INFORMATION TRANSMISSION IN THE ONSHORE AND OFFSHORE RMB MARKETS

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Abstract- The study investigates the impact of the improved central parity quotation on price discovery between onshore (USD/CNY) and offshore (USD/CNH) markets. We find that USD/CNH market provides greater contribution to RMB price discovery and the relatively rising contribution of USD/CNH is attributed to improved quotation policy. After implement the policy, central parity could incorporate more USD/CNH market information and transmit the information to USD/CNY market.

Keywords- Price discovery, USD/CNY, USD/CNH, quotation of the central parity JEL classification: F31; F38; G15

I. INTRODUCTION

In this paper, we investigate the RMB price discovery process and its response to the improved quotation of the RMB central parity.[1] RMB transactions occur in the onshore (USD/CNY) and offshore (USD/CNH) markets. CNY is used to designate RMB in FX transactions and represents the onshore or mainland Chinese spot currency market. In addition, Hong Kong, which has served as an international hub for mainland China, naturally happened to be a great place for an offshore RMB market. Moreover, Singapore, Taiwan, and London also have developed their own offshore RMB markets, which broadly refer to CNH market.

There are some differences between onshore and offshore markets including central bank control, market participants, and trading mechanism. USD/CNY rate is only allowed to move ±2% around official central parity one day but USD/CNH rate is not restricted. USD/CNH rate which is a free market is determined by market forces and offshore market participants and, in contrast, USD/CNY market remains highly regulated and controlled. These differences may influence information aggregation capabilities (price discovery), incentives for liquidity provision, and volatility between two markets.

Hence, we employ the common factor component weight approach to explore the contribution of USD/CNY and USD/CNH rates to RMB price discovery and adopt the information share approach of Hasbrouck (1995) and the modified information share approach of Lien and Shrestha (2009) to check the robustness of these results. Previous studies that explore RMB onshore and offshore markets generally focus only on the pricing gap between the USD/CNY and USD/CNH markets (Funke, Shu, Cheng, and Eraslan (2015); Liu (2015)) and the impact of order flow on USD/CNY and USD/CNH prices (Zhang, Chau, and Zhang (2013); Cheung and Rime (2014)).[2] Few studies compare the relative contribution of USD/CNY and USD/CNH rates to RMB price discovery. Ding, Tse, and Williams (2014) find that USD/CNY rates returns provide little explanatory power to USD/CNH rates returns (and vice versa), supporting that the onshore and offshore spot markets are not informationally integrated. They use the sample, from September 2009 to June 2011. However, with PBC's capital account liberalization and the introduction of the improved quotation of the central parity, the information integration and price discovery between onshore and offshore RMB markets may change over time.

In this study, we examine the impact of the new mechanism for determining the central parity on price discovery between USD/CNY and USD/CNH rates, covering the sample period from February 10, 2015 to February 11, 2016 with high-frequency data. Our results indicate that USD/CNH rates provide greater contribution to RMB price discovery than USD/CNY rates and the relatively rising contribution of USD/CNH market to price discovery is attributed to the improved central parity rate policy. Our finding supports that, after improved quotation policy, central parity rate could incorporate more USD/CNH rate

[1] Price discovery is the process by which market incorporates information to arrive equilibrium price.

[2] Funke et al. (2015) find that market liquidity in the offshore market plays an important role in explaining the level of the CNH–CNY differential and point out that policymakers – both within and outside of China – looking to extract information about the fundamental value of the renminbi from the two rates. Liu (2015) find that the persistence of CNH–CNY differential doesn't change significantly across regimes, rejecting a strong mean-reverting tendency. On the other side, Cheung and Rime (2014) find the CNH exchange rate has an increasing impact on the CNY rate, and significant predictive power for the official RMB central parity rate. Zhang et al. (2013) find that order flow as a measure of excess demand pressure explains a significant part of the fluctuations in the exchange rate of the RMB against the US dollar.

information and transmit more market information from USD/CNH to USD/CNY rate. Central parity rate plays a key role in reflecting and aggregating RMB demand and supply in the offshore market. Therefore, USD/CNH market relatively enhances the role in RMB price discovery.

II. DATA AND SUMMARY STATISTICS

2.1 Data

We use daily and five minute deal prices data of USD/CNY and USD/CNH to analyze price discovery process. Trading hour is from 9:30 to 16:30 and the open and close prices are canceled in this study. Our data sample covers from February 10, 2015 to February 11, 2016 and comes from the Wind Database provided by Wind Information Co., a major financial data vendor in China. Numerous previous studies focusing on the stock or foreign exchange markets in China has adopted the Wind Database. In addition, we also collect the daily central parity of USD/CNY from CFETS website. The daily central parity occurs before the opening of the market on each business day.

2.2 Summary Statistics and Cointegration Test

Table 1 contains the summary statistics for USD/CNY and USD/CNH rates levels and differences at the daily and intra-day five minutes frequencies. Three periods are considered including the full sample (February 10, 2015 to February 11, 2016) and the two subsamples (before and after August 11, 2015). Table 1 shows that the average values of USD/CNY and USD/CNH rates are very close, whereas they are relative lower in period-1 (before August 11), and higher in period-2 (after August 11) at the daily and intra-day five minutes frequencies. In addition, the standard deviation of the USD/CNH rate is over that of the USD/CNY rate, whereas two rates are relatively lower in period-1, and higher in period-2. USD/CNY and USD/CNH levels and differences display excess kurtosis and the excess kurtosis in two rates enlarged after August 11, 2015, indicating that extreme fluctuations of two rates usually occur more after the improved quotation of the central parity.

<Table 1 is inserted about here>

Table 1 also reports the results of the augmented Dickey-Fuller (ADF) and Zivot-Andrews unit root tests for USD/CNH and USD/CNY rates levels and differences. The ADF tests suggest that the USD/CNH and USD/CNY levels are all non-stationary time-series and their first differences are stationary in the full and subsample periods. However, Figure 1 may show the structural change occurrences on Aug. 11 in USD/CNH and USD/CNY rates series. Perron (1989) has shown that standard tests of the unit root hypothesis may be unreliable if the non-stationary time series contains a structural break that is exogenously determined. Then, Zivot and Andrews (1992) propose a testing procedure where the timing of the break is estimated, rather than assumed exogenous.[3] The Zivot and Andrews tests suggest that USD/CNY and USD/CNH rates levels at the daily and five minutes frequencies have unit root with a structural break in the full sample and other series reject the existence of unit root with a structural break. In addition, endogenous structural break occurs on Aug. 11.

Before analyzing price discovery between USD/CNY and USD/CNH rates, we need to check whether these two rates are cointegrated or have long-run equilibrium relationship. Cointegration refers to the feature that while two rates series may be nonstationary, they do not diverge without bound from each other. If the cointegration exists between USD/CNY and USD/CNH rates, we can consider the vector error correction (VEC) model to provide clear evidence on which market has "more informative" price or who moves first in the process of price adjustment. Ding et al. (2014) find no cointegration for daily USD/CNY and USD/CNH rates but Cheung and Rime (2014) find the presence of one cointegration for intraday data of two rates. Ding et al. (2014) suggest that destabilizations in the cointegrated relationship between USD/CNY and USD/CNH rates may be affected by government policy changes, different sample size, and different sample period.

The results of the cointegration tests (i.e. Johansen maximum-eigenvalue and trace tests) reported in Table 2 indicate that the daily USD/CNY, USD/CNH, and central parity rates are cointegrated in the two subsample periods, with cointegrating vectors $r = 1$; this implies one common stochastic trend. However, there is no cointegration in the full sample period. In addition, Table 2 shows that the five minute USD/CNY and USD/CNH rates are cointegrated, with cointegrating vectors $r = 1$ in full and subsample periods. The improved quotation of the central parity would not affect the existence of cointegrated relationship between USD/CNY and USD/CNH rates.

<Table 2 is inserted about here>

III. EMPIRICAL ANALYSIS

At first, to analyze the price discovery between USD/CNY and USD/CNH, I perform Granger causality tests in the vector autoregressive (VAR) models. Panel A in Table 3 reports Granger causality tests results of the trivariate VAR model for daily

[3] Zivot and Andrews (1992) endogenous structural break test is a sequential test which utilizes the full sample and uses a different dummy variable for each possible break date. The break date is selected where the t-statistic from the ADF test of unit root is at a minimum. Please see the details in Zivot and Andrews (1992).

USD/CNY, USD/CNH, and central parity rates differences. The number of lags used in the Granger causality test is 2, as determined by the Schwarz information criterion (SIC). Panel A in Table 3 shows that the price changes of USD/CNH are found to Granger cause the price changes of USD/CNY; in contrast, the price changes of USD/CNY do not Granger cause USD/CNH price changes in the full sample period and period-2. This unidirectional causality from USD/CNH to USD/CNY disappears in period-1. These results support that USD/CNH rate plays a leading informational role in the RMB price discovery process after the improved quotation of the central parity.

<Table 3 is inserted about here>

In addition, the price changes of USD/CNH and USD/CNY are found to Granger cause the price changes of central parity in the period-2 and the unidirectional causality from USD/CNY prices to central parity prices disappears in period-1. These results support that, after the improved quotation, central parity prices could incorporate more previous information of USD/CNH and USD/CNY rates and reflect RMB market prices. These also motivate our further exploration of the comparison of official central parity rate determination before and after the improved quotation in subsection 3.4.

Panel B in Table 3 reports Granger causality tests results of the bivariate VAR model for five minute USD/CNY and USD/CNH prices. Panel B in Table 3 shows that the bi-directional causality result; the price changes of USD/CNH are found to Granger cause the price changes of USD/CNY and vice versa. Although the Granger test for five minute data analysis indicates bi-directional causality between USD/CNY and USD/CNH prices, the effect of USD/CNH prices on USD/CNY prices is found to be more significant than the effect of USD/CNY prices on USD/CNH prices in the period-2, implying the relatively better price discovery of USD/CNH prices after improved quotation. Furthermore, we would perform VEC model and common factor component weight approach to explore the dynamic price discovery process for the five minute USD/CNY and USD/CNH rates data.

CONCLUSIONS

We investigate the impact of the improved quotation of the USD/CNY central parity on the price discovery process between onshore and offshore markets. The results show that USD/CNH rates provide greater contribution to RMB price discovery than USD/CNY rates and the relatively rising contribution of USD/CNH market to price discovery is attributed to the improved central parity quotation policy. The differences between onshore and offshore markets including central bank control, market participants, and trading mechanism affect the information integration between USD/CNH and USD/CNY rates. The less regulated offshore market has the advantage to reflect more market RMB information, especially after the improved quotation of the central parity. After that, central parity rate could incorporate more USD/CNH rate information on the previous day and transmit the information to USD/CNY rate today.

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Table 1: Summary Statistics of USD/CNY and USD/CNH Rates at the Daily and Five Minute frequencies

Panel A: Summary statistics for USD/CNY and USD/CNH rates at the daily frequency

	Full sample period						Period-1 (Before 8/11)						Period-2 (After 8/11)					
	Levels			Differences			Levels			Differences			Levels			Differences		
	P_t^{CNY}	P_t^{CNH}	P_t^{C}	ΔP_t^{CNY}	ΔP_t^{CNH}	ΔP_t^{C}	P_t^{CNY}	P_t^{CNH}	P_t^{C}	ΔP_t^{CNY}	ΔP_t^{CNH}	ΔP_t^{C}	P_t^{CNY}	P_t^{CNH}	P_t^{C}	ΔP_t^{CNY}	ΔP_t^{CNH}	ΔP_t^{C}
Mean	6.34	6.36	6.28	0.24	0.41	2.62	6.22	6.22	6.12	0.24	0.21	-0.18	6.43	6.48	6.41	0.24	0.58	5.42
Std. Dev.	0.13	0.15	0.16	1.72	3.24	19.57	0.02	0.02	0.01	1.03	1.10	4.53	0.09	0.10	0.07	2.14	4.30	27.07
Skew.	0.59	0.47	0.37	-0.12	2.73	6.11	1.20	1.20	1.02	0.86	1.12	-0.15	0.76	0.36	0.67	-0.20	2.06	4.34
Kurt.	2.24	1.93	1.63	16.01	29.24	52.84	2.86	2.89	2.84	4.32	8.28	3.96	2.06	1.93	2.28	12.22	17.42	27.23
ADF	0.19	0.55	-0.78	-29.06***	-14.61***	-8.45***	-1.24	-0.13	-0.96	-2.89***	-10.47***	-9.88***	0.40	-0.99	3.76	-20.91***	-10.64***	-5.94***
Zivot–Andrews unit-root tests (H_0 : series has unit root with a structural break in both the intercept and trend)																		
t-Stat.	-3.56	-4.18	-6.45	-12.19***	-13.20***	-7.66***	-6.69***	-6.22***	-6.18***	-12.57***	-10.41***	-6.39***	-7.65***	-7.95***	-5.80***	-10.09***	-11.12***	-9.55***

Panel B: Summary statistics for USD/CNY and USD/CNH rates at the five minutes frequency

	Full sample period				Period-1 (Before 8/11)				Period-2 (After 8/11)			
	Levels		Differences		Levels		Differences		Levels		Differences	
	P_t^{CNY}	P_t^{CNH}	ΔP_t^{CNY}	ΔP_t^{CNH}	P_t^{CNY}	P_t^{CNH}	ΔP_t^{CNY}	ΔP_t^{CNH}	P_t^{CNY}	P_t^{CNH}	ΔP_t^{CNY}	ΔP_t^{CNH}
Mean	6.34	6.36	0.03	0.03	6.21	6.22	-0.01	-0.01	6.44	6.49	0.07	0.07
Std. Dev.	0.13	0.15	2.45	3.45	0.02	0.02	1.28	1.37	0.09	0.10	3.15	4.59
Skew.	0.60	0.51	22.19	17.07	1.54	1.53	-1.78	-4.28	0.51	0.22	19.89	13.97
Kurt.	2.08	1.87	1499.34	1206.83	3.93	3.97	112.93	135.91	1.69	1.78	1035.18	736.67
ADF	-0.35	-0.56	-56.08***	-51.92***	-1.71	-1.69	-97.51***	-88.95***	-2.13	-2.54	-40.76***	-37.49
Zivot–Andrews unit-root tests (H_0 : series has unit root with a structural break in both the intercept and trend)												
t-Stat.	-2.73	-1.36	-69.90***	-58.79***	-7.42***	-7.33***	-45.21***	-51.95***	-7.05***	-7.10***	-48.00***	-41.42***

Notes: This table reports the summary statistics on the daily and five minute frequency data of the levels and returns of USD/CNY and USD/CNH rates over the full sample period (February 10, 2015 to February 11, 2016) and the two subsamples (before and after August 11, 2015). The USD/CNY and USD/CNH rates differences are calculated by the difference in the log price multiplied by 10,000. The augmented Dickey-Fuller (ADF) test is used to test the null hypothesis that the series has a unit root, with an optimal length of lags of 14, according to the Schwarz information criterion. *, **, and *** significant at the 10%, 5%, and 1% levels. For Zivot-Andrews test statistic, null hypothesis series has unit root with a structural break in both the intercept and trend. 1%, 5%, and 10% critical values for Zivot-Andrews test statistic are -5.57, -5.08, and -4.82. One endogenous structural break occurs on August 11, 2015 for the full sample period data.

Table 2: Johansen Cointegration Tests

Panel A: USD/CNY, USD/CNH, and central parity rates at the daily frequency

	H_0	λ_{max}	Critical Value (5 % level)	λ_{trace}	Critical Value (5 % level)
Full sample period	$r \leq 0$	13.06	22.29	19.95	35.19
	$r \leq 1$	5.31	15.89	6.89	20.26
	$r \leq 2$	1.58	9.16	1.58	9.16
Period-1	$r \leq 0$	29.65***	22.29	45.85***	35.19
	$r \leq 1$	11.64	15.89	16.20	20.26
	$r \leq 2$	4.56	9.16	4.56	9.16
Period-2	$r \leq 0$	64.98***	17.79	73.66***	24.27
	$r \leq 1$	7.23	11.22	8.67	12.32
	$r \leq 2$	1.44	4.12	1.44	4.12

Panel B:USD/CNY and USD/CNH rates at the five minutes frequency

	H_0	λ_{max}	Critical Value (5 % level)	λ_{trace}	Critical Value (5% level)
Full sample period	$r \leq 0$	13.27**	11.22	14.93**	12.32
	$r \leq 1$	1.66	4.12	1.66	4.12
Period-1	$r \leq 0$	18.85***	11.22	18.85***	12.32
	$r \leq 1$	0.01	4.12	0.01	4.12
Period-2	$r \leq 0$	13.90**	11.22	15.54**	12.32
	$r \leq 1$	1.65	4.12	1.65	4.12

Notes: This table reports that the results of Johansen cointegration test of the daily USD/CNY, USD/CNH, and central parity rates for the full and subsamples in Panel A. The subsamples include before and after August 11, 2015 periods. In addition, it reports the results of Johansen cointegration test of the five minutes frequency USD/CNY and USD/CNH rates for the full and subsamples in Panel B. λmax is the Johansen maximum eigenvalue test statistic, and λtrace is the Johansen trace test statistic. The null hypothesis H0 states that the system contains at most r cointegrating vectors. The number of lags used in the Johansen tests is 4, as determined by the SIC (Schwarz information criterion). ** and *** denote rejection of the null hypothesis at the 5% and 1% levels.

Table 3: Granger-Causality Tests

Panel A: USD/CNY, USD/CNH, and central parity rates at the daily frequency		F-stat.	p-value
Full sample period	H_0: ΔP_t^{CNH} does not Granger-cause ΔP_t^{CNY}	2.62	0.07
	H_0: ΔP_t^{CNY} does not Granger-cause ΔP_t^{CNH}	1.74	0.17
	H_0: ΔP_t^{C} does not Granger-cause ΔP_t^{CNY}	1.28	0.27
	H_0: ΔP_t^{CNY} does not Granger-cause ΔP_t^{C}	2.77	0.02
	H_0: ΔP_t^{C} does not Granger-cause ΔP_t^{CNH}	0.15	0.95
	H_0: ΔP_t^{CNH} does not Granger-cause ΔP_t^{C}	2.99	0.02
Period-1	H_0: ΔP_t^{CNH} does not Granger-cause ΔP_t^{CNY}	1.51	0.22
	H_0: ΔP_t^{CNY} does not Granger-cause ΔP_t^{CNH}	0.13	0.87
	H_0: ΔP_t^{C} does not Granger-cause ΔP_t^{CNY}	1.04	0.39
	H_0: ΔP_t^{CNY} does not Granger-cause ΔP_t^{C}	0.98	0.41
	H_0: ΔP_t^{C} does not Granger-cause ΔP_t^{CNH}	1.30	0.27
	H_0: ΔP_t^{CNH} does not Granger-cause ΔP_t^{C}	2.14	0.08
Period-2	H_0: ΔP_t^{CNH} does not Granger-cause ΔP_t^{CNY}	2	0.07
	H_0: ΔP_t^{CNY} does not Granger-cause ΔP_t^{CNH}	1.86	0.17
	H_0: ΔP_t^{C} does not Granger-cause ΔP_t^{CNY}	1.28	0.28
	H_0: ΔP_t^{CNY} does not Granger-cause ΔP_t^{C}	2.86	0.06
	H_0: ΔP_t^{C} does not Granger-cause ΔP_t^{CNH}	0.00	0.99
	H_0: ΔP_t^{CNH} does not Granger-cause ΔP_t^{C}	4.09	0.01
Panel B:USD/CNY and USD/CNH rates at the five minutes frequency		**F-stat.**	**p-value**
Full sample period	H_0: ΔP_t^{CNH} does not Granger-cause ΔP_t^{CNY}	75.47	0.000
	H_0: ΔP_t^{CNY} does not Granger-cause ΔP_t^{CNH}	68.92	0.000
Period-1	H_0: ΔP_t^{CNH} does not Granger-cause ΔP_t^{CNY}	42.02	0.000
	H_0: ΔP_t^{CNY} does not Granger-cause ΔP_t^{CNH}	47.48	0.000
Period-2	H_0: ΔP_t^{CNH} does not Granger-cause ΔP_t^{CNY}	166.98	0.000
	H_0: ΔP_t^{CNY} does not Granger-cause ΔP_t^{CNH}	99.57	0.000

Notes: This table reports that the results of Granger causality test of the daily frequency USD/CNY, USD/CNH, and central parity rates differences for the full sample and subsamples. It also reports that the results of Granger causality test of the five minutes frequency USD/CNY and USD/CNH rates differences for the full and subsamples. The number of lags used in the Granger causality test is 2, as determined by the SIC (Schwarz information criterion). ** and *** denote rejection of the null hypothesis at the 5% and 1% levels. VEC model(8)

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