Volatility Spillover Effect of U.S. Economic Policy Uncertainty on China's Financial Submarkets

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Abstract—As the uncertainty of American economic policy increases, the impact of it on China, a rapidly developing country which is constantly improving its financial market, cannot be ignored. In this paper, we divide China's financial market into eight submarkets, and use the DCC-GARCH model to compare and analyze the volatility spillover effects of U.S. economic policy uncertainty on these different financial submarkets in China from the macro level. Results show that the U.S. economic policy uncertainty promotes China's stock market volatility most of the time, which highlights that the stock market is more vulnerable to the impact of external information. It also turns out that the U.S. economic policy suppresses the volatility of the bond market and money market most of the time, highlighting the hedging function of these two markets to external shocks. Besides, results show that the U.S. economic policy uncertainty has no obvious impact on the volatility of other submarkets.

Keywords-DCC-GARCH; AEPU; China's Financial Submarkets;

1. INTRODUCTION

China has basically formed a financial market system in which the money market, capital market, foreign exchange market, and gold market coexist. The prices of these submarkets are affected by the relationship between supply and demand, fluctuating around the value. They are uncertain and risky. Since the new century, the development of all kinds of financial markets has accelerated, and the market participants have been expanding. How to orderly promote the domestic financial market into the international market and effectively protect the interests of small and medium-sized investors is more and more worthy of attention. Since Trump took office, he has carried out a series of economic policies different from previous administrations, adhering to the economic and trade protectionism governing philosophy of "America first" and "global austerity". Now Biden takes office and his governing philosophy will be different from Trump. In addition, combined with the impact of the new coronary epidemic, economic policy uncertainty in the United States has increased significantly.

Bloom confirmed one of the conjectures in his article "Fluctuations in Uncertainty" that greater uncertainty would affect a firm's behavior and reduce their willingness to invest [1]. And he also validated that a surge in uncertainty has deepened the sharp economic decline in 2008, i.e., the Great Recession, and slowed the recoveries for many reasons, including unemployment rate rise,

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volatility of income increase, and household consumption expenditure reduction. Other researchers also show that the negative effect of uncertainty might result from many reasons, both in the short and long terms. Comprising managerial risk aversion since idiosyncratic volatility could act on executives when making investment decisions and financial distortions since it could be a core mechanism affecting macroeconomic outcomes [2, 3]. As noted, it is clear to say that the impact of uncertainty plays a significant role in the economy.

After partisanship disputes in the United States, the continuous advancement of the process of Brexit, and the bankruptcy of Lehman Brothers, turbulent international and society situation also raise people's awareness to consider the relationship between the uncertainty of fiscal, regulatory, and monetary policies and economical. As Al-Thaqeb and Algharabali put forward in their paper, policy uncertainty is the economic risk of impending indeterminate government and regulatory policies. It will cause industries and households to postpone their investment expenses owing to a less assured market [4]. Therefore, this calls for discovering some indicators to monitor uncertainty in government policies and regulations.

To keep track of the volatility, several measures have been introduced. One of the most widely used measures is the VIX—the Chicago Board Options Exchange (CBOE) Market Volatility Index. The VIX was first presented to provide a standard of short-term market volatility and an index based on which derivative contracts on volatility could be written [5]. However, this market measure has its limitation since it relies on the market's maturity and cannot be applied in many countries. And as mentioned by Jurado, Ludvigson, and Ng, this popular proxy lacked the concern of persistence of uncertainty shocks. Therefore, they bring about a new method using time series techniques to better indicate macroeconomic uncertainty [6].

However, many factors can affect policy uncertainty, including market, politics, policies, and news. While most measures proposed are accepted, they were constrained in evaluating certain types of uncertainty and not publicly accessible [4]. In the seminal work "Measuring Economic Policy Uncertainty" publicized in 2016, Baker et al. discovered an index—economic policy uncertainty (EPU)— that could successfully capture all the factors mentioned above.

EPU proves to be valid by several types of evidence, comprising fluctuations of fiscal policy, firm-level data, and macro level innovations. Baker et al. collect data from articles released in ten chief U.S. newspapers and then count the frequency when containing specific words such as "economic", "uncertain", "Congress", "legislation", etc. Since this method is based mainly on the newspaper coverage frequency, the source of information is easy to approach and has strong reliability. By putting on additional criteria, EPU indexes could also be category-specific and country-specific, contributing a lot to various empirical studies.

When studying China's financial market, most scholars have two main research directions: the influence of financial markets, such as between China's financial submarkets [7], foreign financial markets, and China's financial markets [8]. And the impact of non-financial market factors on financial markets, like discussing the impact of COVID-19 on financial submarkets [9], or the frequent adjustment of the Federal Reserve interest rate and the impact of trade friction on China's financial market [10]. Among them, many studies take the uncertainty of China's economic policy as an influencing factor. However, few papers take the uncertainty of American economic policy as an influencing factor. At the same time, the United States has an important influence in the global economic and financial field, and the disturbance factors from the United States cannot be ignored.

Based on the above background, here comes the questions: Will the uncertainty of American economic policy affect China's financial market volatility? With the change of domestic and international economic environment, how to evaluate its impact on China's financial market? Because the economic uncertainty of the United States has increased significantly, the answers to the above questions will help the Chinese government accurately identify the foreign factors that affect the fluctuation of the financial market, improve the system of the financial market, and better promote the development of the financial market.

2. METHOD

2.1 Model Setting

This paper uses the DCC-GARCH model. This model can well capture the conditional correlation between American EPU and the Chinese financial submarkets. The method can be divided into two steps：1. Estimate the GARCH model of a single variable; 2. Estimate the dynamic conditional correlation coefficient between variables.

$$r_t = \mu_t + e_t \tag{1}$$

$$e_t \sim N(0, H_t) \tag{2}$$

$$H_t = D_t R_t D_t \tag{3}$$

$$D_t = diag(\sqrt{h_{11,t}}, \sqrt{h_{11,t}}, \cdots, \sqrt{h_{NN,t}}) \tag{4}$$

$$[R_t]_{i,j} = \rho_{i,j,t} \tag{5}$$

$$\rho_{i,j,t} = q_{i,j,t} / \sqrt{q_{i,i,t}} \sqrt{q_{j,j,t}} \tag{6}$$

$$q_{i,j,t} = (1 - \alpha - \beta)\bar{\rho}_{i,j} + \alpha \varepsilon_{i,t-1} \varepsilon'_{j,t-1} + \beta q_{i,j,t-1} \tag{7}$$

In the equations, D_t is the diagonal matrix composed of the conditional standard deviation calculated by the univariate GARCH model and R_t is the required dynamic conditional correlation coefficient matrix. $\rho_{i,j,t}$ is the dynamic correlation coefficient of variables i and j at time t, $\overline{\rho}_{i,j}$ is the unconditional variance of standardized residuals， $\varepsilon_{i,t}$ is the normalized residual sequence of the variable i, $\varepsilon'_{j,t}$ is the normalized residual sequence of the variable j, and α is the coefficient of the normalized residual of the lag period; β is the coefficient of the conditional covariance of the lag period. Equation (7) in matrix form is as follows:

$$Q_t = (1 - \alpha - \beta)S + \alpha \varepsilon_{t-1} \varepsilon'_{t-1} + \beta Q_{t-1} \tag{8}$$

Q_t is the conditional covariance matrix of standardized residuals, S is the unconditional covariance matrix of standardized residuals, ε_t and ε'_t are normalized residual vectors, α and β are coefficient matrices.

2.2 Data Processing

To systematically study the impact of U.S. economic policy uncertainty on China's financial market volatility, this paper divides China's financial system into four primary submarkets:

money market, capital market, bulk commodity trading market, and foreign exchange market [11]. The capital market can be subdivided into the stock market and bond market. The bulk commodity trading market can be subdivided into the metal market, energy market, and agricultural products market. Since the SDR exchange rate index has only been published since December 31, 2014, and only the data at the end of each Friday and month are published, we calculate the daily SDR exchange rate index by ourselves according to the formula on the official China currency website.

The explanatory variables representing each market are shown in Table 1. IBR7 refers to 7-day interbank offered rate. RPR7 refers to the 7-day repo rate. CSI300 refers to hushen 300 index. CSIC refers to ZhongZhai composite net price index. SCMI refers to NanHua metals index. SCEI refers to NanHua energy index. SCAI refers to NanHua agricultural products index. SDRI refers to exchange rate index regarding SDR basket. The above data are all from the wind database.

TABLE1. FINANCIAL SUB MARKET CLASSIFICATION

	Primary Submarket	**Secondary Submarket**	**Explanatory Variable**
China's Financial System	Money Market	Interbank Market	IBR7
		Repo Market	RPR7
	Capital Market	Stock Market	CSI300
		Bond Market	CSIC
	Bulk Commodity Trading Market	Metal Market	SCMI
		Energy Market	SCEI
		Agricultural Produce Market	SCAI
	Foreign Exchange Market		SDRI

Besides, we use daily news-based Economic Policy Uncertainty Index based on newspaper archives from Access World New's NewsBank service as a proxy variable of the uncertainty of American economic policy. The data comes from the website (http://www.policyuncertainty.com).

Table 2 describes the main statistical characteristics of the selected variables.

TABLE2. STATISTICAL CHARACTERISTICS

	min	**max**	**mean**	**var**	**skewness**	**kurtosis**
AEPU	3.38	626.03	122.5734	5610.872	1.429001	3.675619
IBR7	-117.51	79.62278	0.025724	101.3455	-1.11492	17.86841
RPR7	-122.218	76.56282	0.039859	89.43708	-1.12181	21.14128
CSI300	-2.19509	2.311847	0.007219	0.058859	-0.28627	8.099891
CSIC	-0.71276	0.976821	3.69E-05	0.007592	0.83979	17.89888

SCMI	-5.34282	5.213494	0.002685	1.751611	-0.21404	1.848967
SCEI	-4.58234	4.172716	-0.0022	0.61533	-0.29454	3.191671
SCAI	-5.71724	5.665232	0.002456	1.642776	-0.27133	1.49424
SDRI	-9.69494	8.931021	0.012886	3.277133	-0.54409	3.580003

It can be seen from Table 2 that the average value of the American economic policy uncertainty (AEPU) index is greater than zero, showing a right skewed distribution; The average returns of China's financial submarkets are also close to zero. The average return of the energy market is negative, which means that the return of this submarket is negative in the sample period. The average return of other submarkets is positive, which means that the return of these sub-markets is positive in the sample period. The standard deviation of the interbank market is the smallest, which indicates that the fluctuation range of the interbank market is the smallest, followed by the foreign exchange market and energy market. The standard deviation of other submarkets is more than 1. Except for the right distribution of the interbank market, the distribution of other submarkets is left skewed. From the kurtosis coefficient, the kurtosis coefficient values of all financial submarkets are greater than 1. All series show the characteristics of "peak and thick tail", so DCC-GARCH model is suitable to estimate the dynamic correlation coefficient between AEPU index and China's financial market.

3. RESULTS AND DISCUSSION

Table 3 shows the empirical results of DCC-GARCH model. The coefficients of the ARCH term and GARCH term of each series are greater than zero. The sum of the coefficients are smaller than one, indicating that the return series has obvious volatility clustering characteristics and the GARCH model can fit the data characteristics well.

TABLE 3. EMPIRICAL RESULTS OF DCC-GARCH

	ω	α	β	$\alpha+\beta$
AEPU	32.401251***	0.029765***	0.958457***	0.988222
IBR7	1.359490***	0.159273***	0.839726***	0.998999
RPR7	1.060534**	0.155508***	0.843492***	0.999
CSI300	0.000604	0.065638	0.925752***	0.99139
CSIC	0.000212**	0.211015***	0.787985***	0.999
SCMI	0.011366***	0.077599***	0.917734***	0.995333
SCEI	0.007680***	0.067765***	0.919324***	0.987089
SCAI	0.017420***	0.048429***	0.940764***	0.989193
SDRI	0.008491**	0.051730***	0.946812***	0.998542

*, * *, * * * are significant at the confidence levels of 10%, 5%, and 1%

Fig.1-8 shows the dynamic correlation coefficients between the AEPU index and China's financial submarkets.

It can be seen from Fig.1 and Fig.2 that the fluctuation of the correlation coefficients between China's interbank lending market and repo market and AEPU index is relatively consistent, which gradually rises after 2008, reaches the peak around 2011, and then decreases back to the

previous level. In 2011, the correlation coefficients of both were all positive, indicating AEPU has a positive relationship with China's money market returns in this range, which means the frequent changes in US policies promoted the fluctuation of China's money market returns in 2011.

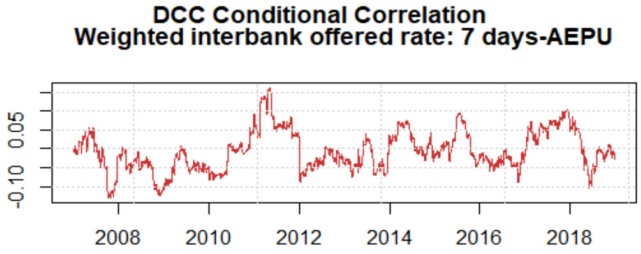

Figure 1. DCC Conditional Correlation between AEPU and IBR7

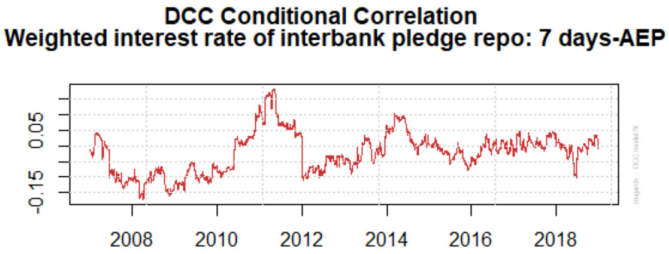

Figure 2. DCC Conditional Correlation between AEPU and RPR7

In Fig.1, the correlation coefficient between the interbank market and AEPU reached a peak in the whole year of 2017. In Fig.2, the correlation coefficient between the return rate of the repo market and AEPU approached zero after 2016, indicating that AEPU mainly affected the interbank market in China's money market from 2016 to 2018.

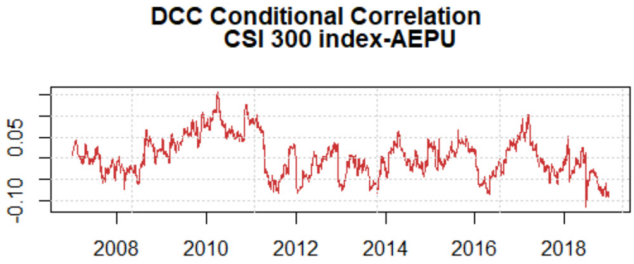

Figure 3. DCC Conditional Correlation between AEPU and CSI300

The dynamic correlation coefficient between AEPU and CSI300 has been rising since 2008 and reached its peak in 2010, as shown in Fig.3. It can be seen that during this period, the fluctuation of AEPU promotes the fluctuation of China's stock market. The greater the change of the AEPU index, the more intense the fluctuation of China's stock market. This means that after the

financial crisis in 2008, the United States frequently adjusted its policies to save the financial system, probably prompting a lot of Chinese investors to join the stock market to seek higher returns, thus increasing the volatility of the stock market.

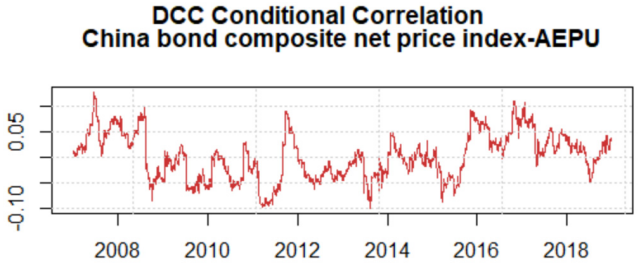

Figure 4. DCC Conditional Correlation between AEPU and CSIC

The dynamic correlation coefficient between AEPU and CSIC is less than zero most of the time, as shown in Fig.4, indicating that the fluctuation of AEPU suppresses the fluctuation of bond market most of the time. The larger the AEPU index is, the more investors are willing to hold bonds with less risk. The results are consistent with the fact that the hedging function of the bond market is more prominent.

The dynamic volatility coefficient of the returns of AEPU and commodity submarket is close to zero most of the time, as shown in Fig.5, Fig.6, and Fig.7, which indicates that its volatility will have almost no effect on the volatility of China's commodity market. However, the dynamic correlation coefficients of the three submarkets and AEPU all reached the peak in early 2010, indicating that the fluctuation of AEPU promotes the fluctuation of the commodity market at this time.

The dynamic correlation coefficient between AEPU and RMB exchange rate is approximate zero most of the time, as shown in figure 8, which means the fluctuation of AEPU will have no effects on the fluctuation of the foreign exchange market time. However, the coefficient reaches the lowest value in 2010. It indicates that the stronger the fluctuation of AEPU in this year, the smaller the fluctuation of the foreign exchange market.

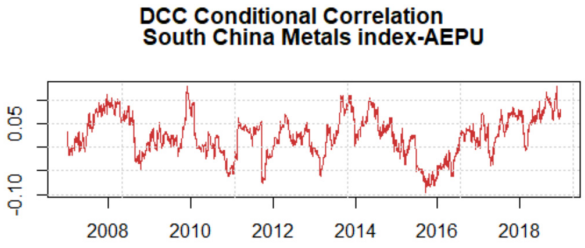

Figure 5. DCC Conditional Correlation between AEPU and SCMI

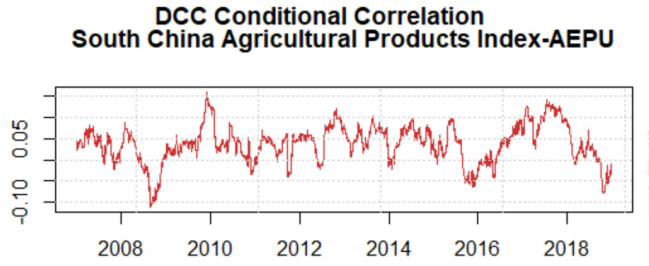

Figure 6. DCC Conditional Correlation between AEPU and SCAI

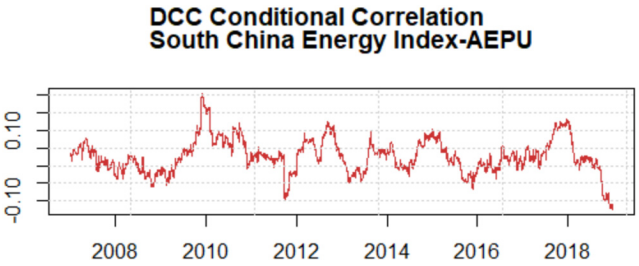

Figure 7. DCC Conditional Correlation between AEPU and SCEI

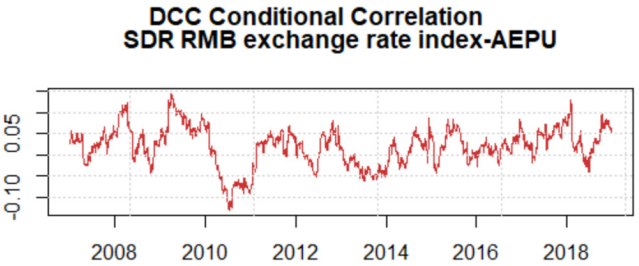

Figure 8. DCC Conditional Correlation between AEPU and SDRI

The fluctuation of US economic policy uncertainty mainly suppresses the fluctuation of China's money market, and after 2016, it mainly affects the fluctuation of interbank lending market rather than repo market. It can promote the fluctuation of China's stock market before 2012, but has little effect after 2012, which shows that the larger the AEPU index, the stronger the investors' speculation motivation in the stock market before 2012. It can restrain the fluctuation of bond market most of the time, which indicates that the larger the AEPU index is, the more investors are willing to hold bonds with less risk, which consists with the fact that the hedging function of the bond market is more prominent. Most of the time, it has little effect on the fluctuation of commodity market and foreign exchange market. However, in 2010, its fluctuation has obviously promoted the fluctuation of commodity market and restrained the

fluctuation of foreign exchange market, which may be due to some changes in Obama's Afghan and Iranian policies one year after he took office.

4. CONCLUSION

This paper uses the DCC-GARCH model to study the uncertainty of American economic policy and the volatility spillover effect of the Chinese financial submarkets. We divide China's financial submarkets into the money market, stock market, bond market, foreign exchange market, and bulk commodity market. To be more accurate, we subdivide the money market into the interbank lending market and repo market, the bulk commodity market into the energy market, metal market and agricultural product market. After the score is stable, we analyze the dynamic correlation coefficient between it and the uncertainty index of U.S. economic policy, and get the volatility spillover effect of U.S. economic policy uncertainty on different financial submarkets in China.

Results shows that the U.S. economic policy uncertainty promotes the volatility of China's stock market most of the time, suppresses the volatility of the bond market and money market most of the time and has no obvious impact on the volatility of other markets. However, it can be seen that the dynamic correlation coefficient between the uncertainty of U.S. economic policy and multiple financial submarkets reached the extreme value from 2008 to 2012, which may be related to the financial crisis in 2008 and a series of new policies of the Obama administration in 2009.

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