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THE NEGATIVE INTEREST RATE POLICY EFFECT ON FOREIGN EXCHANGE MARKET

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Abstract: This paper investigates negative interest rate policy (NIRP) effect for EUR, DKK, SEK, and JPY by GARCH model. The empirical result reveals the NIRP effect increases the market volatility and destabilizes the forex market, especially for active trading currency market EU Euro and Japanese Yen. This paper gives the evidence of NIRP effect at the level of bilateral forex rates, rather than the whole currency market level. Our empirical findings also confirm the conclusions of previous literature which NIRP destabilizes the financial market and deteriorates the profitability of forex trading.

Keyword: Negative Interest Rate Policy, Foreign Exchange, Bilateral Exchange Rate, GARCH

1. INTRODUCTION

Negative interest rate policy (NIRP) means central bankers lower the short-term nominal policy rate into a negative value and serves as central bankers' policy response for 2008 financial crisis and ensuing recovery. The NIRP and its effectiveness draw greatest public attention. As a new one in the unconventional monetary policy toolkit, it is rare of academic research for NIRP effect in the related field. This paper intends to fill this gap by testing NIRP effect on foreign exchange market.

The existing literatures on NIRP mainly focuses on descriptive expositions for monetary transmission of NIRP. Bech and Malkhozov (2016) and Jobst and Lin (2016) offer an overall reviews of the operational execution of NIRPs. For earlier studies, Angrick and Nemoto (2017) providing a comprehensive review for NIRP effect on macroeconomic and financial market variables. Beyond descriptive expositions, the literatures need more econometrical analysis to discover convincing pattern behind the data.

The NIRP effect on the foreign exchange market seems to attract minor attention to the researchers. As an exception, Hameed and Rose (2018) explores the relationship between the nominal interest rate level and effective exchange rate under NIRP. Based on the whole market panel dataset, they conclude NIRP seems without significant effect on forex market. The effective exchange rate is a multilateral rate for counterparty countries with substantial international trade contribution and it aggregates the informational contents over a basket of bilateral forex rate. Instead of international forex rate dataset (WM/Reuters), we inspect the NIRP effect by daily time series data with disaggregated local bilateral rates, if local rate exists.

In this article, we use the GARCH model to test the NIRP effect for target currencies of policy enforcement entities, which are European Union Euro (EUR), Danish Krone (DKK), Swedish Krona (SEK), and Japanese Yen (JPY). Due to data availability, we drop the Swiss Franc (CHF) as testing currency. We only use the bilateral rate involving two testing currencies coming from NIRP execution entities and do not consider the bilateral rate involving just one target currency. Based on GARCH, we model NIRP effect as an exogenous binary dummy variable for both mean and volatility equation. We also take robustness check for volatility asymmetry effect and fat tail effect.

The major empirical finding of this article presents NIRP tends to increase the conditional volatility, not conditional mean, of bilateral forex rate of active trading currency markets, Euro and Yen markets. Based on volatility-expanding effect on active trading currencies, this finding implies the market destabilizing effect may be coming from the risk-tolerance shrinkage of international institutional investors. While mean return holding constant and volatility increasing, the empirical finding also implies risk adjusted return and profitability will decrease in forex market. Our empirical findings also confirm the previous conclusion of Arteta, Kose, Stocker, and Taskin (2018), the NIRP increases the risk for financial stability and adversely erodes the profitability of forex market. The remainder of this paper is organized as follows. Section 2 describes the empirical design and econometric model. Section 3 presents empirical results for NIRP effect and robust check. Section 4 concludes this study.

2. DATA AND METHODOLOGY

2.1. Empirical Design

Based on four target currency markets, this paper examines the NIRP effect on testing bilateral forex rate which involving two target currencies. It is possible of NIRP effect to show in the bilateral forex rate only involving one target currency. To avoid exhaustive search such possible bilateral rate, this paper confines to the target bilateral forex rate involving two testing currencies. The EUR has not a single physical currency market, so we select international forex rate provided by WM/Reuters to proxy Euro bilateral forex rates. The forex rate data offered by WM/Reuters is the international standard for portfolio valuation, performance measurement, and index compilation used by global investment industry. The WM/Reuters rate reflects the supply-demand condition of international forex market. And the bilateral rate of Denmark, Swedish, and Japan uses local exchange rate, which reflect the supply-demand condition of local forex markets.

The empirical analysis of this article studies the average return and volatility behavior of bilateral exchange rate by GARCH model. Based on standard GARCH model, we model NIRP effect as an exogenous dummy variable. The NIRP dummy variable is a binary indicator variable that is zero before the policy enforcement event and one after the policy enforcement event. According to the modeling strategy, the sample period should cover the period prior to the policy event and the period later than the policy event. The period length behind the policy event is obviously restricted. If we trace the starting date further back to earlier, we will increase the sample size but we will outweigh the non-fresh information for possible NIRP effect. To avoid such harmfully informational effect, we conservatively choose the period length ahead of the policy event is the same as the period length subsequent to the policy event. Table I summarizes the empirical arrangement parameters of this paper. All the data series used in this article is on the daily basis and collected from the Thomson Reuters Datastream Database.

The observations reported at the last row of Panel C, Table II is available maximum sample period. However, it maybe not long enough from the viewpoint of daily frequency time series empirical research. Restriction to limited sample period available, the empirical results of this paper should interpret with caution, especially for Japanese Yen currency market.

Table I
The Summary for Empirical Arrangement

Currency	*EU Euro*			*Danish Krone*			*Swedish Krona*			*Japanese Yen*		
Forex	DKK/EUR	SEK/EUR	JPY/EUR	EUR/DKK	SEK/DKK	JPY/DKK	EUR/SEK	DKK/SEK	JPY/SEK	EUR/JPY	DKK/JPY	SEK/JPY
Market Type	International			Local			Local			Local		
Event Date	Jun/11/2014			Jul/06/2012			Feb/12/2015			Feb/16/2016		
Sample Period	Jan/19/2012~Oct/31/2016			Mar/12/2008~Oct/31/2016			May/27/2013~Oct/31/2016			Jun/02/2015~Oct/31/2016		

Table II
Descriptive Statistics of Bilateral Foreign Exchange Rate

	EU Euro (EUR)			*Danish Krone (DKK)*			*Swedish Krona (SEK)*			*Japanese Yen (JPY)*		
Panel	DKK/ EUR	SEK/ EUR	JPY/ EUR	EUR/ DKK	SEK/ DKK	JPY/ DKK	EUR/ SEK	DKK/ SEK	JPY/ SEK	EUR/ JPY	DKK/ JPY	SEK/ JPY
A.	Jan/19/2012~Jun/ 10/2014			Mar/12/2008~Jul/ 05/2012			May/27/2013~Feb/ 11/2015			Jun/02/2015~Feb/ 15/2016		
AV	0.00	0.00	0.05	-0.00	0.01	0.04	0.02	0.02	0.01	-0.04	-0.04	-0.04
SD	0.01	0.42	0.73	0.01	0.52	0.98	0.38	0.38	0.66	0.60	0.61	0.70
B.	Jun/11/2014~Oct/ 31/2016			Jul/06/2012~Oct/ 31/2016			Feb/12/2015~Oct/ 31/2016			Feb/16/2016~Oct/ 31/2016		
AV	-0.00	0.01	-0.03	0.00	-0.01	-0.00	0.01	0.01	0.04	-0.05	-0.05	-0.08
SD	0.02	0.41	0.65	0.02	0.41	0.70	0.36	0.36	0.70	0.80	0.80	0.93
C.	Jan/19/2012~Oct/ 31/2016			Mar/12/2008~Oct/ 31/2016			May/27/2013~Oct/ 31/2016			Jun/02/2015~Oct/ 31/2016		
AV	0.00	0.01	0.01	-0.00	-0.00	0.01	0.01	0.02	0.03	-0.05	-0.04	-0.06
SD	0.02	0.41	0.69	0.02	0.47	0.85	0.37	0.37	0.70	0.71	0.71	0.82
Skew	0.36	0.05	-0.19	1.32	-0.33	0.38	0.52	0.54	0.82	-1.63	-1.61	-2.25
Kurt	16.73	4.16	8.15	37.10	5.60	7.48	5.59	5.74	8.48	19.28	19.00	23.24
OBS	1248	1248	1248	2254	2254	2254	896	896	896	370	370	370

The AV, SD, Skew, Kurt, and OBS denote mean, standard deviation, skewness, kurtosis, and observations for return series. Panel A, B, and C report descriptive statistics coming from subsample before policy event, subsample after policy event, and full sample.

Panel C of Table II illustrates the descriptive statistics of all testing bilateral rates and captures the full sample distributional characteristics of bilateal forex return by mean, standard deviation, skewness, and kurtosis. Panel A and B of Table II also reports the mean and standard deviation of two subsamples before and after the NIRP enforcement date. Comparing between subsamples, the mean almost holds constant and the standard deviation shows large differentials. Therefore, we expect the NIRP will influence conditional volatility more largely than conditional mean in the GARCH model. The leptokurtic phenomenon seems pervasive in most cases of Panel C, Table II. Such full sample distributional characteristics suggest we should consider non-normal error distribution. In robustness analysis, we use heavy tail t-distribution to cope with fat tail problem.

2.2. Empirical Model

Engle (1982) introduces Autoregressive Conditional Heteroskedastic model (ARCH model) to deal with time-varying conditional heteroskedastic problem. Bollerslev (1986) generalizes the ARCH model (GARCH) to allow ARMA presentation for conditional variance. The ARCH/GARCH model delivers a parsimonious model that is easy to analyze and forecast the conditional volatility more accurately.

In this paper, we uses the GARCH model with exogenous NIRP dummy to evaluate the possible variation for mean return and conditional volatility of testing bilateral rates. Assuming mean return of testing rate follows AR(1) process, the benchmark model is AR(1) – GARCH(1,1) with NIRP dummy both in mean equation and variance equation as Model I.

$$\text{Mean Equation: } y_t = \alpha_M + \rho y_{t-1} + \eta_M D_t + \varepsilon_t \quad (1.1)$$

$$\text{Variance Equation: } \sigma_t^2 = \alpha_V + \beta\varepsilon_{t-1}^2 + \gamma\sigma_{t-1}^2 + \eta_V D_t \quad (1.2)$$

Where y_t is the conditional mean return of testing forex rate at time t, σ_t^2 is the conditional variance for return of testing forex rate at time t, and D_t is the NIRP dummy at time t. For mean equation, α_M is the constant term, ρ is the coefficient of AR (1) term, η_M is the coefficient of NIRP dummy at time t, and ε_t is the market shock at time t. For variance equation, α_V is the constant term, β is the coefficient of squared market shock at time t-1, γ is the coefficient of conditional variance at time t-1, and η_V is the coefficient of NIRP dummy at time t. Assume ε_t follows the normal distribution. The estimation result of Model I reports at Table III in section 3-1 and conclude the basic conclusion for NIRP effect.

In financial market, the asymmetric effect describes market volatility reacting to bad news is greater than reacting to good news. To cope with such asymmetric effect in the forex market, we plug the NIRP dummy into the variance equation of Threshold GARCH model introduced by Zakoian (1994). Model II as follows.

Mean Equation: $y_t = \alpha_M + \rho y_{t-1} + \eta_M D_t + \varepsilon_t$ (2.1)

Variance Equation:

$$\sigma_t^2 = \alpha_V + \beta\varepsilon_{t-1}^2 + \lambda\varepsilon_{t-1}^2 I_{t-1} + \gamma\sigma_{t-1}^2 + \eta_V D_t \quad (2.2)$$

Where $I_{t-1} = 1$ if $\varepsilon_{t-1} < 0$ and 0 otherwise.

Apart from asymmetric effect, there is another issue about fat tail problem in the financial market. We also re-estimate the benchmark model, Model I, with alternative error assumption, heavy tail t-distribution, as Model III. Table IV and Table V report the estimation results for Model II and Model III in the section 3-2.

3. EMPIRICAL RESULTS

3.1. NIRP Effect

Table III reports the estimation results of the benchmark Model I. There are four panels in the Table III to present four currency markets respectively. Table III reports the

Table III
NIRP Effect on Conditional Mean and Conditional Variance

		Panel A. EU Euro (EUR) International Market						*Panel B. Danish Krone (DKK) Local Market*					
		DKK/EUR		*SEK/EUR*		*JPY/EUR*		*EUR/DKK*		*SEK/DKK*		*JPY/DKK*	
		Coef	*PV*	*Coef*	*PV*	*Coef*	*PV*	*Coef*	*PV*	*Coef*	*PV*	*Coef*	*PV*
EQ	α_M	0.0001	0.78	-0.0001	1.00	0.0346	0.14	-0.0004	0.20	0.0093	0.43	0.0225	0.38
1.1	ρ	0.0198	0.48	-0.0625	~~0.04~~	0.0348	0.24	0.0415	0.06	0.0037	0.86	-0.0293	0.19
	η_M	-0.0009	0.16	0.0134	0.55	-0.0593	0.07	0.0006	0.20	-0.0268	0.11	-0.0250	0.43
EQ	α_V	3.02E-06	0.00	0.1847	0.00	-0.001	0.20	2.29E-06	0.00	0.0023	0.00	0.0160	0.00
1.2	β	0.1002	0.00	0.0932	0.00	0.0344	0.00	0.0885	0.00	0.0507	0.00	0.0572	0.00
	γ	0.8836	0.00	-0.1603	0.41	0.9658	0.00	0.9096	0.00	0.9379	0.00	0.9263	0.00
	η_V	3.58E-06	0.00	-0.0088	0.49	0.0031	0.00	-4.28E-07	0.14	0.0004	0.31	-0.0080	0.00
		Panel C. Swedish Krona (SEK) Local Market						*Panel D. Japanese Yen (JPY) Local Market*					
		EUR/SEK		*DKK/SEK*		*JPY/SEK*		*EUR/JPY*		*DKK/JPY*		*SEK/JPY*	
		Coef	*PV*	*Coef*	*PV*	*Coef*	*PV*	*Coef*	*PV*	*Coef*	*PV*	*Coef*	*PV*
EQ	α_M	0.0243	0.18	0.0246	0.17	0.0133	0.65	-0.0631	0.20	-0.0619	0.21	-0.0742	0.19
1.1	ρ	0.0022	0.95	0.0043	0.91	0.0098	0.80	-0.0511	0.51	-0.0509	0.51	-0.1057	0.19
	η_M	-0.0100	0.68	-0.0099	0.68	0.0252	0.57	-0.0565	0.44	-0.0556	0.45	-0.1012	0.23
EQ	α_V	0.0087	0.00	0.0093	0.00	0.0148	~~0.03~~	0.3368	0.00	0.3403	0.00	0.4259	0.00
1.2	β	0.0473	0.00	0.0483	0.00	0.0646	0.00	0.2649	0.00	0.2568	0.00	0.3345	0.00
	γ	0.8969	0.00	0.8919	0.00	0.9004	0.00	-0.0525	0.59	-0.0558	0.59	-0.0349	0.58
	η_V	-0.0017	0.08	-0.0018	0.07	0.0056	0.12	0.1609	~~0.02~~	0.1643	~~0.02~~	0.1865	~~0.03~~

The parameter please refer to Model I. The sample period shows on Table I. Coef is the estimated coefficient and PV is the p_value of univariate t test for testing estimated coefficient different from 0. Underlined figure and strikethrough figure stands for significance level at 1% and 5%.

estimated coefficients of NIRP policy dummy and p-value of univariate t test for testing NIRP dummy significantly different from 0. Since this study focuses on NIRP effect, we concentrates on interpreting the coefficient of NIPR policy effect for variance equation and/or mean equation.

Based on Table III, all of twelve bilateral rates show statistically insignificance on NIRP effect and AR(1) effect for mean equation. The NIRP takes no effect on conditional average return of forex market. Panel A and D of Table III shows positive statistically significant NIRP effect in the variance equation on Euro and JPY currency markets. In the Euro market, two forex rates out of three are statistically siginificant at 99% level. In the JPY market, all of three bilateral rates show statistically significant at 95% level. Besides statistical significance in JPY market, conditional variance also averagely increases 16.09%, 16.43%, and 18.65% respectively On the contrary, Panel B and C of Table III cannot show any consistent statistically significant NIRP effect in variance equation on DKK and SEK currency markets.

According to Triennial Central Bank Survey conducted by Bank for International Settlements, the Euro and Yen are the second and third largest turnover currency in the world for our sample period. As a conclusion, the NIRP effect tends to exit in conditional volatility, not conditional mean, of more active trading currency, EU Euro and Japanese Yen. Moreover, the NIRP effect generates the volatility-enhancing shock and destablizes the active trading currency markets.

Table IV
NIRP Effect with Asymmetric Volatility Effect on Currency Market

		Panel A. EU Euro (EUR) International Market						*Panel B. Danish Krone (DKK) Local Market*					
		DKK/EUR		*SEK/EUR*		*JPY/EUR*		*EUR/DKK*		*SEK/DKK*		*JPY/DKK*	
		Coef	*PV*	*Coef*	*PV*	*Coef*	*PV*	*Coef*	*PV*	*Coef*	*PV*	*Coef*	*PV*
EQ	α_M	0.0003	0.41	0.0050	0.76	0.0344	0.15	-0.0003	0.33	0.0081	0.50	0.0290	0.26
2.1	ρ	0.0216	0.46	-0.0547	0.07	0.0349	0.24	0.0395	0.08	0.0036	0.87	-0.0313	0.16
	η_M	-0.0009	0.20	0.0095	0.68	-0.0598	0.07	0.0005	0.22	-0.0281	0.09	-0.0293	0.36
EQ	α_V	0.0000	0.00	0.0054	~~0.03~~	-0.0010	0.23	0.0000	0.00	0.0023	0.00	0.0155	0.00
2.2	β	0.1430	0.00	0.0264	~~0.04~~	0.0337	0.00	0.0977	0.00	0.0408	0.00	0.0676	0.00
	λ	-0.0869	0.00	0.0119	0.43	0.0025	0.78	-0.0170	~~0.02~~	0.0177	0.09	-0.0228	~~0.02~~
	γ	0.8789	0.00	0.9360	0.00	0.9652	0.00	0.9091	0.00	0.9389	0.00	0.9270	0.00
	η_V	0.0000	0.00	-0.0001	0.93	0.0031	0.00	-0.0000	0.21	0.0004	0.33	-0.0073	0.00
		Panel C. Swedish Krona (SEK) Local Market						*Panel D. Japanese Yen (JPY) Local Market*					
		EUR/SEK		*DKK/SEK*		*JPY/SEK*		*EUR/JPY*		*DKK/JPY*		*SEK/JPY*	
		Coef	*PV*	*Coef*	*PV*	*Coef*	*PV*	*Coef*	*PV*	*Coef*	*PV*	*Coef*	*PV*
EQ	α_M	0.0241	0.19	0.0241	0.19	0.0120	0.71	-0.0491	0.39	-0.053	0.32	-0.0722	0.22
2.1	ρ	0.0022	0.95	0.0042	0.91	-0.0049	0.87	-0.1297	0.09	-0.136	0.00	-0.1340	0.05
	η_M	-0.0100	0.68	-0.0099	0.68	0.0328	0.50	-0.0757	0.38	0.0000	1.00	0.0074	0.94
EQ	α_V	0.0087	0.00	0.0093	0.00	0.4400	0.26	0.2872	~~0.03~~	0.3370	0.00	0.5128	0.00
2.2	β	0.0462	~~0.04~~	0.0451	~~0.04~~	-0.0169	0.00	0.2275	0.00	0.6140	0.00	0.4157	0.00
	λ	0.0022	0.94	0.0063	0.82	0.0061	0.89	-0.2460	0.00	-0.6280	0.00	-0.4240	0.00
	γ	0.8969	0.00	0.8920	0.00	0.0131	0.99	0.2625	0.38	-0.0030	0.96	-0.1000	0.38
	η_V	-0.0017	0.10	-0.0018	0.09	0.0938	0.32	0.1593	~~0.05~~	0.1960	~~0.01~~	0.2281	~~0.04~~

The parameter please refer to Model II. The sample period shows on Table I. Coef is the estimated coefficient and PV is the p_value of univariate t test for testing estimated coefficient different from 0. Underlined figure and strikethrough figure stands for significance level at 1% and 5%.

3.2. Robustness Check for NIRP effect

There are two famous effect on volatility, asymmetry and fat-tail, will confuse the possible NIRP effect. We will try alternative setup or assumption to exclude such possibilities for our empirical findings about NIRP effect. In this section, Table IV and V report the estimation results for Model II and III respectively. The asymmetric effect describes the market volatility responding to bad news is greater than good news in the financial market. To handle such asymmetric effect in the forex market, we use Model II to check NIRP effect and asymmetry effect simultaneousely. Table IV reports the estimation results of the Model II.

The asymmetry effect of conditional variance is mixed. Only JPY currency maket, all three bilateral rates have statistically significant asymmetry effect. There are two bilateral rates out of three have significant asymmetry effect in DKK market. However, the results about asymmetric effect do not vary the results related to NIRP effect. Comparing Table IV with Table III, they share the same results about NIRP effect. The positive NIRP effect tends to exist in the conditional volatility, not the conditional mean, of more active trading currency, EU Euro and Japanese Yen.

The fat-tailed problem points out the classical normal error assumption can not describe the empirical return distribution in the financial markets. To handle the possible fat-tailed problem in the dataset, we re-estimating the benchmark model with error distribution following the heavy tail t-distribution,. The Table V documents the estimation results of Model III.

Comparing Table V with Table III, Panel A and D still show destablizing NIRP effect in the more active trading currency markets. Panel B of Table V makes an

Table V
NIRP Effect with Fat-tailed Distributional Assumption on Currency Market.

		Panel A. EU Euro (EUR) International Market						*Panel B. Danish Krone (DKK) Local Market*					
		DKK/EUR		*SEK/EUR*		*JPY/EUR*		*EUR/DKK*		*SEK/DKK*		*JPY/DKK*	
		Coef	*PV*	*Coef*	*PV*	*Coef*	*PV*	*Coef*	*PV*	*Coef*	*PV*	*Coef*	*PV*
EQ	α_M	0.0004	0.15	0.0029	0.85	0.0321	0.17	-0.0003	0.33	0.0117	0.30	0.0091	0.71
1.1	ρ	-0.0041	0.89	-0.0577	~~0.04~~	0.0440	0.11	0.0186	0.35	-0.0030	0.88	-0.0230	0.25
	η_M	-0.0008	0.16	0.0117	0.58	-0.0541	0.09	0.0006	0.09	-0.0210	0.18	-0.0188	0.52
EQ	α_V	0.0000	0.00	0.0040	0.12	-0.0001	0.94	0.0000	0.00	0.0013	~~0.04~~	0.0130	0.01
1.2	β	0.2048	0.00	0.0386	0.00	0.0336	0.00	0.1490	0.00	0.0424	0.00	0.0450	0.00
	γ	0.7815	0.00	0.9407	0.00	0.9626	0.00	0.8539	0.00	0.9546	0.00	0.9457	0.00
	η_V	0.0000	~~0.04~~	-0.0007	0.47	0.0020	~~0.04~~	-0.0000	~~0.04~~	-0.0005	0.28	-0.0091	0.01
		Panel C. Swedish Krona (SEK) Local Market						*Panel D. Japanese Yen (JPY) Local Market*					
		EUR/SEK		*DKK/SEK*		*JPY/SEK*		*EUR/JPY*		*DKK/JPY*		*SEK/JPY*	
		Coef	*PV*	*Coef*	*PV*	*Coef*	*PV*	*Coef*	*PV*	*Coef*	*PV*	*Coef*	*PV*
EQ	α_M	0.0148	0.36	0.0144	0.37	0.0026	0.92	-0.0419	0.35	-0.0423	0.35	-0.0577	0.30
1.1	ρ	-0.0028	0.93	-0.0017	0.96	-0.0004	0.99	-0.0512	0.37	-0.0508	0.38	-0.0739	0.30
	η_M	-0.0057	0.80	-0.0052	0.81	0.0259	0.53	-0.0144	0.83	-0.0132	0.85	-0.0637	0.45
EQ	α_V	0.0026	0.15	0.0036	0.11	0.0100	0.12	0.4561	0.00	0.4540	0.00	0.4561	0.00
1.2	β	0.0386	0.01	0.0431	0.01	0.0447	0.00	0.0263	0.31	0.0284	0.30	0.1736	0.00
	γ	0.9459	0.00	0.9353	0.00	0.9302	0.00	-0.3803	0.27	-0.3647	0.32	-0.0535	0.61
	η_V	-0.0005	0.48	-0.0007	0.46	0.0034	0.37	0.2003	~~0.03~~	0.1997	~~0.03~~	0.1638	~~0.05~~

The parameter please refer to Model III, that is Model I specification with error distribution obeying t-distribution. The sample period shows on Table I. Coef is the estimated coefficient and PV is the p_value of univariate t test for testing estimated coefficient different from 0. Underlined figure and strikethrough figure stands for significance level at 1% and 5%.

exception comparing with previous results, they have two forex rates out of three showing negative NIRP effect. The empirical results of Table V still largerly confirms the major findings of this article.

In general, the empirical conclusions of this section prove the major finding of this paper is robust with asymmetry effect and fat-tailed risk. Therefore, the NIRP will destablize the market volatility in the active trading currency markets, EU Euro and Japanese Yen.

4. DISCUSSION AND CONCLUSION

This article exams and discusses the impact of the NIRP on four target currency markets, including EUR, DKK, SEK, and JPY. The NIRP effect focuses to test the policy enforcement effect over bilateral forex rates invloving two target currencies. The major empirical finding in this paper, the NIRP enforcement will amplify the market volatility and destabilize the forex market, especially for more active trading currency markets, EUR and JPY.

Intuitionally, the NIRP have two conflicting effects. Firstly, the NIRP will keep money creation continuing to relax and the investors optimistically expect bullish for financial market. This easing money effect of NIRP will predict a positive NIRP effect for conditional mean of financial market. On the other hand, the NIRP will break the theoretical interest rate zero lower bound and incur heavy uncertainty in financial market. The investors are obviously unwilling to tolerate such risk in the financial market. Henceforth, the risk-tolerance shrinkage effect predicts a positive NIRP effect for conditional volatility of financial market.

The empirical findings of this paper imply the risk-tolerance shrinkage effect for NIRP implementation in the active trading forex markets. Although we cannot find the empirical evidence for NIRP on conditional mean, it maybe need longer sample period to validate easing money effect of NIRP. Besides, the direct tests for risk-tolerance shrinkage effect and easing money effect are the future research topic in negative interest rate policy study.

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