Theoretical and Applied Economics
Volume XXIV (2017), No. 3(612), Autumn, pp. 29-38

Causality between economic policy uncertainty and exchange rate in China with considering quantile differences

Yin DAI
Ocean University of China, Qingdao, Shandong, China
dydy1216@126.com
Jing-wen ZHANG
College of Finance and Statistics, Hunan University, Changsha, China
zhangjingwen@hnu.edu.cn
Xiu-zhen YU
Qingyang Municipal Sub-branch PBC, Qingyang, Gansu, China
877472595@qq.com
Xin LI
Antai College of Economics & Management, Shanghai Jiao Tong University, Shanghai, China
shin_li@foxmail.com

Abstract. *Under an existing theoretical framework regarding the relationship between investment decision and the size of economic policy uncertainty (EPU), this paper tests the causality between EPU and exchange rate (ER). Theoretically, the impact of EPU on ER should be treated asymmetrically since investors need higher risk premiums to offset the consequences of growing EPU. The causality is investigated by using the quantile Granger causality test. This test shows that causality is more significant in the tail quantile interval. Since EPU of China is extremely high since 2016, and ER also experienced huge fluctuations during this period, our result provides an empirical basis for international investors to protect themselves against the risks associated with EPU in the exchange market.*

Keywords: economic policy uncertainty; exchange rate; quantile causality.

JEL Classification: C32; G10.

1. Introduction

Economic policy has played an important role in stabilizing the economy and promoting global economic recovery especially since the financial crisis of 2008. However, given the increasing complexity of macroeconomic and market related processes, the uncertainty of economic policies has been high (Krol, 2014). Uncertainty in economic policy will affect economic stability from both microeconomic and macroeconomic perspective; variations in "uncertainty" could cause changes in "confidence", a term which often implies both mean and variance effects (Baker et al., 2011). Uncertainty gives firms an incentive to delay investment and hiring when investment projects are expensive to cancel or workers are costly to hire and fire (Bernanke, 1983). Uncertainty also affects precautionary spending processes by rising pressure on the cost of finance (e.g., Gilchrist et al., 2010 and Pastor and Veronesi, 2011), and increases managerial risk aversion (Panousi and Papanikolaou, 2012). As the largest and most liquid financial market in the world, the foreign exchange market may be influenced by this uncertainty (Balcilar et al., 2016). Changes in exchange rate (*ER*) are counterproductive to the economy, influencing economic policy design and increasing economic policy uncertainty (*EPU*).

China has reformed its *ER* regime in 2005, switching from a fixed to a managed floating *ER* system. This caused *ER* of the Renminbi (*RMB*) to show increased sensitivity to a number of factors, thus leading to greater volatility. As the complexity of the exchange rate influencing factors grows, it is increasingly harder to explain these fluctuations by using the classical *ER*-theory. However, the importance of this issue in international economics remains undisputed (Beckmann and Czudaj, 2016). Greater *ER* deviation not only influences the domestic economy through the increase in volatility of business profits and inflation uncertainty, but also changes the relative structure of production costs and raises the transaction risk associated with international trade (see Braun and Larrain, 2005; Grier and Grier, 2006; Aghion et al., 2006; Baum and Caglayan, 2006). Short-term changes in the *ER* of the *RMB* are largely influenced by economic policies (Zhu and Yan, 2015), this is of great interest to policy makers regarding the pass-through mechanism and how exchange movements affect domestic policy uncertainty (Balcilar et al., 2015).

There are detailed studies aimed at analyzing the impact of the *EPU* on macroeconomic variables: Balcilar et al. (2014) find the *EPU* has an important role in inflation forecasting; Karnizova and Li (2014) use probit recession forecasting models to assess the ability of *EPU* indexes developed by Baker et al. (2013) and suggests that the policy uncertainty indexes are statistically and economically significant in forecasting recessions at the horizons beyond five quarters; and Balcilar et al. (2016) analyze the performance of the monthly *EPU* index in predicting recessionary regimes of the US gross domestic product *(GDP)* and highlight the importance of using high-frequency values of the *EPU* when forecasting recessionary regimes for the US economy.

However, the relationship between *EPU* and *ER* is rarely addressed. Benigno et al. (2012) use the vector autoregressive (*VAR*) model to analyze the influence of domestic uncertainty on dollar-based *ER* and find an increase in monetary policy uncertainty will lead to an *ER* appreciation in the medium run. Colombo (2013) investigates the effects of the US *EPU* shock on nominal Euro-Dollar *ER* and finds the contribution of the US uncertainty shock on the European aggregates to be quantitatively larger than the one exerted by a Euro area-specific uncertainty shock. Krol (2014) investigates the impact of general economic and *EPU* on *ER* volatility for ten industrial and emerging economies since 1990. The results suggest that domestic and US economic policy uncertainty directly increase *ER* volatility for some of the currencies examined. For China, Sim (2015) applies the structural vector autoregressive model (*SVAR*) to the economies of Taiwan and Hong Kong to investigate the impacts of the Chinese uncertainty on *ER* over the past decade. The results indicate that uncertainty shock have a significant impact on *ER*. Zhu and Yan (2015) focus on the dynamic spillover relationship between *ER* and *EPU*. The result indicates that *EPU* of China, the US, Euro area and Japan all have significant spillover effect on *ER* of the *RMB*.

ER expectations reflect all available information in case of market efficiency. However, the role of macroeconomic policy uncertainty for *ER* has not been empirically considered (Beckmann and Czudaj, 2016). The central idea in this paper is that *ER* is determined by expectations of economic fundamentals and policies. If this is true, a high level of *EPU* will lead to more revisions in expectations of the fundamental factors that determine the value of *ER*, resulting in greater *ER* fluctuation (Krol, 2014). In return, *ER* fluctuations will affect the domestic production and trade, which affect the macroeconomic and increase *EPU*. Against this background, this study contributes to the literature by analyzing the impact of China policy uncertainty on *ER*.

Taking into account quantile interval differences, this paper uses the quantile causality test to investigate the relationship between *EPU* and *ER*. In fact, over the past decade, China and the world economy have undergone a series of structural changes. For example, the 2008 financial crisis leading to a significant increasing in EPU of China. In response to the financial crisis, China restored a fixed exchange rate system during the economic crisis in order to stimulate the economy. After 2011, the debt crisis in Europe also had worldwide consequences, one of which being a significant increase in *EPU* for China. During this period, the Chinese stock and housing markets as well as the *RMB* exchange rate have experienced severe fluctuations, which caused widespread concern. After 2015, following structural changes, the *EPU* of China increased rapidly, even higher than during the financial crisis. The exchange rate showed a devaluation trend for the first time, and fluctuations were intense. Since during these periods *EPU* and *ER* have undergone great changes, in order to explore the association more essentially, we use the quantile test. Results indicate that *EPU* and *ER* in the tail (lowest or highest) quantile interval within the interaction are more significant. In contrast to the trend of *EPU* and *ER*, we find that these significant effects of the quantile range are more distributed in the financial crisis mentioned earlier, the European debt crisis and after 2015. Such conclusion is consistent with the theoretical analysis of this paper. A higher *EPU* is more likely to cause changes in the *ER*. In this case, investors need to target higher risk premiums, which in turn may hinder them from investing into the exchange market, thus triggering variations of the exchange rate. Since 2015, the EPU of the Chinese economy increased unprecedentedly, with RMB exchange rate devaluation. Based on this, this paper provides an empirical basis for investors to deal with *ER* risk when *EPU* is high.

The remainder of the paper is organized as follows: Section 2 presents the economic model of this paper; Section 3 explains the methodology; Section 4 describes the corresponding data and empirical results; Section 5 concludes.

2. Theoretical analysis

We refer to the model from Rodrik (1991) to investigate the investment decision under the condition of policy uncertainty. Supposing *ER* is $r - t_0$ before the implementation of the policy, where r denotes the marginal return of capital, t_0 denotes the impact of policy distortions on investment returns, t_0 will reduce to t ($t < t_0$) after the implementation of the policy. Assuming that the policy is implemented to get the optimal allocation of capital, and $r - t_0 < r^*$, where r^* denotes the risk-free interest rate, *EPU* can be measured as π, which is the probability of policy exit. Risk neutral investors have to make decision on r^* and $r - t$. Supposing the discount factor is ρ, the value of this decision (V_0) is as follows:

$$V_0 = r^*/\rho \tag{1}$$

Supposing V_1 denotes the maximum value of a unit of capital after policy implementation, the value of V_1 depends on π and the cost of policy exit. Further supposing V_1^R denotes the maximum value of capital held when policy exit, $V_1 - V_1^R$ denotes the accumulated capital loss in the case of policy exit. V_1 consists of $r - t$ and the expected capital loss: $\pi(V_1 - V_1^R)$. As a result, V_1 can be written as:

$$V_1 = \{(r - t) - \pi[V_1 - V_1^R]\}/\rho \tag{2}$$

Equation (2) can be transformed into:

$$V_1 = (\rho + \pi)^{-1}[(r - t) + \pi V_1^R] \tag{3}$$

Supposing t will restore to t_0 in the case of policy exit, if $r - t_0 < r^* - \rho\theta$, where θ denotes costs of capital exiting from the exchange market, which means the *ER* returns before policy implementation is less than the net profit when capital withdrawal from the exchange market, then the capital will invest in the exchange market. Investors' decision making in the presence of *EPU* depends on the value of t_0.

$$\begin{cases} V_1^R = \left(\frac{r^*}{\rho}\right) - \theta, & when\ t_0 > (r - r^*) + \rho\theta \\ V_1^R = \frac{r - t_0}{\rho}, & when\ t_0 \leq (r - r^*) + \rho\theta \end{cases} \tag{4}$$

Therefore, V_1 can be written as follows:

$$V_1 = (\rho + \pi)^{-1}\left[(r - t) + \pi \max\left\{\frac{r - t_0}{\rho}, \left(\frac{r^*}{\rho}\right) - \theta\right\}\right] \tag{5}$$

The boundary condition for capital investing in the exchange market is as follows:

$$V_1 \geq V_0 + \varepsilon \tag{6}$$

where ε denotes the entry cost of unit capital, the capital will enter the exchange market only when the net income of the reset capital is positive. When $t_0 > (r - r^*) + \rho\theta$, based on Equation (1), Equation (5) and Equation (6), the boundary condition for capital investing in the exchange market is as follows:

$$(r-t)-r^{*} \geq \varepsilon\rho+\pi(\varepsilon+\theta) \tag{7}$$

Based on Equation (7), t must be small enough to make up for the cost of capital reconfiguration ($\varepsilon\rho$) and the cost of policy exit ($\pi(\varepsilon+\theta)$), or the capital will not be invested in the exchange market. Specifically, if *EPU* is at a high level, which means the cost of policy exit ($\pi(\varepsilon+\theta)$) is higher, then the inhibitory effect of *EPU* on investment will be stronger. Rodrik (1991) suggests that if π, ε and θ are big enough, investors are hard to make up for these costs even when $t=0$. Equation (7) suggests that, the essence of *EPU* is taxing on investors. In this case, higher risk premiums are needed to hedge the negative impact of *EPU* on investment.

When $t_0 \leq (r-r^{*})+\rho\theta$, the boundary condition for capital investing in the exchange market is as follows:

$$t \leq (r-r^{*})-\varepsilon\rho-[\pi/(\rho+\pi)]t_0 \tag{8}$$

Equation (8) suggests that, when the discount factor ρ is much smaller than the probability of policy exit π, $\pi/(\rho+\pi)$ is close to 1. Investors need a risk premium greater than r^{*} to offset the risk of *EPU*.

Investors need a risk premium to make up for costs from *EPU*. Especially, when *EPU* is at a higher level, the risk premiums will increase accordingly, resulting in greater inhibition of investment (Gulen and Ion, 2016). As a result, when costs from *EPU* are high, willingness to invest is hard to achieve even when the negative impact of policy distortions t is small enough. French and Sichel (1993) prove that investment is closely related to the size of uncertainty, external negative shocks being usually associated with higher uncertainty. The negative effect occupies the main position when the uncertainty is high. Therefore, the impact of *EPU* on *ER* depends on the size of uncertainty.

3. Quantile Granger causality test

To provide a complete understanding of the internal causality between EPU_t and SR_t, Chuang et al. (2009) consider the following Granger non-causality test in quantiles:

$$Q_{y_t}(\tau|(\mathcal{Y},\mathcal{X})_{t-1}) = Q_{y_t}(\tau|\mathcal{Y}_{t-1}), \forall\tau \in [a,b] \tag{9}$$

where $Q_{y_t}(\tau|\mathcal{F})$ denotes the τ-th quantile of $F_{y_t}(\cdot\,|\mathcal{F})$. If Equation (11) holds, then x_t does not Granger cause y_t over the quantile interval $[a,b]$. We can conduct the Granger non-causality test in quantiles by using the quantile regression method in Koenker and Bassett (1978). The conditional quantile function of y_t can be written as follows:

$$Q_{y_t}(\tau|\boldsymbol{z}_{t-1}) = \omega(\tau)+\sum_{i=1}^{p}\alpha_i(\tau)y_{t-i}+\sum_{j=1}^{p}\beta_j(\tau)x_{t-j} = \boldsymbol{z}'_{t-1}\theta(\tau) \tag{10}$$

where

$\boldsymbol{z}_{t-1} = [1, \boldsymbol{y}'_{t-1,p}, \boldsymbol{x}'_{t-1,p}]$,

$\boldsymbol{y}_{t-1,p} = [y_{t-1}, \mathcal{Y}_{t-2}, \ldots, \mathcal{Y}_{t-p}]'$,
$\boldsymbol{x}_{t-1,p} = [\mathcal{X}_{t-1}, \mathcal{X}_{t-2}, \ldots, \mathcal{X}_{t-p}]'$ and
$\theta(\tau) = [\omega(\tau), \alpha_1(\tau), \ldots, \alpha_p(\tau), \beta_1(\tau), \ldots, \beta_p(\tau)]'$. In Equation (4), we can estimate $\hat{\theta}(\tau)$ by minimizing asymmetrically weighted absolute deviations, that is, the check function. Under some regularity conditions, $\hat{\theta}(\tau)$ is consistent and asymptotically normal:

$$\sqrt{T}\left(\hat{\theta}_T(\tau) - \theta(\tau)\right) \rightsquigarrow [\tau(1-\tau)]^{\frac{1}{2}} \Omega(\tau)^{\frac{1}{2}} \mathcal{N}(0, I_k) \tag{11}$$

where
$\Omega(\tau) = D(\tau)^{-1} M_{zz} D(\tau)^{-1}$,
$M_{zz} = lim_{T\to\infty} \sum_{t=1}^{T} \boldsymbol{z}_{t-1}\boldsymbol{z}'_{t-1}$,
$D(\tau) = lim_{T\to\infty} \sum_{t=1}^{T} f_{t-1}(F_{t-1}^{-1}(\tau))\boldsymbol{z}_{t-1}\boldsymbol{z}'_{t-1}$ and
$\rightsquigarrow$ denotes convergence in distribution. Here F_{t-1} and f_{t-1} denote the distribution and density functions of y_t conditional on $\mathcal{Z}_{t-1}$, which is the information set generated by $\boldsymbol{z}_{t-1}$, $\boldsymbol{z}_{t-2}$, …, respectively.

The null hypothesis for the Granger causality test in quantile is:

$H_0: \beta(\tau) = 0, \forall\tau \in [a, b]$
where $\beta(\tau) = [\beta_1(\tau), \beta_2(\tau), \ldots, \beta_p(\tau)]'$. For a given τ, the Wald statistic of $\beta_i(\tau) = 0$, for all $i = 1,2, \ldots, p$, is as follows:

$$\mathcal{W}_T(\tau) = T\,\frac{\hat{\beta}_t(\tau)'\left(\boldsymbol{\Psi}\hat{\Omega}(\tau)\boldsymbol{\Psi}'\right)^{-1}\hat{\beta}_T(\tau)}{\tau(1-\tau)} \tag{12}$$

where $\hat{\Omega}(\tau)$ denotes a consistent estimator of $\Omega(\tau)$ and $\boldsymbol{\Psi}$ denotes $q \times k$ election matrix such that $\boldsymbol{\Psi}\theta(\tau) = \beta(\tau)$. However, the above Wald test cannot be used to test H_0 because it is valid only for fixed τ, not $\forall\tau \in [a, b]$. Koenker and Machado (1999) suggest a sup-Wald test to test H_0. Using a vector of p independent Brownian bridges, $\boldsymbol{B}_p(\tau) = [\tau(1-\tau)]^{\frac{1}{2}}\mathcal{N}(0, I_p)$, we can write:

$$\sqrt{T}\left(\hat{\theta}_T(\tau) - \theta(\tau)\right) \rightsquigarrow [\boldsymbol{\Psi}\Omega(\tau)\boldsymbol{\Psi}']^{1/2}\boldsymbol{B}_p(\tau) \tag{13}$$

Under suitable conditions, Equation (13) holds uniformly on the closed interval $\mathcal{T} \subset [a, b]$. Therefore, under the null hypothesis, we can express the Wald statistic as follows:

$$\mathcal{W}_T(\tau) \Rightarrow \left\|\frac{\boldsymbol{B}_p(\tau)}{\sqrt{\tau(1-\tau)}}\right\|^2, \text{for } \tau \in \mathcal{T}$$

where the weak limit is the sum of square of p independent Bessel processes and $\Rightarrow$ stands for weak convergence. However, note that when a and b are very close to 0 and 1, respectively, $\mathcal{W}_T(\tau)$, $\tau \in \mathcal{T}$ may not be well defined asymptotically because $\frac{\boldsymbol{B}_p(\tau)}{\sqrt{\tau(1-\tau)}}$ diverges (Andrews, 1993). From the above result, we have the following equation:

$$sup_{\tau \in \mathcal{T}} \mathcal{W}_T(\tau) \rightsquigarrow \left\| \frac{\boldsymbol{B}_p(\tau)}{\sqrt{\tau(1-\tau)}} \right\|^2 \tag{14}$$

When we conduct the above test, we choose n points, say, $a = \tau_1 < \cdots < \tau_n = b$, and calculate the sup-Wald test by $sup\, \mathcal{W}_T = sup_{i=1,2,\ldots,n} \mathcal{W}_T(\tau_i)$.

By considering various $[a, b]$ we can capture the quantile range from which causal relationship arises. For the critical values of the sup-Wald test we simulate the standard Brownian motion by using a Gaussian random walk with 10,000 independent identically distributed $N(0,1)$ iterations.

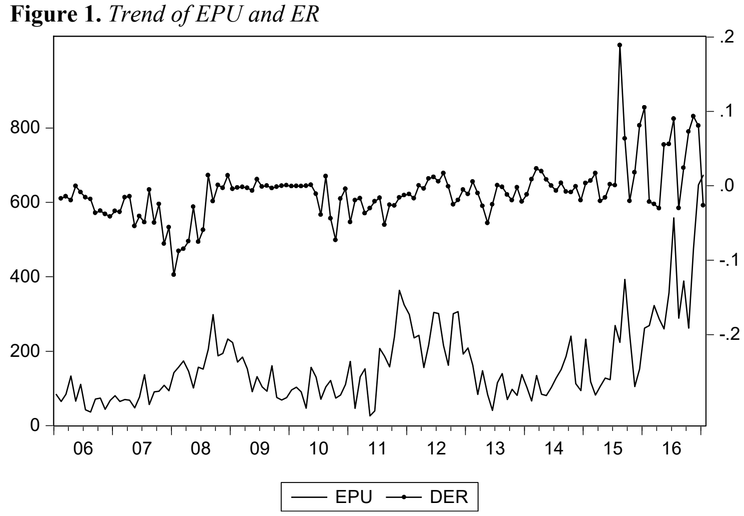
4. Data and empirical results

Considering that before 2005 China implemented a fixed exchange rate regime, we use the monthly data covering the period from 2006:M1 to 2017:M1. Data of *ER* is the US dollar against the Renminbi (*RMB*), which can be obtained from the National Bureau of Statistics of the People's Republic of China. Baker et al. (2013) measured *EPU* for major countries and regions in the world, and the data can be obtained from the Economic Policy Uncertainty database. It includes uncertainties regarding tax, spending, monetary and regulatory policy by the government that is calculated from 3 components: the frequency that economic policies appear in the newspaper, the number of expired code, and the extent of forecaster disagreement over future inflation and government purchases. All data are transformed by taking natural logarithms to correct for potential heteroskedasticity. Some unit root tests (the *ADF* test, the *PP* test and the *KPSS* test) are applied to test the stationarity of the data. *EPU* of China is a stationary process in the level, and data of *ER* is integrated of order one *I(1)*. As a result, data of *ER* is taken first order difference processing to ensure the data stability.

Figure 1 shows the trend of *EPU* and *ER*. It can be intuitively seen that *EPU* and *ER* experience abnormal fluctuations in three periods (the financial crisis during 2007-2010, the European debt crisis during 2011-2013, and Chinese economic structure reforming since 2015). Among them, during 2007-2008, *EPU* of China rises significantly affected by the financial crisis. Meanwhile, *ER* also shows a huge fluctuation before 2008:M4. In 2007, the rapid economic growth of China causes surge in exports, massive inflows of short-term international capital and domestic inflation. As a result, the Chinese government implements the *RMB* appreciation strategy. Nevertheless, the Chinese economy suffers a huge shock (such as the rapid decline of external demand and exports, and the slowdown of economic growth) since 2008:M4 caused by the financial crisis. In response to the financial crisis, the Chinese government makes a substantial adjustment from the macro policy to stimulate the economic growth, such as the 4 trillion government investment, the lower interest rates and deposit reserve ratio and the recovery of the fixed exchange rate regime. In 2010, China shortly after the end of the financial crisis, the housing price enters into a new round of rising cycle, further generating domestic inflation. As a result, the government implements the managed floating exchange rate regime, and the *RMB* begins a continuous process of appreciation. During 2011-2013, *EPU* of China rises caused by the

European debt crisis. Since 2015, the Chinese economy experiences a series of turmoil (such as the downturn of the economy, the stock market crash and the continued devaluation of the *RMB*). In this time period, *EPU* of China is significantly higher. It is worth noting that, the *RMB* shows a substantial depreciation for the first time in the past decade. In order to promote the economic structural reform and maintain the stability of the *RMB*, the government implements a series of policies and further causing the rise of the *EPU*.

Figure 1. *Trend of EPU and ER*



We utilize the quantile Granger causality test to examine the relationship between *ER* and *EPU*. Table 1 and Table 2 show the result of the quantile causality test. We consider 5 quantile intervals ([0.05, 0.2], [0.2, 0.4], [0.4, 0.6], [0.6, 0.8], [0.8, 0.95]) to test the correlation between *EPU* and *ER*, and find some more regular results. The optimal lag length in each quantile interval is selected by the Akaike Information Criterion (*AIC*).

Table 1. *Causality in Quantiles: EPU does not Granger cause ER*

Quantile interval	*EPU* $\nRightarrow$ *ER*	Lag Length	Critical values		
			1%	5%	10%
[0.05, 0.2]	4.14	1	9.86	6.77	5.32
[0.2, 0.4]	0.48	1	8.53	6.50	5.18
[0.4, 0.6]	1.78	1	8.91	6.31	5.15
[0.6, 0.8]	4.29	1	10.15	6.40	4.87
[0.8, 0.95]	12.16**	1	9.87	7.10	5.68

Note: ** denotes the rejection of the null of no Granger causality at 5% level of significance.

Table 2. *Causality in Quantiles: ER does not Granger cause EPU*

Quantile interval	*ER* $\nRightarrow$ *EPU*	Lag Length	Critical values		
			1%	5%	10%
[0.05, 0.2]	22.51***	1	9.86	6.77	5.32
[0.2, 0.4]	6.43*	1	8.53	6.50	5.18
[0.4, 0.6]	4.84	1	8.91	6.31	5.15
[0.6, 0.8]	10.14**	1	10.15	6.40	4.87
[0.8, 0.95]	14.56**	1	9.87	7.10	5.68

Note: *, ** and *** denotes the rejection of the null of no Granger causality at 10%, 5% and 1% level of significance, respectively.

First, Table 1 shows the causality from *EPU* to *ER*, suggesting *EPU* causes *ER* only in the quantile interval of [0.8, 0.95] at 5% significance level. We find *EPU* is more likely to cause *ER* in the tail quantile interval (extremely high). From Figure 1 we can see that, *EPU* is extremely high during the period of 2008-2009 and 2015-2016. Intuitively, Table 2 shows that the causality from *ER* to *EPU* is significant in several quantile intervals. Table 2 shows that, *ER* significantly causes *EPU* of China in most quantile intervals except [0.4, 0.6]. It can be seen that, *EPU* of China is mostly influenced by *ER* when it is higher (or lower). *ER* is relatively low in 2007-2008 and 2010-2012, and it is relatively high in 2015-2016. Above all, the quantile test can reveal the causality between *EPU* and *ER* more essentially without considering exogenous variables. Results of the quantile causality test provide the internal relationship between *EPU* and *ER*, which is more robust than the full-sample causality test. The regularity of the relationship between *EPU* and *ER* is of great significance for government's policy making and investors' prospective risk aversion in the exchange market.

5. Conclusions

This paper elaborates the relationship between *EPU* and *ER* theoretically from the perspective of investment decision, and uses the quantile causality test to empirically investigate the causality between them. The quantile Granger causality test can investigate the causality from the perspective of sample distribution. Results suggests the causality of *EPU* and *ER* mostly exists in the tail quantile interval. From the empirical result a conclusion can be draw that when the value of EPU is extremely high, the causal relationship exits from EPU to ER in China. At the same time, when ER is too high (or too low), EPU is easily be affective by ER. In conclusion, the relationship between EPU and ER is more likely exist in extreme situations. In view of the interrelation between *EPU* and *ER*, this paper provides evidence for international investors' decision making in the exchange market. Macroeconomic volatility often leads to increased *EPU*, while higher *EPU* will raise investor risk premiums. *EPU* of China is relatively high since 2015, therefore, investors should guard against the exchange rate risk caused by policy changes.

References

Aghion, P., Bacchetta, P. and Rancière, R., 2006. Exchange rate volatility and productivity growth: The role of financial development. *Journal of Monetary Economics,* 56(4), pp. 494-513.

Baker, S.R., Bloom, N. and Davis, S.J., 2013. Measuring Economic Policy Uncertainty. *National Bureau of Economic Research*, pp. 57-66.

Balcilar, M., Gupta, R. and Jooste, C., 2014. The Role of Economic Policy Uncertainty in Forecasting US Inflation Using a VARFIMA Model. *Working Papers.*

Balcilar, M., Gupta, R. and Kyei, C., 2016. Does Economic Policy Uncertainty Predict Exchange Rate Returns and Volatility? Evidence from a Nonparametric Causality-in-Quantiles Test. *Open Economies Review*, 27(2), pp. 229-250.

Balcilar, M., Gupta, R. and Segnon, M., 2016. The Role of Economic Policy Uncertainty in Predicting US Recessions: A Mixed-frequency Markov-switching Vector Autoregressive Approach. *Working Papers,* 10.

Baum, C.F. and Caglayan, M., 2006. On the sensitivity of the volume and volatility of bilateral trade flows to exchange rate uncertainty. J*ournal of International Money & Finance,* 29(1), pp. 79-93.

Beckmann, J. and Czudaj, R., 2016. Exchange rate expectations and economic policy uncertainty. *European Journal of Political Economy.*

Benigno, G., Benigno, P. and Nisticò, S., 2012. Risk, Monetary Policy, and the Exchange Rate. *NBER Macroeconomics Annual,* 26(1), pp. 247-309.

Bernanke, B., 1983. Irreversibility, Uncertainty and Cyclical Investment. *Quarterly Journal of Economics,* 98, pp. 85-106.

Braun, M. and Larrain, B., 2005. Finance and the Business Cycle: International, Inter-Industry Evidence. *The Journal of Finance,* 60(3), pp. 1097-1128.

Brogaard, J. and Detzel, A.L., 2015. The Asset Pricing Implications of Government Economic Policy Uncertainty. *Ssrn Electronic Journal,* 61(1), pp. 3-18.

Chuang, C.C., Kuan, C.M. and Lin, H.Y., 2009. Causality in quantiles and dynamic stock return – volume relations. *Journal of Banking & Finance*, 33(7), pp. 1351-1360.

Colombo, V., 2013. Economic policy uncertainty in the US: Does it matter for the Euro area? *Economics Letters,* 121(1), pp. 39-42.

French, M.W. and Sichel, D.E., 1993. Cyclical patterns in the variance of economic activity. *Journal of Business & Economic Statistics*, 11(1), pp. 113-119.

Gilchrist, S., Sim, J. and Zakrajsek, E., 2010. Uncertainty, Financial Frictions, and Investment Dynamics. *Society for Economic Dynamics.*

Grier, R. and Grier, K.B., 2006. On the real effects of inflation and inflation uncertainty in Mexico. *Journal of Development Economics,* 80(2), pp. 478-500.

Gulen, H. and Ion, M., 2016. Policy uncertainty and corporate investment. *Review of Financial Studies*, 29(3), pp. 523-564.

Karnizova, L. and Li, J., 2014. Economic policy uncertainty, financial markets and probability of US recessions. *Economics Letters,* 125(2), pp. 261-265.

Koenker, R. and Bassett, G.Jr., 1978. Regression quantiles. *Econometrica: journal of the Econometric Society*, pp. 33-50.

Koenker, R. and Machado, J.A.F., 1999. Goodness of fit and related inference processes for quantile regression. *Journal of the American statistical association*, 94(448), pp. 1296-1310.

Krol, R., 2014. Economic Policy Uncertainty and Exchange Rate Volatility. *International Finance,* 17(2), pp. 241-256.

Panousi, V. and Papanikolaou, D., 2012. Investment, Idiosyncratic Risk, and Ownership. *The Journal of Finance,* 67(3), pp. 1113-1148.

Pastor, L. and Veronesi, P., 2011. Uncertainty about government policy and stock prices. *Forthcoming Journal of Finance.*

Pastor, L. and Veronesi, P., 2012. Uncertainty about government policy and stock prices. *The Journal of Finance*, 67(4), pp. 1219-1264.

Rodrik, D., 1991. Policy uncertainty and private investment in developing countries. *Journal of Development Economics*, 36(2), pp. 229-242.

Sin, C.Y., 2015. The economic fundamental and economic policy uncertainty of Mainland China and their impacts on Taiwan and Hong Kong. *International Review of Economics & Finance,* 40, pp. 298-311.

Su, D., Li, X., Lobonţ, O.R. and Zhao, Y.P., 2016. Economic policy uncertainty and housing returns in Germany: Evidence from a bootstrap rolling window. *Zbornik radova Ekonomskog fakulteta u Rijeci: časopis za ekonomsku teoriju i praksu*, 34(1), pp. 43-61.

Zhu, M.N. and Yan, S., 2015. Dynamic Spillovers of Economic Policy Uncertainty and RMB Exchange Rate. *Journal of International Trade*, 10, p. 111.