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# The Risk Spillover Effect of China's P2P (Peer-to-peer) Lending on Internet Finance

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## ABSTRACT

**The article analyzes the P2P lending, one of the main formats of internet finance. Firstly, the EGARCH-GED model is used to analyze the fluctuation of the yield of China's P2P lending. The empirical results show that the fluctuation of online loan yield has clustering and risk accumulation effects, and it also has leverage effect. Then, based on this, the Copula function is used to obtain the overall correlation coefficient and tail correlation coefficient between the online loan platform and Internet finance. The research results show that the fluctuation of the P2P lending platform's yield has a positive correlation with the change of the Internet financial index's return rate, and the tail correlation is asymmetric, the upper tail correlation is more significant, and the lower tail correlation is not obvious. Therefore, the supervision authorities should establish a comprehensive supervision mode suitable for the development of China's Internet finance, improve laws and the supervision system, perfect the credit information system and information disclosure system, and strengthen investors' education.**

***Keywords:*** *P2P lending, Internet finance, risk spillover effect, GARCH-Copula model*

## I. INTRODUCTION

Peer to peer lending is the third new financing model for borrowers and lenders to use online lending platforms to reach lending transactions. It is different from the indirect financing method of the money market and the direct financing method of the capital market. Prosper, the world's largest P2P lending, was established in 2006. In the process of "financial disintermediation" and the marketization of interest rates, China's first P2P lending, FinVolution Group, was established in 2007. Since then, there has been a wave of P2P lending in China. According to the First Online Loan data, the turnover of China's P2P lending industry in 2015 was 1.18 trillion yuan, 2016 was 2.80 trillion yuan, 2017 was 3.90 trillion yuan, and 2018 was 1.94 trillion yuan. However, with the rapid development of the P2P lending industry, the problem is also constantly exposed. According to the statistics of Online Loan Home, there were a total of 5,409 closed and problem platforms in 2018, accounting for 84% of the 6430 P2P lending platforms in China. Due to the low threshold and high efficiency of P2P lending, it provides convenience for individual investors and small, medium and micro enterprises in financing. Meanwhile, it is also accompanied by credit risk, illegal fund raising, illegal operation, operational risk, and moral hazard. Since 2015, the Internet financial incidents represented by P2P lending collapse have continued to erupt, which has brought about a significant negative impact on the industry. Therefore, the rapid development of Internet finance has attracted more and more attention from the government. Premier Li Keqiang proposed 2016 government work report that it is necessary to further deepen China's financial reform, strengthen and improve financial supervision, and promote the healthy and stable development of China's Internet finance.

Due to the rapid development of Internet technology and the accelerated pace of financial innovation, the Internet financial industry is experiencing regulatory gaps and lagging supervision. When the industry development far lags behind supervision, risks can easily lose control. Compared with the traditional financial market of separate operation and separate supervision, the form of Internet finance business is more and more diversified, the cross-section of Internet finance business is more and more, and mixed operation is a development trend. The relationship is close, and the risks are easily contagious. However, the traditional financial service model based on institutional logic and product logic has formed a supervision system with separate supervision as the core, which is difficult to adapt to the cross-border operation and innovative development of Internet finance. In this

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context, this paper studies the risk spillover effect of P2P lending on Internet finance, and then puts forward policy recommendations that are consistent with the current status of Internet finance development.

## II. LITERATURE REVIEW

Since its birth in 2005, P2P lending has experienced explosive growth, which is accompanied by challenges and problems faced by the industry. Therefore, the academic community is paying more attention to the risks of P2P online lending platforms. The current research on the risks of P2P lending mainly focuses on the following three aspects:

### *A. The analysis of P2P lending platform's own risk situation*

Lu Xin and Li Huimin (2015) believe that China's P2P lending currently faces policy supervision risks, operational risks, legal risks, network risks, credit risks, money laundering risks [1]. Wang Bingbing (2015) explained that the legal risks of P2P lending platforms are high, manifested in illegal fund-raising, illegal operations, misappropriation of funds, etc. In operation, there may be dangers of bad debt crisis and platform running [2]. An Junya (2016) empirically analyzes the internal risk composition and measurement of P2P lending supply chain financing business [3].

### *B. Research on the risk spillover of P2P lending to other financial markets*

Wei Qi and Zhang Qiang (2015) use the GARCH-GPD-Copula model to analyze the risk spillover effect of China's P2P lending platform on commercial banks [4]. Ruan Sumei and He Haoran (2016) use the SV model and dynamic stochastic volatility model to analyze the volatility spillover effect between the P2P lending market and the stock market [5]. Liu Jingxiu and Men Ming (2016) use the Copula-GARCH model to analyze the risk spillover effect of the P2P lending market on the capital market [6].

### *C. Regarding the risk prevention and supervision measures of P2P lending*

Wang Lamei (2015) suggested designing access according to the classification ideas, and to stipulate different access methods, and also establish a civil compensation liability investigation system for P2P lending applicants to weaken the risk of P2P lending [7]. Ye Liang (2015) borrowed from the US P2P lending platform's supervision model, and suggested that China should clarify the supervision structure, improve the personal credit reporting system, standardize the management of intermediate accounts, and establish risk reserve systems [8]. Song Yixin and Wu Hong (2016) proposed that the CBRC should control high-risk investments by restricting low-income groups and leverage investment, and introduce third-party institutions to review financing information [9].

According to the above literature introduction and the data held by the author, there has not been any research related to the risk spillover effect of P2P lending on Internet financial. Regarding the tools to characterize the risk spillover effect, the Copula model is currently the mainstream method for studying the dependence of financial markets. The Copula model has great flexibility, allowing the construction of separate models for the marginal distribution function and the dependence function, and can also describe the relationship between the two Non-linear relationship and tail correlation. Ouyang Zisheng, Liu Yuan and Luo Changqing (2016) used Copula model to analyze the dependent structure of credit spreads and market risks, and the results showed that there was a certain positive correlation between them [10]. Ma Wei, Zhang Zhuoqun and Zheng Lin (2016) used the Copula model to analyze the correlation between the Shenzhen Component Index and the Hong Kong Hang Seng Index after the 2008 financial crisis, and empirically concluded that the upper-tail correlation between Shenzhen and Hong Kong is higher than the lower-tail correlation [11]. Guo Lifu (2017) studied the tail correlation between the RMB onshore exchange rate and the offshore exchange rate based on the Copula function. The results show that the correlation between the upper and lower tails has obvious asymmetric characteristics [12].

Therefore, GARCH model is adopted to analyze the distribution of P2P lending and Internet finance in combination with T distribution and GED. Then Gumbel Copula and Clayton Copula were used to calculate the overall correlation and the upper and lower tail correlation between P2P lending and Internet finance. Secondly, based on the empirical results, this paper analyzes the volatility characteristics of P2P lending and the risk spillover effect on Internet finance. Finally, according to the empirical results put forward relevant policy recommendations.

## III. THEORETICAL MODEL

### *A. Marginal distribution model*

*1) GARCH model:* The GARCH model is called the generalized autoregressive conditional heteroskeasticity model, which was proposed by Bollerslev Tim (1986) [13]. The idea is to use a simpler GARCH model to represent a higher-order ARCH model, thus solving the difficulty of estimating Problems with many parameters. The GARCH (p, q) model is:

$$R_t = \phi X_t + \varepsilon_t \quad (1)$$

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-1}^2 \qquad (2)$$

Where $\varepsilon_{t-i}^2$ is ARCH term, also known as residual lag term; $\sigma_{t-j}^2$ is GARCH term, also known as conditional variance lag term; p is the order of ARCH term, q is the order of GARCH term; $\omega > 0$, $\alpha_{i.} \geq 0$, $\beta_j \geq 0$, $\sum_{i=1}^{p} \alpha_i + \sum_{j=1}^{q} \beta_j < 1$. To ensure that the variance is positive and that the unconditional variance of the disturbance term is finite.

*2) GARCH-M model:* The GARCH model can only explain the volatility aggregation characteristics of financial asset returns, but it cannot reflect the close relationship between returns and risks. Assets with higher return rates generally correspond to higher risks. Therefore, Engle Robert, David M. Lilien and Russell P. Robins(1987) proposed the GARCH-M model [14], the mathematical expression is as follows:

$$R_t = \phi X_t + \lambda \sigma_t + \varepsilon_t \qquad (3)$$

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j \sigma_{t-1}^2 \qquad (4)$$

The parameter λ in equation (3) is a risk spillover parameter, which indicates the observable impact of the predicted risk. If the parameter λ is positive, it indicates that the rate of return is positively related to its volatility.

*3) EGARCH model:* The GARCH model cannot explain the leverage effect of the return rate of financial assets, so Nelson (1991) proposed the EGARCH model[15], also known as the index EGARCH model, to describe the asymmetry of volatility through a parameter γ, and the model can guarantee the variance is positive, the conditional variance equation of EGARCH (1, 1) is as follows:

$$\ln(\sigma_t^2) = \omega + \alpha \frac{|\varepsilon_{t-1}|}{\sigma_{t-1}} + \beta \ln(\sigma_{t-1}^2) + \gamma \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \qquad (5)$$

Compared with the GARCH model, the restrictions on parameters are reduced, so the EGARCH model is more flexible. The leverage effect is reflected by $\alpha \frac{|\varepsilon_{t-1}|}{\sigma_{t-1}}$ and $\gamma \frac{\varepsilon_{t-1}}{\sigma_{t-1}}$, if γ=0, there is no asymmetry in the influence of fluctuation, if $\gamma \neq 0$, there is asymmetry in the influence of fluctuation. When γ>0, it means that the impact of good news on volatility is greater than the impact of bad news on volatility; when γ <0, the opposite is true.

*B. Copula function*

In order to characterize the overall correlation and tail correlation of P2P lending and Internet finance, this paper uses the Gumbel Copula and Clayton Copula. The Gumbel Copula shows that there is a strong correlation between the variables at the upper tail of the distribution, and at the lower tail of the distribution, the variables are gradually independent. The Clayton Copula is more sensitive to changes in the lower tail of the distribution and better captures the correlation between the lower tails of the variables.

*1) Probability distribution function*

*a) Probability distribution function of Gumbel Copula:*

$$C_G(u,v) = \exp\{-((-\ln u)^{1/\alpha} + (-\ln v)^{1/\alpha})^{\alpha}\} \qquad (6)$$

Where, α is the parameter, and $\alpha \in (0,1]$.

*b) Probability distribution function of Clayton Copula:*

$$C_{cl}(u,v;\theta) = (u^{-\theta} + v^{-\theta} - 1)^{-1/\theta} \qquad (7)$$

Where, θ is the parameter, and $\theta \in (0,\infty)$.

*2) Kendall rank correlation coefficient:* If the random variables $(x_1, y_1)$ and $(x_2, y_2)$ follow the same joint distribution, the Kendall rank correlation coefficient τ that defines the joint distribution is:

$$\tau = P[(x_1 - x_2)(y_1 - y_2) > 0] - P[(x_1 - x_2)(y_1 - y_2) < 0] \qquad (8)$$

If the Copula function of the random variables x and y is C, the Kendall rank correlation coefficient τ can be expressed as:

$$\tau = 4\int_0^1 \int_0^1 C(u,v)dC(u,v) - 1 \qquad (9)$$

Specifically, the rank correlation coefficient of the Gumbel Copula:

$$\tau_G = \frac{\alpha - 1}{\alpha} \qquad (10)$$

The rank correlation coefficient of the Clayton Copula:

$$\tau_{cl} = \frac{\theta}{\theta + 2} \qquad (11)$$

*3) Tail correlation measure:* The distribution functions of the random variables x and y are assumpted be F (x) and G (y), respectively, a Copula function $C(F(x), G(y))$ is adopted, and $\lambda^U$ and $\lambda^L$ are the upper-tail and lower-tail correlation coefficients, respectively.

$$\lambda^U = \lim_{u\to 1} P(y > G^{-1}(u) \mid x > F^{-1}(u)) = \lim_{u\to 1} \frac{1-2u+C(u,u)}{1-u} \quad (12)$$

$$\lambda^L = \lim_{u\to 0} P(y < G^{-1}(u) \mid x < F^{-1}(u)) = \lim_{u\to 0} \frac{C(u,u)}{u} \quad (13)$$

## IV. EMPIRICAL ANALYSIS

### A. Data selection

The interest rate index of the P2P lending comes from the Home of Online Loan. The component platform of the index is to select 20 P2P lending platforms based on the principles of large influence, strong representativeness, diversification and continuous stability, and then based on the change and development of P2P lending platforms regularly and irregularly adjust the component platform and P2P interest rate index. The Internet Finance Index is derived from the Wind. Internet Finance is a financial business activity carried out by Internet carriers, including but not limited to third-party payment, financial e-commerce, online wealth management product sales, financial intermediaries, and credit evaluation review modes. Due to the activity of the P2P lending and the availability of data, the sample interval was selected from data on all trading days from December 1, 2014 to December 14, 2018, for a total of 988 groups. Data processing uses Eviews8 and Matlab (R2014).

In the research of risk measurement, the calculation and analysis of return rate series are mostly used. Here, the data is processed as follows:

$$R_t = \ln(P_t / P_{t-1}) \quad (14)$$

Where, $R_t$ is the market return rate of day t, $P_{t-1}$ and $P_t$ is the market index of day t-1 and day t, respectively.

### B. Descriptive statistics

Descriptive statistics are shown in "Table I". The skewness of the P2P lending interest rate series is greater than 0, indicating that the sample shows a certain right deviation, and the kurtosis is much greater than 3, indicating that the peak characteristics are obvious, and the distribution has " peak and thick tail" shape. The sequence of Internet finance is to the left, but also has the characteristics of peak. The accompanying probability of the J-B test result is 0, indicating that both sequences do not follow the normal distribution. It can also be seen from "Table I" that the standard deviation of the P2P lending is greater than that of Internet finance, indicating that the P2P lending is highly volatile.

TABLE I. DESCRIPTIVE STATISTICS

| | ***Mean*** | ***Std*** | ***Skewness*** | ***Kurtosis*** | ***Jarque-Bera ( p value)*** |
|---|---|---|---|---|---|
| P2P | -0.0008 | 0.0312 | 0.5710 | 38.2217 | 39946.92 (0.000) |
| Internet Finance | 0.0010 | 0.0254 | -0.6944 | 5.3965 | 246.7860 (0.000) |

### C. ADF test and ARCH effect test

The autocorrelation and partial autocorrelation of the series (lagging order 12) are shown in "Fig. 1" and "Fig. 2". It can be seen that the Q statistic results show that the null hypothesis of the autocorrelation coefficient is 0, so there is a significant autocorrelation relationship between the two sequences. Moreover, the autocorrelation of the P2P lending is truncated at the first order of lag, the partial autocorrelation has a tailing phenomenon, and the Internet financial autocorrelation and partial autocorrelation both have a tailing phenomenon.

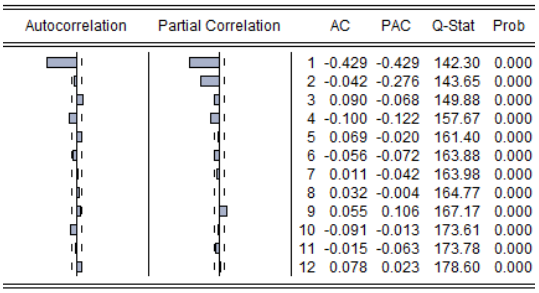


Fig. 1. Autocorrelation and partial autocorrelation graph (P2P).

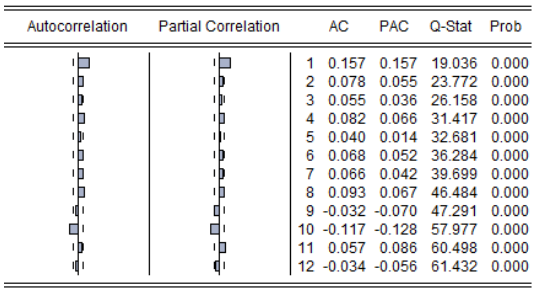


Fig. 2. Autocorrelation and partial autocorrelation graph (Internet Finance).

In order to further observe the characteristics of the two yield series, it is necessary to draw a graph of their time trend. As shown in "Fig. 3" and "Fig. 4", both P2P lending and Internet finance have volatility aggregation.

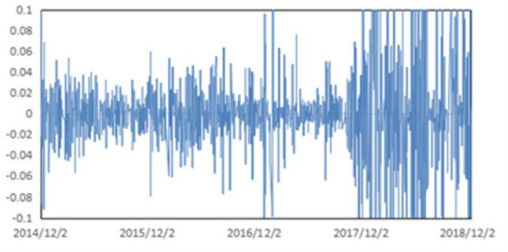


Fig. 3. Time trend graph(P2P).

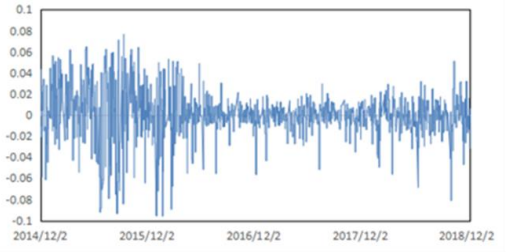


Fig. 4. Time trend graph (Internet Finance).

The ADF test was then used to analyze the sequence stationarity. As shown in "Table II", both ADF tests of the two yield sequences have p values of 0, so the null hypothesis of unit root is rejected, that is, the yield series is considered stable. Therefore, it is appropriate to use this sequence for empirical analysis.

The J-B test in "Table I" rejects the return rate series following a normal distribution, and it exhibits a phenomenon of volatility clustering, indicating that there may be an ARCH effect, so the ARCH-LM test is performed. As shown in table Ⅱ, both yield series have a strong ARCH effect. In other words, they have conditional heteroscedasticity. Therefore, it seems reasonable to use the GARCH model to fit the distribution of the sequences.

TABLE II. RESULTS OF ADF TEST AND ARCH TEST

| | *ADF test* | **ARCH test** | |
|---|---|---|---|
| | | ***F-statistic (12)*** | ***Obs*R-squared (12)*** |
| P2P | -19.4776 (0.0000)[a] | 6.08253 (0.0000) | 67.6504 (0.0000) |
| Internet Finance | -23.6621 (0.0000) | 20.7497 (0.0000) | 189.9387 (0.0000) |

[a.] ( ) is the corresponding p value

## *D. Marginal distribution estimation*

Based on the analysis of autocorrelation and partial autocorrelation analysis, AIC criteria, and the existence of "peak and tail" of the data, it is assumed that the random error term follows the T distribution or the generalized error distribution (GED), which is more suitable for describing the thick tail feature of the sequence than the normal distribution. . The simulation effect of the EGARH model of the P2P lending is better than other GARCH models. The coefficient estimation results are shown in "Table III". The fitting effect of the EGARCH model under T distribution and GED is not much different, but the estimated value of the constant term c in the mean equation under T distribution does not pass the significance test at 5% significance level, so this article select the EGARCH model under GED. The parameter a in the variance equation is 0.2273, and the estimated value of the asymmetric term coefficient γ is -0.1127. When $\varepsilon_{t-1}>0$, the impact of the information impact on the log of the conditional variance is 0.2273+(-0.1127)=0.1146 times; when $\varepsilon_{t-1}<0$, its impact on the log of the conditional variance is 0.2273+(-0.1127)*(-1)=0.34 times, the bad news has greater volatility than the equal amount of good news, which shows that the fluctuation of interest rates in P2P lending market has a leverage effect. When the interest rate in P2P lending market drops, investors will cash out their creditor's rights for the purpose of risk aversion to prevent the borrower from defaulting and causing losses to himself. When adverse news appears in the market, investors will give a larger proportion weight to the low risk yield, which will cause the impact of the decline in P2P interest rates on the market to be greater than the impact of the increase, that is, the leverage effect mentioned above.

Meanwhile, the leverage effect coefficient γ passed the significance test at 5% confidence level, indicating that the effect of this leverage effect is obvious. In other words, there is a significant difference in the impact of falling and rising interest rates on P2P lending market. The β in the variance equation indicates the continuity of the information shock. The β value is 0.9438, which is almost close to 1, indicating that the information in the market is highly implied and cannot be easily absorbed by the market. This is mainly because the P2P lending is in the initial stage of development, the relevant system needs to be improved, and there is a high degree of uncertainty in the market. Investors can only make decisions based on limited and lagging information and make rough judgments.

TABLE III. ESTIMATION RESULTS OF EGARCH MODEL OF P2P

| | **T** | | **GED** | |
|---|---|---|---|---|
| | ***estimated value*** | ***p value*** | ***estimated value*** | ***p value*** |
| c | -0.0003 | 0.1575 | -0.0004 | 0.0160 |
| ma(1) | -0.6990 | 0.0000 | -0.6995 | 0.0000 |
| ω | -0.6047 | 0.0003 | -0.6022 | 0.0001 |
| a | 0.2610 | 0.0000 | 0.2273 | 0.0000 |
| γ | -0.1047 | 0.0092 | -0.1127 | 0.0038 |
| β | 0.9346 | 0.0000 | 0.9438 | 0.0000 |
| AIC | -4.9775 | | -4.9481 | |

The estimated results of the GARCH (1, 1) - M model of Internet finance are shown in "Table IV". A variable M, which measures risk, is added to the

autoregressive equation. Its performance is in the form of conditional standard deviation σ and the corresponding coefficient is λ. Although its GARCH-M model fits better under T distribution, it does not meet the coefficient requirements of GARCH model, so we choose the model under GED. λ is 0.0813 greater than 0, and the significance test is passed at a confidence level of 5%, indicating that the returns and risks of the Internet financial market show a positive change, that is, when the expected risk in the Internet financial market increases by 1%, it will cause Investors expected the yield to increase by 0.0813%. In the variance equation, the ARCH term coefficient a and the GARCH term coefficient β are both positive and add up to 0.9990, which is very close to 1. It meets the requirements of GARCH model for parameter setting and passes the significance test at 5% confidence level. This shows that the fluctuation shock of the Internet financial market in the early stage will have a continuous impact on the conditional variance in the subsequent stage. The actual performance is that the Internet financial market shows the characteristics of risk accumulation. The risk accumulated in the early stage may continue to be passed on, which will give the Internet financial market brings a lot of uncertainty, so the monitoring and prevention of Internet financial market risks are more important, which is also related to the orderly and healthy development of the entire financial system.

TABLE IV. ESTIMATION RESULTS OF GARCH-M MODEL OF INTERNET FINANCE

| | T | | GED | |
|---|---|---|---|---|
| | ***estimated value*** | ***p value*** | ***estimated value*** | ***p value*** |
| λ | 0.2072 | 0.0220 | 0.0813 | 0.0100 |
| ar(1) | 0.9915 | 0.0000 | -0.8914 | 0.0000 |
| ma(1) | -0.9821 | 0.0000 | 0.9150 | 0.0000 |
| ω | 0.0000 | 0.3774 | 0.0000 | 0.1163 |
| a | 0.0928 | 0.0005 | 0.0740 | 0.0001 |
| β | 0.9141 | 0.0000 | 0.9250 | 0.0000 |
| AIC | -5.1540 | | -5.1173 | |

After filtering by the GARCH model, the autocorrelation and ARCH effects do not exist. Due to space limitations, the corresponding data is not given here. According to the setting of GARCH model, if the fitting of the model is sufficient, the sequences of standardized residual sequences obtained by the model will be sequences of independent and identic-distributed random variables after probability integral transformation, and obey the uniform distribution of (0,1). Therefore, Patton (2006) believes that independence and distribution settings can be tested separately [16]. First, this paper tests the independence of the sequence by regressing the P2P lending $(u_t - \bar{u})^k$ and the Internet finance $(v_t - \bar{v})^k$ on their own lagged order 10 and 20, respectively, where k = 1, 2, 3, 4. Under the condition that the null hypothesis holds, the asymptotic distribution of the test statistic $(T-20)\cdot R^2$ is $\chi^2(20)$. Secondly, for the test of distribution setting, the Kolmogorov-Smirnov (KS) test and Anderson-Darling (AD) test of the sequence after the probability integral transformation of the standardized residual sequence were carried out.

The original hypothesis was that the sequence was uniformly distributed (0, 1). As shown in "Table V", the moment LM test cannot reject the null hypothesis of sequence independence at the significance level of 5%. The p value of KS test and AD test are almost greater than 0.05, which means it is reasonable to select GED as the information distribution of GARCH model. All in all, it can be considered that the EGARCH-GED model is reasonable for the P2P lending and the GARCH (1, 1)-M-GED model for Internet financial marginal distribution.

TABLE V. TEST RESULTS OF THE MARGINAL DISTRIBUTION

| | ***First moment LM*** | ***Second moment LM*** | ***Third moment LM*** | ***Fourth moment LM*** | ***KS test*** | ***AD test*** |
|---|---|---|---|---|---|---|
| P2P | 0.3763 | 0.7934 | 0.4832 | 0.7411 | 0.0408 | 0.0670 |
| Internet Finance | 0.6816 | 0.0555 | 0.3563 | 0.0781 | 0.2810 | 0.1902 |

### *E. Estimate of overall and tail correlation*

In order to explore the correlation between the P2P lending and Internet finance, the data of the two return rates converted by GARCH model and GED is depicted as a scatterplot. As shown in "Fig. 5", the scatter plots in the upper right and lower left corners of the figure are different. The scatter plots in the upper right corner are more concentrated, while the scatter plots in the lower left corner are relatively dispersed, which can intuitively reflect the asymmetric tail dependence between the two. In addition, it can be preliminarily judged that the up-tail correlation between P2P lending and Internet finance is larger than the down-tail correlation.

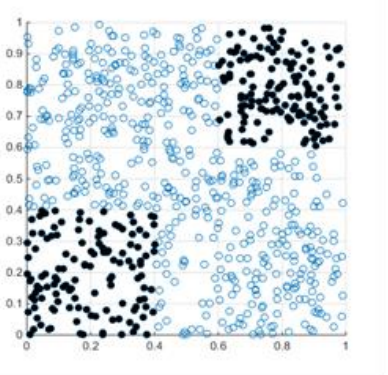


Fig. 5. Scatter plot of P2P and Internet Finance.

In order to further explore the tail correlation between the two, this paper uses the Gumbel Copula and Clayton Copula to obtain the estimated values of the corresponding parameters, and then uses the parameter estimates to obtain the overall Kendall correlation coefficient and tail correlation coefficient of the corresponding Copula function, as shown in "Table VI".

TABLE VI. THE OVERALL AND TAIL RELATIONSHIP BETWEEN P2P AND INTERNET FINANCE

| Copula | *a* | *Kendall* | *Lower tail* | *Upper tail* |
|---|---|---|---|---|
| Gumbel | 0.3763 | 0.7934 | 0.4832 | 0.7411 |
| Clayton | 0.6816 | 0.0555 | 0.3563 | 0.0781 |

The fluctuation of P2P lending platform's return rate has a positive correlation with the change of the Internet financial index, indicating that when the negative return of P2P lending platform's return rate fluctuates, the Internet's financial index also experiences negative fluctuations, and vice versa.

In the estimation of the tail correlation coefficient, the confidence level of the Gumbel Copula is 95%, and the confidence level of the Clayton Copula is 5%. It can be seen from "Table VI" that when the P2P lending platform's comprehensive interest rate return sequence exceeds the 95% quantile, the probability of the Internet financial return rate sequence exceeding the 95% quantile is 1.77%. When the bottom end of the P2P lending platform's comprehensive interest rate return sequence is less than 5% quantile, the probability that the bottom end of the Internet finance return rate sequence is less than 5% quantile is almost zero, which is consistent with the phenomenon depicted in "Fig. 5".

At the corresponding confidence level, the tail correlation between the rate of return of P2P lending platforms and the rate of return of Internet finance index is asymmetric. The correlation of the upper tail is greater than the correlation of the lower tail, which is inconsistent with the tail relationship of the traditional financial market. To analyze the reasons, on the one hand, China's Internet finance is an emerging financial form, which is not yet mature, with imperfect relevant systems and incomplete information. Therefore, investors are unable to make accurate judgments based on timely and reliable information. On the other hand, compared with bank wealth management products, P2P lending platforms are not safe and offer a higher rate of return to attract investors. Moreover, P2P lending platforms are dominated by small and medium-sized investors, most of whom have the psychology of seeking profits. The P2P lending mainly facilitates the financing of small, medium and micro enterprises and individuals. It is more difficult for them to obtain funds from traditional commercial banking channels, but they urgently need funds, so they can accept higher loan interest rate, to add to the P2P lending integrated interest rates, in turn, which makes the Internet financial index yields to rise.

However, it should not be overlooked that the P2P lending also has a low correlation with Internet finance, but it is only relatively small. Moreover, the P2P lending has also experienced “running money” in the past two years, the capital chain has been broken, and the bankruptcy of poor management has occurred. In extreme events, with the continuous development of the market and the gradual supervision of the government, we believe that this irrational behavior will gradually be regulated. Therefore, the situation in which the upper tail correlation between the P2P lending platform's return rate and the Internet financial index's return rate is greater than the lower-tail correlation is only temporary. We should not be too optimistic. The most important thing is to pay attention to the hidden risks and prevent them from happening.

## V. CONCLUSION

First, this paper studies the ARCH effect of the return rate of China's P2P lending. Using the EGARCH-GED model to characterize the volatility of the P2P lending platform's return rate, it is concluded that the fluctuation of P2P lending platform's return rate has a significant aggregation and has a phenomenon of sharp “peak and thick tail”. The decline in platform interest rates has a greater impact on the interest rate volatility brought about by the P2P lending market than a similar increase. Then, the Copula function is used to test the spillover effect of the fluctuation of the P2P lending platform's return rate on Internet finance. Empirical evidence shows that the fluctuation of the P2P lending platform's return rate has a positive correlation with the change of the Internet financial index, and the upper-tail correlation is greater than the lower-tail correlation. Further, the following suggestions are made:

First, the yield of P2P lending fluctuates greatly and has a significant leverage effect, showing the phenomenon of risk accumulation. Therefore, the establishment of illegal online loan platforms must be eliminated from the source to prevent illegal fund-raising by P2P lending platforms and avoid systemic risks.

Second, China's P2P lending has a positive risk spillover effect on Internet finance, so it is necessary to effectively prevent the risk of P2P lending, further improve the legal system and credit reporting system of P2P lending, improve the information disclosure system, and ensure platform information Integrity and authenticity, weakening its risk spillover effect.

Third, the upper-tail correlation between P2P lending returns and Internet financial index returns is

greater than the lower-tail correlation. Although the lower-tail losses between the two are lower than the upper-tail returns, this is inconsistent with the phenomenon of mature financial markets. Therefore, the relevant authorities should strengthen the reasonable guidance and legislative supervision of P2P lending interest rates, strengthen the education of investors, improve their market information screening ability, avoid being confused by high yields, and realize the rule that "high yields will be accompanied by high risks".

Fourth, the Internet finance business types are increasingly diversified, and the mixed business characteristics are increasingly obvious. The original supervision model of separate businesses cannot effectively supervise the comprehensive business of Internet finance. Therefore, it is necessary to establish a comprehensive supervision model suitable for the development of Internet finance, and coordinate supervision among various regulatory agencies to avoid duplicate supervision or blind spots in supervision.

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