Monetary Policy Surprises and Interest Rates under China's Evolving Monetary Policy Framework*

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Abstract

China's monetary policy framework has evolved considerably in the past two decades, increasingly moving from using quantity-based instruments and targets to using price-based instruments and targets. This paper assesses the effectiveness of monetary policy in China by examining the influence of monetary policy on market interest rates using an event-study approach. We find that the effectiveness of price-based instruments in impacting market interest rates increases over time, and that price-based instruments are as effective as quantity instruments during the period since the completion of interest rates liberalization. Furthermore, central bank communications, an increasingly important aspect of monetary policy, affect medium- and long-term market interest rates. Our findings are robust to the use of an alternative measure of monetary policy surprise and an alternative estimation method.

Keywords: Monetary policy; Interest rates; Event study

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1 Introduction

Accompanying structural changes in China's economy, the monetary policy in China has evolved considerably in the past two decades, increasingly moving from using quantity-based instruments and targets to price-based instruments and targets. The monetary policy in China traditionally focused on quantity-based intermediate targets such as growth rates of monetary and credit aggregates (for example, M2 and the total amount of commercial bank lending) (Huang, Ge, and Wang 2020).[1] Since 2013, the People's Bank of China (PBC), China's central bank, has introduced a range of lending facilities to develop an interest rate corridor (Yi 2018)[2], shifting the focus toward price-based targets such as short-term market interest rates. While a large literature has evaluated China's traditional quantity-based monetary policy framework (for example, Qin et al. 2005; Dickinson and Liu 2007; Burdekin and Siklos 2008; Fernald, Spiegel, and Swanson 2014; Chen, Chow, and Tillmann 2017; Chang et al 2019), less is known about the effectiveness of the price-based framework relative to that of the quantity-based framework. This paper aims to fill this gap by providing novel evidence on how well the PBC guides market interest rates with the quantity- and price-based monetary policy frameworks.

This paper examines the effects of monetary policy on market interest rates in China from March 2008 to December 2020. We conduct the empirical analysis in several steps. We start by compiling a comprehensive set of monetary policy announcements released during the sample period. Following Kuttner (2001) and Kamber and Mohanty (2018), we construct surprise components of monetary policy announcements by extracting unobserved expectations of monetary policy using financial market data. China's monetary policy is not represented by the target of a short-term market interest rate; the central bank in China uses a range of monetary policy instruments to signal policy changes. This has posed an empirical challenge for previous studies, such as Sun (2020), since changes in different monetary policy instruments are not

[1] We provide more details on China's monetary policy in the next section.

[2] An interest rate corridor system is used to implement monetary policy by many central banks, including the European Central Bank (ECB) and the central banks of Australia, Canada, and England. An interest rate corridor is a system that steers the market interest rate toward the chosen target through standing central bank facilities that lend to and accept deposits from commercial banks. Banks are allowed to borrow freely (with acceptable collateral) at an interest rate above the target from the standing lending facility. The deposit facility allows banks to earn overnight interest on their excess reserve holdings at a rate below the target. The interest rates on the lending and deposit facilities thus form a corridor around the target rate (Keister, Martin, and McAndrews 2008).

comparable. Our unified market-based measure of monetary policy surprise makes it possible to compare the effectiveness of different monetary policy instruments. We document that monetary policy surprises arising from adjustments in quantity-based instruments are overall larger in magnitude than those arising from changes in price-based instruments.

We then employ a high-frequency event-study approach to estimate the responses of market interest rates to monetary policy surprises constructed in the preceding step. Our major findings are as follows. First, monetary policy tightening is followed by increases in market interest rates at all maturities. The responses of market interest rates to monetary policy changes are different across maturities, showing an overall weakening as maturity lengthens. Second, the new price-based monetary policy framework is as effective as the traditional quantity-based framework in moving market interest rates. Market interest rates respond significantly to adjustments in required reserve ratios (RRRs) and benchmark interest rates (BIRs)[3], the two most frequently used monetary policy instruments during the time of the quantity-based framework. The effectiveness of price-based monetary policy instruments in affecting market interest rates increases over time. The price-based instruments are as effective as traditional quantity-based instruments during the period since the completion of liberalization of bank deposit and lending rates. Third, central bank communications, an increasingly important aspect of monetary policy, affect medium- and long-term market interest rates. Our findings provide novel evidence on the effective transmission of the price-based monetary policy in China.

We perform two robustness checks for our results. First, we examine whether our results are robust to the use of an alternative measure of monetary policy surprise. Second, we use the instrumental variable method to address the omitted variable problem that plagues the high-frequency monetary policy event-study analysis. Due to the absence of intraday data, the market-based measure of monetary policy surprise and the change in the market interest rate is measured over a one-day window bracketing every monetary policy announcement; both of them could be affected by important macroeconomic news released throughout the one-day window. To address this potential omitted variable problem, we use the actual change in the policy rate as an instrument for the measure of monetary policy surprise (Kohlscheen 2014). The actual change in the policy rate is highly correlated with the market-based measure of monetary policy surprise. Due to the timing of monetary policy announcements in China, the

[3]The BIRs are interest rates set by the central bank that commercial banks pay for deposits and charge for loans. We provide more details in the next section.

actual change in the policy rate is unlikely to be correlated with non-policy news that could affect the change in the market interest rate. Encouragingly, our empirical results are robust to both checks.

Our work is related to a growing literature on monetary transmission in emerging market and developing economies (EMDEs). Mishra, Montiel, and Spilimbergo (2012) and Mishra and Montiel (2013) provide comprehensive reviews of monetary transmission in low-income developing countries. Frankel (2010) reviews monetary policy in emerging markets. Our work is mostly related to Bulir and Vlcek (2015) and Brandao-Marques et al. (2020). Bulir and Vlcek (2015) find significant transmission from short-term policy and interbank rates to longer-term bond yields in a sample of 16 EMDEs. Brandao-Marques et al. (2020) examine the effectiveness of price-based monetary policy frameworks in 40 EMDEs. They find significant transmission from monetary policy rates to output and prices. Those two studies focus on comparing the effectiveness of the price-based monetary policy across EMDEs. Different from them, we examine the evolution of monetary policy transmission over time in China, the largest emerging market economy.

Our work is mostly related to Kamber and Mohanty (2018) and Sun (2020), who analyze how market interest rates respond to monetary policy announcements in China using an event-study approach with daily data.[4] Kamber and Mohanty (2018) examine adjustments in RRRs and BIRs and releases of monetary policy reports (MPRs) for the period 2006–2016. They find that adjustments in RRRs and BIRs affect market interest rates at all maturities, and that releases of MPRs affect long-term market interest rates. Sun (2020) examines changes in BIRs and RRRs and press releases of monetary policy committee (MPC) meetings from 2002 to 2017. She finds that changes in RRRs and BIRs affect market interest rates at all maturities, and that press releases of MPC meetings do not affect market interest rates. She also examines a sample of four announcements in 2017 involving two main price-based monetary policy instruments, but finds insignificant responses of market interest rates to changes in price-based instruments. However, these two studies do not have enough information to compare the new monetary policy framework to the traditional quantity-based framework.

We contribute to the literature by comparing the effectiveness of the new price-based mon-

[4]Because of data limitations, there are few event studies on monetary policy in developing economies. Few exceptions include Duran et al (2012) and Lakdawala and Sengupta (2021), who focus on Turkey and India, respectively.

etary policy framework to that of the traditional quantity-based framework. More specifically, in contrast to Sun (2020), we find that price-based monetary policy instruments significantly affect market interest rates at all maturities except the 1-month rate. The price-based instruments are as effective as traditional quantity-based instruments during the period since the completion of interest rates liberalization. Our novel results are driven by two differences between our work and hers. First, we expand the set of monetary policy announcements to the year 2020. Second, we account for anticipated changes in the monetary policy by employing monetary policy surprises instead of actual monetary policy changes in event studies. These two differences allow us to more accurately estimate the responses of market interest rates to changes in price-based monetary policy instruments.

There is an emerging literature on China's transition from a quantity-based to a price-based monetary policy framework. Jones and Bowman (2019) examine the impact of monetary policy on market interest rates using a structural vector autoregression (SVAR) model over 1997–2008 and 2009–2018. They find that the impact of price-based monetary policy instruments on market interest rates is more pronounced in the post-2009 period. Kim and Chen (2019) examine the effects of monetary policy on the real economy over two periods, 1997–2006 and 2007–2016. They find that the effects of price-based policy instruments on the economy become stronger over time and that the effects of price-based instruments are larger than those of quantity-based instruments in the post-2007 period. Those two works employ SVAR models to study the dynamic impact of monetary policy. Our work complements them in using the release of monetary policy changes as a quasi-experiment to identify monetary policy surprises and estimate the effects of monetary policy on market interest rates. Our findings provide further evidence on the effective transmission of the price-based monetary policy in China.

Methodologically, our work connects to a large literature that examines the impact of monetary policy on market interest rates using a high-frequency event-study approach since the seminal work of Cook and Hahn (1989) and Kuttner (2001).[5] Recent event studies on monetary policy in advanced economies take advantage of the intraday data available to specify a narrow event window (for example, a 30-minute window) around announcements to reduce contamination from other news, as it is unlikely that any other significant events took place within

[5]More broadly, there is a substantial event-study literature examining the influence of monetary policy on asset prices, surveyed in Neely and Dey (2010), Fawley and Neely (2014), and Kuttner (2018). Gürkaynak and Wright (2013) discuss the use of event studies in macroeconomics and finance.

this narrow window.[6] Exploiting the timing of monetary policy announcements in China, we use the instrumental variable approach to address the omitted variable problem that arises in the daily event-study analysis.[7]

The remainder of the paper proceeds as follows. Section 2 provides background of China's monetary policy. Section 3 presents our empirical strategy. Section 4 reports the empirical results. Section 5 concludes.

2 Monetary Policy in China

The PBC conducts monetary policy with the objective of maintaining the stability of currency value and thereby promoting economic growth.[8] To achieve its objective, the PBC relies on a range of monetary policy instruments and communications. In this section, we discuss the transition of monetary policy in China, monetary policy instruments frequently used by the PBC, and the PBC's communications.

2.1 Monetary policy framework

China's monetary policy framework has evolved considerably in the past two decades, with the focus increasingly shifting from quantity-based instruments and targets to price-based instruments and targets. In this subsection, we present an overview of the transition of monetary policy in China.[9] We provide more details on monetary policy instruments in the next subsection.

Quantity-based monetary policy framework. Traditionally, the focus of monetary policy in China had been on quantity-based intermediate targets. At the beginning of every year,

[6] See, among others, studies on the euro area (Altavilla et al. 2019; Andrade and Ferroni 2020) and the U.S. (Gürkaynak, Sack, and Swanson 2005; Wright 2012; Nakamura and Steinsson 2018; Swanson 2021).

[7] Earlier studies on conventional monetary policy and recent studies on unconventional monetary policy in advanced economies also use daily data; see, for example, studies on the euro area (Ambler and Rumler 2019), Greece (Kaketsis and Sarantis 2006), Japan (Honda and Kuroki, 2006; Ueda 2012; Arai 2017), the U.K. (Dale, 1993; Joyce et al., 2011), and the U.S. (Cook and Hahn 1989; Roley and Sellon 1995; Thornton 1998; Kuttner 2001; Demiralp and Jorda 2004; Gagnon et al. 2011).

[8] http://www.pbc.gov.cn/en/3688229/3688299/3688302/index.html

[9] For a comprehensive discussion of monetary policy in China, see Hess (2020) and Huang, Ge, and Wang (2020).

specific targets for growth rates of the monetary aggregate (M2) or credit aggregates (such as newly increased bank loans) were laid out in the Report on the Work of the Government (Annual Work Report).[10] To achieve those quantitative targets, the PBC relied on a mixed set of quantity- and price-based monetary policy instruments, among which required reserve ratios (RRRs) and benchmark interest rates (BIRs) were the two most important ones.

Price-based monetary policy framework. The emphasis on quantity-based intermediate targets has declined, as the correlation weakens substantially between the quantitative intermediate targets, such as M2 growth, and monetary policy objectives, such as inflation rate and GDP growth (Ma 2017). Since 2018, the Annual Work Report has not set specific targets for monetary or credit aggregates.[11] Since 2013, the PBC has introduced a range of lending facilities to develop an interest rate corridor system. The interest rates on banks' excess reserves and the standing lending facility act as the floor and ceiling of the corridor, respectively. In the corridor, an important interest rate is the 7-day interbank D-repo rate (DR007)—the implied interest rate for transactions in which depository institutions sell collateral eligible debt instruments to other depository institutions in the interbank market subject to an agreement to repurchase them back seven days later, as made clear in the PBC's monetary policy reports[12] and by the PBC's current governor.[13]

[10]The Annual Work Report is delivered by the Premier to the delegates of the National People's Congress of China, usually held in March every year, for their review and approval. The report presents a comprehensive view of the country's economic and social development in the previous year, and lays out general guidelines for government policies for the current year.

[11]For example, the 2018 report states:"Our prudent monetary policy will remain neutral, with easing or tightening only as appropriate. We need to make sure that the valve of aggregate monetary supply is well controlled, maintain moderate growth in M2 money supply, credit, and aggregate financing, ensure a reasonable, stable level of liquidity, and increase the proportion of direct finance, particularly equity finance."

[12]The 2016Q3 monetary policy report states:"The interest rates on 7-day repos with rate securities as pledges (DR007) for deposit-taking institutions in the inter-bank market were stable around the interest rates on 7-day repos in the open market and elasticity has been enhanced since September, ... DR007 can lower the credit risks of counterparties and mitigate the disturbance of collateral quality on the pricing of interest rates, better reflect the situation of banking liquidity, and play a positive role in fostering market benchmark interest rates." The 2020Q4 monetary policy report states:"when observing market rates, we need to focus on the weighted average of DR007, which is the main indicator of market rates".

[13]The price-based monetary policy framework was outlined by Gang Yi, the current governor of the PBC, in a speech in December 2018:"As the correlation between quantitative indicators and economy gradually

China's monetary policy framework is converging to but to date is still different from that of major advanced economies. First, the PBC does not set a target for a short-term market interest rate such as DR007, but instead employs a range of monetary policy instruments to signal policy changes. Second, the PBC does not publish a calendar of announcement dates but instead announces policy changes at its discretion. Third, RRRs, a quantity-based monetary policy instrument, are still playing a very important role in the conduct of monetary policy.[14]

2.2 Monetary policy instruments

The PBC deploys a range of monetary policy instruments to achieve its objective. In this subsection, we briefly discuss important monetary policy instruments used by the PBC in implementing monetary policy.[15]

Required reserve ratios (RRRs) Unlike central banks in most advanced economies, the PBC extensively uses reserve requirements as a monetary policy instrument. The RRRs were adjusted 35 times over our sample period (see Figure 1).

[Figure 1 about here.]

Benchmark interest rates (BIRs) For commercial banks in China, the PBC sets the benchmark deposit and lending rates with maturities ranging from overnight to five years. Originally, banks were obliged to apply these rates to all deposits and loans. The PBC started to liberalize commercial banks' interest rates at the end of the 1990s, allowing banks to offer a range of deposit and lending rates within narrow bands. The upper and lower bands of lending rates were widened several times before being completely removed in July 2013. On October 23,

declines, the monetary policies of major developed countries and market economies are principally aimed at regulating price indicators. Reforms in China were also focused on nurturing a market-based interest rate system and enhancing a price-oriented regulation and transmission mechanism. ... At present, the focus of China's monetary policy is gradually shifting from quantity control to price control. ... This figure is an illustration of interest rate corridor. In the corridor an important interest rate is DR007, namely the seven-day repo rate in the inter-bank market. ... As you can see, the red line of DR007 lies between the blue line on the upper side and the green line on the lower side. The blue line represents the interest rate of SLF and the green one is the interest rate of excess reserves" (Yi 2018).

[14] The RRRs were adjusted 24 and 12 times over 2008-2013 and 2014-2020, respectively.

[15] For more details on monetary policy instruments, see McMahon, Schipke, and Li (2018) and Wang (2020).

2015, the PBC finally lifted the upper band of the deposit rate, completing the liberalization of bank's deposit and lending rates.[16] Since then, the BIRs have not been changed and have become less important.

From March 2008 to October 2015, the BIRs were adjusted 18 times. Figure 2 plots the 1-year benchmark deposit and lending rates over our sample period.

[Figure 2 about here.]

Interest rate on excess reserves (IOER) Under the price-based monetary policy framework, the IOER acts as the floor of the interest rate corridor. The IOER was only adjusted twice over our sample period (see Figure 3).

[Figure 3 about here.]

Open market operations (OMO) OMO—the purchase and sale of securities in the open market by the PBC—is a key instrument in the implementation of monetary policy. The PBC carries out OMOs with primary dealers in the interbank market to manage liquidity. Among OMOs conducted by the PBC, we focus on repurchase agreement (repo) and reverse repo transactions as they play important roles in implementing monetary policy.

In an OMO repo transaction, the PBC sells collateral eligible securities from a counterparty in the interbank market subject to an agreement to repurchase the securities at a later date.[17] An OMO (reverse) repo transaction can be either price-based or quantity-based, depending on whether the PBC sets the interest rate or the quantity.[18] Over our sample period, the PBC set the interest rates of OMO (reverse) repos and adjusted those rates to signal policy changes.

The frequent use of OMO reverse repos started on June 26, 2012. The tenors of OMOs reverse repos include 7-, 14-, 21-, 28-, 63-, and 91- day. The 7-day reverse repo was frequently used.[19] The OMO 7-day reverse repo rate is an important monetary policy instrument under the price-based monetary policy framework. As discussed in the previous subsection, the PBC

[16]For more details on China's interest rate liberalization, see Ma and He (2020).

[17]Note that a repo conducted by the PBC is the inverse of that conducted by other central banks such as the Federal Reserve and the European Central Bank.

[18]We thank a referee for pointing out this.

[19]The 14- and 28-day reverse repos were occasionally used. The 63-day reverse repo was rarely used. The 21- and 63-day reverse repos have not been used since March 2015 and April 2018, respectively. The 91-day reverse repo was never used.

does not set a target for DR007. To some extent, the OMO reverse repo 7-day rate acts as a target for DR007 (Wang 2020), as indicated in the PBC's monetary policy reports.[20] The PBC adjusts the OMO reverse repo 7-day rate to signal policy changes. For example, from the end of 2015 until mid-2018, the PBC changed the OMO reverse repo 7-day rate seven times, three of which followed increases in the federal funds rate target.

We identify 31 changes in OMO revere repo rates from June 2012 through December 2020. Figure 3 plots the OMO reverse repo 7-day rate.

Lending facilities Since 2013, the PBC has created a variety of lending facilities, among which the two most important ones are the Standing Lending Facility (SLF) and the Medium-term Lending Facility (MLF).

The SLF, comparable to the Federal Reserve's discount window, was created in early 2013. The tenors of the SLF include overnight, 7-day, and 1-month. The SLF 7-day rate acts as the ceiling of the interest rate corridor. The SLF 7-day rate was adjusted 7 times from March 2015 through December 2020 (see Figure 3).

The MLF was created in September 2014. Comparable to the ECB's longer-term refinancing operations, the MLF is a tool for providing longer-term financing to commercial and policy banks that meet the requirements of macro-prudential management. The tenors of the MLF include 3-month, 6-month, and 1-year. The 1-year MLF is frequently used. The 3- and 6-month MLFs have not been used since August 2016 and June 2017, respectively. The PBC uses MLF rates to guide medium-term market interest rates. The MLF rates were adjusted 10 times from November 2015 through December 2020. Figure 3 plots the MLF 1-year rate.

2.3 Central bank communications

In addition to monetary policy instruments, the PBC has increasingly used communications to achieve its objective (McMahon, Schipke, and Li 2018). We focus on two main channels

[20] The 2016Q3 monetary policy report states: "The interest rates on 7-day repos with rate securities as pledges (DR007) for deposit-taking institutions in the inter-bank market were stable around the interest rates on 7-day repos in the open market and elasticity has been enhanced since September." The 2020Q4 monetary policy report states: "To judge the trend of short-term interest rates, we need to determine whether policy rates have changed in the first place, especially whether the 7-day reverse repo rate of the central bank's open market operations has changed, and to avoid paying excessive attention to the number of open market operations.".

through which the PBC communicates with the public.

Monetary policy committee (MPC) meetings The MPC is a consultative body for the PBC to formulate monetary policy. It performs its functions through its regular quarterly meeting.[21] The MPC meeting was first held in 1997 and now takes place at the end of each quarter. The PBC typically publishes press releases one or two days following the meeting. The actual meeting dates, however, are not announced in advance and are only revealed in press releases following the meeting.

Monetary policy reports (MPRs) The PBC has released quarterly MPRs since 2001. Through these reports, the PBC often communicates its intentions for future policy actions as well as details of future changes in the monetary policy framework. For example, the PBC emphasized the importance of DR007 and OMO 7-day reverse repo rate in multiple MPRs.

3 Empirical strategy

Our empirical methodology follows the standard monetary policy high-frequency event-study literature. A high-frequency event-study analysis uses changes in financial markets within narrow windows of time around major, discrete announcements to measure the effects of those announcements. Under the hypothesis of rational expectations in financial markets, asset prices should fully incorporate all information from a public announcement shortly after the announcement is made. If financial markets are efficient, the expected component of monetary policy change would have little or no effect on asset prices following a policy announcement. To measure the effects of unexpected monetary policy shocks on market interest rates, we follow Gürkaynak, Sack, and Swanson (2005) to estimate the below regression:

$$\Delta i_t = \alpha + \beta \Delta m_t + \varepsilon_t, \tag{1}$$

where t is not a time-series index but an index of monetary policy announcement (event), Δm_t and Δi_t denote the unexpected change in the monetary policy and the change in the market interest rate, respectively, over an interval that brackets a monetary policy announcement, and ε_t is an error term that captures the effects of factors other than the monetary policy that influence the market interest rate.

[21] For more details on the MPC, please see http://www.pbc.gov.cn/en/3688229/3688311/3688314/index.html.

Our main analysis uses a 1-day event and response window; both the unexpected change in the monetary policy (Δm_t) and the change in the market interest rate (Δi_t) are measured over a 1-day window bracketing every monetary policy announcement. Selecting the window length involves a trade-off between allowing sufficient time for the announced news to become fully incorporated in market interest rates and keeping the window narrow enough that it is unlikely to contain the release of other important information. A 1-day window is the narrowest possible window for our data.[22] This window choice is motivated by previous studies that argue for the use of a narrow window to better isolate the response of asset prices to monetary policy announcements (Gürkaynak, Sack, and Swanson 2005).

The parameter of interest if β, which measures the effects of unexpected monetary policy shocks on market interest rates. The ordinary least squares (OLS) estimate of β would be unbiased if the following two conditions are satisfied. First, monetary policy actions were not endogenous to interest rate movements within the announcement window. Second, no other major news were released within the announcement window; otherwise, Δm_t and Δi_t could be responding jointly to those news (ε_t).

3.1 Monetary policy announcements

As discussed in Section 2, China's monetary policy is not represented by the target of a short-term market interest rate. The PBC uses a range of monetary policy instruments to signal policy changes (Chen, Chen, and Gerlach 2013). To examine the impact of monetary policy changes, we consider announcements that involve changes in any of the following monetary policy instruments: RRRs, BIRs, OMO reverse repo rates, SLF rates, and MLF rates. For central bank communications, we consider both press releases of quarterly MPC meetings and releases of quarterly MPRs.

The PBC does not publish a calendar of announcement dates but instead announces policy changes at its discretion on various platforms. For example, since December 2013, the PBC has made some major monetary policy announcements through its Weibo account.[23] We collect

[22] Kamber and Mohanty (2018) and Sun (2020) use 1-day window in their event studies of China's monetary policy.

[23] Launched on August 14, 2009, Sina Weibo—a Chinese microblogging website—is one of the biggest social media platforms in China, with over 500 million monthly active users as of the last quarter of 2020. The PBC's Weibo account, launched on December 1, 2013, had over 3.5 million followers as of December 2020.

information on the exact timing of each announcement from various sources, including the PBC's website, the PBC's Weibo account, and the financial press. We also perform extensive cross-checking with data sources to ensure the accuracy of announcement timing. Throughout our sample period from March 2008 to December 2020, we identify 91 and 102 announcements on monetary policy changes and central bank communications, respectively. Table 1 provides detailed information on the number of each type of monetary policy announcement. Notably, some announcements involve the use of multiple monetary policy instruments. Table A.1 in the appendix lists all monetary policy announcements and their exact timing.

[Table 1 about here.]

3.2 Measuring monetary policy surprises

Measuring monetary policy surprises surrounding monetary policy announcements (Δm_t) is crucial for estimating the impact of unexpected monetary policy shocks on market interest rates. In a seminal paper, Kuttner (2001) uses daily data on Fed Funds futures to measure market expectations of the Federal Reserve's monetary policy actions. The unexpected component of the change in the federal funds rate target can be measured from the change in Fed Funds futures prices over a tight window around an announcement since the expected component of the change in the federal fund rate target is incorporated into the Fed Funds futures prices available immediately before the announcement. This unexpected target change represents an exogenous monetary policy shock.[24]

As discussed in Section 2, DR007 can be considered as a proxy for China's monetary policy stance. Following Kuttner (2001) and Kamber and Mohanty (2018), we can use interest rate swaps (IRSs) rates based on DR007 as a market-based proxy for unobservable expectations of monetary policy.[25] An IRS contract based on DR007 is an agreement between two parties to

[24]Since Kuttner (2001), a sizable literature has used the market-based approach to measure monetary policy surprises for monetary policy announcements. See, for example, Demiralp and Jorda (2004), Gürkaynak, Sack, and Swanson (2005), and Altavilla et al. (2019).

[25]Kuttner (2001) uses Fed funds futures prices as a market-based proxy for unobservable expectations of the federal funds rate target. The Fed funds futures contract's settlement price is based on the average effective federal funds rate that is realized for the calendar month specified in the contract. Thus, changes in the current-month futures price largely reflect revisions to the market's expectations for the federal funds rate over the remainder of the month. IRS rates have been used to measure monetary policy surprises of the ECB (Altavilla et al. 2019; Andrade and Ferroni 2020) and Reserve Bank of India (Lakdawala and Sengupta 2021).

exchange fixed-rate payments for floating-rate payments based on DR007 for a specified period of time. The fixed interest rate for an IRS agreement is referred to as the IRS rate. At the time of the swap agreement, the total value of the swap's fixed-rate flows will be equal to the total value of expected floating-rate payments implied by the expected path of DR007 over the specified period of time. As the market's expectations of DR007 in the future change, so will the fixed rate that investors demand to enter new swaps. Thus, changes in the IRS rate largely reflect revisions to the market expectation of DR007 over the remainder of the contract period. The change in the IRS rate on DR007 over a tight window around a monetary policy announcement then measures the monetary policy surprise. The idea is that the IRS rate on DR007 before the announcement embodies the expected change in the monetary policy after the announcement; the IRS rate will remain unchanged if the change in the monetary policy occurs as expected.

However, DR007 and IRSs based on DR007 were introduced in December 2014 and May 2017 respectively, making them unsuitable for empirical analysis. Following previous studies (Kamber and Mohanty 2018; Kim and Chen 2019; Cheng and Wang 2020), we use the 7-day interbank repo rate (R007) as a proxy for monetary policy stance and then use IRS rates based on R007 to proxy market expectations of monetary policy.[26] The difference between DR007 and R007 is that R007 applies to all financial institutions in the interbank market while DR007 only applies to depository institutions. The PBC started pilot IRSs based on R007 in 2006. In early 2008, participants for the IRSs were expanded to include all financial institutions in the interbank market.

Following Kamber and Mohanty (2018), we construct the market-based measure of monetary policy surprise using the change in the 1-year IRS rate based on R007 within a narrow window around a monetary policy announcement.[27] More precisely, using daily data on the 1-year IRS rate based on R007, we compute monetary policy surprises according to the following procedure. First, if a policy announcement was made on a trading day when markets were open, our surprise measure is the difference between the close value of the announcement day and the close value of the previous trading day. Second, if a policy announcement was made on

[26]Before DR007 was introduced by the PBC, R007 was considered as a proxy for monetary policy stance by the markets.

[27]Among all IRSs based on R007, the 1-year contract is the most liquid one. We consider alternative tenors of IRSs based on R007 for robustness checks.

a trading day after markets were closed, our surprise measure is the close value of the following trading day minus the close value of the announcement day. Finally, if an announcement was made during a non-trading day (the weekend or a holiday period), our surprise measure is the close value of the first trading day following the announcement minus the close value of the last trading day before the announcement.

Figure 4 illustrates our method of constructing monetary policy surprises with an example. On April 3, 2020, the PBC cut the RRR for small and medium-sized banks from 10.5% to 9.5%, and lowered the IOER from 0.72% to 0.35%. Figure 4 plots the evolution of the 1-year IRS rate based on R007 before and after the announcement. As the announcement was made on a trading day after the markets were closed, the IRS rate was 1.80% before the announcement. The IRS rate fell sharply to 1.54% the next trading day after the announcement (April 7, 2020). Thus, our estimate of the monetary policy surprise for this announcement, which involved multiple policy instruments, is $1.54\% - 1.80\% = -0.26\%$.

[Figure 4 about here.]

Figure 5 shows the market-based measure of monetary policy surprises for all announcements listed in Table A.1. Notably, monetary policy surprises arising from adjustments in RRRs or BIRs (Panel [A]) are overall larger in magnitude than those arising from changes in OMO reverse repo rates, SLF rates, or MLF rates (Panel [B]).

[Figure 5 about here.]

3.3 Market interest rates

For market interest rates, we use government bond yields (sovereign yields) with maturities ranging from 1 month to 30 years. Using daily data on government bond yields, the change in the market interest rate (Δi_t) around every monetary policy announcement is computed using the procedure described in the previous subsection for measuring monetary policy surprises.

3.4 Data

All data are obtained from Wind, a major provider of economic and financial data in China. Our sample starts on March 1, 2008, when the data on IRSs became available, and ends on

December 31, 2020. Therefore, a disadvantage of using the data on IRSs to measure monetary policy surprises is that it limits the analysis to the post-2008 period.

4 Empirical Results

4.1 Monetary Policy Surprises

4.1.1 Baseline estimates

Our baseline results focus on the one-day responses of market interest rates to monetary policy surprises. We estimate regression (1) using OLS for all announcements pertaining to monetary policy surprises listed in A.1 and report the results in Panel (A) of Table 2. The proportions of variations in market interest rates explained by monetary policy surprises differ across maturities, ranging from 34% for the 20-year rate to 60% for the 1-year rate. The estimates of β are positive and highly statistically significant for all market interest rates; monetary policy tightening is followed by increases in market interest rates at all maturities. The responses of market interest rates to monetary policy surprises differ across maturities, weakening overall as maturity lengthens. A monetary policy surprise that is accompanied by a 100 basis points increase in the 1-year IRS rate is associated with a 69, 55, and 42 basis points increase in the 1-month, 1-year, and 10-year rate, respectively.

[Table 2 about here.]

4.1.2 Robustness

In this subsection, we test the robustness of our baseline results to an alternative measure of monetary policy surprise and an alternative estimation method, and report the results in Table 2.

An alternative measure of monetary policy surprises To check the robustness of our results to the use of the 1-year IRS rate on R007 to construct monetary policy surprises, we estimate regression (1) with the surprise measure constructed using the 5-year IRS rate.[28] Panel

[28] Among all IRSs based on R007, the 1-year contract is the most liquid one followed by the 5-year contract (Kamber and Mohanty 2018).

(B) of Table 2 shows that using this alternative IRS rate produces results that are qualitatively similar to our baseline estimates.

An alternative estimation method The OLS estimate of β would be biased if monetary policy actions were endogenous to interest rate movements within the announcement window. It is unlikely, however, that interest rates changes have led the PBC to adjust monetary policy, given the timing of monetary policy changes. To see this, we classify monetary policy changes into two types, those that occurred when markets were closed[29] and those that occurred when markets were open. For announcements that occurred when markets were closed, it is impossible that the monetary policy action was endogenous to the interest rate change within the announcement window, as the change occurred in the next trading day following the announcement (Panel [A] of Figure 6).

For announcements made when markets were open on trading days, it is indeed possible that the monetary policy change could be responding to the interest rate change. However, among 40 such announcements, 34 of them were made early in the morning.[30] It is unlikely that the PBC would adjust the monetary policy in response to changes in market interest rates in one and half hours. In summary, monetary policy actions were unlikely to be endogenous to interest rate movements within the announcement window.

The OLS estimate of β would be biased if other major news were released within the announcement window, as Δm_t and Δi_t could be responding jointly to those news (ε_t). To address the omitted variable problem that arises in daily event-study regressions, we employ the actual change in policy rate as an instrument variable (IV) for the market-based measure of monetary policy surprise (Δm_t). On one hand, the actual change in the policy rate is correlated with the monetary policy surprise arising from the policy change. On the other hand, as most policy changes were announced very in the late afternoon (Panel [A] of Figure 6) or very early in the morning (Panel [B] of Figure 6), it is unlikely that they were endogenous to important macroeconomic news released within the announcement window. The actual change in the policy rate is thus uncorrelated with other non-policy factors that might affect the change in

[29]There are 51 such changes. Those include announcements made after markets were closed on trading days and announcements made on non-trading days.

[30]The interbank market for governments bonds and IRS agreements in China starts trading at 9 am. All of those 34 announcements were made before 10:30 am. Dropping those 6 announcements made late on trading days yields results similar to our baseline estimates.

the market interest rate.

[Figure 6 about here.]

We re-estimate regression (1) using the actual change in the policy rate as an IV and report the results in Panel (C) of Table (2). The results are qualitatively similar to our baseline results in Panel (A); all coefficients are positive and highly significant. The weak IV F-tests are all rejected at the 10% level.[31]

In summary, the use of an alternative measure of monetary policy surprise and an alternative estimation method yield results that are similar to those obtained from the baseline estimations, in which the monetary policy surprise constructed using the 1-year IRS rate and the OLS are used. Thus, we proceed with the baseline estimation approach for futher analyses.

4.2 Persistence of monetary policy effects

Our baseline analysis focuses on the 1-day responses of market interest rates to monetary policy surprises. To examine whether the effects of monetary policy are persistent, we estimate regression (1) with various response windows and report the results in Table 3. For a k-day response window, $k = 1, 2, \cdots, 7$, Δi_t is the cumulative change in the market interest rate over k days following the monetary policy announcement.

The estimates of β are positive and significant for all maturities and response windows, which suggests that the impact of monetary policy is persistent. As the response window widens, the confidence intervals of estimates become wider and the proportions of variations in market interest rates explained by monetary policy surprises decline. Over time, other factors than monetary policy account for an increasing share of variations in market interest rates. Further, the point estimates of the 7-day response window are larger than those of the 1-day response window in most cases, suggesting that it takes several days for the information contained in the monetary policy announcement to be fully incorporated into market interest rates.

[Table 3 about here.]

[31] The Cragg-Donald Wald F statistic and Kleibergen-Paap rk Wald F statistics are 63.13 and 29.04, respectively. The null hypothesis that the instrument is weak is rejected, since the 10% Stock-Yogo weak IV F-test critical values for single endogenous regressor is 16.38.

4.3 Effects of different monetary policy instruments

Our unified measure of monetary policy surprises for all monetary policy announcements allows us to quantitatively compare the responses of market interest rates to different types of announcements. To compare the effectiveness of different monetary policy instruments in affecting market interest rates, we estimate regression (1) for six subsets of announcements on monetary policy changes listed in Table A.1 and report the results in Table 4.

[Table 4 about here.]

Table 4 shows that the responses of market interest rates to monetary policy surprises differ across monetary policy instruments. Panels (A) and (B) present the results when the estimation only includes policy actions with changes in RRRs and adjustments in BIRs, respectively. The estimates of β are positive and statistically significant for all market interests. Panel (C) includes the monetary policy actions in the previous two panels and announcements with changes in both RRRs and BIRs. The results are similar to those in the previous two panels. Our results confirm earlier studies (He and Wang 2012; Kamber and Mohanty 2018; Sun 2020) that market interest rates respond significantly to changes in RRRs and adjustments in BIRs.

Turning to price-based monetary policy instruments, if we consider only the changes in the OMO reverse repo rates, the movements in market interest rates are not very significant (see Panel (D)). Due to the short sample period since the creation of SLF and MLF, our sample has only a few announcements for changes in SLF rates and MLF rates. Panel (E) of Table 4 presents the results obtained when pooling announcements pertaining to those two instruments together in the estimation. While short-term interest rates do not respond significantly to changes in SLF and MLF rates, some medium- and long-term yields do. In addition to the announcements used in both Panels (D) and (E), Panel (F) also includes four announcements involving multiple policy instruments (two announcements in which both OMO reverse repo rates and SLF rates changed, one announcement in which both OMO reverse repo rates and MLF rates changed, and one announcement in which all three rates changed). Panel (F) reports that medium- and long-term interest rates respond significantly to changes in price-based monetary policy instruments.[32]

[32]To further explore the pivotal role of the multi-action announcements, we also estimate regression (1) with 12 announcements for Panel (E) and 4 multi-instrument announcements and find that the results are similar to those in Panel (F).

Since we find significant effects of price-based monetary policy instruments, the next subsection explores how they evolve over time.

4.4 Effectiveness of the price-based monetary policy framework

4.4.1 Sub-period analysis

As discussed in Section 2, the PBC has not changed BIRs since October 23, 2015, and is increasingly using price-based instruments—OMO reverse repo rates, SLF rates, and MLF rates—in implementing monetary policy. To examine whether the responses of market interest rates to changes in those three price-based instruments are different before and after October 23, 2015, we estimate equation (1) for two subsamples of announcements pertaining to OMO reverse repo rates, SLF rates, and MLF rates listed in Table A.1 and report the results in Table 5. For ease of comparison, Table 5 also includes the results for the full sample presented in Panel (F) of Table 4.

[Table 5 about here.]

Panels (B) and (C) of Table 5 show that the responses of market interest rates to changes in price-based instruments are substantially different across two periods. Before October 23, 2015, the responses are smaller and insignificant; after October 23, 2015, except for the 1-month rate, the responses are larger and highly significant.

4.4.2 Time-varying parameter regression

To further examine how the responses of market interest rates to changes in three price-based instruments (i.e., OMO reverse repo rates, SLF rates, and MLF rates) have evolved over time, we extend regression (1) to allow for time-varying parameters:

$$\begin{aligned} \Delta i_t &= \alpha_t + \beta_t \Delta m_t + \varepsilon_t, \quad \varepsilon_t \sim \mathrm{N}(0, \sigma_\varepsilon^2) \\ \alpha_t &= \alpha_{t-1} + u_t, \quad u_t \sim \mathrm{N}(0, \sigma_u^2) \\ \beta_t &= \beta_{t-1} + v_t, \quad v_t \sim \mathrm{N}(0, \sigma_v^2) \end{aligned} \tag{2}$$

We estimate (2) using the Bayesian method proposed in Bitto and Frühwirth-Schnatter (2019). For all estimations, we simulate 100,000 draws from the posterior distribution and

drop the first 20,000 ones. To reduce autocorrelation between draws, we keep every 10th draw for posterior inference.[33]

Figure 7 plots the point estimates of β_t (solid line) along with 90% and 95% credible intervals (dashed and dotted lines). Before 2016, the effects of price-based monetary policy instruments on market interest rates are small and insignificant. From 2016, except for the 1-month rate, there is an upward trend in the responses of market interest rates to changes in price-based monetary policy instruments. These results indicate that the price-based monetary policy instruments started becoming effective in affecting market interest rates since late 2015, confirming the results from the sub-period analysis above.

[Figure 7 about here.]

In summary, our findings show an increasing effectiveness of price-based instruments in affecting market interest rates over time. The price-based instruments are as effective as traditional quantity-based instruments for the period after the completion of interest rate liberalization. Kim and Chen (2019) find that the effects of short-term interest rate on output have become stronger over time. Our findings of an effective transmission from policy rates to market interest rate complement theirs since monetary policy affects the real economy through steering market interest rates.

4.5 Central Bank Communication

Central bank communication is becoming an increasingly important aspect of monetary policy in China. As discussed in Section 2, the PBC communicated changes in the monetary policy framework in its MPRs. In this section, we examine how market interest rates respond to the information contained in the PBC's communications. To this end, we estimate regression (1) using OLS for announcements on central bank communications listed in A.1 and report the results in Panel (A) of Table 6. Monetary policy surprises only account for a small share of variations in market interest rates. The responses of market interest rates to surprises from central bank communications are different across maturities: the responses of medium- and long-term rates are small but statistically significant, while the responses of short-term rates are insignificant. This suggests that the PBC's communications contain information on future

[33]For details on the estimation, see Knaus et al. (2021).

monetary policy and effectively affect the long end of the yield curve. Our results are in line with Kamber and Mohanty (2018), who focus on only releases of MPRs.[34]

[Table 6 about here.]

5 Conclusion

This paper examines how market interest rates react to monetary policy changes and central bank communications in China from March 2008 to December 2020, using an event-study approach with daily data. The surprise components of monetary policy announcements are measured using financial market data.

We find that monetary policy tightening is followed by persistent increases in market interest rates at all maturities. The responses of market interest rates to monetary policy actions differ across maturities, weakening overall as maturity lengthens. The effectiveness of price-based monetary policy instruments in affecting market interest rates increases over time. The price-based instruments are as effective as traditional quantity-based instruments for the period after the completion of interest rates liberalization. Further, central bank communications, an increasingly important aspect of monetary policy, affect medium- and long-term market interest rates.

To conclude, we call for future research on monetary policy transmission. Here, to initiate the discussion, we estimate Equation (1) with stock market indices as the outcome variables. Interestingly, we find that stock prices do not respond significantly to changes in price-based monetary policy instruments (see Table 7). A comprehensive study of monetary transmission to financial market and macroeconomic aggregates is needed to deepen our understanding on the boarder impacts of the transition of monetary policy framework in China.

[Table 7 about here.]

[34] Encouragingly, Panel (B) of Table 6 shows that using an alternative IRS rate produces results that are qualitatively similar to our baseline estimates.

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Table 1: Number of monetary policy announcements (3/1/2008–5/31/2020)

Type	**Number**
Monetary policy changes:	
Required reserve ratios (RRRs)	29
Benchmark interest rates (BIRs)	12
RRRs & BIRs	6
Open market operations (OMO) reverse repo rates	28
Standing Lending Facility (SLF) rates	4
Medium-term Lending Facility (MLF) rates	8
OMO reverse repo rates & SLF rates	2
OMO reverse repo rates & MLF rates	1
OMO reverse repo rates & SLF rates & MLF rates	1
Total:	91
Central bank communications:	
Press release of Monetary Policy Committee meeting	51
Release of Monetary Policy Report	51
Total:	102

Source: Table A.1

Table 2: One-day responses of market interest rates to monetary policy surprises

	Δi^{1m}	Δi^{3m}	Δi^{6m}	Δi^{1y}	Δi^{3y}	Δi^{5y}	Δi^{10y}	Δi^{20y}	Δi^{30y}
(A) Baseline									
β	0.69***	0.49***	0.53***	0.55***	0.49***	0.44***	0.42***	0.29***	0.27***
	(0.08)	(0.12)	(0.10)	(0.09)	(0.10)	(0.09)	(0.08)	(0.07)	(0.07)
R^2	0.42	0.41	0.51	0.60	0.57	0.51	0.56	0.34	0.35
(B) 5-year IRS rate									
β	0.50***	0.38***	0.43***	0.44***	0.44***	0.42***	0.39***	0.32***	0.26***
	(0.10)	(0.10)	(0.09)	(0.08)	(0.09)	(0.08)	(0.07)	(0.07)	(0.06)
R^2	0.26	0.30	0.39	0.47	0.55	0.56	0.59	0.49	0.41
(C) Instrumental variable estimation									
β	0.64***	0.60***	0.52***	0.65***	0.57***	0.46***	0.48***	0.32***	0.28***
	(0.12)	(0.14)	(0.12)	(0.11)	(0.10)	(0.10)	(0.08)	(0.08)	(0.08)
	0.42	0.39	0.51	0.58	0.55	0.51	0.55	0.34	0.35

Note: This table presents the results of estimating regression (1), $\Delta i_t = \alpha + \beta \Delta m_t + \varepsilon_t$, for all announcements on monetary policy changes (i.e., RRR, BIR OMO, SLF, and MLF) listed in Table A.1. The sample size is 91 for all panels.

The first row denotes the left-hand-side variable (Δi) in regression (1). i^{am} and i^{by} denote a-month and b-year sovereign yield, respectively. The right-hand-side variable (Δm) in regression (1) is measured using the 1-year IRS rate for all panels except Panel (B), in which the 5-year IRS rate is used; see text for details. Both Δm_t and Δi_t are measured over a one-day window bracketing every monetary policy announcement. All variables are expressed in percentage terms.

Heteroskedasticity-consistent standard errors are reported in parentheses. $*$, $**$, and $***$ denote significance at the 10%, 5%, and 1% level, respectively. The estimates of the intercept (α) are not of interest and hence not reported in the table.

Table 3: Persistence of monetary policy effects

	Δi^{1m}	Δi^{3m}	Δi^{6m}	Δi^{1y}	Δi^{3y}	Δi^{5y}	Δi^{10y}	Δi^{20y}	Δi^{30y}
(A) 1-day response window									
β	0.69***	0.49***	0.53***	0.55***	0.49***	0.44***	0.42***	0.29***	0.27***
	(0.08)	(0.12)	(0.10)	(0.09)	(0.10)	(0.09)	(0.08)	(0.07)	(0.07)
R^2	0.42	0.41	0.51	0.60	0.57	0.51	0.56	0.34	0.35
(B) 3-day response window									
β	0.72***	0.62***	0.62***	0.72***	0.63***	0.63***	0.47***	0.32***	0.30***
	(0.17)	(0.16)	(0.15)	(0.15)	(0.12)	(0.11)	(0.07)	(0.06)	(0.07)
R^2	0.16	0.23	0.30	0.41	0.42	0.47	0.40	0.29	0.27
(C) 5-day response window									
β	0.73**	0.69***	0.75***	0.80***	0.63***	0.64***	0.48***	0.32***	0.27***
	(0.36)	(0.24)	(0.19)	(0.17)	(0.13)	(0.10)	(0.08)	(0.06)	(0.07)
R^2	0.07	0.16	0.24	0.36	0.30	0.36	0.31	0.21	0.17
(D) 7-day response window									
β	1.07**	0.85***	0.89***	0.87***	0.79***	0.68***	0.49***	0.30***	0.25***
	(0.43)	(0.31)	(0.26)	(0.26)	(0.18)	(0.13)	(0.07)	(0.07)	(0.06)
	0.08	0.16	0.21	0.23	0.31	0.28	0.25	0.14	0.13

Note: This table presents the results of estimating regression (1), $\Delta i_t = \alpha + \beta \Delta m_t + \varepsilon_t$, using OLS for all announcements on monetary policy changes (i.e., RRR, BIR, OMO, SLF, and MLF) listed in Table A.1. The sample size is 91 for all panels.

The first row denotes the left-hand-side variable (Δi) in regression (1). i^{am} and i^{by} denote a-month and b-year sovereign yield, respectively. The right-hand-side variable (Δm) in regression (1) is measured using the one-year IRS rate for all panels; see text for details. For all panels, Δm_t is measured over a 1-day window bracketing every monetary policy announcement. For a k-day response window, $k = 1, 3, 5, 7$, Δi_t is the cumulative change in the market interest rate over k days following the monetary policy announcement. All variables are expressed in percentage terms.

Heteroskedasticity-consistent standard errors are reported in parentheses. $*$, $**$, and $***$ denote significance at the 10%, 5%, and 1% level, respectively. The estimates of the intercept (α) are not of interest and hence not reported in the table.

Table 4: Effects of different monetary policy instruments

	Δi^{1m}	Δi^{3m}	Δi^{6m}	Δi^{1y}	Δi^{3y}	Δi^{5y}	Δi^{10y}	Δi^{20y}	Δi^{30y}
(A) Required reserve ratios (RRRs)									
β	0.77***	0.46**	0.53***	0.53***	0.38***	0.33***	0.27***	0.19***	0.19***
	(0.11)	(0.17)	(0.15)	(0.14)	(0.11)	(0.11)	(0.07)	(0.06)	(0.06)
R^2	0.65	0.46	0.57	0.59	0.63	0.54	0.57	0.44	0.45
(B) Benchmark interest rates (BIRs)									
β	0.71**	0.25*	0.38***	0.51***	0.52***	0.61***	0.61***	0.42**	0.40**
	(0.27)	(0.13)	(0.08)	(0.09)	(0.12)	(0.12)	(0.14)	(0.14)	(0.14)
R^2	0.41	0.38	0.74	0.82	0.70	0.83	0.79	0.68	0.64
(C) RRRs & BIRs									
β	0.74***	0.49***	0.53***	0.57***	0.49***	0.44***	0.42***	0.28***	0.26***
	(0.08)	(0.13)	(0.10)	(0.10)	(0.10)	(0.10)	(0.09)	(0.07)	(0.07)
R^2	0.55	0.49	0.59	0.64	0.63	0.54	0.61	0.35	0.37
(D) Open market operations reverse repo rates (OMO reverse repo rates)									
β	0.27	0.41	0.46	0.26*	0.51*	0.45**	0.42*	0.36	0.32
	(0.33)	(0.37)	(0.37)	(0.13)	(0.26)	(0.21)	(0.22)	(0.21)	(0.19)
R^2	0.03	0.13	0.16	0.27	0.31	0.36	0.30	0.26	0.26
(E) Standing Lending Facility (SLF) rates & Medium-term Lending Facility (MLF) rates									
β	0.65	0.72	0.34	0.26*	0.55**	0.65**	0.64**	0.47	0.38
	(0.49)	(0.42)	(0.20)	(0.13)	(0.18)	(0.28)	(0.24)	(0.29)	(0.24)
R^2	0.12	0.14	0.18	0.20	0.35	0.35	0.52	0.32	0.24
(F) OMO reverse repo rates & SLF rates & MLF rates									
β	0.28	0.50*	0.50*	0.31***	0.43**	0.41***	0.41**	0.35**	0.31**
	(0.23)	(0.25)	(0.25)	(0.09)	(0.18)	(0.15)	(0.16)	(0.15)	(0.14)
R^2	0.03	0.19	0.23	0.34	0.29	0.33	0.32	0.28	0.26

Note: This table presents the results of estimating regression (1), $\Delta i_t = \alpha + \beta \Delta m_t + \varepsilon_t$, using OLS for six subsets of announcements on monetary policy actions listed in Table A.1. The sample size for Panels (A) through (F) is 29, 12, 41, 28, 12, and 44, respectively.
The first row denotes the left-hand-side variable (Δi) in regression (1). i^{am} and i^{by} denote a-month and b-year sovereign yield, respectively. The right-hand-side variable (Δm) in regression (1) is measured using the one-year IRS rate for all panels; see text for details. Both Δm_t and Δi_t are measured over a 1-day window bracketing every monetary policy announcement. All variables are expressed in percentage terms. Heteroskedasticity-consistent standard errors are reported in parentheses. $*$, $**$, and $***$ denote significance at the 10%, 5%, and 1% level, respectively. The estimates of the intercept (α) are not of interest and hence not reported in the table.

Table 5: Sub-period analysis

	Δi^{1m}	Δi^{3m}	Δi^{6m}	Δi^{1y}	Δi^{3y}	Δi^{5y}	Δi^{10y}	Δi^{20y}	Δi^{30y}
(A) Sample period: 5/10/2012–12/31/2020									
β	0.28	0.50*	0.50*	0.31***	0.43**	0.41***	0.41**	0.35**	0.31**
	(0.23)	(0.25)	(0.25)	(0.09)	(0.18)	(0.15)	(0.16)	(0.15)	(0.14)
R^2	0.03	0.19	0.23	0.34	0.29	0.33	0.32	0.28	0.26
(B) Sample period: 5/10/2012–10/23/2015									
	0.22	0.03	0.06	0.14	0.23*	0.22*	0.15	0.09	0.07
	(0.38)	(0.12)	(0.16)	(0.09)	(0.14)	(0.11)	(0.11)	(0.08)	(0.06)
R^2	0.02	0.00	0.01	0.09	0.13	0.19	0.11	0.06	0.06
(C) Sample period: 10/24/2015–12/31/2020									
β	0.31	1.04***	1.01**	0.52***	0.74***	0.68***	0.75***	0.68***	0.61***
	(0.26)	(0.36)	(0.36)	(0.07)	(0.24)	(0.20)	(0.20)	(0.20)	(0.20)
R^2	0.07	0.49	0.63	0.74	0.64	0.59	0.65	0.62	0.55

Note: This table presents the results of estimating regression (1), $\Delta i_t = \alpha + \beta \Delta m_t + \varepsilon_t$, using OLS for three subsets of monetary policy announcements listed in Table A.1. The sample size for Panels (A) through (C) is 44, 25, and 19, respectively.
The first row denotes the left-hand-side variable (Δi) in regression (1). i^{am} and i^{by} denotes a-month and b-year sovereign yield, respectively. The right-hand-side variable (Δm) in regression (1) is measured using the 1-year IRS rate for all panels; see text for details. Both Δm_t and Δi_t are measured over a 1-day window bracketing every monetary policy announcement. All variables are expressed in percentage terms.
Heteroskedasticity-consistent standard errors are reported in parentheses. $*$, $**$, and $***$ denote significance at the 10%, 5%, and 1% level, respectively. The estimates of the intercept (α) are not of interest and hence not reported in the table.

Table 6: One-day responses of market interest rates to central bank communications

	Δi^{1m}	Δi^{3m}	Δi^{6m}	Δi^{1y}	Δi^{3y}	Δi^{5y}	Δi^{10y}	Δi^{20y}	Δi^{30y}
(A) Baseline									
β	0.74	0.02	-0.03	0.08**	0.13**	0.09*	0.09**	0.07*	0.06*
	(0.47)	(0.05)	(0.07)	(0.04)	(0.05)	(0.05)	(0.04)	(0.04)	(0.03)
R^2	0.14	0.00	0.00	0.04	0.15	0.06	0.07	0.05	0.05
(B) 5-year IRS rate									
β	1.01*	0.10	0.10	0.23***	0.29***	0.22***	0.22***	0.18***	0.19***
	(0.56)	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.06)
R^2	0.09	0.01	0.01	0.13	0.27	0.11	0.15	0.13	0.17

Note: This table presents the results of estimating regression (1), $\Delta i_t = \alpha + \beta \Delta m_t + \varepsilon_t$, using OLS for all announcements on central bank communications (i.e., MPC and MPRs) listed in Table A.1. The sample size is 102 for both panels.
The first row denotes the left-hand-side variable (Δi) in regression (1). i^{am} and i^{by} denote a-month and b-year sovereign yield, respectively. The right-hand-side variable (Δm) in regression (1) is measured using the 1-year and 5-year IRS rate Panel (A) and (B), respectively; see text for details. Both Δm_t and Δi_t are measured over a 1-day window bracketing every monetary policy announcement. All variables are expressed in percentage terms.
Heteroskedasticity-consistent standard errors are reported in parentheses. $*$, $**$, and $***$ denote significance at the 10%, 5%, and 1% levels, respectively. The estimates of the intercept (α) are not of interest and hence not reported in the table.

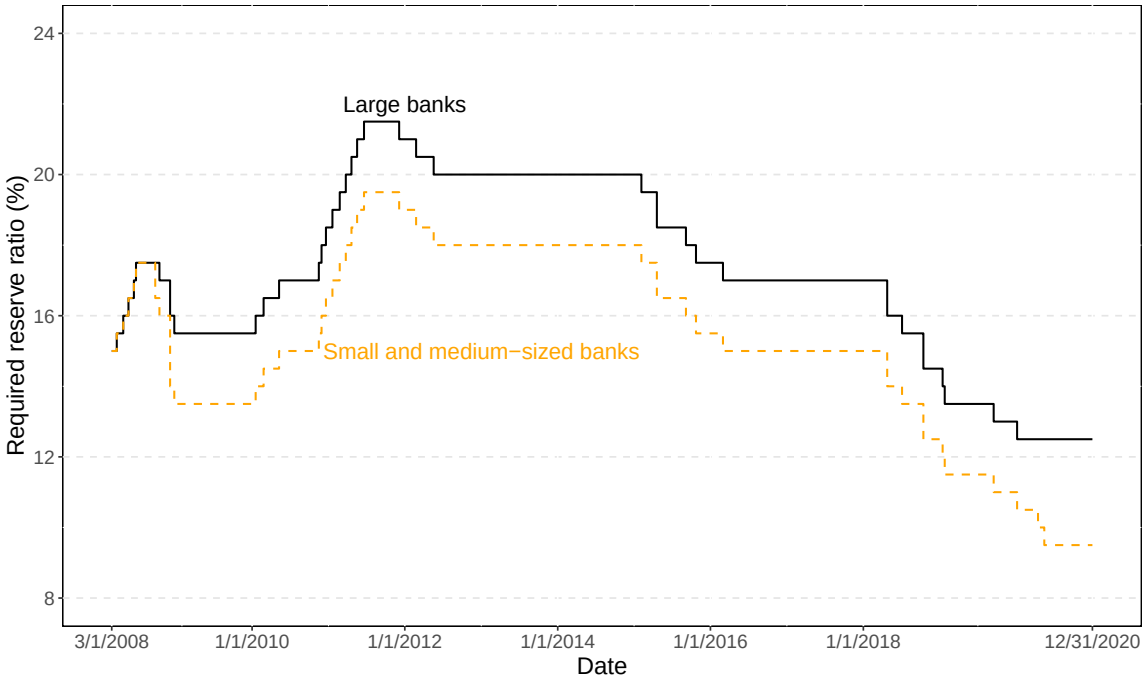
Table 7: One-day responses of stock prices to monetary policy changes

	Stock prices	R^2	No. of obs
(A) CSI 300			
All announcements	-0.045	0.05	92
	(0.032)		
RRRs & BIRs	-0.059*	0.13	47
	(0.030)		
OMOs reverse repo rates & SLF rates & MLF rates	0.055	0.02	45
	(0.102)		
(A) HSI			
All announcements	-0.039*	0.04	92
	(0.020)		
RRRs & BIRs	-0.040*	0.05	47
	(0.022)		
OMOs reverse repo rates & SLF rates & MLF rates	-0.026	0.01	45
	(0.040)		

Note: This table presents the results of estimating regression (1) with stock market indices as the outcome variables. The CSI 300 is a stock market index tracking the performance of the top 300 stocks traded on the Shanghai Stock Exchange and the Shenzhen Stock Exchange. It has been seen as the Chinese counterpart of the S&P 500 index. The Hang Seng Index (HSI) is a stock market index tracking the performance of the largest 50 companies traded on the Stock Exchange of Hong Kong

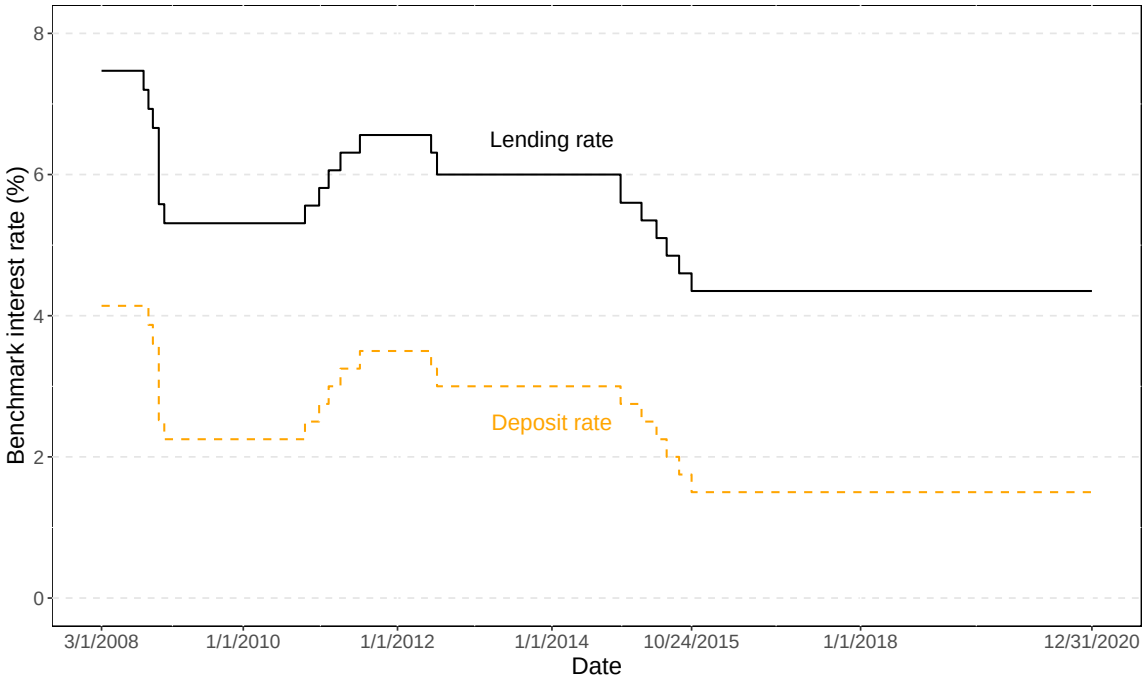
Heteroskedasticity-consistent standard errors are reported in parentheses. $*$, $**$, and $***$ denote significance at the 10%, 5%, and 1% levels, respectively. The estimates of the intercept (α) are not of interest and hence not reported in the table.

Figure 1: Required reserve ratios (3/1/2008–12/31/2020)



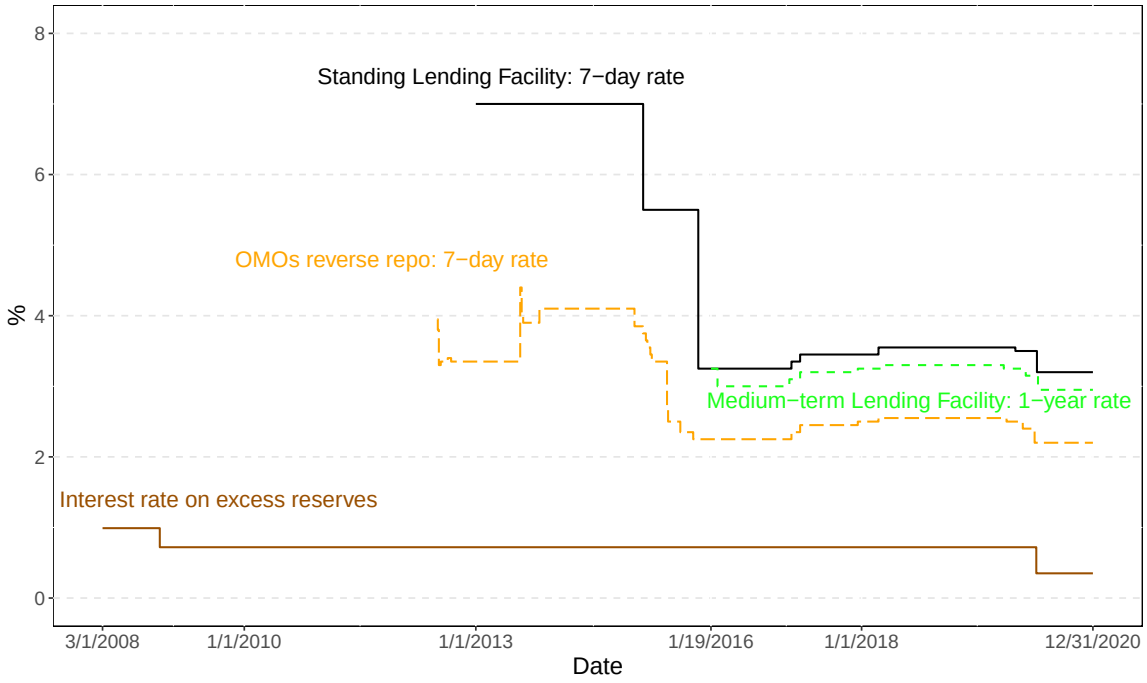
Source: Wind.

Figure 2: One-year benchmark interest rates (3/1/2008–12/31/2020)



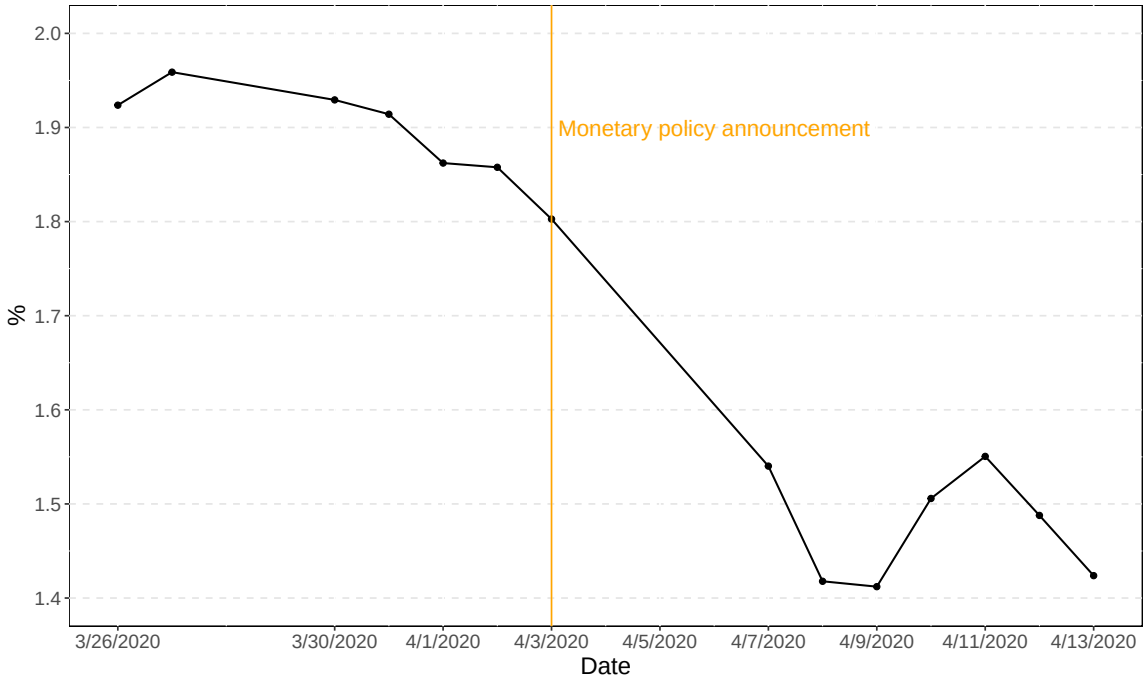
Source: Wind.

Figure 3: Various price-based monetary policy instruments (3/1/2008–12/31/2020)



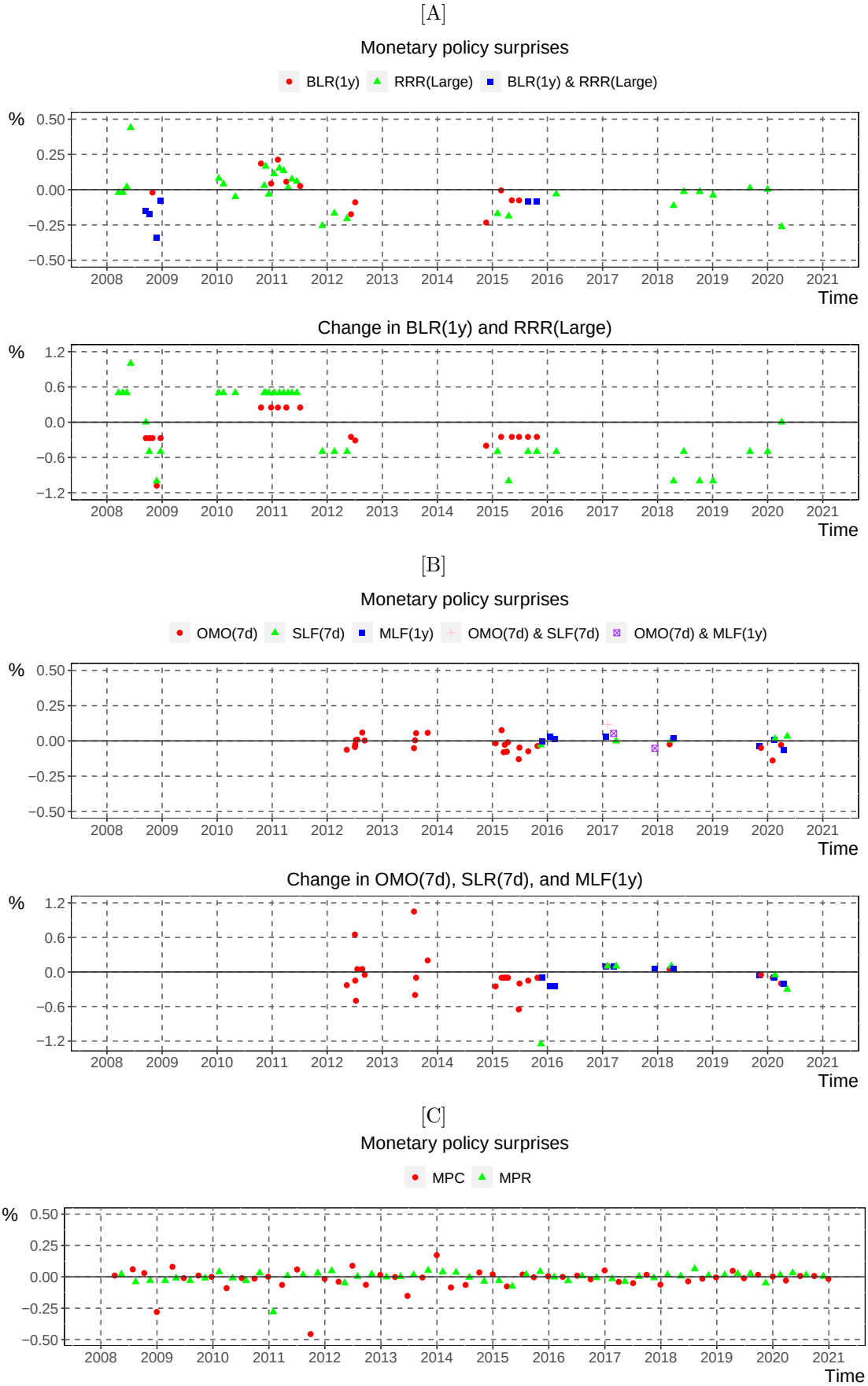
Source: Wind.

Figure 4: 1-year IRS rate around April 3, 2020



Source: Wind.

Figure 5: Monetary policy surprises



Note: BLR(1y): 1-year benchmark lending rate; RRR(Large): required reserve ratio for large commercial banks; OMO(7d): OMO reverse repo 7-day rate; SLF(7d): SLF 7-day rate; MLF(1y): MLF 1-year rate. Monetary policy surprises are measured using the 1-year IRS rate based on R007; see text for details.

Figure 6: Announcement window

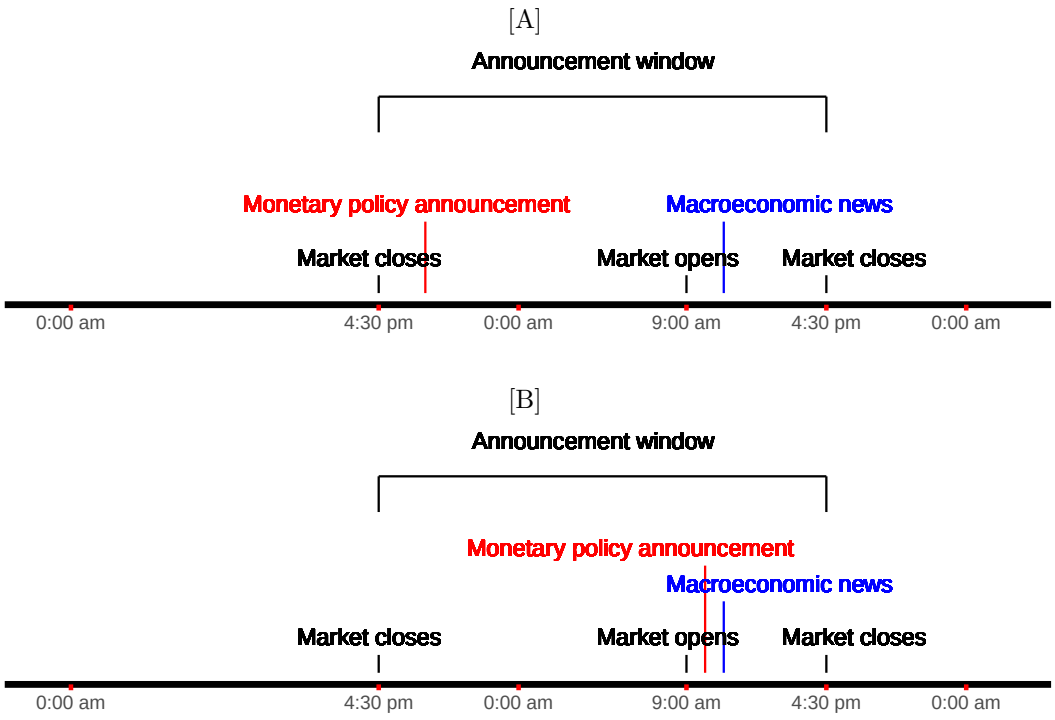
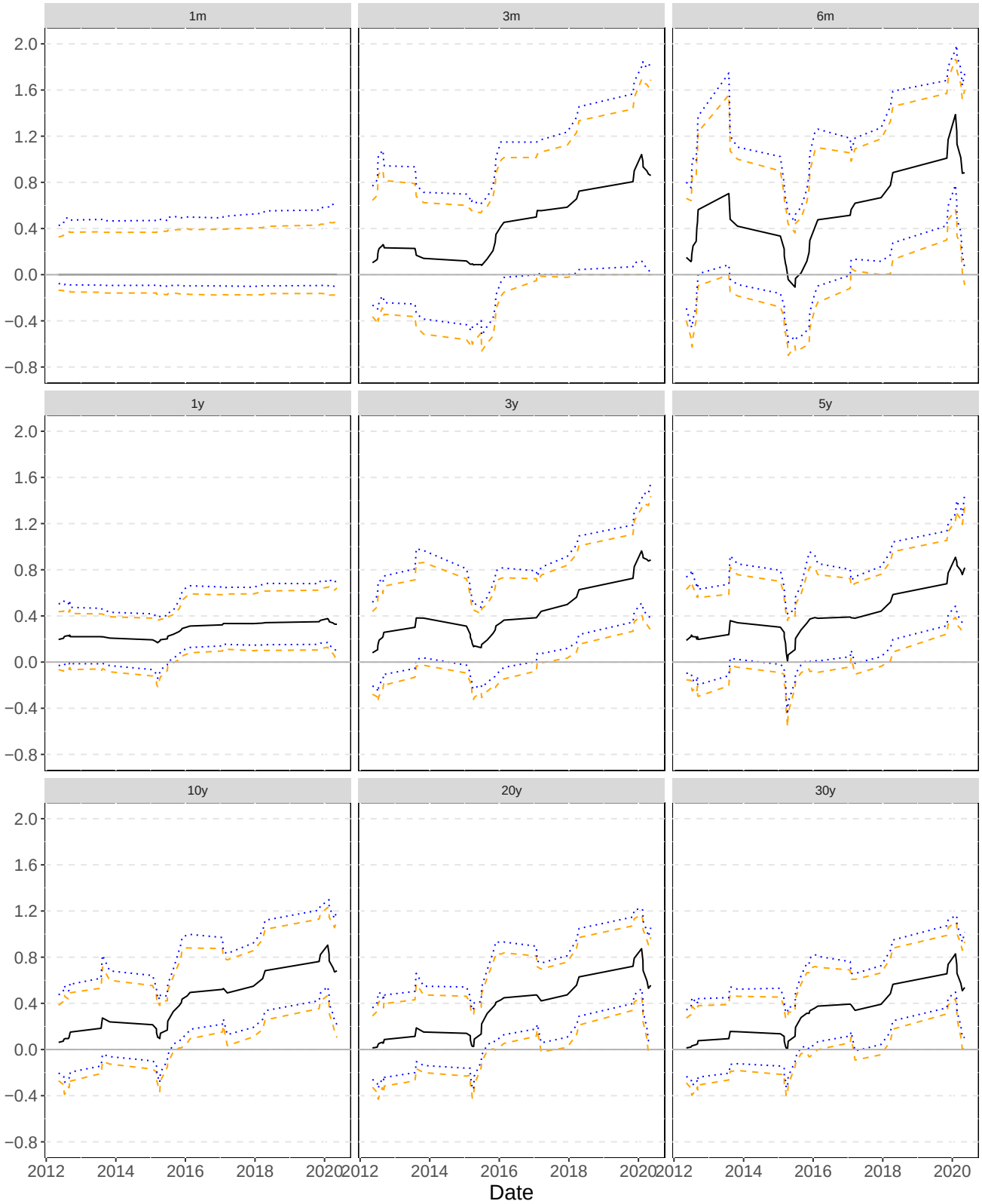


Figure 7: Time-Varying parameter regression



Note: All graphs plot estimates of β_t from estimating regression (2) using the sample of announcements involving the use of price-based monetary policy instruments (i.e., OMOs, SLF, and MLF) listed in Table A.1. The horizontal axis corresponds to time. The maturity of market interest rate used in estimations is given above each graph. The solid line represents the posterior median. The dashed and dotted lines represent the 90% and 95% posterior credible intervals, respectively.

Appendix A: Monetary Policy Announcements

Table A.1 lists 191 monetary policy announcements (with the exact timing) from March 2008 through December 2020. Table 1 provides information on the number of each type of monetary policy announcements.

The PBC does not publish a calendar of announcement dates but announces policy actions at its discretion on various platforms. We collect the information on the exact timing of each announcement from various sources, including the PBC's website, the PBC's Weibo account, and the financial press. Table A.2 provides details on sources of information used to identify the exact timing of the announcements in Table A.1.

Table A.1: Monetary policy announcements (3/1/2008–12/31/2020)

Date		Time[a]	RRRs[b]	BIRs[c]	OMO[d]	SLF[e]	MLF[f]	MPC[g]	MPRs[h]
2008	3/18	18:00:00	0.50%						
	3/31	16:55:00						*	
	4/16	17:00:00	0.50%						
	5/12	16:20:00	0.50%						
	5/14	17:59:00							*
	6/7	18:07:00	1.00%						
	7/27	18:50:00						*	
	8/15	16:23:00							*
	9/15	17:01:00	0[i]	-0.27%					
	10/8	18:58:00	-0.50%	-0.27%					
	10/10	17:00:00						*	
	10/29	19:00:00		-0.27%					
	11/17	18:59:00							*
	11/26[j]	16:45:00	-1.00%	-1.08%					
	12/22	18:32:00	-0.50%	-0.27%					
	12/31	18:10:00						*	
2009	2/23	19:41:00							*

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Date		Time[a]	RRRs[b]	BIRs[c]	OMO[d]	SLF[e]	MLF[f]	MPC[g]	MPRs[h]
	4/12	20:00:57						*	
	5/6	16:10:00							*
	6/25	20:52:57						*	
	8/5	17:00:00							*
	9/29	16:32:00						*	
	11/11	16:00:00							*
	12/23	15:30:00						*	
2010	1/12	19:00:00	0.50%						
	2/11	18:20:09							*
	2/12	18:00:00	0.50%						
	3/31	16:58:49						*	
	5/2	18:43:27	0.50%						
	5/10	17:30:05							*
	7/8	15:50:02						*	
	8/5	18:45:48							*
	9/29	16:53:00						*	
	10/19	18:59:36		0.25%					
	11/2	18:21:02							*
	11/10	18:45:00	0.50%						
	11/19	17:59:46	0.50%						
	12/10	18:00:01	0.50%						
	12/25	17:35:21		0.25%					
	12/27	17:36:29						*	
2011	1/14	17:55:26	0.50%						
	1/30	19:23:48							*
	2/8	18:30:30		0.25%					
	2/18	18:02:18	0.50%						
	3/18	18:20:56	0.50%						
	3/28	15:58:09						*	

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Date		Time[a]	RRRs[b]	BIRs[c]	OMO[d]	SLF[e]	MLF[f]	MPC[g]	MPRs[h]
	4/5	18:00:14		0.25%					
	4/17	17:02:15	0.50%						
	5/3	18:35:17							*
	5/12	18:30:02	0.50%						
	6/14	15:18:25	0.50%						
	7/4	17:33:14						*	
	7/6	18:32:12		0.25%					
	8/12	16:13:59							*
	9/30	17:30:26						*	
	11/16	15:30:00							*
	11/30	19:03:42	-0.50%						
	12/31	16:00:46						*	
2012	2/15	17:07:02							*
	2/18	20:00:00	-0.50%						
	3/31	17:00:00						*	
	5/10	10:36:55			-0.23%				
	5/10	19:02:49							*
	5/12	19:00:00	-0.50%						
	6/7	19:00:00		-0.25%					
	6/28	10:24:26			0[k]			*	
	6/29	17:00:00						*	
	7/3	10:21:10			0[k]				
	7/5	10:19:40			-0.15%				
	7/5	19:00:00		-0.31%					
	7/10	10:16:39			-0.50%				
	7/19	10:15:26			0.05%				
	8/2	17:22:09							*
	8/21	10:30:20			0.05%				
	8/28	10:31:46			0[k]				

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Date		Time[a]	RRRs[b]	BIRs[c]	OMO[d]	SLF[e]	MLF[f]	MPC[g]	MPRs[h]
	9/4	10:15:46			0[k]				
	9/6	10:20:40			-0.05%				
	9/11	10:28:42			0[k]				
	9/25	17:00:00						*	
	11/2	18:06:12							*
	12/28	16:00:00						*	
2013	2/6	18:49:42							*
	4/3	16:09:23						*	
	5/9	18:43:08							*
	6/23	17:01:11						*	
	7/30	10:27:14			1.05%				
	8/2	17:29:20							*
	8/6	10:24:54			-0.40%				
	8/13	10:12:10			-0.10%				
	9/29	18:01:58						*	
	10/29	10:16:13			0.20%				
	11/5	16:12:14							*
	12/31	12:00:36						*	
2014	2/8	18:52:32							*
	4/3	17:12:52						*	
	5/6	18:55:09							*
	7/7	15:01:02						*	
	8/1	20:02:13							*
	10/5	12:36:56						*	
	11/6	17:23:57							*
	11/21	18:30:15		-0.40%					
	12/31	16:01:06						*	
2015	1/22	10:18:01			-0.25%				
	2/4	18:21:17	-0.50%						

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Date		Time[a]	RRRs[b]	BIRs[c]	OMO[d]	SLF[e]	MLF[f]	MPC[g]	MPRs[h]
	2/10	17:47:18							*
	2/28	17:54:59		-0.25%					
	3/3	9:46:09			-0.10%				
	3/4	12:34:00				-1.5%			
	3/17	9:46:03			-0.10%				
	3/24	9:45:55			-0.10%				
	4/3	17:02:52						*	
	4/7	9:45:52			-0.10%				
	4/14	9:45:53			-0.10%				
	4/19	17:01:07	-1.00%						
	5/8	17:51:52							*
	5/10	17:00:54		-0.25%					
	6/25	9:45:50			-0.65%				
	6/27	16:55:24		-0.25%					
	6/30	9:46:10			-0.20%				
	7/14	17:12:42						*	
	8/7	18:19:14							*
	8/25	18:15:34	-0.50%	-0.25%					
	8/27	9:46:04			-0.15%				
	9/25	17:00:00						*	
	10/23	19:17:52	-0.50%	-0.25%					
	10/27	9:45:35			-0.10%				
	11/6	19:15:23							*
	11/19	17:00:00				-1.25%			
	11/27	17:00:00					0[l]		
	12/28	16:59:00						*	
2016	1/19	19:32:00					-0.25%		
	2/6	14:10:10							*
	2/19	16:37:00					-0.25%		

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Date		Time[a]	RRRs[b]	BIRs[c]	OMO[d]	SLF[e]	MLF[f]	MPC[g]	MPRs[h]
	2/29	18:00:00		-0.50%					
	4/1	16:00:10						*	
	5/6	19:57:59							*
	7/4	18:50:00						*	
	8/5	19:09:56							*
	9/30	17:00:00						*	
	11/8	19:05:39							*
	12/30	17:00:00						*	
2017	1/24	16:13:00					0.10%		
	2/3	9:46:50			0.10%				
	2/3	14:18:55				0.10%			
	2/17	19:44:17							*
	3/16	9:46:29			0.10%	0.10%	0.10%		
	4/1	17:34:00						*	
	5/12	19:47:16							*
	7/4	16:30:00						*	
	8/11	20:37:37							*
	9/30	17:00:00						*	
	11/17	22:43:24							*
	12/14	9:46:09			0.05%		0.05%		
	12/29	17:00:00						*	
2018	2/14	17:24:57							*
	3/22	9:46:12			0.05%	0.05%			
	4/17	9:46:14					0.05%		
	4/17	18:26:32		-1.00%					
	5/11	21:09:24							*
	6/24	17:02:18		-0.50%					
	6/28	19:05:54						*	
	8/10	21:35:21							*

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Date		Time[a]	RRRs[b]	BIRs[c]	OMO[d]	SLF[e]	MLF[f]	MPC[g]	MPRs[h]
	9/29	17:00:00						*	
	10/7	11:49:46		-1.00%					
	11/9	22:15:03							*
	12/27	16:16:48						*	
2019	1/4	17:20:40		-1.00%					
	2/21	19:42:13							*
	4/15	17:38:20						*	
	5/17	20:24:55							*
	6/27	17:00:01						*	
	8/9	21:52:59							*
	9/6	17:22:05		-0.50%					
	9/27	19:17:17						*	
	11/5	9:46:16					-0.05%		
	11/16	9:00:00							*
	11/18	9:46:10			-0.05%				
2020	1/1	10:00:00						*	
	1/1	15:07:56		-0.50%					
	2/3	9:46:30			-0.10%				
	2/17	9:46:49					-0.10%		
	2/19	20:29:12				-0.05%			*
	3/27	20:32:33						*	
	3/30	9:45:05			-0.20%				
	4/3[j]	16:57:32		0[i]					
	4/15	9:45:15					-0.20%		
	5/10	9:00:20				-0.30%			*
	6/28	18:04:00						*	
	8/6	18:01:45							*
	9/28	17:36:22						*	
	11/26	17:00:36							*

(continued on next page)

Date	Time[a]	RRRs[b]	BIRs[c]	OMO[d]	SLF[e]	MLF[f]	MPC[g]	MPRs[h]
12/29	18:00:01						*	

Note: *a*. Beijing time (GMT+8).

b. RRRs denotes requited reserve ratios; change in the ratio that applies to large commercial banks is shown in the table. *Sources*: Reserve requirements; Press releases.

c. BIRs denotes benchmark interest rates; change in the 1-year lending rate is shown in the table. The benchmark interest rates have not been adjusted since October 23, 2015. *Sources*: Interest rate policy; Press releases.

d. OMO denotes open market operations reverse repo; change in the interest rate on 7-day reverse repo is shown in the table. *Sources*: Open market operations.

e. SLF denotes Standing Lending Facility; change in the interest rate on 7-day SLF is shown in the table. *Sources*: Standing Lending Facility; Weibo account of the PBC.

f. MLF denotes Medium-term Lending Facility; change in the interest rate on 1-year MLF is shown in the table. *Sources*: Open market operations; Weibo account of the PBC.

g. MPC denotes press releases of quarterly monetary policy committee meetings. *Sources*: Monetary Policy Committee; Activities of governors.

h. MPRs denotes releases of quarterly monetary policy reports. *Sources*: Monetary Policy Report.

i. In these two cases, the required reserve ratio for large commercial banks was unchanged, while the ratio for small- and medium-sized banks was cut by 1%.

j. In these two cases, the interest rate on excess reserves was cut by 0.27% and 0.37%, respectively.

j. In these five cases, the interest rate on 7-day reverse repo was unchanged, while the rate on 14-day reverse repo was cut by 0.05%.

l. In this case, the interest rate on 1-year MLF was unchanged, while the rate on 6-month MLF was cut by 0.1%.

Table A.2: Sources of monetary policy announcements

Interest rate policy	http://www.pbc.gov.cn/zhengcehuobisi/125207/125213/125440/125835/17091/index1.html
Reserve requirements	http://www.pbc.gov.cn/zhengcehuobisi/125207/125213/125434/125798/index.html
Open market operations	http://www.pbc.gov.cn/zhengcehuobisi/125207/125213/125431/125475/17081/index1.html
Standing Lending Facility	http://www.pbc.gov.cn/zhengcehuobisi/125207/125213/125443/125857/index.html
Monetary policy committee meetings	http://www.pbc.gov.cn/zhengcehuobisi/125207/3870933/3870936/af7dde41/index1.html
Monetary policy reports	http://www.pbc.gov.cn/zhengcehuobisi/125207/125227/125957/index.html
Press releases	http://www.pbc.gov.cn/goutongjiaoliu/113456/113469/index.html
Activities of governors	http://www.pbc.gov.cn/hanglingdao/128697/128719/128769/index.html
Weibo account of the PBC	