

WILL PEER-TO-PEER ONLINE LENDING AFFECT THE EFFECTIVENESS OF MONETARY POLICY?

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Abstract. Online lending is a product of digital transformation, which has had a profound impact on the traditional money market. This paper discusses the impact of peer-to-peer (P2P) online lending on the effectiveness of monetary policy. Through the bootstrap sub-sample rolling-window Granger causality tests show that P2P has both positive and negative impacts on the money supply (M2). The positive impact of P2P on M2 indicates that online loans increase the amount of money supply. The negative impact of P2P on M2 shows that it may cut the money supply, thus weakening the monetary policy effectiveness. The general equilibrium model is inconsistent with these results, which underlines a positive effect from P2P to M2. In turn, the negative impact points out that the adjustment of monetary policy will hinder the development of P2P. The negative impact of M2 on P2P indicates that through the regulation of money supply, the online lending market can be correctly guided to prevent financial market from getting out of control. Through the supervision of online lending industry, we can accurately grasp the development of the internet financial industry and reduce its impact on monetary policy.

Keywords: online peer-to-peer lending, money supply, causal relationship, Internet finance, time-varying.

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1. Introduction

With the opening of the digital wave, internet finance has strongly impacted the traditional financial model, and the rise of online lending has brought great challenges to the implementation of monetary policy. As an emerging field, internet finance combines traditional financial industry with the internet (Goldstein et al., 2019), which has both positive and negative effects on traditional finance (Xie & Zou, 2012; Hou, 2019). For example, internet finance not only expands the traditional financial production-possibility frontier, but also increases the difficulty of money supply calculation (Jiang & Zhou, 2019). Since the number of balance

sheets of market-based financial intermediaries is an important macroeconomic state variable in the implementation of monetary policy (Tobias & Hyun, 2009; Jiménez et al., 2012), the number of money supply is an important indicator of its effectiveness. As the main force of internet finance, P2P (also known as fintech credit) plays an important role in promoting the development of China's financial system. It's easier to get into the lending business with P2P because it enables financial lenders and borrowers to cross time and space constraints (Basha et al., 2021). Monetary policy decisions will have unexpected changes because of P2P (Wong & Eng, 2019). One of the most immediate effects is that it reduces bank deposits (Frag et al., 2019) and the control force of bank credit (Athanasoglou et al., 2008). On the one hand, P2P could affect bank lending (Allen et al., 2002; DeYoung & Rice, 2006; Lee, 2007; Balyuk, 2016; Papanikolaou, 2018), in which it can reduce loan costs (Freedman & Jin, 2008) and provide a loan for small and medium-sized enterprise (Schmidt & Westbrook, 2011; Mawardi et al., 2019). On the other hand, there is a competitive effect between P2P and commercial banks deposits. With the rise of P2P industry, the cost of bank deposits will also increase (Frag et al., 2019). The impact of P2P on credit boosts direct financing and but weakens the central bank's control over credit channel of monetary policy transmission, and the influence on deposits makes its liquidity more unstable and volatile, thus inhibiting the growth of money supply. On the contrary, the change of money supply can change the development direction of the whole P2P industry. For example, through bank risk-taking channels, monetary policy can reduce the need for online loans or increase its supply through rational expectation channels (Li, 2020). The interaction between P2P and money supply helps investors to avoid loss ahead of time according to the policy changes. In addition, it encourages the central bank to make technological innovations to mitigate the impact of shocks on the money supply.

Previous studies have proved that P2P may not completely change the process of monetary policy formulation (Dabrowski, 2017), but Liu et al. (2020) believe that it may replace traditional finance. Monetary policy increases the money supply by inducing higher savings, increasing the supply of credit and stimulating investment, which will help traditional banks generate higher levels of profitability (Yimka et al., 2020). However, the number of online lending platforms increased significantly (Light, 2012) due to inadequate services provided by bank branches (Faia & Paiella, 2019; Havrylchuk et al., 2021). After 2013, the number of online lending platforms increased significantly (Light, 2012) due to inadequate services provided by bank branches (Faia & Paiella, 2019; Havrylchuk et al., 2021). In 2014, the importance of refinancing as a base money delivery channel increased (Wang & Wang, 2018), and money supply growth was affected by similar credit¹ (include P2P). The channels of money supply (Li & Wang, 2016) and credit (De Roue et al., 2016; Jagtiani & Lemieux, 2018) are broaden by P2P. However, in China, the ratio of P2P to new bank loans increased to nearly 40% in 2016 and then decreased to less than 10% in 2018 as the online lending industry was fully integrated into the credit reporting system (Claessens et al., 2018). This phenomenon means that the increase in default probability may have a negative impact on the P2P market, which

¹ The scope mainly includes the businesses in which the ultimate underlying assets on and off the balance sheet of the banking system are credit assets.

will restore the effectiveness of the money supply as a monetary policy intermediary (Braggion et al., 2019). If the industry continues to grow, it may also have a negative impact on the stability of money supply (Liang et al., 2017; Tule & Oduh, 2017). With the rapid development of P2P, it enables many financial institutions to start the business of deposits and withdrawals. It uses online platforms to match investors and financiers to earn interest income (Li & Wang, 2016). This amounts to add a base currency in the original system, which gains the ability to earn deposits. In addition, the automatic credit quota on Alibaba's e-commerce platform increases the opportunities for companies and individuals with low credit scores to obtain credit (Tang, 2019). However, compared with the United States, China does not have a mature credit system (Xu et al., 2015). One of the problems of online lending is the information asymmetry between borrowers and lenders (Emekter et al., 2015). Basically, the lender does not know the borrower's reputation. P2P financing service is simple and fast, and it doesn't even need guarantee (Sitorus et al., 2020). In terms of security, there is still no comprehensive policy to protect consumers' data information (Lastusti & Tri, 2018). The security problem of online lending platform will lead to systemic financial risks. For the sake of financial stability, it is necessary to play a regulatory role of monetary policy. Therefore, P2P is related to the efficiency of monetary policy.

This paper has several marginal contributions. Firstly, the existing studies mainly focuses on the negative impact of P2P on traditional commercial banks, and the comparison with traditional financial intermediaries (Li et al., 2017; Thakor, 2020; Yao & Song, 2021), lacking the perspective of money supply to study its impact on the effectiveness of monetary policy. Secondly, studying the impact of P2P on money supply is helpful to examine the changes in monetary policy under the background of internet finance from a new perspective, which provides experience for the central bank to formulate reasonable countermeasures to reduce the risks brought by the increase in credit. The general equilibrium model is not always supported, which shows that P2P has a positive effect on money supply. Thirdly, earlier studies only use the full-sample causality test, without considering that the causality may change over time between the two factors. To disclose the time-varying causality between P2P and money supply, the sub-sample test is used for ensuring the reliability and accuracy of the results. It can provide inspiration for borrowers and lenders of online lending as well as central banks. Online lending users can assess the future development of the entire industry based on the money supply adjusted by the central bank. This allows to make timely adjustments to their investments to avoid unnecessary losses. In addition, the central bank can establish diversified credit transmission channels through the impact of P2P on money supply, thus to strengthen the effect of money transmission.

The specific arrangement of this article is as below: Section 2 introduces the relevant articles of this study. The general equilibrium models of P2P and money supply are revealed in Section 3. Section 4 introduces the method of Granger causality test. Section 5 is descriptive statistics of data. In Section 6, the empirical results and analysis are presented. At the Section 6, the research results of this study are summarized.

2. Literature review

Some studies have different views on whether P2P will affect the effectiveness of monetary policy. DeYoung and Rice (2006) argue that P2P has a negative impact on deposits and lending channels (Lee, 2007; Athanasoglou et al., 2008). Freedman and Jin (2008) find that the cost of online lending is lower and fill the gaps in bank lending (Light, 2012), but this part of the money flow is not considered by the money supply (Wang & Wang, 2018; Wong & Eng, 2020). Jiang and Zhou (2019) show that P2P online lending has the function of “credit creation”, which will aggravate the instability of quantitative monetary policy control (Al-Laham et al., 2009; Fernandez-Villarverde & Sanches, 2016). If the central bank wants to guarantee the implementation of monetary policy and achieve the expected results, it must suppress the P2P industry. However, Papanikolaou (2018) indicates that P2P has two impacts on money supply, which are positive and negative. The positive impact is conducive to promote the reform and innovation of monetary policy, which will more effectively reduce financing costs and make better use of idle funds. Schmidt and Westbrook (2011) show that P2P provides lending services to small and medium-sized enterprises that cannot meet the credit standards of traditional financial institutions. Balyuk (2016) believes that P2P can play an important role in reducing the imperfections in the consumer credit market, enabling investors to obtain loans from more channels (also Basha et al., 2021). This will lead to an increase in the money supply.

In addition, some researchers suggest that P2P will not influence the validity of monetary policy. Robb and Robinson (2014) point out that the role of P2P is less important when credit markets are more developed. Although informal finance is more readily available than formal finance, P2P generates shadow costs², which tend to make borrowers prefer formal credit (Lee & Persson, 2016). Dabrowski (2017) emphasizes that P2P will not significantly affect the monetary policy-making process, nor it influence the central bank’s effect in implementing macro-stability policies (Heller, 2017). Braggion et al. (2019) show that the unregulated and informality of P2P means that its audience is not extensive, which imply that it will not affect the money supply. Tang (2019) notes that the credit expansion caused by P2P may only happen to borrowers who have already obtained bank credit. Muhammad et al. (2020) examine the effect of financial technology on the transmission mechanism of monetary policy and find that it may have a negligible impact on monetary policy. Klein et al. (2023) argue that people prefer to save because of the high risk of P2P, which indicates that it will not reduce the money supply and thus affect the validity of monetary policy.

In China, the strong demand for financial services makes the scale of internet financial products in a far leading position in the world. Although China is not the origin of the P2P model, its total amount exceeds other countries. Xie and Zou (2012) indicate that the third-party payment and P2P weakens the role of the secondary commercial banking system, which would have a significant impact on the definition of money supply (Wang & Wang, 2018). Xie et al. (2014) point out that internet finance has expanded the border of transaction possibilities, but it will have a liquidity impact on banks, which affect the efficiency of

² If the requirement of a certain quality indicator (utility) is lowered, the revenue of the product may be reduced, and the shadow cost is the maximum revenue that the operator can accept to reduce the unit of the quality indicator.

monetary policy implementation. Tang (2015) finds that P2P makes the impact of changes in benchmark interest rates on bank credit significantly weakened, which indicates that the interest rate transmission effectiveness of monetary policy is reduced. Zhao and Ye (2016) argue that P2P causes a certain amount of inflation by influence the rate of conversion of current accounts into fixed accounts, thus disrupt the central bank's intention of monetary policy. Chen and Ma (2016) indicate that under the environment of tight monetary policy and increased capital pressure, the turnover in P2P industry will increase in the short term instead, which will alleviate the contractionary monetary policy. Liu et al. (2016) show that the internet financial system also has credit creation function, but lacks sensitivity to the deposit reserve policy, which indicates that P2P also reduces the effectiveness of quantitative transmission of monetary policy. In turn, P2P is also influenced by monetary policy. Zhou and Fan (2016) show that interest rates in P2P market are not only directly affected by commercial banks, but also indirectly affected by some monetary policy adjustments (Hu & Shui, 2019). Jiang and Zhou (2019) prove that quantitative monetary policy can accelerate P2P, while price-based monetary policy has the opposite effect. Therefore, P2P impacts the effectiveness of monetary policy by affecting the traditional banking business.

However, the previous studies mainly explore the impact of P2P on monetary policy by comparing with traditional banks, ignoring the impact of money supply. Besides, there are few studies that discuss the reciprocal influence between P2P and money supply. Wong and Eng (2020) find that P2P erodes the effectiveness of monetary policy in mitigating fluctuations. In addition, they also argue that monetary policy is largely effective in making the economy respond to favorable shocks as expected, which cause a sharp decline in P2P. Therefore, from the perspective of money supply, the interaction between P2P and monetary policy has not been clearly explained. Moreover, the current research ignores the structural changes and unstable parameters of time series in Granger causality test, and cannot analyze the causal relationship and trend of time changes between P2P and money supply. In this paper, by applying the rolling-window causality test, we can analyze the impact of P2P on money supply. The result can prove whether online lending weakens the validity of monetary policy and the effect of policy changes on the internet finance industry. By exploring the relationship between P2P and money supply, we have increased the literature related to internet finance and monetary policy.

3. General equilibrium model

The general equilibrium model developed by Sunderam (2014) can explore the interaction between the shadow banking system and money creation, which are represented by P2P and M2. In this model, the financial institution and the central bank make joint efforts to the need for money-like claims. Suppose money services are provided by deposits, bank credit and P2P and they provide different amounts of money services. Deposit offers a certain amount of monetary services γ_D , which is normalized to 1. The monetary service provide by bank credit is $\gamma_T > 0$. The P2P provides $\gamma_{P2P} > 0$ of monetary services. The substitution elasticity of the aggregate of the effective monetary services in the economy is assumed to be constant. We can construct an Eq. (1):

$$M2 = (\gamma_D m_D^{\delta-1} + \gamma_T m_T^{\delta-1} + \gamma_{P2P} m_{P2P}^{\delta-1})^{\frac{1}{\delta}}, \quad (1)$$

where m_D represents the amount of deposits, m_T represents the amount of Bank credit and m_{P2P} is the amount of P2P. δ is the alternative elasticity among deposits, bank credit and P2P. Household demand for these services is on the decline. Especially, suppose that households maximize $E \left[\sum \lambda^t C_t \right]$, where $C_t = c_t + \theta v(M2)$. $v(M2)$ is a function in reduced-form of the utility of consuming gross monetary services $M2$. $\theta > 0$ is a kind of currency demand shifter that enables to inspect the impacts of demand increases for all money-like claims just by using comparative statics to θ . Therefore, households with the total return required by this utility specification can be expressed by Eq. (2):

$$R_{P2P} = R - \gamma_{P2P} \theta v'(M2) \left(\frac{M2}{m_{P2P}} \right)^{\frac{1}{\delta}}, \quad (2)$$

where R is the total return of non-money claims. The total return of money-like claims under R because households gain extra utility from money services. Sunderam (2014) defines the money premium, which is the dissimilarity between the returns required on these two claims. For example, the money premium for P2P is represented by Eq. (3):

$$\frac{\partial}{\partial m_{P2P}} [\theta v(M2)] = \theta v'(M2) \frac{\partial M2}{\partial m_{P2P}} = \gamma_{P2P} \theta v'(M2) \left(\frac{M2}{m_{P2P}} \right)^{\frac{1}{\delta}}. \quad (3)$$

A key to the following comparative statics is to analyze the influence of change in the demand shifter θ . Suppose that $v' > 0$ and $v'' < 0$, so that the marginal utility of monetary services is positive but declining.

In the comparative static, as the level of money demand θ fluctuate, the prices and volumes in the model change accordingly, the following makes their response characteristic. Because the substitution elasticity between deposits and P2P is $\delta > 1$, in response to a higher level of money demand θ , the central bank increase reserve supply, expressed as $\frac{\partial R^*}{\partial \theta} > 0$. The critical intuition behind the central bank's response is kept interest rates at target levels. The prevailing interest rate i is decided by the monetary premium $\theta v'(M2) \left(\frac{M2}{m_D} \right)^{\frac{1}{\delta}}$ of the deposit. The increasing of money demand θ adds this premium, and holding fixed $M2$ and m_D . As a result, to capture this larger premium, banks may hope to issue more deposits. This has raised their demand for storage, and hence current interest rates. To keep interest rates at target i , the central bank would then raise the supply of storage. It should be noted that since deposits and P2P are imperfect alternatives, the regulation of interest rates does not give the central bank control over the amount of P2P. The rise in storage supply has not completely squeezed out P2P production. Similarly, bank credit and P2P are imperfect substitutes. The marginal value of money claims will reduce, mainly because the increase in bank credit supply can increase the total supply of money services. On the contrary, the smaller money premium decreases the incentive to issue P2P. We can also prove that the increase of P2P

will cause M2 to change in the same direction with other conditions unchanged, according to the general equilibrium model. High P2P means an increase in the gross amount of money in the economy, M2 will remain at a high level which stabilize interest rates at the target level. We can also prove that the effectiveness of monetary policy will be affected because P2P is not a perfect substitute.

4. Methodology

4.1. Bootstrap full-sample causality test

The traditional vector auto-decreasing (VAR) model based on Granger causality test might not meet the standard asymptotic distribution, which will cause analysis results are inaccurate. According to Shukur and Mantalos (1997), this problem can be solved by the residual-based bootstrap (RB), which is developed by them and enhance the accuracy of Granger causality test. Besides, it is also proved by them that the likelihood ratio statistic can be rectified, even when the time series is small, because they study the power and size characteristics. Developed by Shukur and Mantalos (2000), the likelihood ratio (LR) tests, which can be rectified by power and size characteristics. Consequently, Granger causality between P2P and M2 can be tested, by using the modified-*LR* statistic based on *RB*. The following is the bivariate VAR (*p*) process we construct:

$$Y_t = \beta_0 + \beta_1 Y_{t-1} + \dots + \beta_p Y_{t-p} + \delta_t. \quad (4)$$

The minimum value of the Schwarz Information Criterion (SIC) optimal determin the lag order *p*. In the VAR (*p*) process, *Y* can be grouped into P2P and M2, namely $Y_t = (P2P_t, M2_t)'$. Besides, because the fluctuation of bank credit (BC) can affect both P2P and M2 (Greenwood et al., 2015; Balyuk, 2016; Li, 2020; Wong & Eng, 2020), it will affect the correlation of a pair of variables. Hence, in the VAR model, we choose BC as the control variable, as shown in Eq. (5) below:

$$\begin{bmatrix} P2P_t \\ M2_t \end{bmatrix} = \begin{bmatrix} \alpha_{10} \\ \alpha_{20} \end{bmatrix} + \begin{bmatrix} \alpha_{11}(L) & \alpha_{12}(L) & \alpha_{13}(L) \\ \alpha_{21}(L) & \alpha_{22}(L) & \alpha_{23}(L) \end{bmatrix} \begin{bmatrix} P2P_t \\ M2_t \\ BC_t \end{bmatrix} + \begin{bmatrix} \delta_{1t} \\ \delta_{2t} \end{bmatrix}, \quad (5)$$

where $\delta_t = (\delta_{1t}, \delta_{2t})'$ is a white-noise process with zero mean and covariance matrix. $\alpha_{ij}(L) = \sum_{k=1}^p \alpha_{ij,k} L^k$, $i, j=1, 2$ and *L* is a lag operator, and we have $L^k Y_t = Y_{t-k}$.

Next, we can test null hypothesis and inverse null hypothesis that P2P makes no difference on M2 ($\alpha_{12,k} = 0$ for $k = 1, 2, \dots, p$) and M2 has no effect on P2P ($\alpha_{21,k} = 0$ for $k = 1, 2, \dots, p$), which can be checked in term of the Eq. (5). If P2P causes M2 to fluctuate prominently and vice versa, these two null hypotheses can be rejected.

4.2. Parameter stability test

The assumption that the bootstrap full-sample causality test is that the parameters in the VAR model have no structural changes, and this suppose is not always realistic. Therefore, if the parameters are not fixed at the sampling period, the full-sample test is not reliable. Then, the Sup-*F*, Ave-*F* and Exp-*F* tests are used to test the parameters steadiness, which is developed

by Andrews (1993) and Andrews and Ploberger (1994). The abrupt structural changes and whether the parameter changes with time trajectory can be tested by the Sup- F , the Ave- F and Exp- F . The time-varying parameters can lead to the unreliability of full-sample causality test, so to analyze the causal relationship between P2P and M2, this study apply the bootstrap sub-sample rolling-window test.

4.3. Bootstrap sub-sample rolling-window causality test

According to the rolling-window width, this method splits the entire time series into small samples (Balcilar et al., 2010). From the start to the finish of the entire sample, the segmented small samples are rolled by degrees. It includes the following specific steps: Make T as the length of the time series and l is the width of the rolling-window. We can get $T - l + 1$ sub-sample because every split small sample ends with $l, l + 1, \dots, T$. By using the RB -based modified- LR test, Granger causality results can be obtained for each sub-sample. Then according to summarize all the p -values and LR statistics of sub-samples in the chronological order, we can gain the results. The average values of a large number of estimations are $N_b^{-1} \sum_{k=1}^p \hat{\alpha}_{12,k}^*$ and $N_b^{-1} \sum_{k=1}^p \hat{\alpha}_{21,k}^*$, respectively representing P2P's impact on M2 and opposite meaning. N_b is the bootstrap repetition frequency. The parameters of Eq. (5) are $\hat{\alpha}_{12,k}^*$ and $\hat{\alpha}_{21,k}^*$. In this paper, 90% confidence interval is used, and the 5th and 95th quantiles of $\hat{\alpha}_{12,k}^*$ and $\hat{\alpha}_{21,k}^*$ are the corresponding lower and upper limits (Balcilar et al., 2010). A small rolling-window width cannot get sound test results, which means that its selection is sophisticated. A larger may decrease the frequency of scrolls, but the accuracy of the test results can be improved. Pesaran and Timmermann (2005) show that if the parameters are unstable, the minimum rolling-window width have better be greater than 20.

5. Data

Monthly data from 2013: M11 to 2021: M06 are used in this paper to test the causal relationship between P2P and M2, and further explores connections between the development of online lending and the effectiveness of monetary policy. We choose the turnover in P2P to reflect the changes in the market size³. The two "crises"⁴ in the banking industry in 2013 caused major banks to start to reduce their loans, and many enterprises or speculators could not borrow from banks are given access to loans from P2P platforms. Online lending has experienced rapid expansion since 2013, the cumulative transaction volume of online lending in 2013 exceeded 100 billion yuan. Under the influence of commercial interbank business, the money creation channel has changed, and the money supply of the financial system has been increased through non-interbank and interbank channels. However, if the non-bank institutions do not directly invest in the real economy after receiving the money from the

³ P2P turnover is taken from Prospective database.

⁴ The "outbreak" in June 2013 of defaults by two medium-sized banks in the inter-bank market and the central bank's failure to inject capital into the market through reverse repos, and large banks stopped lending, which cause a "money shortage". In July 2013, the central bank announced that it would fully liberalize the lending interest rate control and allow financial institutions to independently determine the loan interest rate level based on commercial principles.

bank, but circulate within the financial system, this will cause the M2 growth rate to be excessively high. Since 2018, the number of problem platforms in the online lending industry has increased significantly. The government begins to supervise the online lending industry. Under the background of financial deleveraging, M2 continued to fall to 8%, because the above-mentioned additional monetary channels are blocked. It can be observed that the change of M2⁵ may be related to P2P. Therefore, there may be mutual influence between the online loan market and money supply. In this paper, to avoid the non-stationary, P2 and M2 are converted by considering the natural logarithm and the first differences. Figure 1 displays the trend of P2P and M2.

From Figure 1, it shows that M2 does not increase in the whole periods with P2P. In the initial development stage of P2P platform, most of the participants are internet entrepreneurs and has not been popularized. Until the “Money Shortage⁶” in 2013, the capital panic in the inter-bank market spread rapidly, but the central bank did not increase the money supply in time as usual. This money shortage, which has been affecting the market until 2014, is actually a contest between the monetary authorities and financial institutions for macro-policy direction, and a confrontation around “deleveraging”. In order to alleviate the lack of funds, some real estate developers begin to borrow from the private sector, which has liberalized interest rate regulation. In 2015, the central bank approves overseas RMB clearing banks and overseas participate in bond repurchase transactions in the inter-bank market. P2P has also begun to carry out business and started to attract foreign capital and increase the money supply. It expands the scope of investment and increases derivative deposits, which leads to a rapid rebound in M2 growth. From 2016, under the background of financial deleveraging, the money supply channels for internet finance such as P2P are blocked, thus causing M2

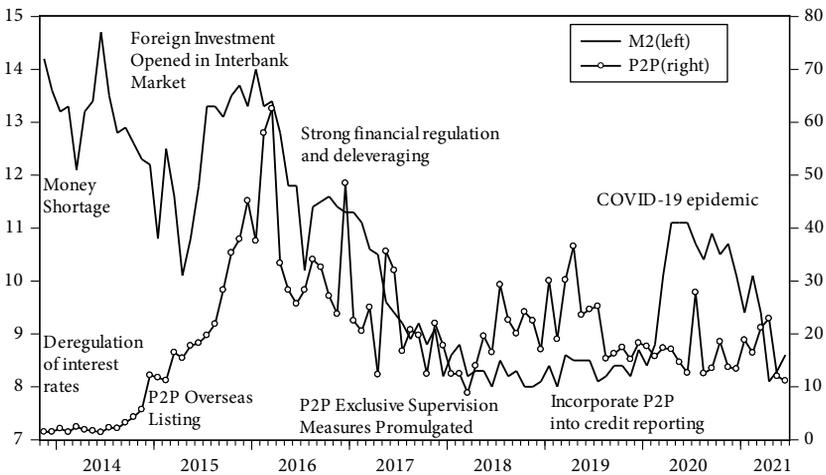


Figure 1. The trends of P2P and M2

⁵ M2 is taken from National Bureau of Statistics (NBS).

⁶ The bank's debts that fall due are temporarily unpaid.

to continue to decline. At the same time, online lending's "1 + 3" system⁷ has been officially introduced, which indicates that P2P has gained formal and legal status. P2P begins to be fully integrated into the credit investigation system at the end of 2018, which causes the industry to lose a large number of customers, and strong supervision also keeps M2 growth at the lowest level. A series of previous regulatory policies shut down the financial system money supply channel of P2P, while the temporary rebound in money supply growth in 2020 is due to the impact of the COVID-19 epidemic. In conclusion, the relationship between P2P and M2 is complex and time-varying.

In addition, P2P may affect bank credit, mainly due to the increase in loan channels will compete with commercial banks (Greenwood et al., 2015; Balyuk, 2016; Li, 2020). Changes in credit scale will cause changes in money supply (Wang, 2011; Dai, 2021; Shu, 2021). As an intermediate target of monetary policy, M2 affects the ultimate target of the policy and plays a pivotal role in the whole transmission process. Therefore, fluctuations in M2 may be affected by bank credit, and a decrease in credit will result in a decrease in M2, and the reverse is also true. As the interrelation between P2P and M2 may be influenced by bank credit (BC) (Balyuk, 2016; Wang, 2011), we take it a control variable. As shown in Table 1.

The descriptive statistics are reported in Table 1. The means of the P2P, M2 and BC are 19.646, 10.541 and 12387.610, respectively. Skewness are positive for P2P, M2 and BC. P2P and BC with the characteristic of leptokurtic distribution because the kurtosis is bigger than 3. M2 is with the feature of platykurtic distribution because its kurtosis is less than 3 (Su et al., 2022a, 2022b, 2022d). Besides, at 1% level, P2P and M2 are significantly non-normally distributed, which is proved by Jarque-Bera test. Therefore, the study should not apply traditional Granger causality test (Su et al., 2021a, 2021b, 2022c). Then, to settle the issue of the potentially non-normal distributions in P2P and M2, we employ the *RB* method. In order to investigate the time-varying Granger causal relationship between these two variables, this essay also apply the bootstrap sub-sample rolling-window test. To prevent parameters' potential heteroscedasticity, we can adopt the natural logarithm of P2P, M2, and BC.

Table 1. Descriptive statistics for P2P and M2

	M2	P2P	BC
Observations	92	92	92
Mean	10.541	19.646	12387.610
Median	10.500	18.027	10896.520
Maximum	14.700	62.551	38182.000
Minimum	8.000	1.408	3852.000
Standard Deviation	1.997	11.853	6824.263
Skewness	0.284	0.942	1.855
Kurtosis	1.721	4.783	6.654
Jarque-Bera	7.509***	25.791***	103.961***

Note: *** denotes significance at the 1% level.

⁷ Set up 13 red lines for network supervision; Determining the implementation department and specific process of online loan filing management; Clarifying the requirements for the custody of online loan funds; Standardize the credit approval content of online lending platforms.

6. Empirical results

Based on Eq. (5), we construct the bivariate VAR models to estimate the full-sample Granger causality of P2P and M2. And we choose 4 as the optimal lag order according to SIC. By observing the p -value of Table 2, we can know that P2P does not Granger cause M2 and the reverse is also true. These results contradict with existing studies (Zhou & Fan, 2016; Allen et al., 2002) and the general equilibrium model.

We use full sample estimates in a VAR model with P2P and M2, assuming that the parameters are stable and there have only one causal relationship throughout the whole sample period. Nevertheless, because of structural changes in the VAR system (Balcilar et al., 2010), the parameters may be inconsistent and the causal relationship between P2P and M2 exhibits time-varying characteristics. To enhance the precision of causality analysis, the stability of P2P and M2 parameters in VAR model are tested by Sup- F , Ave- F and Exp- F tests. In addition, to ensure the reliability of Granger causality test, we also used L_c statistics test (Nyblom, 1989; Hansen, 2002). Table 3 shows the results of parameter stability test.

At 1% and 10% level, the Sup- F test shows that P2P, VAR systems and M2 have undergone abrupt structural changes respectively, according to Table 3. The parameters may change gradually along the time trajectory of P2P and VAR systems at 1% level, which shown by the Ave- F test, but they are not obvious in M2. The Exp- F test shows the P2P and VAR systems' time variation parameters at 1% level and M2 at 10% level. At the level of 10%, we can refuse the random walk process of the parameters in the VAR system, which is the null hypothesis of L_c statistics test. In time series and VAR systems, the parameters change over time, according to Sup- F , Ave- F , Exp- F and L_c statistics test. Then, we can find that the Granger causality between P2P and M2 is inconsistent through the parameter steadiness test, thus, the application of full-sample causality test is not suitable. In this study, we explore

Table 2. Full-sample Granger causality tests

Tests	H_0 : P2P does not Granger cause M2		H_0 : M2 does not Granger cause P2P	
	Statistics	p -values	Statistics	p -values
Bootstrap LR test	1.148	0.852	5.454	0.183

Note: To calculate p -values using 10000 bootstrap repetitions.

Table 3. The results of parameter stability test

Tests	P2P		m2		VAR system	
	Statistics	p -value	Statistics	p -value	Statistics	p -value
Sup-F	55.722***	0.000	15.353*	0.028	28.695***	0.002
Ave-F	22.498***	0.000	2.243	0.617	18.500***	0.000
Exp-F	24.575***	0.000	4.054*	0.061	12.156***	0.001
L_c					3.479*	0.050

Notes: To calculate p -values using 10000 bootstrap repetitions. *** and * denote significance at the 1% and 10% levels, respectively.

the causal relationship between P2P and M2 over time through the bootstrap sub-sample rolling-window causality test. The rolling window width of 24-months⁸ is chosen to make sure the accuracy of the causal relationship. Moreover, by using this sub-sample test, we can also know the direction of P2P impact on M2 (or M2 impact on P2P).

The bootstrap p -value and influence direction of P2P on M2 are respectively revealed by Figures 2 and 3. We can accept the null hypothesis that P2P has no influence on M2, but the null hypothesis was rejected at the level of 10% in 2017: M04-2018: M03 and 2020: M06-2020: M11. In addition, during the above period, there are positive (2017: M04-2018: M03) and negative impacts (2016: M10-2016: M12 and 2020: M06-2020: M11) impacts of P2P on M2.

The positive impact shows that P2P is a supplement to banks rather than a substitute, which is beneficial to strengthen the efficiency of monetary policy. According to the previous literature, P2P can reduce the loan cost, provide services for small enterprises and supplement the banking business (Schmidt & Westbrook, 2011; Mawardi et al., 2019), which also proves its impact on M2. In 2017, the development of online lending industry begins to become formal, the state encourages the development of small-scale decentralized businesses such as personal credit and consumer finance (Zou et al., 2021). In September 2017, in support of financial institutions to develop their business in inclusive finance (Chinhui, 2017), central bank focus on providing loans to small enterprises with loan amount less than RMB 5 million, targeted cuts to require reserve ratios. The decline in the cost of loans has led to a corresponding increase in the demand for capital and faster flow of money within the financial system. The acceleration of money circulation makes monetary policy more systematic and transparent (Bordo & Levin, 2017; Camera, 2017). In the era of strict supervision, the high-quality standardization platform has entered the stage of rapid expansion (Schmidt & Westbrook, 2011; Balyuk, 2016; Basha et al., 2021). Moreover, some leading enterprises in the online lending industry begin to expand overseas and introduced high-quality foreign capital (Malloy et al., 2017). For example, in April 2017, "XinErFu" is officially listed on the New York Stock Exchange and the total market value is US\$ 420 million. In November, China establishes the earliest P2P platform "PaiPaiDai" and successfully lands on the New York Stock Exchange, and the total financing amounted to 270 million U.S. dollars; internet finance company "HeXinDai" is list on the Nasdaq Stock Exchange. The inflow of foreign capital increases foreign exchange reserves and enables the central bank to increase the money supply (Wang, 2001). Therefore, the positive impact of P2P on M2 can be proved.

The negative impact of P2P on M2 can be observed in 2016: M10-2016: M12 and 2020: M06-2020: M11. Previous studies have shown that the implementation of monetary policy is hindered by systemic financial risks caused by P2P security issues (Sitorus et al., 2020; Lastusti & Tri, 2018). Before the introduction of regulatory policies, the risk of P2P platforms makes it difficult to obtain bank funds (Tian, 2019). At least 70% of the platforms will be shut out based on the bank's requirements on the transaction scale and asset quality. Starting from 2016, small P2P platforms begin to withdraw from the industry, and big platforms are transformed

⁸ In this study, we also adopt the rolling-window widths of 20-, 28- and 32- months to investigate the causality to prove the reliability of the test results, and the results are same with the 24-months rolling-window.

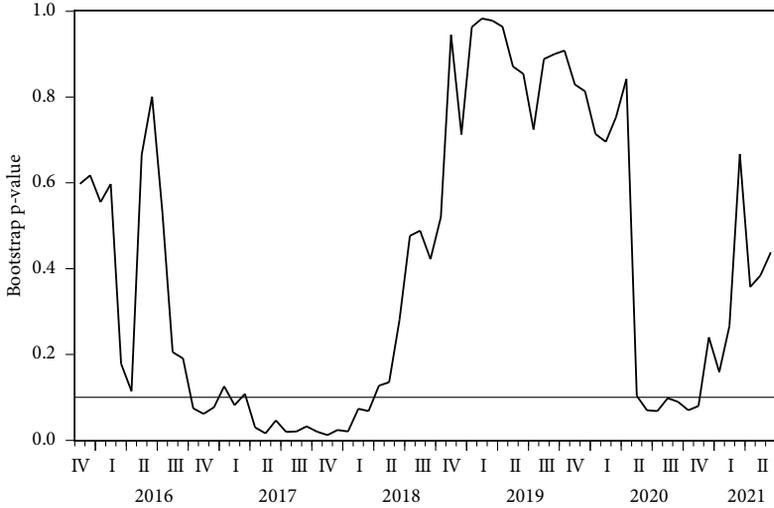


Figure 2. Bootstrap p -values of rolling test statistic testing the null hypothesis that P2P does not Granger cause M2

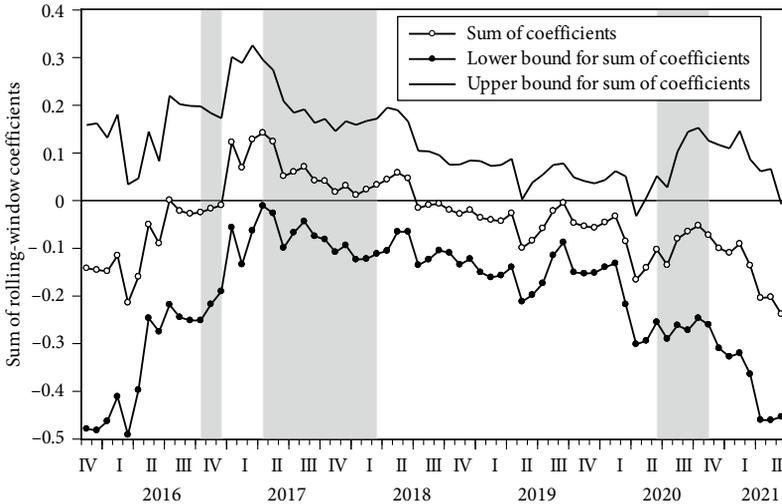


Figure 3. Bootstrap estimates of the sum of the rolling-window coefficients for the impact of P2P on M2

and upgraded into internet finance groups, with business expanding into consumer finance, wealth management and other aspects. In 2016, compliance development for the online lending industry start to develop compliance, while face various challenges. The introduction of online supervision policies has regulated the P2P industry and platforms from the perspective of risk control, which has led to a decrease in the flow of funds within the financial system. With less idling of funds within the financial system, M2 will naturally fall (Hu & Jiang, 2022).

Existing literatures indicates that internet finance will encourage financial institutions to take risks (Norden et al., 2014; Guo & Shen, 2016), which may affect the lending business of

commercial banks. The risk of default arising from low access standards affects credit investigation and normal bank credit (Guo, 2020). Although lenders want to reduce risk and secure their investments, riskier borrowers are encouraged by P2P companies. (Klein et al., 2023), even if they do not meet bank lending standards (Tang, 2019). In order to reduce the risk in P2P, a notice⁹ was issued in September 2019, deciding to incorporate P2P into the credit investigation system. In July 2020, more than 20 online credit platforms announce or are allowed to enter the central bank Credit Reporting system. Although the scale of P2P industry is shrinking rapidly due to strict supervision, some individuals and enterprises' credit are adversely affected, which will increase the cost and difficulty of borrowing from banks (Zhang et al., 2015; Čehajić & Košak, 2022). In addition, the macro leverage ratio in 2020 increased to 270.1% at the end of 2019. Risk prevention has become the focal point of macro-control policy, and the monetary policy will not be further relaxed, which leads to a drop in M2 (Cozzi et al., 2020). Consequently, the negative impact of P2P on M2 can be confirmed, which also indicates that the P2P has a negative impact on the monetary policy effectiveness.

The bootstrap p -value and direction of M2 on P2P are exposed by Figures 4 and 5, separately. It can accept the null hypothesis that M2 has no impact on P2P, but 2016: M11-2017: M02, 2017: M11-2018: M03 and 2019: M07-2020: M02 reject the null hypothesis at a 10% level. During these periods, there are positive (2016: M11-2017: M02) and negative impacts (2017: M11-2018: M03 and 2019: M07-2020: M02) from M2 on P2P.

The positive impact of M2 on P2P in 2016: M11-2017: M02 indicates that monetary policy can promote the development of online lending to a certain extent. Previous studies have studied the loan problem of small enterprises from the perspective of bank size, and the results show that smaller banks are more inclined to lend to small and medium-sized enterprises (Ekpū, 2016). In addition, they also believe that incentive plans and stronger law enforcement inspire commercial banks to lend to small and medium-sized enterprises (Shen et al., 2009). The decrease in M2 during this period is mainly because of the "Macro Prudential Assessment (MPA)" implemented by the central bank in 2016 has strengthened the supervision and restrained the growth of bank credit (Zhou & Fan, 2016). When monetary policy is tightened, commercial banks reduce credit supply due to strict supervision of loan interest rates, making it difficult for high-risk enterprises to obtain financing from banks (Funke et al., 2015). On the one hand, the central bank proposes structural deleveraging to reduce the money supply. On the other hand, it formulates and implements a differentiated credit policy specifically aimed at improving the financing of small and micro enterprises (Hu & Shui, 2019). Large commercial banks are required to complete the establishment of inclusive finance business units to serve small enterprises within 2017, and it should not be lower than the average growth rate of various loans. From 2016 to 2017, when the average interest rate of RMB loans from financial institutions increases by 0.44% during the same period, the differentiated credit policy reduces the interest rate of P2P by 0.32%, and the financing situation of small enterprises improved to a certain extent. After the above policy

⁹ The "Notice on Strengthening the Construction of Credit Reporting System in peer-to-peer online lending" made it clear that P2P institutions will access credit reporting institutions such as the Central Bank Credit Reporting Center and Baihang Credit Reporting, which are operating institutions of the basic financial credit information database.

adjustments, P2P enters a period of steady growth in 2016. Therefore, we can prove that M2 has a positive impact on P2P in this period.

However, this idea can not always be supported, the period of negative impact can be comprehended from two aspects: the strengthening of supervision (2017: M11-2018: M03) and the increase of bank loans (2019: M07-2020: M02). Since 2018, the number of problematic P2P platforms has increased significantly, disrupting the economic order of market (Klein et al., 2023). Information asymmetry and moral hazard problems cause a decline in public

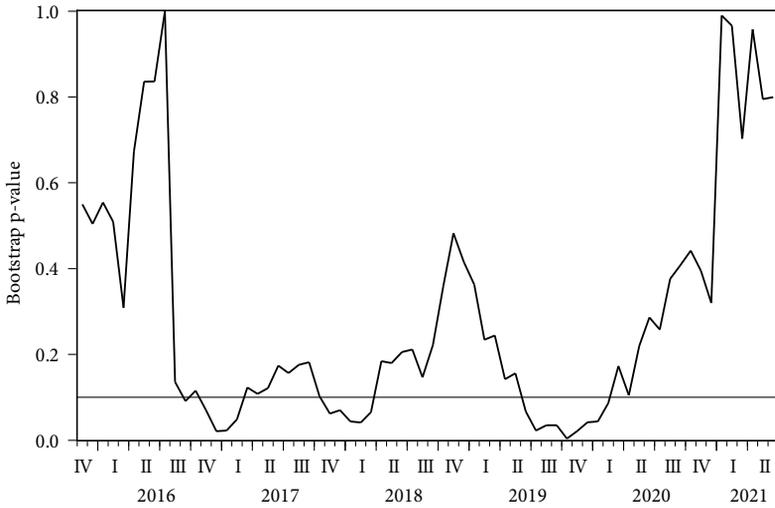


Figure 4. Bootstrap p -values of rolling test statistic testing the null hypothesis that M2 does not Granger cause P2P

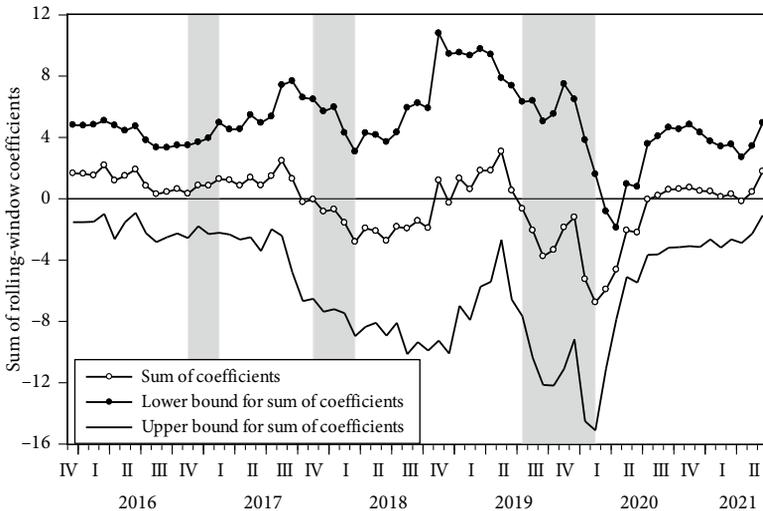


Figure 5. Bootstrap estimates of the sum of the rolling-window coefficients for the impact of M2 on P2P

confidence (Bachmann et al., 2011), which lead to a large number of investors leave from the P2P market. In March 2018, the China Banking Regulatory Commission (CBRC) and the China Insurance Regulatory Commission (CIRC) amalgamated to establish the "China Banking and Insurance Regulatory Commission"¹⁰, which formally forms a unified regulatory system. This indicates that China's financial industry move towards separate supervision, which makes the control of off-balance sheet banking stricter and more efficient. Previous research also shows that the CBRC has been trying to crack down on intermediary loans, and they only allow P2P platforms to serve as information intermediaries and not engage in loan business (Shen, 2015). The strengthening of supervision causes the decrease of M2, as the P2P sector does not dominate the financial industry and has a small market share (Verdier, 2011; Shtudiner et al., 2017; Klein et al., 2023), which results in no more funds allocated to the online lending industry. Therefore, the change in money supply makes the P2P industry unstable, which indicates that the decrease of money supply will bring negative impact to P2P.

At the end of 2019, M2 grows by 8.7%, exceeding market expectations. It mainly affected by two factors, one is the increase in RMB loans (Krylova, 2002) and derivative deposit¹¹ (Frag et al., 2019). Second, the trade surplus in December is \$46.79 billion, which increased the supply of base money. According to the People's Bank of China, RMB loans increases by RMB16.81 trillion for the whole year of 2019. The growth rate of social financing scale¹² and M2 growth rate in 2019 have all increased. Compared with 2018, the credit structure of 2019 is also optimized, with a significant increase in the proportion of medium-and long-term loans to entities and manufacturing industries. During this period, banks will actively reduce the difficulty of loan approval (Hu & Shui, 2019), and the increased loans will squeeze P2P's market share. To guard against bank risk, the central bank makes strategic over-investment in its branches (Havrylchuk et al., 2021). The increase in bank loanable funds has further shrunk the scale of the P2P industry. Although informal finance is easier to obtain than formal finance in the previous literature, it will generate shadow cost, so when the formal credit Chen Ben drops, P2P will no longer have an advantage (Robb & Robinson, 2014; Lee & Persson, 2016). Therefore, in this period, M2 has a negative impact on P2P.

In summary, the question of whether P2P affects the effectiveness of monetary policy cannot be reached to a consistent conclusion in this paper. M2 has been positively affected by P2P in some periods, which indicates that online lending may increase the money supply to a certain degree. At other periods, this view is untenable, mainly because credit risk and other macro-prudential measures have weakened M2. Thus, due to its potential risks, P2P cannot always be beneficial to M2. The general equilibrium model shows that P2P has a positive influence on M2, which is not supported by the results. In turn, the decline in M2 will lead to a decrease in P2P, which provides evidence for investors to forecast changes in the industry based on the money market and reduce investment costs.

¹⁰ The biggest change in 2018 was the establishment of the bimodal regulatory system, with the amalgamation of the CBRC and the CIRC.

¹¹ It refers to the deposits derived from commercial banks' business activities such as lending, discounting or investment on the basis of absorbing the original deposits.

¹² At the end of 2019, the stock of social financing scale was RMB251.31 trillion, representing of 10.7%, while at the end of 2018, the growth rate of social financing under comparable scope was 10.3%.

7. Conclusions

This paper discusses whether Peer-to-Peer Online Lending will influence the effect of monetary policy by assessing the causal interaction. Due to the parameter instability is not considered, the results of the whole sample causality test indicate that no obvious correlation has been found is not credible. Thus, to solve this problem, this paper applies the bootstrap sub-sample rolling-window causality test. The major conclusion is that Peer-to-Peer Online Lending affects the efficiency of monetary policy. In some periods, M2 has been positively affected by Peer-to-Peer Online Lending, which indicates that online lending can promote the effectiveness of monetary policy to a certain extent. At other periods, this view is untenable, mainly because credit risk and other macro-prudential measures reduce M2. Thus, Peer-to-Peer Online Lending cannot always influence the efficiency of monetary policy because of the change of share in the market. In turn, the decrease in M2 has led to a decrease in Peer-to-Peer Online Lending, which indicates that investors should pay close attention to changes in the money market in order to avoid unnecessary losses. Through the interaction between Peer-to-Peer Online Lending and M2, we can draw the conclusion that online lending does not always have an influence on the monetary policy, because the scale of online lending is unstable due to risk and security issues, which leads to changes in influence.

The relationship between Peer-to-Peer Online Lending and M2 can provide reference for investors and government. On the one hand, Peer-to-Peer Online Lending has certain influence on M2, the government can accurately grasp the effect of the Internet financial market on the money supply, and take measures to guide the market and prevent the collapse, according to the changes in Peer-to-Peer Online Lending. The government should also take notice of the credit reporting problem caused by Peer-to-Peer Online Lending which will affect the bank credit. Prevent vicious competition between Peer-to-Peer Online Lending and traditional commercial banks, which will affect the efficiency of monetary policy implementation. In addition, Peer-to-Peer Online Lending will increase the money supply in the financial system because of the change in money supply channels. Investors can reduce losses caused by changes in economic situation by investing in Peer-to-Peer Online Lending. When the economy downturn, increasing investment in internet financial businesses such as Peer-to-Peer Online Lending can increase M2 in the financial system, which eases the tight monetary policy. As the economy is booming, reduce investment in Peer-to-Peer Online Lending to avoid the inflation caused by the rapid growth of money supply. On the other hand, the decline of M2 may cause the decrease of Peer-to-Peer Online Lending. This indicates that investors can grasp the trend of Peer-to-Peer Online Lending more accurately according to the change of M2 and reduce the financing cost reasonably. Furthermore, the government should strictly supervise the fluctuation of Peer-to-Peer Online Lending through the change of M2 to reduce the financial risk, which prevents a negative impact of Internet finance on the efficiency of monetary policy.

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