market panic, and the values of any one of these indices is no less than their respective 95% percentile(P95).

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3.5. Vector Autoregression model(VAR)

Compared to the linear regression model, a remarkable feature of the VAR model is that it considers the lag effect: An adverse event, whose magnitude is measured by the combination of indices, does not necessarily wholly change the exchange rate on the same day so that the rate becomes static on the second day. In other words, it could take several days for the exchange market to incorporate information contained in such an event fully. If the adjustment is a negative impact, it means the rebounce of the CNH value.

In this part, we examine whether there is a lag effect between market volatility and the appreciation/depreciation of RMB. We would determine which order is the optimal lag order. Then we use the impulse response function to test if there is a lag effect between the rate of return of CNH and one of the five independent variables.

In this part, we selected the highest 2 percent of the three indices(P98) to represent market panic days. Our model is as follows(take the second-order lag model as an example):

$$Y_{(t)} = A_1 Y_{(t-1)} + A_2 Y_{(t-2)} + B_1 X1_{(t-1)} + B_2 X1_{(t-2)} + C_1 X2_{(t-1)} + C_2 X2_{(t-2)} + E_1 X3_{(t-1)} + E_2 X3_{(t-2)} + F_1 D1_{(t-1)} + F_2 D1_{(t-2)} + G_1 D2_{(t-1)} + G_2 D2_{(t-2)} \quad (2)$$

where
Y: First order logarithmic difference of CNH's relative value against USD or JPY
X1: First order logarithmic difference of Osaka University Center for the Study of Finance and Insurance near-term implied volatility measure of Nikkei 225 index options
X2: Chicago Board Options Exchange (CBOE) Volatility Index
X3: CBOE China ETF Volatility Index, which is a measure of near-term implied volatility based on the iShares China Large-Cap ETF
D1: Dummy variable, D1(t)=1 means on day t, there is an "extreme" global market panic, and the values of the three indices are no less than their respective 98% percentile(P98) at the same time.
D2: Dummy variable, D2(t)=1 means in day t there is a regional market panic, and the values of any one of these indices is no less than their respective 98% percentile(P98).
Based on the VAR model, we use the impulse-response model to test if there is a lag effect between the rate of return of CNH and one of the independent dummy variables, one by one and a total of 4 pairs(CNHUSD-Dummy1, CNHUSD-Dummy2, CNHJPY-Dummy1, CNHJPY-Dumm2)

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4. Result and Discussion

4.1. Results of Multiple Linear Regression model

Table2: Results of Multiple Linear Regression model.

dlnUSDCNH	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
dlnVXJGI	-.001	.001	-1.35	.178	-.003	0	
dlnVXFXIGI	.005	.001	4.75	0	.003	.007	***
dlnVIXGI	.004	.001	4.80	0	.002	.005	***
Dummy1	.003	.001	4.36	0	.002	.004	***
Dummy2	. 000	0	0.73	.464	0	.001	
Constant	0	0	-0.59	.555	0	0	

Mean dependent var	0.000	SD dependent var	0.003
R-squared	0.068	Number of obs	2355
F-test	34.399	Prob > F	0.000
Akaike crit. (AIC)	-21559.690	Bayesian crit. (BIC)	-21525.104

*** *p*<.01, ** *p*<.05, * *p*<.1

Table3: Robustness test.

dlnJPYCNH	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
dlnVXJGI	.005	.002	2.67	.008	.001	.008	***
dlnVXFXIGI	.008	.002	3.51	0	.003	.012	***
dlnVIXGI	.022	.002	12.71	0	.019	.025	***
Dummy1	.007	.001	4.46	0	.004	.009	***
Dummy2	.001	0	1.19	.234	0	.001	
Constant	0	0	-2.09	.036	0	0	**

Mean dependent var	-0.000	SD dependent var	0.006
R-squared	0.180	Number of obs	2355
F-test	103.276	Prob > F	0.000
Akaike crit. (AIC)	-17956.188	Bayesian crit. (BIC)	-17921.602

*** *p*<.01, ** *p*<.05, * *p*<.1

Independent variables: dlnVXFXIGI, dlnVIXGI, and Dummy1 are significant and robust. Our results demonstrated a positive relationship between the three variables: dlnVXFXIGI, dlnVIXGI, and Dummy1 and variable dlnUSDCNH. Our model predicts that every 1% increase in VXFXIGI or VIXGI will lead to 0.005% and 0.004% depreciation in CNH(the higher the exchange rate, the lower the CNH's relative value). In addition, when there is an "extreme" global market panic, CNH will depreciate by 0.3%. As a result, the hypothesis that Renminbi could hedge against risk should be rejected.

In the robustness test, we replaced the dependent variable with the first difference of the exchange rate of CNH to JPY. Variables dlnVXFXIGI, dlnVIXGI, and Dummy1 are still significant at 0.01 level, suggesting that our results are robust.

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This means when there is a market panic, either in America or in China, as indicated by the rise in their market indices or a global market panic(5% percentile), the relative value of CNH would depreciate. In summary, the CNH is unable to hedge against risks.

4.2. Results of VAR model

Table4: Test for best order of lag.

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	22925.9				4.00E-14	-19.4997	-19.4962	-19.4899*
1	22980.7	109.57	16	0	3.90E-14	-19.5327	-19.5149*	-19.4837
2	23005.7	50.001*	16	0	3.8e-14*	-19.5404*	-19.5083	-19.4521
3	23015	18.543	16	0.293	3.90E-14	-19.5347	-19.4882	-19.4072
4	23027	24.014	16	0.089	3.90E-14	-19.5313	-19.4706	-19.3646

* denotes the best order of difference using a criteria(indicated by the first row of the column)

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Table5: Tests of Different Impulse Variables.

Impulse/Response variable	Coef.	Std.Err.	z	P>z	[95%Conf.	Interval]
dlnUSDCNHFX						
dlnUSDCNHFX						
L1.	-0.034	0.022	-1.570	0.116	-0.077	0.008
L2.	-0.026	0.022	-1.210	0.227	-0.069	0.016
dlnJPYCNHFX						
L1.	0.007	0.010	0.750	0.454	-0.012	0.027
L2.	-0.004	0.010	-0.440	0.661	-0.024	0.015
Dummy1						
L1.	-0.000	0.001	-0.110	0.916	-0.002	0.002
L2.	-0.000	0.001	-0.120	0.905	-0.002	0.002
Dummy2						
L1.	-0.000	0.000	-0.410	0.682	-0.000	0.000
L2.	0.000	0.000	1.430	0.152	-0.000	0.001
_cons	-0.000	0.000	-0.260	0.797	-0.000	0.000
	Coef.	Std.Err.	z	P>z	[95%Conf.	Interval]
dlnJPYCNHFX						
dlnUSDCNHFX						
L1.	-0.014	0.050	-0.280	0.776	-0.112	0.084
L2.	-0.068	0.050	-1.350	0.175	-0.165	0.030
dlnJPYCNHFX						
L1.	0.002	0.023	0.110	0.912	-0.042	0.047
L2.	0.025	0.022	1.110	0.267	-0.019	0.069
Dummy1						
L1.	-0.009	0.003	-3.300	0.001	-0.014	-0.004
L2.	-0.002	0.003	-0.760	0.450	-0.007	0.003
Dummy2						
L1.	-0.000	0.000	-1.100	0.271	-0.001	0.000
L2.	0.000	0.000	0.230	0.819	-0.001	0.001
_cons	-0.000	0.000	-0.620	0.535	-0.000	0.000

As lag=2 gets the most “best” than other lags, we determine the 2nd order as the optimal lag order. Then we use the impulse response function to test if there is a lag effect between the rate of return of CNH and one of the independent dummy variables(the results are not significant when

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dlnVXJGI, dlnVXFXIGI, and dln VIXGI are set to be the impulse variable). The robustness test is also in the table.

Our results demonstrated that there is no significant lag effect, in general, between the rate of CNH and market volatility indices, meaning could be reflected on the same day.

Such insignificance could be interpreted as the reaction between the two variables: they are basically contemporaneous. i.e., RMB depreciates the very day when there is dramatic price movement in American or China market.

However, when Dummy1(global market panic) is the impulse variable and CNH's rate of return to JPY is the response variable, a 0.001 significance level on first order lag is observed.

We decided to explore the two variables further. Here are the results:

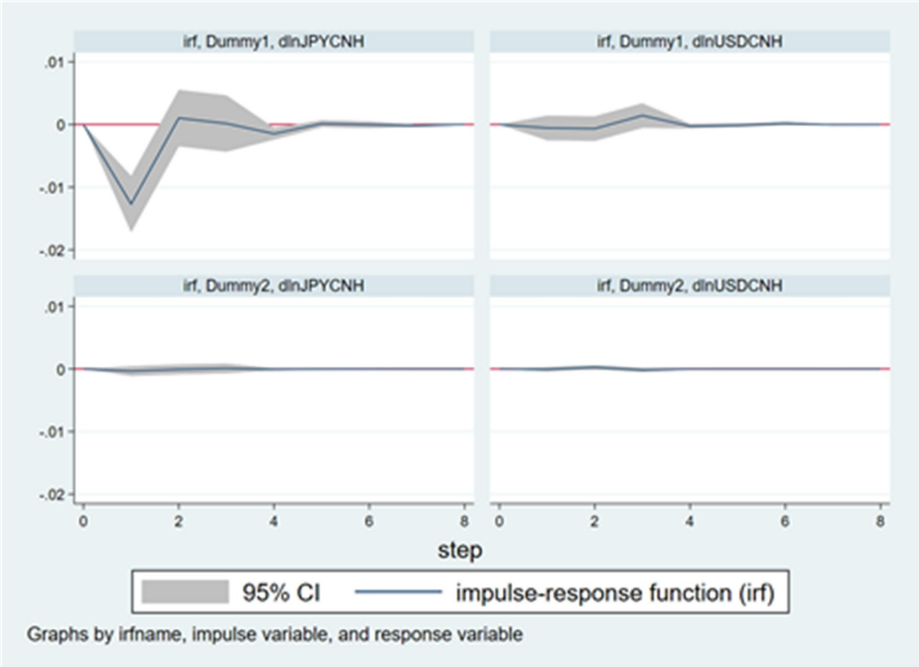

Figure1： Impulse-response function under market panic, irf,Dummy1,dlnJPYCNH are picture name, impluse variable and response variable, respectively.

When Dummy1(global market panic) is the impulse variable and CNH's rate of return to JPY is the response variable, a 0.05 significance level in step 1 and step 4 is observed. Both impulses are negative, and the one in step 1 is greater than the other.

This shows our model predicts that under extreme global market panic, a one-day and four-day lag effect in the JPYCNH exchange market is predicted to happen, meaning the value of CNH would rebound on the second and, more slightly fifth day. One possible interpretation is that the yen-CHN market is not efficient: it overacts to panic and adjusts on the second day and slightly on the fifth day.

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4.3. Heterogeneity Test

Table6: Heterogeneity Test.

VARIABLES	(1) USDCNHBefore 2017	(2) USDCNHafter 2017	(3) JPYCNHBefore 2017	(4) JPYCNafter 2017
dlnVXJGI	-0.001	-0.001	0.006**	0.005***
	(-0.94)	(-0.80)	(2.17)	(2.63)
dlnVXFXIGI	0.003*	0.005***	0.004	0.008***
	(1.80)	(3.76)	(0.91)	(3.90)
dlnVIXGI	0.001	0.007***	0.024***	0.021***
	(0.82)	(5.37)	(8.58)	(10.72)
Dummy1	0.004***	0.002**	0.011***	0.003*
	(4.59)	(2.08)	(4.62)	(1.89)
Dummy2	0.000	0.000	0.001*	0.000
	(1.14)	(0.25)	(1.85)	(0.02)
Constant	0.000	-0.000	-0.000**	-0.000
	(0.62)	(-1.12)	(-2.25)	(-0.62)
Observations	1,138	1,217	1,382	1,217
R-squared	0.04	0.09	0.16	0.22

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

It is clear that dlnVXFXIGI and dlnVIXGI are not significant at 0.05 level before 2017. However, in the period after 2017, these two variables show a 0.01 level of significance. Dummy1 is significant throughout 2010 to 2021 with different levels of significance.

It is noticeable that the coefficients of dlnVXFXIGI and dlnVIXGI are greater after 2017, while Dummy1 is smaller and less significant.

In most cases, dummy1=0, which means the market is not panicking. In the light of greater coefficients of dlnVXFXIGI and dlnVIXGI after 2017, we could conclude that the Renminbi is more sensitive to American and China equity market volatility after its inclusion into the SDR basket.

Suppose there is an extreme global market panic, with all of dlnVXJGI, dlnVXFXIGI, and dlnVIXGI equal to 0.1, our P95 threshold to cause Dummy1=1, CNH's degree of depreciation would be 0.44%(10%*(0.003+0.001)+1*100%*0.004) and 0.32% (10%*(0.005+0.007)+1*100%*0.002) before and after 2017, respectively. This provides a piece of preliminary evidence that the Renminbi is more robust under extreme global market panic. Note that some coefficients are not significant.

In summary, our data and projection suggest that in the period after 2017, RMB showed more sensitivity to market indices but more robust under global market panic, the latter of which could be a sign of the globalization of RMB.

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5. Conclusion

This research is aimed to evaluate whether the Renminbi is a hedging asset. We select the exchanger rate of CNH against USD as the dependent variable in our primary test and the exchange rate of CNH against JPY as the dependent variable in our robustness test. Three market volatility indices to give a sketch of the regional and global market. Based on the regression results of our MLR and VAR(on which the impulse response function is based) models, which consider the immediate and subse-quent(lag) effects of market volatility indices on RMB prices, respectively, it can be concluded that RMB is not a hedging asset as it depreciates against USD when the market becomes volatile. This is in line with the findings of (Cheng et al., 2021; Fa-tum et al., 2017) that RMB cannot hedge against risks.

Besides, a heterogeneity test is also performed to compare RMB's sensitivity to market volatility indices. The outcome shows CNH's higher degree of sensitivity to these indices after its inclusion in the SDR basket. Also, Renminbi is found to be more firm(or less vulnerable) in the case of an "extreme" global equity market panic.

The hypothesis that the Renminbi is a save-haven asset should be rejected as significant($p<0.01$), and robust evidence is found: that investors tend to sell RMB on the same day when uncertainty rises. They will sell more if this is an "extreme" global equity market panic. As stated, there is basically no lag effect between CNH's value and these indices. However, an exciting anomaly emerged during the robustness test: the exchange rate of CNH against JPY would rebound on the second and fifth day of the outbreak of an "extreme" market panic. Such anomaly could be good evidence of market inefficiency: the foreign exchange market seems to overreact under terror to make adjustments later.

Our research is subject to some limitations, and possible ones are as follows: First, we consider that the use of three market indices could not be adequate to give an accurate view of the global equity market. To better understand the implications of these results, future studies could improve the number of indices used and how these indices are combined. Secondly, we notice JPY's depreciation against USD in 2022 Q2; this phenomenon could suggest that JPY is not a hedging asset, country to the finding of (Ranaldo and Söderlind, 2009). As a result, the use of JPY in our robust-ness test is somewhat questionable. Thirdly, the thresholds are set according to the usual practice in econometrics(top 5% and 2%) rather than a tested method. Finally, although a degree of lag effect is detected, its magnitude is not explored. Because of transaction cost, such inefficiency may not lead to an arbitrage opportunity.

Our research attempts to enrich the field of Renminbi research. A distinguished contribution is that we adopt the impulse response function (based on the VAR model) to find different results in CNH to USD market and CNH to JPY market; the latter shows a certain degree of inefficiency. This anomaly provides a direction for future research. In addition, the two main results in our heterogeneity test give an alternative perspective to evaluate the globalization of the Renminbi.

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