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Dynamic Correlations between Economic Policy Uncertainty and Financial Distress: Based on DCC-MIDAS Model

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***Abstract*-**In this paper, the DCC-MIDAS Model is used to study the dynamic correlations between economic policy uncertainty and ST sector. The empirical study shows: the volatility sequence between economic policy uncertainty index and ST sector has a positive effect on the whole; the volatility change of ST sector is affected by domestic events, while the volatility change of the of economic policy uncertainty index tends to be influenced by international events; the dynamic correlation between economic policy uncertainty index and ST sector shows a positive correlation and large fluctuation on the whole, and the correlation changes frequently influenced by domestic and foreign events. Therefore, the results provide a new perspective for scholars to study the corporate financial distress when the uncertainty of economic policy fluctuates greatly.

***Keywords*-** *Economic Policy Uncertainty, DCC-MIDAS Model, Dynamic Correlations*

I. INTRODUCTION

It has been more than 40 years since China's reform and opening up. During this time, China has gradually transformed from a planned economy to a socialist market economy. Nowadays, China has gradually perfected the construction of the market system to allow the market economy to play a more important role in the allocation of resources. At the same time, the government's macro regulation and management level has been continuously improving. However, due to the delay and uncertainty of the current macroeconomic policy regulation, the government sometimes does bad things with good intentions. The issued policies may disturb the normal operation of the market. Therefore, under the condition of great fluctuation of economic policy uncertainty, whether corporations can continue to operate normally has aroused widespread concern from the decision-making level and scholars. Economic policy uncertainty means that during the business period, economic subjects (that is, many micro-enterprises) cannot know exactly whether and when policy makers will formulate new macroeconomic policies based on the current economic environment, and what changes policy makers will make in the existing macroeconomic policies, resulting in the uncertainty of many micro-enterprises in the operation (Gulen and Ion, 2016)[1]. The increase of uncertainty in domestic economic policy is mainly reflected in three aspects: first, due to the imperfect domestic market economic system, the government needs to use administrative means to assist in intervening in the operation of the market economy and frequently formulates administrative policies to regulate according to the trend of the market economy, resulting in the increase of economic policy uncertainty; second, the government will provide policy support or regional development according to the international situation and domestic demand and therefore, many corporations will adjust their original investment strategies in accordance with the new government policy, causing fluctuations in the uncertainty of domestic economic policies; finally, sometimes the macro-policy formulated by the leadership is distorted or even misunderstood by the grass-roots authorities when it is transmitted downward, so macro-policy may be easily over-implemented or even local policies are contrary to the original intention of the macro-policy, increasing the uncertainty of economic policies. After investigating the status of the corporate operations, Rao and Xu (2017)[2] believed that more than half of domestic and foreign corporations believed that frequent changes in government regulations were the main reason for affecting the corporate operations. At the same time, they believed that the grassroots government's misinterpretation of policies and excessively severe administrative intervention were the important obstacles faced by corporate operations, and this reality became more and more severe.

In this context, it is particularly important to study the linkage between economic policy uncertainty and corporate financial distress. Financial distress, also known as financial crisis, is a kind of corporate default. In the course of operation, the corporation does not immediately fall into financial distress, but experiences stable development in the early stage, and then adjusts when there is a period of volatility. If the enterprise is not well managed, it will fall into financial difficulties. If the corporation is not out of financial difficulties after a period of operation, it will eventually lead to bankruptcy. Scholars at home and abroad have conducted an extensive research on financial distress, but different scholars have different definitions of financial distress, so there is no uniform definition of financial distress in the academic world.

In the studies of foreign scholars, the standards of corporate financial distress are not uniform, and the definitions of financial distress standards are also diverse. In the classic literature on the definition of financial distress, Beaver (1966)[3] counted 79 companies in financial distress, including three types of companies: bankrupt companies, companies in default of preferred stock dividends, and companies in default of debts. In the end, the author defines these three types of criteria for assessing whether a company is in financial distress. After that, Altman (1968)[4] identified corporate bankruptcy as the standard for financial distress, that is, a corporate in financial distress enters into legal bankruptcy procedures, which became an important literature for later foreign scholars to study financial distress. It can be seen that there are many standards for corporate financial distress, but the most serious and generally accepted standard is that corporates in financial distress are entering legal bankruptcy procedures. China began to implement the Corporate Bankruptcy Law in 1988, but the domestic market economy system is incomplete and the financial data of non-listed companies are not publicly released. As a result, although many domestic non-listed companies have gone bankrupt, it is very difficult to obtain financial data. Scholars tend to study public companies where data is more readily available. Since the domestic stock market was piloted in 1989, many listed companies have filed for bankruptcy due to insolvency, but ultimately they all avoided the final enterprise bankruptcy in the form of asset restructuring (He and Zhou, 2006)[5], therefore, the definition of financial distress by foreign scholars is not suitable for the actual situations of China. In the early stage, Lu and Han (2004)[6] defined the standard for corporate financial distress as a current ratio of less than 1, but domestic scholars are more inclined to associate financial distress with listed companies that are "special treatment", because the "Special Treatment System (ST)" is clearly defined in the "Stock Listing Rules" promulgated by China, most domestic scholars define financial distress as "special treatment".

Therefore, does the uncertainty of economic policy affect the normal operation of enterprises? What is the connection between external economic policy uncertainty and corporate financial distress? This is worthy of in-depth research by scholars. Therefore, based on the ST sector data of the Shanghai and Shenzhen stock markets from the first quarter of 2001 to the first quarter of 2018, this paper studies the impact of economic policy uncertainty on the financial distress of listed companies. The empirical results of this paper show: there is a positive correlation between the uncertainty index of economic policy and the fluctuation of the ST sector; the long-term correlation of the economic policy uncertainty index and the ST sector has a positive impact on the whole, and it shows large fluctuations and frequent positive and negative conversion. The innovation of this paper is to first study the impact of economic policy uncertainty on business operations from a new macro perspective and then use the economic policy uncertainty index of high attention in recent years as a macro indicator to study the listed companies in financial distress, which provides a reference for other scholars to further study related topics.

The following parts of this paper are arranged as follows: the second part is model presentation, the third part is data selection and descriptive statistics, the fourth part is the empirical results, and finally the conclusion.

II. MODEL PRESENTATION

A. Construction of DCC-MIDAS Model

In recent years, Colacito et al. (2011)[7] and Engle et al. (2013)[8] improved the traditional GARCH-MIDAS model based on the theory of the wave component model and finally construct the DCC-MIDAS model by using the short-term and long-term components with dynamic correlation. This allows the correlation between the two indices to be analyzed from both long-term and short-term aspects. The following is a brief overview of the GARCH-MIDAS model:

First of all, there are two indexes to be studied in this paper, $r_{1,t}, r_{2,t}$ are ST sector index and economic policy uncertainty index. The vector expression of its assets is:

$$r_t = \left[r_{1,t}, r_{2,t}\right]', r_t \sim_{i,i,d} N\left(\mu_{i,t}, \mathrm{H}_{i,t}\right), \mathrm{H}_{i,t} = D_{i,t} R_{i,t} D_{i,t} \quad (1)$$

Where r_t is defined as the exponential logarithmic rate of return over period t, define $\mathrm{H}_{i,t}$ as the conditional covariance matrix of the yield vector, define $D_{i,t}$ as the diagonal matrix of the standard deviation of the diagonal element index returns, define $R_{i,t}$ as the conditional correlation coefficient matrix. Therefore, the index return of the t and i days can be expressed as:

$$r_{i,t} = \mu + \sqrt{\tau_t g_{i,t}}\,\xi_{i,t}, \forall i = 1, \cdots, N_i \quad (2)$$

Among them, $\xi_{i,t} \left| \Phi_{i-1,t} \sim N(0,1) \right.$ is defined and $\Phi_{i-1,t}$ is the collection of all information within the $i-1$ day of the t month. Define τ_t as the long-term fluctuation of the index, and define $g_{i,t}$ as the short-term fluctuation of the index. From this it can be assumed that the short-term fluctuation $g_{i,t}$ of the index obeys the GARCH (1,1) process, that is:

$$\mathrm{g}_{i,t} = (1 - \alpha - \beta) + \alpha \frac{(r_{(i-1),t} - \mu)^2}{\tau_t} + \beta g_{i-1,t}, \quad (3)$$

Among them, parameter α and parameter β are fixed values and $\alpha > 0, \beta > 0, \alpha + \beta < 1$, index long-term fluctuation τ_t is a fixed value, which can be obtained through the MIDAS process of the realized volatility *(RV_t)*:

$$\tau_t = m + \theta \sum_{K=1}^{K} \varphi(\omega_1, \omega_2) RV_{t-k}, RV_t = \sum_{t=1}^{N_t} r_{i,t}^2 \quad (4)$$

Among them, K is defined as the number of trading days in the smooth interval, and the weight function $\varphi(\omega)$ is in the form of a Beta function.

Formulas (1)-(4) are the basic theories of the GARCH-MIDAS model, the DCC-MIDAS model is an extension of the GARCH-MIDAS model. Therefore, the form of the DCC-MIDAS model used in the empirical research is as follows:

$$q_{i,j,t} = \bar{\rho}_{i,j,t}(1-a-b) + a\xi_{i,t-1}\xi_{j,t-1} + bq_{i,j,t-1} \tag{5}$$

$$\bar{\rho}_{i,j,t} = \sum_{l=1}^{K_c^{i,j}} \varphi_l\left(\omega_r^{ij}\right) c_{i,j,t-l} \tag{6}$$

$$c_{i,j,t} = \frac{\sum_{k=t-N_c^{ij}}^{t} \xi_{i,k}\xi_{j,k}}{\sqrt{\sum_{k=t-N_c^{ij}}^{t} \xi_{i,k}^2}\sqrt{\sum_{k=t-N_c^{ij}}^{t} \xi_{j,k}^2}} \tag{7}$$

Among them, A and B are the ST sector index and the economic policy uncertainty index (EPU index), respectively. $q_{i,j,t}$ is expressed as the short-term correlation between the ST sector index and the EPU index, $\bar{\rho}_{i,j,t}$ is expressed as the long-term correlation between the ST sector index and the EPU index, which is the MIDAS weighted sum of the sample correlation matrix. $c_{i,j,t}$ is a sample correlation matrix of observations. $\xi_{i,k}, \xi_{j,k}$ is the standardized residual after two exponential GARCH-MIDAS processes.

B. DCC-MIDAS model estimation method

We model the parameters of the model by following the two-step maximum likelihood estimation method of Engle et al. (2002) [9] and Colacito et al. (2011). First, we write the univariate GARCH-MIDAS model as $\boldsymbol{\psi} = \{\alpha_i, \beta_i, \theta_i, \omega_i, m_i\},\ i = 1, \cdots, n$. Secondly, the parameter vector of the dynamic correlation model of the mixing condition is denoted as $\boldsymbol{\Theta} = \{a, b, \omega_c\}$, and the maximum likelihood estimation method is adopted. So the quasi-maximum likelihood estimation function expression is:

$$QL(\boldsymbol{\psi}, \boldsymbol{\Theta}) = QL_1(\boldsymbol{\psi}) + QL_2(\boldsymbol{\Theta}) \tag{8}$$

$$\equiv -\sum_{t=1}^{T}\left(n\log(2\pi) + 2\log|D_t| + r_t' D_t^{-2} r_t\right)$$

$$-\sum_{t=1}^{T}\left(\log|R_t| + \xi_t' R_t^{-1}\xi_t + \xi_t'\xi_t\right)$$

Then we divide $QL(\boldsymbol{\psi}, \boldsymbol{\Theta})$ into two parts $QL_1(\boldsymbol{\psi}), QL_2(\boldsymbol{\Theta})$ according to the structure of the log-likelihood estimation function to estimate. The first step is to estimate the univariate GARCH-MIDAS model and obtain the model parameter estimator $\boldsymbol{\psi}$, the second step uses the first step to obtain the standardized residuals to estimate the parameter estimate $\boldsymbol{\Theta}$ of the DCC-MIDAS model.

III. DATA SELECTION AND DESCRIPTIVE STATISTICS

A. Data selection

The economic policy uncertainty index used in this study was compiled by Lu Shangqin and Huang Yun from the Hong Kong Baptist University. In the previous period, Baker et al. (2016)[10] conducted a search on keywords such as "economy", "finance", and "uncertainty" on the South China Morning Post published in Hong Kong in January 1995. Afterwards, the number of reports was divided and divided by the number of all the South China Morning Post reported that month, and finally standardized to 100. After that, the monthly economic policy uncertainty index was calculated based on January 1995. Later, in order for Chinese scholars to fully understand the uncertainty of China's economic policy, Lu Shangqin and Huang Yun of Hong Kong Baptist University followed Baker's practice and selected ten domestic newspapers, including Beijing Youth Daily, to compile a new edition of the "China Economic Policy Uncertainty Index" in accordance with China's national conditions in 2000. The index is derived from https://economicpolicyuncertaintyinchina.weebly.com/.

Since 1998, the Shanghai and Shenzhen Stock Exchanges have conducted Special Treatment for the stock trading of listed companies with abnormal financial or other conditions, and added the "ST" logo in front of their stock names. There are various forms of the status that a listed company is defined as "ST". The study in this paper defines the status of the company as "ST" as a negative result of the net profit audit results of the listed companies for the last two consecutive fiscal years. Therefore, the corporate financial distress data in this paper selects the ST sector index of the Shanghai and Shenzhen stock markets. The data is taken from the Oriental Fortune Choice database and the daily closing price of the ST sector is selected from the first quarter of 2001 to the first quarter of 2018. In order to ensure the stability of the data, referring to the practices of Yao and Liu (2017) [11] and Zhou and Sun (2019) [12], the daily closing price of the ST sector was logarithmically processed to obtain the rate of return before the analysis. The processing formula is: $r_{i,t} = 100 * \log(P_t / P_{t-1})$, where $r_{i,t}$ represents the return of the *i* asset at the *t* time. P_t represents the index of the *t* time.

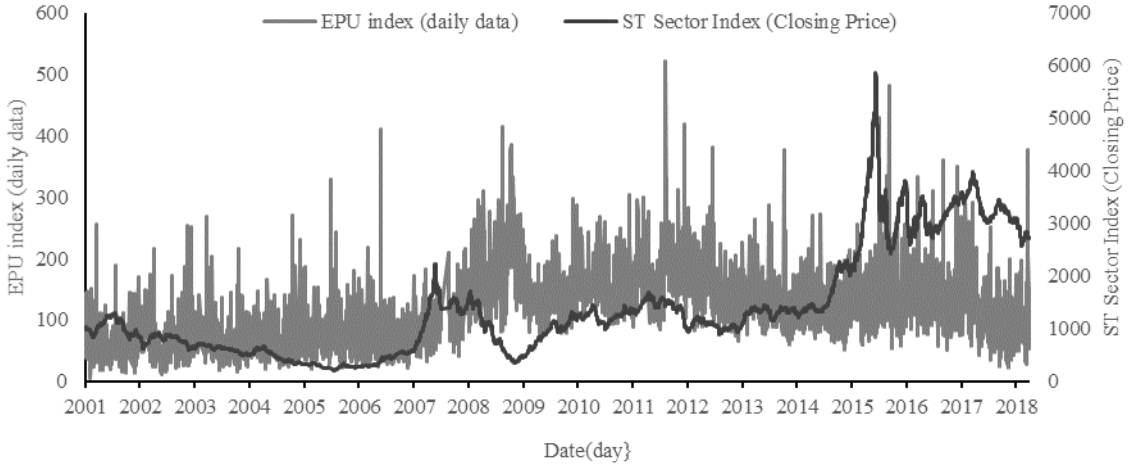

Figure 1. Chart of economic policy uncertainty index (EPU index) and ST sector index

B. Descriptive statistics

First, the time series trend of the EPU index and the ST sector index is plotted, as shown in Figure 1. The results show that the trend of the economic policy uncertainty index is basically consistent with the impact of important events in China, indicating that the index can better reflect the uncertainty of China's economic policy.

In order to intuitively illustrate the relationship between the uncertainty of economic policies and major events in China, Figure 1 shows the daily data trend chart of the EPU index and the ST sector index during the sample period. The daily data trend of the EPU index and the ST sector index is very similar. When the ST sector index increases, the EPU index also increases and vice versa. Specifically, the fluctuations in the uncertainty of economic policies around 2002 are significantly higher than in previous years, which is in line with the fact that the change of economic leadership in neighboring countries has increased the uncertainty of economic policies. During this period, China officially entered the WTO organization, which made the uncertainty of economic policy fluctuate greatly in the following years. After that, the index of economic policy uncertainty reached the highest level in 2008, mainly because of the end of the "Olympic Economy" and the beginning of the global financial crisis. In the following years after 2011, the negative effects of the government's "four trillion" investment plan began to appear and the impact of the European debt crisis made the economic recession and inflation coexist, eventually resulting in the overall uncertainty of economic policy to start to rise sharply. Affected by the decline of the international economic environment and China's economic transformation, the uncertainty of economic policies began to fluctuate and rose sharply in 2015. It peaked in 2017. During this period, China implemented an active fiscal policy and a prudent monetary policy, carried out supply-side reforms and optimized the industrial structure, resulting in strong fluctuations in economic policy uncertainty. In general, the trend of the EPU index will be significantly synchronized with the recession, and at the same time, it will have a positive correlation with the ST sector index as a whole.

TABLE II. ESTIMATION RESULTS OF MIXED VOLATILITY MODEL BETWEEN ST SECTOR AND EPU INDEX

Model regression results	μ	α	β	θ	ω	m
ST sector index	0.0100*** (3.4833)	0.1242*** (7.2098)	0.7471*** (20.333)	0.1853** (18.3820)	19.7870*** (4.6334)	0.0090*** (11.1940)
EPU index	0.0071 (1.4311)	0.0714*** (11.2030)	0.9286*** (161.3100)	0.1305** (2.9186)	4.998 (0.9167)	0.0100 (0.0050)

Note: The values in parentheses are the *t* values of the parameter estimation, ***, ** and * indicate significance levels at the 1%, 5%, and 10%, respectively.

TABLE III. DCC-MIDAS MODEL REGRESSION RESULTS

Panel A: Regression results		*a*	*b*	ω
		0.000 (0.0047)	0.7958* (0.4607)	1.001*** (0.0279)
Panel B: Fitting effect		LLF	AIC	BIC
		-12078.9	24163.7	24182.7

Note: The values in parentheses are the $_t$ values of the parameter estimation, ***, ** and * indicate significance levels at the 1%, 5%, and 10%, respectively.

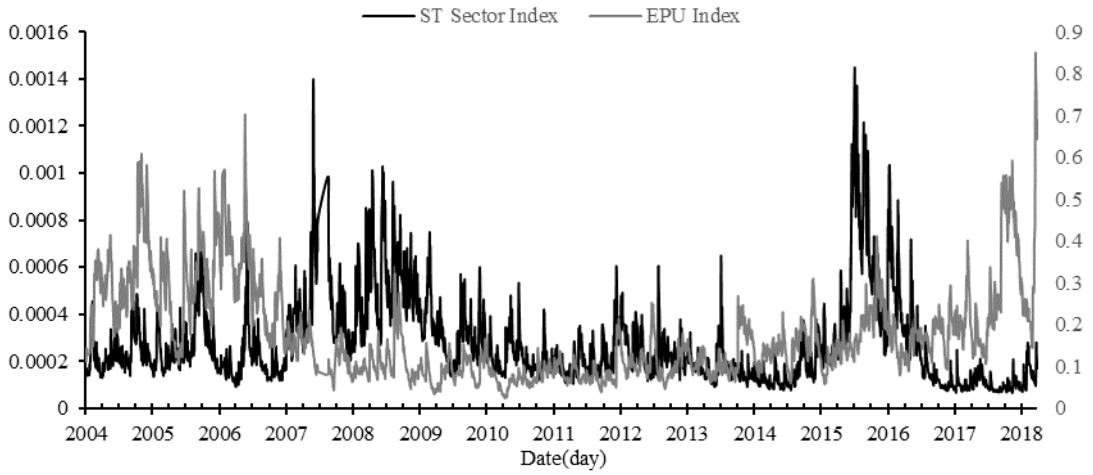

Figure 2. Volatility sequence chart of ST sector and EPU index

TABLE I. DESCRIPTIVE STATISTICS OF ST SECTOR YIELD AND EPU INDEX

Variables	ST sector	EPU index
Mean	-0.0002	116.5557
St.d	0.0165	58.3255
Kurtosis	0.6530	2.2997
Skewness	0.5204	1.0250
Min	-0.0490	4.7299
Max	0.0571	520.0962
Obs	4137	4137
ADF	0.0000	0.0000
Pearson	0.0057	

Table 1 gives the main statistical characteristics of the ST sector yield series and EPU index. The results show that the P value of ADF is 0, that is, the ST yield sequence and the EPU index are both stable non-white noise sequences at the confidence level, indicating that both sequences fluctuate around a constant value. In the yield sequence ST sector, the kurtosis is 0.6530 and the skewness is 0.5204, therefore, the hypothesis of normal distribution is rejected. The static Pearson correlation coefficient is 0.0057, indicating that the static correlation between the ST sector yield and the EPU index is positively correlated.

IV. EMPIRICAL RESULTS

In this section, we refer to the research of Colacito et al. (2011), using the DCC-MIDAS model to test the dynamic correlation of the ST sector index and the EPU index. The exponential logarithm is used and the lag order is selected according to the likelihood function in the DCC-MIDAS model regression. The regression results of the DCC-MIDAS model are showed in table 2-4.

As can be seen from Table 2, the values of parameter θ of the ST sector and the EPU index are both greater than 0, indicating a positive correlation between explanatory variables. That is, the increase of the fluctuation of the EPU index will aggravate the fluctuation of the ST sector. The value of the parameter ω of the ST sector is greater than the EPU index, which indicates that the effect of the lag value of the explanatory variable on the ST sector weakens rapidly and the duration is low.

Table 3 shows the estimation values of the parameter set $\boldsymbol{\Theta}=\{a,b,\omega\}$ of the DCC-MIDAS model, the model's log-likelihood function and two information criteria. The values of parameter *a* and parameter *b* represent the lag values that the dynamic correlation coefficient depends on itself. From the results in the table, it can be seen that compared with the lag value of the correlation coefficient between the ST sector and the EPU index and the actual correlation coefficient, its weight attenuation is relatively smooth.

TABLE IV. DESCRIPTIVE STATISTICS OF CORRELATION COEFFICIENT

Variables	Samples	Min	Max	Mean	St.d
Dynamic correlation coefficient	3897	-0.1233	0.1518	0.0011	0.0552
Long-term correlation coefficient	3897	-0.1236	0.1522	0.0011	0.0558

Variables	Number of positive correlation coefficients	Number of negative correlation coefficients	Negative correlation coefficient ratio
Dynamic correlation coefficient	1980	1938	0.4973
Long-term correlation coefficient	1917	1959	0. 5081

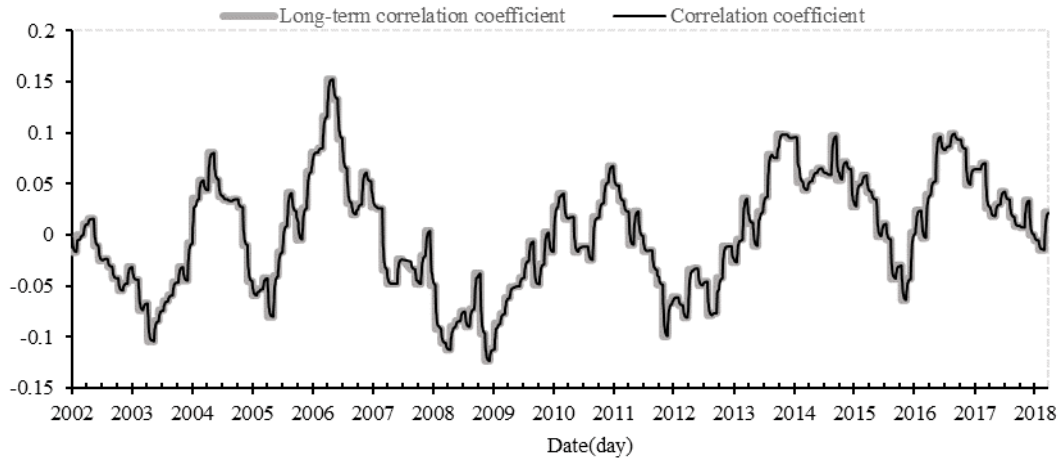

Figure 3. Sequence diagram of the dynamic correlation between the ST sector and the EPU index

Figure 2 shows the volatility sequence chart of the ST sector and the EPU index. As can be seen from the figure, before 2007, the ST sector index and the EPU index operated relatively smoothly. Around 2007, due to the impact of the US subprime housing credit crisis and the subsequent financial crisis in the United States, the EPU index volatility began to soar to a local peak, and then spread to China, which caused a major shock in the domestic economy, and the ST sector index volatility increased significantly. After that, the state's regulation and control subsequently restored the stable operation of China's economy. In the following years, although the ST sector index and the EPU index fluctuated with different amplitudes, they were both in a stable range. Affected by government supply-side reforms after 2015, the volatility of the ST sector index has risen sharply, while the volatility of the EPU index has also shown signs of rising. Affected by the Sino-US trade war around 2018, the EPU index volatility rose to the highest level in the period. In general, the fluctuations of the ST sector and the EPU index affect each other. The volatility sequence of the ST sector index is mainly affected by the domestic financial and economic environment, while the volatility tendency of EPU index is affected by major international economic events.

Table 4 shows the dynamic correlation coefficient and long-term correlation coefficient between the ST sector index and the EPU index estimated by the DCC-MIDAS model. Because the MIDAS lag order is selected as 36, the time is from January 8, 2004 to March 29, 2018. It can be known from Table 5 that the negative correlation ratio of the dynamic correlation coefficient is 0.4973, and the negative correlation ratio of long-term correlation coefficient is 0.5081.

Figure 3 shows the correlation and long-term correlation curves of the ST sector and the EPU index. It can be seen that the dynamic condition correlation between the ST sector and the EPU index has a strong time-varying feature, and the long-term dynamic condition correlation coefficients show periodic positive and negative staggered changes and significant positive and negative changes in the interval. Under normal conditions, the correlation and long-term correlation between the ST sector index and the EPU index are mostly in a positive correlation, while the ST sector and the EPU index show a negative correlation when the major economic events occur at home and abroad, such as the global financial crisis around 2008, the European debt crisis in 2011, and the supply-side reform since 2015. In summary, the long-term correlation coefficient and correlation coefficient fluctuations are in line with the major economic events and the law of fluctuations in China.

V. CONCLUSION

This paper selects the EPU index compiled by the Hong Kong Baptist University and the ST sector index of Shanghai and Shenzhen stock markets to construct a DCC-MIDAS model to study the dynamic correlation between the economic policy uncertainty index and corporate financial distress. On the one hand, in terms of dynamic fluctuations, the ST sector and the EPU index will fluctuate correspondingly with the occurrence of domestic and foreign events in recent years: the volatility tendency of the ST sector is affected by the domestic economic environment, such as the larger volatility when the financial crisis spread to the domestic market in 2008 and the supply-side reform in 2015, while the volatility of the EPU index is more easily affected by international events, such as the Sino-US trade war that broke out around 2017, which made the EPU index fluctuate to its peak. On the other hand, in terms of dynamic correlation, the correlation and long-term correlation between the ST sector index and the EPU index are mostly in a positive correlation, while the ST sector and the EPU index show a negative correlation when the major economic events such as financial crisis and supply-side reform occur at home and abroad.

The study of this paper also has certain enlightenment: the impacts of economic policy uncertainty on enterprises mainly come from the change of government's macroeconomic policies. Therefore, the government should have a correct understanding of the impact of the formulation and change of

macroeconomic policies on the economic environment, and make an administrative intervention in the policies in time according to the existing problems in the market, at the same time, avoiding the events that increase the uncertainty of economic policies, such as changing orders quickly, so as to ensure the economic environment on the right track and enterprises in normal operation.

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