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Monetary policy shocks and peer-to-peer lending in China

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Abstract

This paper studies monetary policy transmission in China's peer-to-peer lending market. Using spectral measures of causality, we explore the impacts of Chinese monetary policy shocks on China's P2P market interest rates and lending amounts. The estimation results indicate significant spectral Granger causality from monetary policy surprises to P2P lending rates for borrowers, but not the reverse. Unlike the lending channel for traditional banks, monetary policy shocks do not Granger-cause the credit amount in the P2P lending market.

JEL Codes: E52, E43, G23, C22
Keywords: non-bank financial institutions, peer-to-peer lending, financial intermediation, granger causality, spectral analysis, China

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1 Introduction

Digital innovation and technological advancement have reshaped the financial system and the global economy. While consumers undoubtedly benefit from convenience and speed, financial technology, or Fintech, challenges central banks in their pursuit of monetary mandates. In particular, challenges arise from the fragmenting roles of traditional banking and Fintech intermediaries, loose regulation in the Fintech arena, shifts in capital allocation, non-traditional information about credit conditions, and novel payment and lending systems.

Fintech business models include peer-to-peer (P2P) lending platforms that allow individual investors and borrowers to circumvent traditional banks. P2P lending can be considered a form of shadow banking, because, unlike traditional banking, it is not subject to capital requirements or secured investment.[1] P2P lending has grown over the past decade to become a significant player in the credit market and is now the leading alternative finance format globally.[2]

China appears to have taken the P2P concept furthest. Because it strives to be a market leader in digital technologies, China intentionally refrained from government involvement in the P2P market early on to allow for rapid platform growth (Nemoto et al., 2019). As China's less-developed financial sector lacks legacy systems as in advanced economies, it is particularly amenable to innovation and stage-skipping (Goldstein et al., 2019). Finally, there is the sheer size of the Chinese market. China has the scale to drive rapid commercialization of digital business models, and capitalizes on the very large home market of consumers who are young and eager to embrace digital in all its forms. This enables digital players to achieve economies of scale quicker than anywhere else. According to the Cambridge Center for Alternative Finance, China accounted for over 85% of the global alternative finance market and over 90% of the global P2P lending market in 2017.

In the following exploration of the nexus of Fintech and Chinese monetary policy, we consider the efficiency of the interest channel by investigating the impacts of monetary policy on P2P lending. Using Chinese data, we evaluate how monetary policy shocks affect interest rates and lending amounts in the P2P credit market. While the influence of Fintech on monetary policy transmis-

[1] Regulatory arbitrage has long been considered a main growth driver for P2P lending and shadow banking. See e.g. for example, Hanson et al. (2011) and Plantin (2014).

[2] According to the Cambridge Center for Alternative Finance (https://www.jbs.cam.ac.uk/faculty-research/centres/alternative-finance/), the market share of P2P lending in the alternative finance market in 2017 was 40% in Americas, 57% in Europe, 60% in Asian Pacific (excluding China), and 90% in China. The diverse alternative finance market includes P2P consumer lending, P2P business lending, P2P property lending, invoice trading, real estate crowdfunding, equity-based crowdfunding, reward-based crowdfunding, balance sheet business lending, debt-based securities, donation-based crowdfunding, minibonds, profit sharing, balance sheet consumer lending, and others. The aforementioned P2P market share includes P2P consumer, business, and property lending.

sion efficiency is acknowleged in both policymaking and academic discussions (Smet, 2016; Philippon, 2016), little research formally addresses this issue. One body of studies considers the effectiveness of various channels of monetary policy transmission, including China's (e.g. He et al., 2013; Fungáčová et al., 2016; Chen et al., 2017; Wang et al., 2017) without taking on P2P specifically. A separate group of studies tackle Chinese P2P lending, but limit the discussion to determinants of successful individual loan listing (e.g. Ding et al., 2019) or default risk analysis (e.g. Lin et al., 2017). Huang et al. (2019), one of a handful of studies that consider the interaction between monetary policy and P2P lending, uses Chinese P2P lending data to study the risk-taking channel of monetary policy. To our best knowledge, we are the first to investigate effects of the interest rate and lending channel of monetary policy on the P2P lending market.

Monetary policy interacts with the P2P lending market in several ways. First, like traditional financial institutions, P2P platforms provide maturity transformation and credit transformation services. As shown in Section 2, Chinese P2P platforms not only provide information intermediation, they also play a big role of credit intermediation. Indeed, the conventional interest rate channel not only works in the P2P lending market, it may work even better than in the case of traditional banks. Traditional financial institutions may seek to dampen the effect of interest rate changes on lending to maintain long-term customer relationships. P2P lending platforms, in contrast, have little incentive to insulate borrowers from monetary policy shocks. With respect to the lending channel, highly leveraged P2P lending platforms could actually strengthen the efficiency of monetary policy transmission.

Second, the relationship between P2P lending and traditional bank lending may impact monetary policy. While there is no consensus about market segmentation of P2P and bank lending, Tang (2019), using US P2P data, shows that P2P lending is a substitute for bank lending in terms of serving infra-marginal bank borrowers and a complement to bank lending with respect to small loans. While Buchak et al. (2018) find that differences in interest rates between traditional and shadow banks are negligible, they show that Fintech lenders in the mortgage market are less willing to lend to borrowers with poor credit scores or those living in regions with high unemployment. In arguing that the credit expansion from P2P lending has been driven by borrowers who already have access to bank credit, they imply P2P lending likely strengthens monetary policy transmission. Jagtiani and Lemieux (2018), however, contradict this assessment, noting that Fintech lenders thrive in areas underserved by traditional banks such as the highly concentrated markets and places with fewer bank branches per capita. Hau et al. (2019) also point out that Chinese Fintech credit benefits borrowers with low credit scores (i.e. those excluded from access to traditional bank credit). Thus, monetary policy transmission efficiency can be ambiguous in a complete substitution conjecture.

The P2P lending market may change the borrower composition at banks as monetary policy changes, and the expansion in the extensive margin can enlarge the scope of policy transmission.

Third, the differences in regulation policy on P2P can alternate the efficiency of monetary policy transmission. As a substantial player in the shadow banking system, the P2P lending market faces much less regulation than the traditional banking sector. It is not subject to capital adequacy ratios and imposes challenges to existing regulation policies (Philippon, 2016). As loose regulation in combination with the increased systemic importance of these financial innovative market agencies is likely to weaken monetary policy outcomes, the People's Bank of China (PBoC) has publicly addressed the danger of a decline in the effectiveness of monetary policy due to a weakly regulated P2P market.[3] Conversely, the analysis in Martinez-Miera and Repullo (2018) shows that monetary tightening may be useful in preventing expansion and reducing the risk of shadow banks, whose funding costs are directly related to the monetary policy stance.

We use Granger causality tests in the frequency domain to study the extent to which monetary policy shocks impact interest rates and credit amounts in China's P2P lending market. Our results suggest that monetary policy transmits well to the P2P lending market in terms of the interest rate channel, but its aggregate credit amount is not Granger-caused by monetary policy shocks. We also confirm interest rate and credit amount transmission in the traditional banking sector, as well as the mutual Granger-causal relationship between monetary policy and the bank lending rate.

The paper is organized as follows. Section 2 defines the data set and provides a brief summary of P2P lending in China. Section 3 presents the empirical analysis. Section 4 concludes with suggestions on topics for further research.

2 Data and variables

2.1 P2P lending in China

The data here are taken from various sources. We obtain the P2P lending rate (P2PR) from P2P001, a website that tracks internet lending in China. The outstanding amount and net inflow of P2P loans, as well as the number of lenders and borrowers per month are taken from WDZJ (*Wang Dai Zhi Jia*). To compare the impact on P2P lending with traditional bank lending and private lending, we use the PBoC's bank lending rate (BLR) and the Wenzhou private lending rate (WZR) of the Wenzhou Municipal Government Finance Office.[4] The lending rate is calculated using a weight scheme

[3] See http://www.chinabankingnews.com/2018/11/19/fintech-weaken-monetary-policy-outcomes-chinese-central-bank/.

[4] The Wenzhou private lending rate (sometimes denoted as the Wenzhou index of private lending interest rate or 温州民间融资综合利率指数) is the weighted average private lending interest rate in Wenzhou. Although the data are sourced from a specific region, it is representative of overall private lending conditions in China because of its huge

based on Delphi method. It applies data collected from both lenders and borrowers at about 400 monitoring sites. The size of each daily sample averages 300 observations (1,500 per week).[5]

Here we use the quarterly data, taking the quarterly average of P2P lending rate, the Wenzhou private lending rate, the number of P2P lenders per month, and the number of P2P borrowers per month. The outstanding amount of P2P loans is the quarter-end value, and the net inflow of P2P loans is the sum of monthly values over the quarter. Interest rates are available from 2013Q2 to 2019Q2, and the credit amount and number of participants spans the period 2014Q1 to 2019Q2.

We first provide a bird's eye view of the Chinese P2P finance sector and its rapidly shifting contours, especially in its relationship with the existing financial intermediary sector.[6] China has the largest P2P market in the world. As of 2017, the global volume of unsecured P2P lending included $327.8 billion in China, $17.6 billion in the Americas, and $2.18 billion in Europe.[7] In the domestic Chinese credit market, P2P was becoming a strong competitor to banks. While the ratio of outstanding P2P loans to bank loans was small, new loan issued in the P2P market accounted for 40% of new lending in 2016, before falling back to less than 10% in 2018.

A detailed description of the dynamics of the Chinese P2P credit market is available in Figure 1. The time series of the P2P lending rate, Wenzhou private lending rate, and the lending rate of commercial banks appears in the upper-left dual-scale graph.[8] The level of P2P lending rate drops from over 20% in 2013 to around 9% in 2019. The P2P lending rate falls after 2013, hitting a trough in 2017. As information asymmetry decreases and competition intensifies amid shifting regulatory policies, interest rates embark on a downward track and risk premiums of P2P lending projects drop. On the supply side, investors seem lured to P2Ps by their relative high yields.[9]

volume and the highly active business environment of the region. Private lending is lending made outside the banking sector. Such lenders include micro-credit companies, private capital management companies, enterprises, designated monitoring stations pawnshops, and credit guarantee companies. Wenzhou is a entrepreneurial hub and famous for private lending. China's State Council Standing Committee established the Wenzhou Financial Comprehensive Reform Experimental Zone in March 2012 in order to guide the development of private financing and gain experience applicable to a national financial reform. The Wenzhou Municipal Government Finance Office first published the Wenzhou private lending rate in December 2012 as a means for tracking private lending.

[5] For more, see the official website of the Wenzhou index: http://www.wzpfi.gov.cn/About.aspx.

[6] Recently, a growing body of research discusses the growth of Fintech credit and its drivers, such as income per capita, regulatory stringency and competition in the banking sector. See, for example, Claessens et al. (2018) and Committee on the Global Financial System and Financial Stability Board (2017). For an overview of the Chinese P2P market, see Deer et al. (2015) and Claessens et al. (2018).

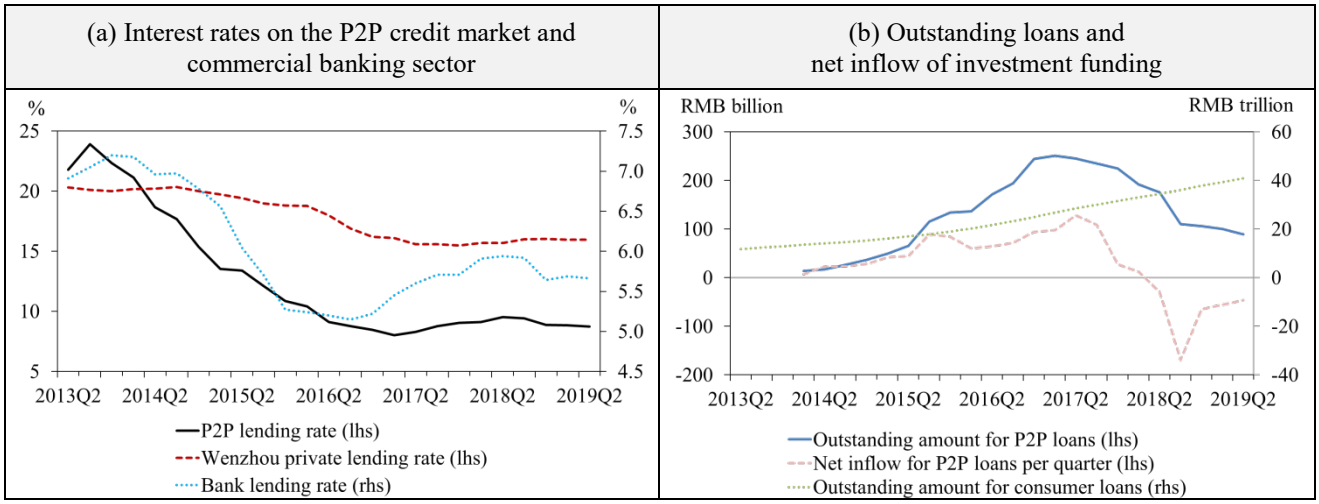
[7] See https://www.jbs.cam.ac.uk/faculty-research/centres/alternative-finance/.

[8] The bank lending rate is the quarterly weighted average interest rates on loans to non-financial enterprises and other sectors made by commercial banks. The PBoC does not publish time series for loans to enterprises with different legal structures. No interest rates are reported for private firms.

[9] In 2004, China started to relax its interest rate control policies by allowing commercial banks to set their lending rates at a discount of 10% of the official base rate issued by the PBoC. This reform process culminated in a complete abolition of the lending rate floor in July 2013. A similar reform pattern occurred with regard to the deposit rate. In October 2015, the caps on deposit rates were entirely removed. It should be noted, however, that the formal removal of limits on the interest rates does not necessarily mean their effective liberalization. In practice, the PBoC continues to influence the

Our side-by-side chart also shows the commercial bank lending rate. The P2P lending rate is significantly higher than the bank lending rate, due to typically lower borrower credit ratings and less effective credit enhancement tools.[10] Despite the significant level differences, both interest rates show a common downward trend, albeit with minor differences. In particular, after the liquidity in the interbank market dries up during 2013Q2–2014Q1,[11] both the P2P lending rate and the bank lending rate decline significantly as eased monetary conditions prevail until early 2016 (Funke and Tsang, 2019). The subsequent transition to a balanced monetary policy stance causes a renewed rise in interest rates on bank loans.

Figure 1 Development of the Chinese P2P market

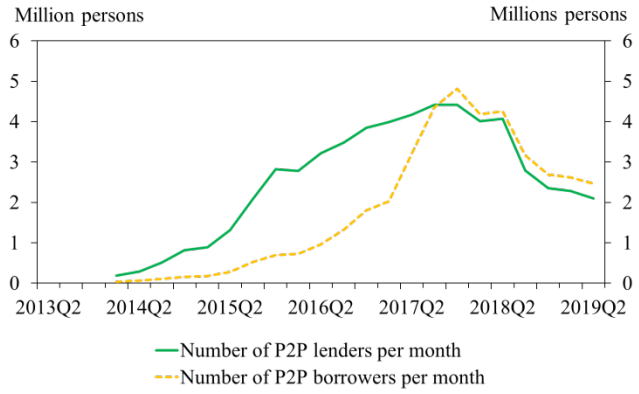


setting of interest rates through informal measures. Thus, deposit rates of commercial banks set have yet to diverge much from official benchmark rates.

[10] Even with the greatest due care, the two average interest rate time series can be affected by slight differences in maturity. The average P2P loan maturity increased from under 4 months to around 10 months from 2013 to 2019. The implied maturity of the average commercial bank loans can only be roughly estimated. The comparison with the interest rate for one-year loans provides an indication. The average lending rate in Figure 1a is always slightly higher than the one-year lending rate. The implied average maturity is therefore slightly greater than one year.

[11] According to the PBoC's Monetary Policy Report for 2013Q2, the funding cost of the commercial banks surged at the end of 2013Q2 as the liquidity in the interbank market dried up. This led to rises in bank lending rates and P2P lending rates. As liquidity conditions eased towards the end of 2013, the P2P lending rate went into decline starting in 2013Q4. However, the bank lending rate remained above 7% until liquidity conditions eased significantly in 2014Q2.

(c) Number of lenders and borrowers



Notes: The series of P2P lending rate and the Wenzhou private lending rate are the quarterly average of the daily data from the P2P001 website and Wenzhou Municipal Government Finance Office, respectively. Only business days are included. The bank lending rate is the quarterly weighted average interest rate on loans to non-financial enterprises and other sectors made by commercial banks as published by the PBoC in its quarterly monetary policy report. The outstanding amount for P2P loans and consumer loans are figures for the end of the quarter. The net inflow for P2P loans is the sum of the monthly figures over the quarter. The number of P2P lenders per month, the number of P2P borrowers per month, and the average per capita lending and borrowing amounts for P2P loans are constructed from the average of the monthly data over the quarter.

Sources: P2P001, WDZJ, the Wenzhou Municipal Government Finance Office and PBoC. The P2P data have been extracted from the WIND and CEIC databases.

Panels (b) and 9c) in Figure 1 describe the P2P market using various supply and demand indicators. Taken together, they show that push and pull factors are clearly in place to catalyze the establishment of the P2P market.

The upper right and the lower chart show a hump-shaped development resulting from the interaction of three factors, despite the consumer loans continued to increase. First, widespread adoption of mobile and internet payment arrangements lay the technological ground to access to rich quantities of financial information commercial banks still cannot reach. In other words, the availability of digital footprints enables the platforms to evaluate the riskiness of borrowers and reach a large number of customers.

Second, China's system of controlled interest rates and its repressed commercial banking sector provides cheap lending to limited borrowers, usually state-owned enterprises or individual borrowers with high-quality assets, while leaving a sizable portion of credit demand underserved by the formal credit sector.[12] As a result, the private lending market, represented by the Wenzhou lending market, is very active and charges much higher interest rates than commercial banks. Shortly

[12] The Chinese banking sector remains predominantly state owned, and bank credit is frequently directed to state-favored companies and projects. Using firm-level data, Guariglia et al. (2011) find evidence of discrimination in access to credit for private-sector firms. Poncet et al. (2010) document that private firms (POEs) face severe financial constraints, while state-owned enterprises (SOEs) tend to be unconstrained. Further evidence showing large-scale inefficiencies and misallocations arising from policy distortions favoring SOEs is provided by e.g. Brandt et al. (2012) and Song et al. (2011). In recent years, Berkowitz et al. (2017) show that the cost of capital for SOEs fall more than that of private firms after reforms, while Liu et al. (2018) find that the implementation of the economic stimulus package from

after their appearance in the credit market, P2P platforms quickly became a strong competitor or substitute for other private lending sources, precisely because they responded to the underserved credit demand.[13]

Third, the blossoming of China's P2P industry was followed by a severe crackdown. From 2007 to 2016, authorities largely maintained a hands-off approach to regulation and supervision of the nascent industry, allowing it to grow by leaps and bounds. A market shake-out began in 2016 following a wave of platform failures and large-scale frauds. Authorities could no longer ignore the downsides and risks of this financial innovation. The wake-up call came with the collapse of the multibillion-dollar "Ezubao" Ponzi scheme in December 2015 and the widespread protests it sparked. In August 2016, The China Banking Regulatory Commission (CBRC) published "Interim Rules for the Administration of the Business Activities of Internet-Based Lending Information Intermediary Institutions,"[14] a document that defined P2P lending platforms were information intermediaries. It further set forth specified activities P2P lending platforms could not engage in, including absorbing public savings, establishing capital pools, providing guarantees and commitments for guaranteed principal and interest, selling financial products, and carrying out credit assignment in such forms as asset securitization. Furthermore, commercial banks were allowed to buy loans underwritten by P2P platforms as such assets were deemed to carry excessive risk. The departure from the minimal laissez-faire regulatory environment and investor jitters precipitated a noticeable decline of the number of P2P platforms. During 2016, P2P platform defaults averaged nearly 200 a month.

Chinese P2P lending has its own unique characteristics. Investors in the Chinese P2P market consist primarily of individual investors, while the institutional investors make up the lion's share in other countries. The available data show that the volume-weighted average institutional funding in the Chinese P2P consumer lending market was around 10% in 2013–2015, well below the US figures of 53% in 2015 and 97% in 2017.[15] Moreover, Chinese P2P plays a larger role in credit intermediation than information intermediation. Most Chinese P2P platforms package loan listings, allowing individual lenders to choose products with certain maturities and investment returns without knowing the specific loan listings or specifying the target borrower pools. Thus, P2P

2009 to 2013 also favored state-owned enterprises (SOEs), which received more bank loans and invested more than non-SOEs. All these studies point to the salient feature of an ownership-dependent pecking order in China.

[13] In additional to horizontal expansion, the P2P industry witnessed an expansion in the depth of the product value chain, with differentiated product solutions created by optimizing maturity flexibility and collateral transactions. These innovations allow P2P platforms to better accommodate borrower and lender needs for funding matchmaking.

[14] See http://en.pkulaw.cn/display.aspx?cgid=278756&lib=law.

[15] See https://www.jbs.cam.ac.uk/faculty-research/centres/alternative-finance/.

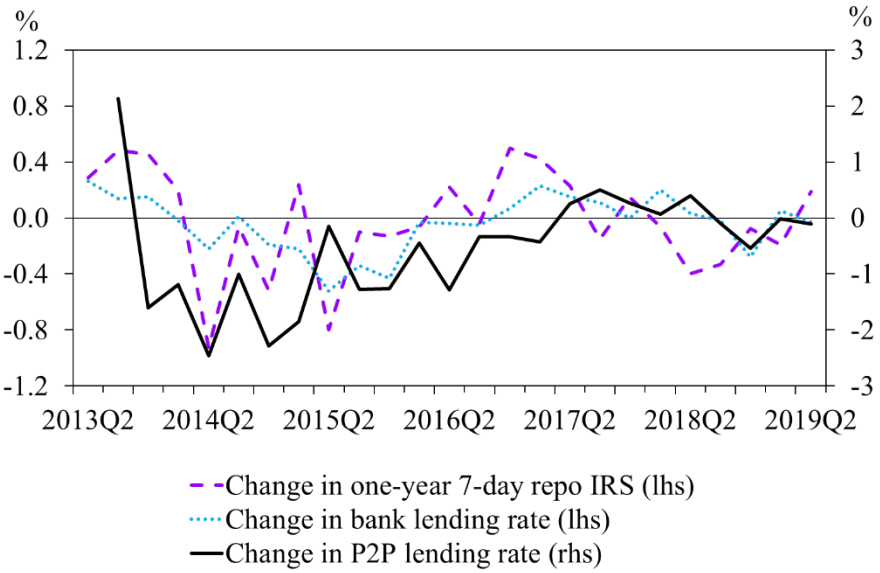
platforms in China play the role of "quasi-bank" financial intermediaries rather than merely information intermediaries.

2.2 Monetary policy surprises in China

Identification of monetary policy shocks is a necessary start to examining the Chinese monetary policy transmission process and its effectiveness. Moreover, proper measurement of monetary policy shocks requires removing the forecastable component of interest-rate changes, because a failure to do so would lead to monetary policy shocks that erroneously categorize forecastable variations as "shocks." In the following analyses, we follow the methodology of Kamber and Mohanty (2018), who measure the impact of a monetary policy surprise by the change in the closing price of the one-year 7-day repo interest rate swap (IRS) rate. The 7-day reverse repurchase (7-day repo) rate captures the Chinese short-term interbank interest rate. The authors argue that the 7-day repo rate is a reliable and informative indicator of the PBoC monetary policy stance because of its importance in determining market liquidity as a cost of capital for financial institutions. This is supported by the rise in daily open market operations to stabilize the volatility of the 7-day repo rate. Accordingly, a monetary policy surprise is measured by the change of the quarterly average of the one-year 7-day repo IRS. The data are downloaded from Bloomberg.

Figure 2 provides our first graphical impression of the data. We can see that the monetary policy was still easing from 2013Q2 to 2015Q2, and then gradually tightens until 2016Q4, after which the monetary stance trends back to neutral. The correlations between the change in the commercial bank lending rate and the monetary policy shocks at the first four lags were 0.35, 0.45, 0.17, and 0.39 respectively. The corresponding correlations for the more volatile P2P lending rate were 0.12, 0.17, 0.05, and 0.01, respectively.

Figure 2 Monetary policy shocks and interest rates on different credit markets



Notes: The monetary policy shock is proxied by the change in one-year 7-day repo IRS. The IRS series and the P2P lending rate are the quarterly average of the daily data (business days only) from Bloomberg and from P2P001, respectively. The commercial bank lending rate is the quarterly weighted average interest rate on loans to non-financial enterprises and other sectors made by commercial banks as published in the PBoC's quarterly monetary policy report.

Sources: PBoC, P2P001 and Bloomberg.

The graphical presentation of important developments and trends leaves the question unanswered as to the extent to which monetary policy shocks have a causal impact on P2P market interest rates and yields. We now examine this question.

3 Empirical methodology and estimation results

3.1 Empirical methodology

Formalizing and testing causality is a fundamental problem with philosphical overtones. A statistical answer that relies on passing from causality to predictability was provided by Clive Granger. The concept of Granger (1969, 1980) causality in the time domain provides a data-driven approach for studying causal interactions from time series. Based on this, Granger causality tests in the frequency domain have developed to allow analysis at which frequencies most interactions take place.[16]

The fundamental concepts of unconditional and conditional Granger causality in the frequency domain were introduced in Granger (1969) and Geweke (1982, 1984), and further extended

[16] Applications of the spectral causality test in the literature that deserve special mention include Croux and Reusens (2003), Gerlach and Assenmacher-Wesche (2007), Gradojevic (2015), and Milas and Panagiotidis (2015).

in Hosoya (1991, 2001). The advantage of frequency-domain Granger causality lies in the disentanglement of the causality structure across a range of frequencies. The teased-out finding often yield original and complementary insights to traditional time-domain versions of Granger causality.

Briefly restating the bases of Granger-causality spectral theory and following Breitung and Candelon (2006), we let $Y_t = (x_t, y_t)'$ be a bivariate stationary (after possible transformations) vector time series that can be represented by the VAR(p) process

$$\Theta(L)Y_t = \varepsilon_t, \tag{1}$$

where $\Theta(L) = I - \Theta_1 L - \Theta_2 L^2 - \cdots - \Theta_p L^p$ is a (2×2) lag polynomial, L is the backshift operator, I is an identity matrix, and $\varepsilon_t = (\varepsilon_1, \varepsilon_2)'$ denotes a vector white-noise process with $E(\varepsilon_t) = 0$ and positive-definite covariance matrix Σ. Applying the Cholesky factorization $G'G = \Sigma^{-1}$ where G is a lower-triangular matrix yields the VMA representation of the VAR as

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \Psi(L)\eta_t = \begin{bmatrix} \Psi_{11} & \Psi_{12} \\ \Psi_{21} & \Psi_{22} \end{bmatrix} \begin{bmatrix} \eta_{1t} \\ \eta_{2t} \end{bmatrix}, \tag{2}$$

where $\eta_t = G\varepsilon_t$ and $\Psi(L) = \Theta(L)^{-1}G^{-1}$. Equation (2) can be mapped to the frequency domain by Fourier transformation. The spectral density of x_t at frequency ω is given by

$$f_x(\omega) = \frac{1}{2\pi}\left\{\left|\Psi_{11}\left(e^{-i\omega}\right)\right|^2 + \left|\Psi_{12}\left(e^{-i\omega}\right)\right|^2\right\} \tag{3}$$

Equation (3) separates the contributions of x (i.e. Ψ_{11}) and y (i.e. Ψ_{12}) to the spectrum of x and therefore allows us to test for Granger causality at any frequency ω. The Geweke (1982) measure of feedback from y_t to x_t at frequency ω is defined as

$$M_{y\to x}(\omega) = \log\left\{\frac{2\pi f_x(\omega)}{\left|\Psi_{11}(e^{-i\omega})\right|^2}\right\} = \log\left\{1 + \frac{\left|\Psi_{12}(e^{-i\omega})\right|^2}{\left|\Psi_{11}(e^{-i\omega})\right|^2}\right\}. \tag{4}$$

From equation (4) it follows that $M_{y\to x}(\omega) = 0$ if $\left|\Psi_{12}\left(e^{-i\omega}\right)\right| = 0$ applies.[17] Subject to this condition, y_t does not Granger-cause x_t at frequency ω.[18]

[17] $M_{y\to x}(\omega)$ is a logarithmic measure which describes the strength of the Granger causality of y on x at a given frequency ω. Accordingly, the higher the value of $M_{y\to x}(\omega)$, the stronger the causality from y to x. If $M_{y\to x}(\omega) = 0$, y does not Granger-cause x at the frequency ω. The Geweke (1982) spectral Granger-causality statistic fulfills two desirable requirements. (i) The measure is non-negative, and (ii) the sum over all frequencies of the spectral Granger-causality components corresponds to the time-domain Granger-causality statistic.

[18] We keep our exposition brief, but the original papers provide valuable details. See Hamilton (1994, pp. 270-275) for basic definitions of spectral analysis.

In Breitung and Candelon (2006), a simple parametric approach testing the null hypothesis $M_{y\to x}(\omega) = 0$ is proposed. They show that when $\left|\Psi_{12}\left(e^{-i\omega}\right)\right| = 0$, we also have $M_{y\to x}(\omega) = 0$. The main contribution of Breitung and Candelon (2006) is their proof that this restriction is equivalent to imposing a set of linear restrictions on the autoregressive parameters in the original VAR(p) model. As a corollary, a straightforward Wald test distributed χ_2^2 can be employed. The practical test procedure of Breitung and Candelon avoids the need to resort either to a parametric bootstrap as suggested by Geweke (1982), or to computationally demanding numerical derivatives as suggested by Yao and Hosoya (2000).[19]

It is well-known that Granger causality tests may produce misleading results when the true causal relationship involves more variables than those that have been selected and so the accuracy of its causal interpretation relies on a suitable preliminary variable selection procedure. For this reason, it is relevant that the spectral procedure permits the inclusion of further conditional variables controlling for further structural drivers of the P2P market. In other words, the conditional variables in the biavariate framework elegantly bypass the omitted variable problem. Formally speaking this means that in case of an additional conditional variable z_t, the null hypothesis $M_{y\to x|z}(\omega) = 0$ is checked instead of the null hypothesis $M_{y\to x}(\omega) = 0$.

In a nutshell, the approach permits us to answer our guiding question: If Chinese monetary policy operates via surprises in the one-year 7-day repo IRS, how does this affect China's P2P loan pricing and yields?

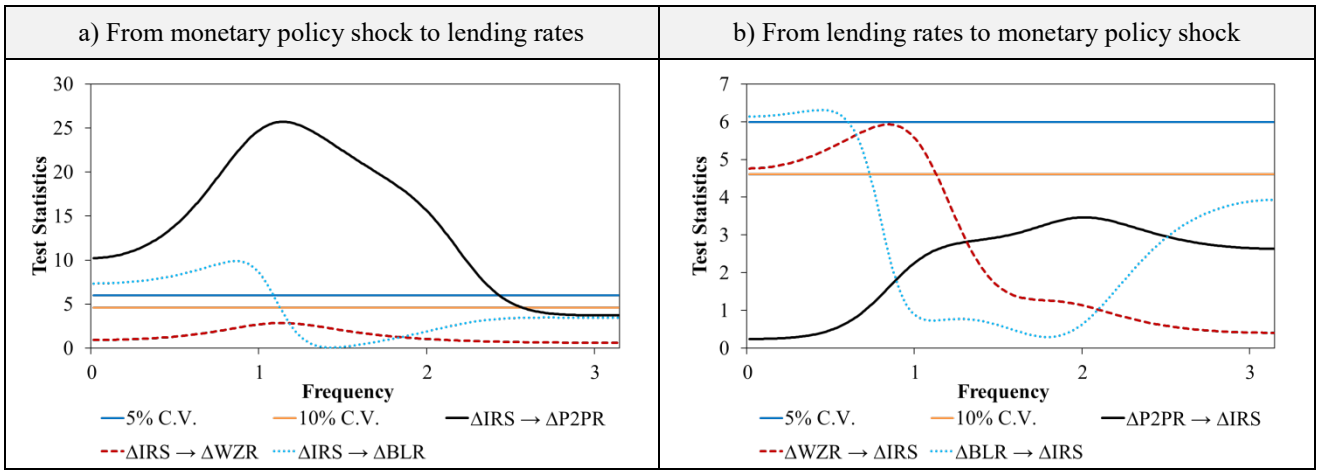
3.2 Estimation results

We exploit the frequency-domain tool described above for studying the mutual relationship between monetary policy shocks and P2P lending in China. Specifically, we investigate whether monetary policy shocks Granger causes the price and quantity in the P2P market, captured by the variables of interest rates, outstanding loan amount in the P2P lending market, and vice versa. To analyze the impact on quantity, we also use net inflow and the number of borrowers and lenders in addition to the loan amount. In Figures 3 to 5, we show the results of Breitung and Candelon's (2006) version of the Geweke (1982, 1094) causality tests over frequencies from 0 to π together with the 5% and 10% critical values of the null hypothesis of no Granger causality, i.e. $M_{y\to x|z}(\omega) = 0$. If the Wald statistics are above the critical values, then the results indicate that the *y* variable Granger causes the *x* variable. The VAR order has been determined using the AIC, SBC and HQ information criteria and autocorrelation tests. The number of lag is 4. Prior to the causality tests, we tested for stationarity

[19] Provided that a lag-length selection is reasonable, the test is found to have good power and size properties. See e.g. Yamada and Yanfeng (2014).

in the variables. The results of commonly used unit root tests are not reported but available on request.[20]

Figure 3 Quarterly frequency domain Granger causality tests for various lending rates



Notes: The underlying null hypothesis is $M_{y \to x|z}(\omega) = 0$. ΔP2PR is the change in P2P lending rate, ΔWZR is the change in the Wenzhou private lending rate, ΔBLR is the change in the bank lending rate, and ΔIRS is the monetary policy shock proxied by the change in the one-year 7-day repo IRS. The sample period is 2013Q3–2019Q2. The conditional z-variables are (i) the ratio of problematic and closed platforms, (ii) the quarterly growth of real GDP, and (iii) the quarterly growth of bank loans. The AIC and other information criteria are employed to determine the lag length. The resulting number of lags is 4.

Sources: P2P001, Wenzhou Municipal Government Finance Office, PBoC, National Bureau of Statistics, P2PEye, and Bloomberg. The P2P data are extracted from the WIND and CEIC databases.

Figure 3 reports the Granger Causality tests between monetary policy and P2P lending rate for borrowers. To compare the P2P lending with traditional bank lending and private lending, we also show the results between monetary policy and bank lending rate, as well as the monetary policy and Wenzhou private lending rate. The main findings are threefold. First, a monetary policy shock Granger-causes the P2P lending and borrowing rate, but not the other way around. At the 5% significance level, the null hypothesis of no Granger causality from monetary policy shocks to P2P lending rate (ΔP2PR) is rejected for low-frequency components in the range $\omega \in (0, 2.42)$, which corresponds to wavelengths of more than 2.60 quarters.[21] Meanwhile, as shown in Figure 3(b), the Wald statistics for the P2P lending rate are smaller than the critical value at the 10% significance level throughout the entire range, indicating that we cannot reject the null hypothesis that P2P lending rate did not Granger-cause the monetary policy shock. Second, there exists a mutual Granger causal relationship between the monetary policy rate and the traditional bank lending rate. Figure 3(a) shows that a monetary policy shock Granger-causes the bank lending rate (ΔBLR) in the range $\omega \in$

[20] We also calculate frequency-domain causality tests using the method suggested by Hosoya (2001) for controlling the effects of third variables. Since the results are quite similar to those of the Geweke (1984), we do not report them here to save space. The calculations are available on request.

[21] The calculation of the wavelength is approximatly $2\pi/\omega$.

$(0, 1.08)$, which corresponds to a wavelength of 5.82 quarters, i.e. longer than that of the P2P lending rate. Moreover, as shown in Figure 3(b), the bank lending rate also Granger-causes a monetary policy shock at the 5% significance level in the smaller range of $\omega \in (0, 0.60)$. Third, the causal relationship between the monetary policy rate and the Wenzhou private lending rate (ΔWZR) is insignificant or weak. The Wald statistics of the private lending rate are both below the critical value of 5% significance level, indicating that the null hypothesis of no Granger causality cannot be rejected in both directions.

Comparing the impact on P2P lending rate and bank lending rate, the results show that monetary policy plays a causal role for the bank lending rate at a lower frequency than that for P2P lending rate. In other words, P2P lending rates respond more quickly to monetary policy shocks than the bank lending rate. This relates to two factors. First, the pricing in the P2P industry is based on innovative technology and big data, and the algorithm-based interest rate can adjust to policy changes at a faster speed. Meanwhile, the traditional bank lending still requires human interaction and the relationship lending limits large changes in interest rates. Second, the interest rate liberalization is still ongoing in the banking sector, though the upper and lower limit on interest rates have been officially removed, and the less regulated P2P lending can act in a more market-based way.

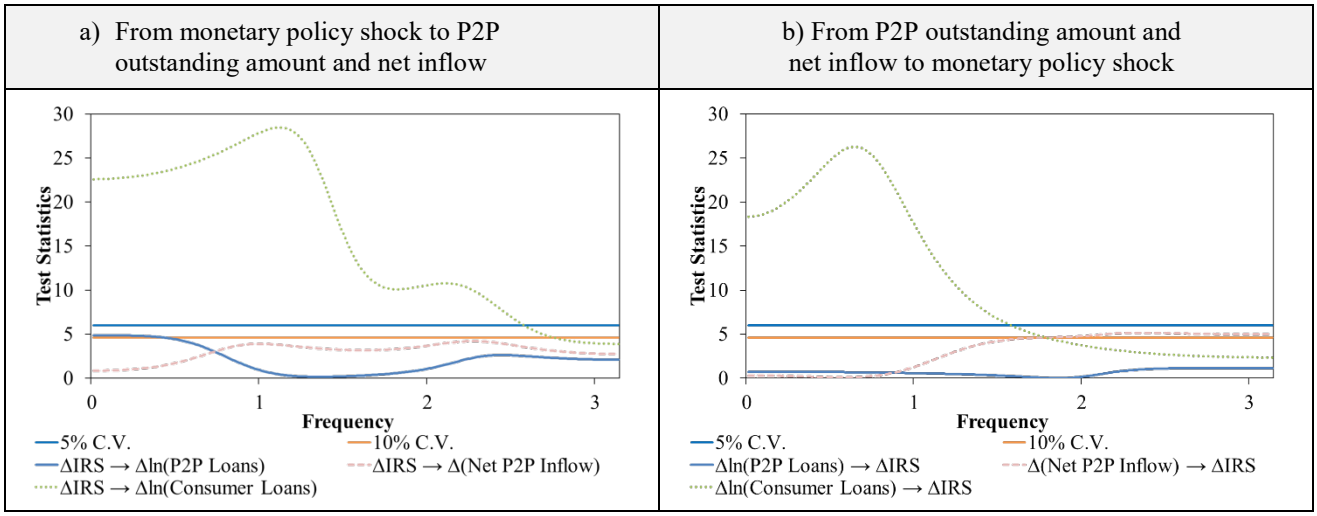
The monetary policy shock does not Granger cause the change of private lending rates because the private lending market is substituted by the P2P lending market. As shown in Panel (a) of Figure, the P2P lending rate lie between the bank lending rate and Wenzhou private lending rate. P2P lending market is able to serve the potential borrowers in the bank sector which are underserved due to the lack of trustworthy credit information. And the pricing efficiency enables the P2P lending market to take over the private lending market by charging lower interest rates. With the development of the P2P market, the private lending market shrank and showed a loose relationship with monetary policy.

Next, we investigate whether the monetary policy transmission in the P2P lending market works in quantity as well as price (i.e. interest rates). Figure 4 presents the results when the outstanding loan amount and net inflow of the P2P market are the variables of interest. The Wald statistics are all below the critical value at 5% significance level, which suggests that monetary policy neither Granger-causes the aggregate loan demand and funding supply in P2P market, nor does it Granger-cause the monetary policy shock. Similar to the bank lending rate, a mutual Granger-causal relationship between monetary policy and the quantity of the consumer loans from the traditional banking sector also exists. Monetary policy Granger-causes consumer loan demand from the banking sector in the range $\omega \in (0, 2.57)$ at the 5% significance level, which corresponds to a wavelength of 2.44 quarters, while the Wald statistics of consumer loan demand shows it

Granger-causes the monetary policy rate in the range $\omega \in (0, 1.57)$, which corresponds to a wavelength of 4.0 quarters. When we use the number of lenders and borrowers to proxy the supply and demand as shown in Figure 5, the finding of insignificant monetary policy transmission in the P2P market in terms of quantity does not change.

The finding that monetary policy shocks do not transmit to the quantity of both credit supply and demand in the P2P market can be explained by borrower differences. Despite the lack of any direct evidence on the credit quality of participants in the P2P market and banking sector, there is a general consensus among borrowers that P2P platforms are riskier and P2P lenders are less risk-averse. When monetary policy eases, the P2P lending platforms may manage the risk arising from lending to low-credit-score borrowers in a low-interest-rate environment by cutting back on lending amounts. Risk Lender risk aversion is also likely to kick in during harsh economic conditions, which also would make net inflow and number of lenders less responsive to monetary policy shocks.

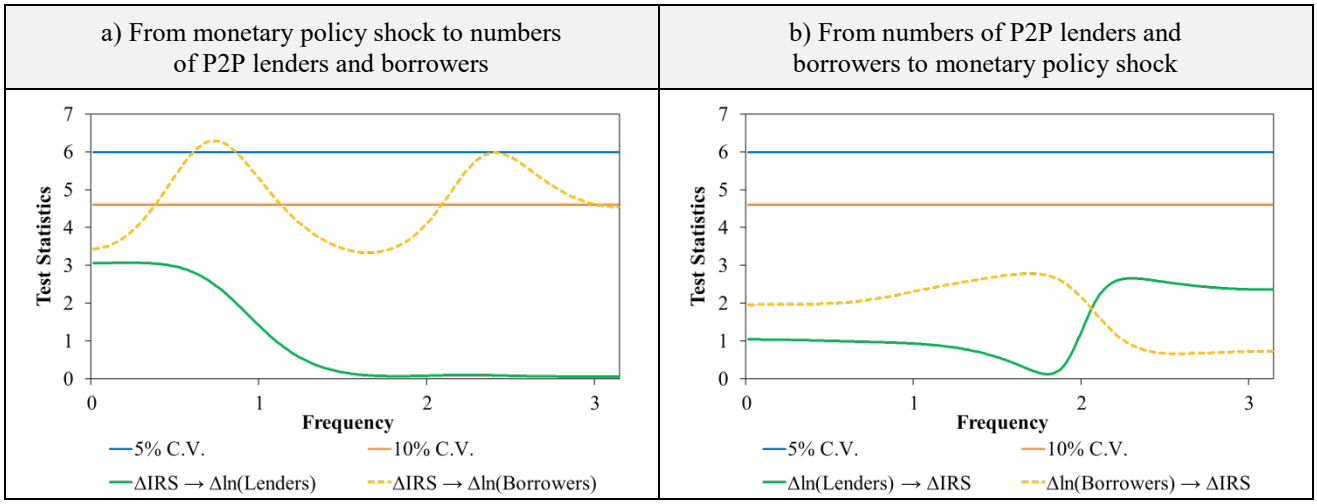
Figure 4 Quarterly frequency-domain Granger causality tests for outstanding P2P loans and net inflow of investment deposits



Notes: Δln(P2P Loans) is the log-differenced series of the outstanding end-quarter amount for P2P loans, Δln(Consumer Loans) is the log-differenced series of the outstanding end-quarter amount for consumer loans of banks, Δ(Net P2P Inflow) is the differenced series of the net inflow for P2P loans over the quarter, and ΔIRS is the monetary policy shock proxied by the change in the one-year 7-day repo IRS. The sample period for Δln(P2P Loans) and Δ(Net P2P Inflow) is 2014Q2–2019Q2. The sample period for Δln(Consumer Loans) is 2014Q2–2019Q2. The AIC and other information criteria have been employed to determine the lag length. The resulting number of lags is 4. The conditional z-variables are (i) the ratio of problematic and closed platforms, (ii) the quarterly growth of real GDP, and (iii) the quarterly growth of bank loans.

Sources: WDZJ, PBoC, National Bureau of Statistics, P2PEye and Bloomberg. The P2P data have been extracted from the WIND and CEIC databases.

Figure 5 Quarterly frequency-domain Granger causality tests for numbers of P2P lenders and borrowers



Notes: Δln(Lenders) is the log-differenced series of the number of P2P lenders per month, Δln(Borrowers) is the log-differenced series of the number of P2P borrowers per month, and ΔIRS is the monetary policy shock proxied by the change in the one-year 7-day repo IRS. The sample period is 2014Q2 – 2019Q2. The AIC and other information criteria have been employed to determine the lag length. The resulting number of lags is 4. The conditional z-variables are (i) the ratio of problematic and closed platforms, (ii) the quarterly growth of real GDP, and (iii) the quarterly growth of bank loans.

Sources: WDZJ, PBoC, National Bureau of Statistics, P2PEye and Bloomberg. The P2P data have been extracted from the WIND and CEIC databases.

While monetary policy does transmit to the P2P market, we conclude that transmission is only observed for interest rates and not credit quantity. In comparison, the tranditional bank sector shows a higher efficiency in monetary policy transmission. The bank lending rate is Granger-caused by monetary policy and shows a longer wavelength than P2P lending rate. It is also a factor behind monetary policy shocks as it also Granger-causes monetary policy in the opposite direction.

4 Conclusions and extensions

Digital innovation and transformation are high priorities on the global agenda as they offer firms new business models and opportunities to enter markets and transform their production processes. China, which strives to be a market leader in digital technologies, offers unique insights due to the sheer size of the Chinese market and strong embrace of new technologies.[22]

Against this background, this paper examines interactions and feedbacks between monetary policy shocks and P2P lending in China for the 2013–2019 period. Our empirical analysis is based on the causality test of Geweke (1982) and Hosoya (1991) in the frequency domain proposed

[22] A new regulatory requirement was announced by the PBoC in September 2019. The PBoC now includes P2P platforms in its credit reference system, with credit information used in line with the same laws and regulations applied to the banking sector. The change is expected to enhance Fintech growth opportunities.
See http://www.xinhuanet.com/english/2019-09/04/c_138365406.htm.

by Breitung and Candelon (2006). The estimation results show that the Chinese authorities have two possible courses of action on the P2P loan market. On the one hand, there is a traditional interest rate channel in the P2P market as monetary policy shocks Granger-cause the change in the lending rate for borrowers. On the other hand, the credit amount channel does not work well in the P2P lending market, possibly due to the market segementation between traditional banks and P2P lending platforms.

Which follow-up avenues for research should be considered going forward? First, in addition to the special focus on the P2P market, the competition effect associated with the Fintech diffusion deserves further attention. The changing structure of financial intermediation exacerbates financial sector competition and sensitizes the market responsiveness to interest rates. This competition effect may have a positive impact on the effectiveness of Chinese monetary policy in the future. Second, the increasing prevalence of P2P loans could have a negative impact on the efficiency of macroprudential policies. In this context, the results of Braggion et al. (2018) provide empirical evidence that Chinese P2P loans act to some degree as a channel that circumvents city-level loan-to-value caps and housing market macroprudential policy in China. This finding should trigger several alarms. Policymakers have been on notice about the risks of excessive household leverage and disintermediation of financial services since the global financial crisis of 2008–2009. A third open question is whether loan-based P2P financing opportunities can fill some of the funding gap that plagues small, innovative firms and may thus spur innovation. Finally, the role of regulation itself in guiding markets based on novel technologies should be of interest. We observe a large disparity in approaches to the regulation of P2P financing across countries. Part of this disparity is probably due to different policy approaches. In particular, some countries see the state as having an important role, while other favor laissez-faire approaches.

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