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Monetary Stimulus Amidst the Infrastructure Investment Spree: Evidence from China's Loan-Level Data

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ABSTRACT

We study the impacts of the 2009 monetary stimulus and its interaction with infrastructure spending on credit allocation. We develop a two-stage estimation approach and apply it to China's loan-level data that covers all sectors in the economy. We find that except for the manufacturing sector, monetary stimulus itself did not favor SOEs over non-SOEs in credit access. Infrastructure investment driven by non-monetary factors, however, enhanced the monetary transmission to bank credit allocated to LGFVs in infrastructure and at the same time weakened the impacts of monetary stimulus on bank credit to non-SOEs in sectors other than infrastructure.

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I. Introduction

During economic crises such as the 2008 global financial crisis, central banks around the world (Federal Reserve System, European Central Bank, Bank of Japan, and People's Bank of China) initiated massive monetary stimulus by providing ample money supply in an attempt to bolster bank loans to businesses and rescue the sagging economy.[1] At the same time, policymakers sought to expand public investment, especially on infrastructure, to boost domestic demands. How monetary stimulus, by interacting with expansionary public investment, translates into credit allocation to firms and businesses has been one of the central issues both in the macro-finance literature and for policymakers. Empirical evidence on this issue, however, has been scant for both developed and emerging-market economies.

This paper addresses this issue from the perspective of China, the second largest economy in the world. During the 2008 global financial crisis, growth of China's real gross domestic product (GDP) plummeted from 13.6% in 2007Q2 to 6.4% in 2009Q1 (top chart of Figure 1). In an attempt to stem the sharp fall of aggregate output the People's Bank of China (PBC) pursued extraordinarily expansionary monetary policy and increased M2 supply by 4.2 trillion RMB in 2009Q1 alone and by a total of 11.5 trillion RMB during the 2009Q1-Q3 period. Accordingly, the growth rate of total bank loans jumped to more than 25% during the same period (bottom chart of Figure 1). Meanwhile, the State Council announced in November 2008 a fiscal expansion plan throughout the country. As Xiong (2019) argues, local governments' infrastructure investment plays a prominent role in understanding China's economic growth. In particular, the government prioritized infrastructure investment as an effective way to stimulate the overall economy after the 2008 global financial crisis. As shown in Figure 2, infrastructure investment growth increased to more than 30% during 2009, in contrast to more moderate growth of investment in other sectors. Such a monetary-fiscal policy mix makes China an ideal case study to help gain a general perspective of how monetary stimulus and its interaction with public investment driven by non-monetary shocks, such as fiscal shocks, affect the banking system and the real economy.

In this paper, we focus on a specific twofold question. How did the 2009 monetary stimulus alone translate into credit allocations between different types of firms? How did infrastructure investment affect the monetary transmission mechanism? We construct a proprietary micro dataset of new loans issued by the 17 largest Chinese banks to individual firms over all sectors in the entire economy.[2] Our dataset allows us to provide an empirical analysis beyond the manufacturing sector and to show that other major sectors such as infrastructure and real estate played a crucial role in the monetary transmission to the credit market.

The main empirical challenge we face is to identify monetary stimulus from other aggregate shocks that drive the fluctuation of infrastructure investment. Although fiscal policy plays

[1]Monetary policy, as well as fiscal policy, has been also expansionary since the outbreak of Covid-19.

[2]For every one RMB loan allocated to the economy, 0.8 RMB is from these 17 largest banks. Thus, loans originated from these commercial banks constitute a vast majority of bank loans in the Chinese economy.

an important role in public or infrastructure investment (Leeper, Walker, and Yang, 2010), a large fiscal expansion is often joined by a "tsunami of bank credit expansion" (Brunnermeier, Sockin, and Xiong, 2017; Leeper, 2019). A failure to distinguish the effects of monetary stimulus from those of infrastructure investment driven by non-monetary factors, such as fiscal policy changes, would result in biased estimates of the effects of monetary stimulus itself and its interaction with infrastructure investment.

To correct for this endogeneity bias, we develop a two-stage empirical framework. In the first stage, we develop a dynamic macro model to disentangle exogenous monetary policy changes from other aggregate shocks in a system of equations. This multi-variable macro model enables one to purge the portion of infrastructure investment fluctuation driven by exogenous monetary policy changes and extract a series of infrastructure investment driven only by shocks orthogonal to monetary policy shocks. In the second stage, we apply a dynamic panel model to our unique loan-level data and estimate the impacts of monetary stimulus and its interaction with infrastructure investment on newly issued loans. We show that without the first stage estimation, the estimated interaction effect of monetary policy shocks with infrastructure investment would be severely biased downward. To our knowledge, this is a new methodological contribution to the macro-finance literature.

We begin our empirical analysis by following the existing literature and applying our dynamic panel model to the manufacturing sector. We find that bank credit in response to the 2009 monetary stimulus was disproportionately allocated to state-owned enterprises (SOEs) in the manufacturing sector.[3] The infrastructure investment spree spurred by non-monetary shocks such as fiscal shocks reduced the monetary effects on bank credit to manufacturing non-SOEs, but not to manufacturing SOEs. Both of these findings are consistent with the results in the existing literature.[4] For the economy as a whole, however, we find that (a) monetary stimulus by itself did not generate favorable credit access enjoyed by SOEs over non-SOEs and (b) when interacting with infrastructure investment, it had opposite effects on SOEs and non-SOEs—a positive effect on SOE loans but a negative effect on non-SOE loans. These opposite effects, both economically and statistically significant, did not exist in the manufacturing sector.

To understand why the monetary transmission mechanism within the manufacturing sector differs from that outside of manufacturing, we extend our analysis to other major sectors of the economy. These other sectors are infrastructure, real estate, and the rest of the economy. We ask whether the 2009 monetary stimulus itself spawned preferential bank

[3]For the Chinese economy, it is essential to study how credit and capital are allocated to state-owned enterprises (SOEs) versus non-SOEs as the literature has documented that SOEs are less efficient than non-SOEs (see, for example, Hsieh and Klenow (2009), Cong, Gao, Ponticelli, and Yang (2019), and Huang, Pagano, and Panizza (Forthcoming)).

[4]Cong, Gao, Ponticelli, and Yang (2019) find that SOEs in the manufacturing sector enjoyed preferential credit access over non-SOEs during the stimulus period. Huang, Pagano, and Panizza (Forthcoming) find that local government debt crowded out private investment, but not investment by state-owned firms, in the manufacturing sector.

loans to SOEs in sectors other than manufacturing and whether infrastructure investment driven by non-monetary shocks amplified or dampened the monetary transmission to credit allocation to SOEs versus non-SOEs. In contrast to the manufacturing sector, we find that the 2009 monetary stimulus did not favor SOEs over non-SOEs in loan allocations to the non-manufacturing sector. Unlike manufacturing firms, most non-SOEs in infrastructure and real estate were capital intensive and thus enjoyed implicit government guarantees of their bank loans and, by the same token, bank credit to non-SOEs in the rest of the economy was mainly in capital intensive sectors such as wholesale and retail trades.

On the other hand, while weakening the monetary transmission to bank credit allocated to non-SOEs in sectors other than infrastructure, infrastructure investment enhanced this transmission to SOE loans within the infrastructure sector. We find that significantly positive interaction effects of monetary stimulus on bank credit to SOEs in the infrastructure sector were entirely driven by local government financing vehicles (LGFVs), since bank loans to LGFVs enjoyed *explicit* local government guarantees.[5] With the total loan volume made by commercial banks severely constrained by the PBC's regulations, it is not surprising that an increase of infrastructure spending dampened the expansionary monetary effect on bank credit to non-SOEs in sectors other than infrastructure.

How important was this credit channel for monetary policy to stimulate capital investment? In the last part of the paper, we address this question in two steps. We first estimate the elasticity of investment to bank credit by merging the publicly available China Stock Market & Accounting Research (CSMAR) database, which has business investment information, and our proprietary banking database, which has firm-quarter loan information. We then provide a back-of-envelope calculation of the response of investment to the 2009 monetary stimulus by taking into account both the estimated elasticity of investment to bank credit and the estimated elasticity of bank credit to monetary stimulus. We find that for the economy as a whole, the 2009 monetary stimulus itself generated higher investment by non-SOEs, while infrastructure spending amplified the monetary effect on investment by SOEs but dampened that effect on investment by non-SOEs. In sum, the total response of SOE investment to the 2009 monetary stimulus was larger than that of non-SOE investment. The infrastructure spending spree, therefore, was the key for understanding the effect of the 2009 monetary stimulus on reallocation of both credit and investment from non-SOEs to SOEs in the economy as a whole.

Our paper is related to the emerging empirical literature on China's post-2008 economic stimulus plan. Cong, Gao, Ponticelli, and Yang (2019) study the effect of an increase in bank credit supply on credit reallocation between SOEs and non-SOEs, while Huang, Pagano, and Panizza (Forthcoming) explore the impact of credit expansion by local governments on

[5]LGFVs are special SOEs that were heavily used by local governments to finance infrastructure investment during the stimulus period (Bai, Hsieh, and Song, 2016). Chen, He, and Liu (2020) attribute a rising shadow banking to a decrease in local government borrowing in 2012-2015.

business investment. Both papers focus on the manufacturing sector exclusively. Our paper makes several contributions to this literature. First, our paper is the first to disentangle monetary stimulus from infrastructure investment driven by non-monetary shocks such as fiscal shocks (the two major components of the 2009 economic stimulus package), and studies the impacts of their interaction on credit allocation. The existing studies identify local credit shocks without identifying macroeconomic policies underlying the increase of credit supply. Our new framework helps shed light not only on the impact of monetary stimulus itself, but also on how it interacts with the infrastructure spending spree in affecting credit and capital reallocation.

Second, we exploit the micro loan data beyond the manufacturing sector. Cong, Gao, Ponticelli, and Yang (2019) use this loan-level data to study the impact of the 2009 economic stimulus on credit reallocation between SOEs and non-SOEs within the manufacturing sector. But bank lending to the manufacturing sector accounted for only 23% of all newly originated bank loans in 2008 and thus an analysis confined to manufacturing provides an incomplete picture of the whole economy. By extending the sample to the entire economy, we establish the evidence that except for manufacturing firms, the 2009 monetary stimulus itself did not favor SOEs in credit access over non-SOEs and that infrastructure investment played a central role in the monetary transmission to credit reallocation from non-SOEs to SOEs.

Third, this effect of monetary stimulus interacting with infrastructure investment is new to the existing literature. Because infrastructure spending potentially has a positive spillover to other sectors of the economy (Ru, 2018) and at the same time loans originated by commercial banks are constrained by the PBC regulations, there is no a priori knowledge of how infrastructure investment would affect the monetary transmission mechanism. Our empirical findings suggest that as long as implicit or explicit government guarantees of commercial loans to infrastructure projects exist, infrastructure investment financed by commercial banks will undermine the effectiveness of monetary policy in channeling loans to private firms.

In addition to the literature discussed above, our paper also relates to two other strands of literature. One studies the impacts of unconventional monetary policy on bank lending through the credit channel.[6] By "unconventional" we mean monetary policy stimulus through direct money supply instead of interest rates. Most of these previous studies examine the impacts of the Federal Reserve's large scale asset purchases (LSAPs) on the financial market or the credit market during and after the 2008 financial crisis, with a finding that increases of bank credit in response to massive monetary stimulus were disproportionate across different types of firms or loans. The other strand studies the effectiveness of infrastructure investment in the 2009 American Recovery and Reinvestment Act with mixed findings.[7]

[6]See, for example, Foley-Fisher, Ramcharan, and Yu (2016), Kandrac and Schlusche (2017), Rodnyansky and Darmouni (2017), Acharya, Eisert, Eufinger, and Hirsch (2019), Cloyne, Ferreira, and Surico (2020), and Chakraborty, Goldstein, and MacKinlay (2020).

[7]See, among others, Wilson (2012), Feyrer and Sacerdote (2012), Leduc and Wilson (2013), Conley and Dupor (2013), Leduc and Wilson (2017), Ramey (2019), and Garin (2019).

Our paper complements these strands of literature but places a special emphasis on how infrastructure investment driven by non-monetary factors can influence the transmission of monetary policy on credit allocation and investment, a perspective largely overlooked by the existing literature. Our paper sheds light on the heterogeneous monetary impacts that were driven by two factors: (a) the interaction between monetary policy and infrastructure investment and (b) the explicit or implicit government guarantees enjoyed by certain type of firms. Both factors influenced the transmission of monetary stimulus to credit allocations across firms of different ownership structures and across sectors.

The rest of the paper is organized as follows. Section II provides necessary institutional facts that are highly relevant to our empirical studies. Section III describes the datasets used for our estimation and provides relevant summary statistics. Section IV proposes a new two-state dynamic empirical framework comprised of both macro and micro models. We document the impact of monetary stimulus on credit allocation and investment in Section V and Section VI. Section VII offers some concluding remarks.

II. Institutional Background

II.1. **Monetary and fiscal policies prior to 2009.** Prior to 1994, China's monetary policy was under inordinate influence of its fiscal authority. Fiscal deficits were primarily financed by the central bank. At the end of 1993, however, the Chinese government announced its decision to decouple monetary policy from fiscal policy completely. On December 25, 1993, the State Council issued the well-known No. 19 notice "Decision of the State Council on Reform of the Financial System." This notice stated the twofold goal of the financial reform. At the macro level, the central bank was to establish a regulatory system that was independent of control by the fiscal authority and allowed the monetary authority to implement its policy away from the influence of the fiscal authority. At the micro level, a financial system was established to separate commercial banks' lending business from direct lending from the government through its own policy banks. This separation allowed commercial banks to make loans based on their own profitability. And the People's Bank of China Law enacted in 1995 explicitly forbade the PBC from lending directly to local governments, non-banking firms, or individuals, and from providing loan guarantees to these entities. To strengthen separation of monetary policy from fiscal policy, the PBC was not allowed to purchase government bonds issued by the Ministry of Finance or to finance local government debts. Prior to 2009, moreover, local governments were restrained from tapping loans from commercial banks to finance infrastructure investment.

China's monetary policy has been quantity-based until recently. That is, the PBC targeted growth of M2 supply, not any interest rate as does monetary policy in the U.S. or European countries. In 1993, the PBC announced various indices of monetary supply to the public. In 1996, it began a transition to using the money supply as an instrument for monetary policy at the national level. In 1998, the PBC announced that M2 growth was the sole policy target.

In May of that year, open market operations were initiated to carry out meeting this target. From then to 2017, China adhered to this quantity-based monetary policy framework both in its public announcements and in practice. Other policy tools, including reserve requirements, lending and deposit rates, and window guidance, were all designed to support the targeted growth of M2.

II.2. **China's stimulus package in 2009.** In response to the 2008 global financial crisis, China implemented a series of stimulus policies to support the government's 4 trillion RMB investment plan. Although the media focused its attention to the initial 4 trillion figure itself, actual stimulus measures comprised a combination of the fiscal initiative to stimulate investment and a regime switch of monetary policy to massive liquidity injections into the banking system.[8]

The investment plan announced by Premier Wen Jiabao on 5 November 2008 was to fund a number of investment projects with 4 trillion RMB (the equivalent of 586 billlion USD). The plan targeted seven key areas of investment and the most important area was infrastructure. Investment in infrastructure was funded by 1.87 trillion RMB, which accounted for 46.8% of all investment funding in the stimulus package.[9] The infrastructure spending included 1.5 trillion RMB for transport and power infrastructure such as railways, roads, airports, water conservation, and urban power grids, and 0.37 trillion RMB for rural village infrastructure. In the 2009 Report on the Work of Government (RWG), infrastructure investment was given a priority for the purpose of boosting domestic demand and sustaining GDP growth.[10] By contrast, the American Recovery and Reinvestment Act passed in January 2009 authorized only 70 billion out of the 800 billion USD stimulus package to financing investment in infrastructure and transportation (Boehm, Forthcoming).

Infrastructure projects played a shovel-ready role in speedy implementation of the government's fiscal stimulus plan. According to the announcement by the Ministry of Finance, 44.4% of the central government's planned 908 billion RMB public investment for 2009 was already completed by April 1, most of which was allocated to infrastructure. Although the original stimulus plan was to allocate all funding over 27 months from the fourth quarter of 2008 through 2010, a majority of infrastructure funding was spent by the end of 2009. As can be seen from Figure 2, the year-over-year growth rate of real infrastructure investment in the first three quarters of 2009 reached as high as 36%. Most infrastructure investment was initiated by local governments; in 2009, the SOE share of infrastructure investment was about 90%.

[8]The other stimulus measures included tax cuts and SOE bailouts (Wong, 2011).

[9]The remaining investment funding included 1 trillion RMB for earthquake reconstruction, 0.40 trillion RMB for affordable housing, 0.15 trillion RMB for health and education, and 0.58 trillion RMB for environment protection and technological innovations.

[10]For the details of the State Council's 2009 RWG, see `http://www.gov.cn/test/2009-03/16/content_1260221_2.htm`.

Although the real estate sector was not part of the post-2008 investment plan, the central government changed various policies in favor of real estate at the end of 2008 and in 2009. In October 2008, for example, the government reduced the minimum mortgage interest rate to 70% of the benchmark interest rate and the down payment ratio for a second home to 30% of the purchase price. According to the State Council's No. 27 notice issued in May 2009, the minimum ratio of capital to assets for real estate developers was reduced to 20%.

Another key component of the stimulus package was monetary stimulus. The State Council's 2009 RWG planned an extraordinary increase in M2 to provide ample liquidity to the banking system. As a result, monetary policy switched to an unprecedentedly accommodative regime with year-over-year growth of M2 reaching over 25% by the end of 2009 (Figure 1). To prepare for achieving such high growth rates of M2 in 2009, the PBC reduced the required reserve ratio four times during the final four months of 2008, from 17.5% to 13.5% for small and medium-sized banks and from 17.5% to 15.5% for large banks, until January 2010.

In December 2008, the State Council issued a decree that called on commercial banks to increase lending to key nonfinancial sectors such as infrastructure and encouraged commercial banks to provide credit support for "sound enterprises that faced temporary financial difficulties."[11] To implement the post-2008 4 trillion investment plan, the State Council eliminated all credit quotas previously imposed on commercial banks and encouraged the supply of bank loans to key government projects. With the banking system saturated with M2 liquidity in 2009, the PBC and the China Banking Regulatory Commission (CBRC) in March 2009 jointly issued a notice that called on commercial banks to provide credit support for qualified large-scale central government investment projects by adjusting their loan compositions.[12]

Commercial banks responded to this notice swiftly. For instance, the Industrial and Commercial Bank of China, one of the five largest state banks in China, stated in its 2009 Annual Report: "The bank accelerated adjustment of its credit policies and promoted production innovations by increasing credit support to major customers in infrastructure areas and the disbursement of loans to medium-term to long-term quality projects that are in line with the orientation of the state policy of boosting domestic demand." As a result, newly issued bank loans reached 9.6 trillion RMB in 2009, of which 7.1 trillion RMB was allocated to the public sector.

II.3. **Funding sources of the investment plan—the role of LGFVs.** The central government was committed to funding 29.5% of the 4 trillion RMB investment plan (1.18 trillion RMB). Over 80% of this financial commitment from the central government was planned for the year 2009. According to the 2009 RGW, the central government budget deficit of 750

[11]For official details, see http://www.csrc.gov.cn/pub/shenzhen/xxfw/tzzsyd/ssgs/zh/zhxx/201409/t20140918_260555.htm.
[12]See http://www.gov.cn/gongbao/content/2009/content_1336375.htm.

billion RMB in 2009, 570 billion RMB more than the 2008 budget, was to be financed by issuing government bonds.

The remaining 2.82 trillion RMB in the investment plan was to be funded by local government budgets, corporate bonds, private funds, and bank loans. This financing arrangement was in contrast to the stimulus program in the U.S., which was funded largely through federal government debt. Under the 1994 Budget Law (i.e. the "Old Budget Law" in effect until January 1, 2015), however, a local government in China was prohibited from borrowing from commercial banks or issuing municipal bonds. To meet the funding needs of local governments for implementing the investment plan, the central government issued additional government bonds in the amount of 200 billion RMB for local governments that participated in the investment plan. The total central government deficit was planned to be 3% of GDP (950 billion RMB).

In addition to the central government's direct funding, local governments created LGFVs as a financing platform to raise money for financing infrastructure projects. The creation of LGFVs for these financing purposes was officially endorsed by the central government. According to the joint No. 92 notice issued on March 18, 2009 by the PBC and CBRC, "Local governments are encouraged to attract and incentivize banking and financial institutions to increase their lending to the central government's investment projects. This can be done through various means, including ... establishment of qualified government investment and financing platforms."

LGFVs are SOEs of which local governments are major shareholders. LGFVs borrowed from banks with local governments' explicit guarantees of debt repayments, and future revenues from local governments' land sales were used as collateral for bank loans. According to Gao, Ru, and Tang (2018), more than 90% of new debts issued by LGFVs during the post-2008 stimulus period were financed directly by bank loans.[13]

In the face of soaring LGFV debt and loan guarantees provided by local governments, the State Council tightened the regulation on LGFV borrowings on June 10, 2010.[14] According to the State Council's 10 June 2010 notice, public-welfare projects were no longer allowed to borrow through LGFVs and must rely solely on the funds from the government budget to repay their debts; commercial banks must cease lending to LGFVs that did not have stable cash inflows; and local governments could no longer provide loan guarantees to LGFVs. This tightened regulation was reinforced by a decree issued jointly by the Ministry of Finance, National Development and Reform Commission (NDRC), PBC, and CBRC in August 2010.[15]

In December 2010, the National Audit Office (NAO) conducted a comprehensive survey on local government debt and LGFVs.[16] According to this survey, outstanding bank loans

[13]The other two financing sources for LGFVs were bond issuance and shadow bank loans.
[14]See http://www.gov.cn/zwgk/2010-06/13/content_1627195.htm.
[15]See http://www.gov.cn/zwgk/2010-08/19/content_1683624.htm.
[16]Another NAO survey was conducted in June 2013.

guaranteed explicitly and implicitly by local governments were 8.47 trillion RMB, 79.01% of total local government debt in 2010. The outstanding LGFV debt was 4.91 trillion RMB, 46.38% of total local government debt in 2010. There are three categories of local government debts: the debt that local governments are obliged to pay, the debt guaranteed by local governments, and the debt to which local governments may be liable only in certain bailout situations. In 2010, the total LGFV debt that local governments explicitly guaranteed or were obliged to pay was 3.14 trillion RMB, 79.5% of the total LGFV debt. By the end of 2010, the outstanding local government debt used for municipal constructions and transportations reached 5.92 trillion RMB, 91.23% of which were explicitly guaranteed or promised to pay by local governments.

III. Data description and summary statistics

In this section, we describe the loan-level and the firm-level databases that are used for our empirical work and provide summary statistics for both macro and micro data.

III.1. **Data description.** Our proprietary loan-level databases covers all newly issued bank loans to borrowers with an annual credit line over 50 million RMB (approximately 8 million USD) from January 2007 to June 2013. The coverage is comprehensive across sectors throughout the economy. It consists of over 7 million individual loan contracts granted by the 17 largest Chinese banks to more than 160,000 unique firms with a specific identifier (i.e. the 9-digit corporate organization code). The borrowers are located in all 31 provinces and autonomous regions and over 90 two-digit industries according to the Economic Industrial Classification Code. We sum up all individual loans for a particular firm in a given quarter to create a firm-quarter dataset from 2007Q1 to 2013Q2.

The loan variable used throughout the paper is the amount of newly issued loans with maturity greater than three years in each firm-quarter. Most of these loans have a maturity greater than five years for investment purposes. Our micro data on newly issued loans with maturity greater than three years is comparable to the aggregate time series of bank loans for fixed asset investment (FAI), which can be obtained from CEIC (a database for financial and economic indicators). There are, however, two main differences between the CEIC aggregate time series and the aggregate series constructed from our loan-level dataset. One difference is that our micro data excludes bank loans with a size of less than 50 million RMB while the CEIC macro data includes all investment loans. In this respect, the aggregated loans to infrastructure from our micro data source are less than those from the CEIC's macro data source. In 2010, for example, infrastructure loans as a percent of GDP is 4.59% from our data source and 4.75% from the CEIC's data source. On the other hand, loans for FAI from the CEIC's aggregate data source are calculated as an increase of outstanding loans from the outstanding balance in the previous year, while our micro data source provides newly issued bank loans. Since some existing loans may be retired at any given time, the loans

aggregated with the bottom-up calculation from our micro data source can be larger than those from the CEIC's aggregate data source. In 2009, for instance, infrastructure loans as a percent of GDP is 6.21% from our data source and only 4.73% from the CEIC's data source.

Quarterly data on capital expenditure is obtained from the Chinese Stock and Market Accounting Research (CSMAR). This database includes all listed firms on both Shanghai and Shenzhen Stock Exchanges and contains information about bank and firm identifiers. In the investment regression studied in Section VI, we merge our newly issued loan data with the CSMAR firm-level investment data, and the sample period of the merged data is from 2007Q1 to 2013Q2 to be consistent with the bank loan regression studied in the rest of the paper. For the lagged variables in our investment regression, we use the CSMAR data prior to 2007Q1. When selecting a sample for our regressions, we remove an observation if the dependent variable or any of the regressors is missing, or if the denominator in a ratio variable we construct is zero.

For both loan-level and firm-level data, we categorize sampled firms into two groups: SOEs and non-SOEs. We define a firm's ownership type according to its official registration status.[17] To obtain information of a firm's registration type, we first merge our data with the firm-level panel data from the Chinese Industry Census (CIC) between 1998 and 2013. The CIC database includes all SOEs and non-SOEs with gross sales exceeding five million RMB (the cutoff standard was increased to 20 million RMB in 2011) in the industrial sector (i.e. manufacturing, mining, and utilities). We use firms' registration information from the CIC database to identify the registration type of a firm belonging to the industrial sector.

Although the CIC database has comprehensive coverage of China's industrial firms, it does not cover firms outside the industrial sector. To obtain the registration information of non-industrial sectors, we supplement our data with the information provided by the National Enterprise Credit Information Publicity System (NECIPS), another national economic census conducted in 2008. For each firm in our database, we manually search for the firm's registration type on the NECIPS website. The NECIPS information enables us to determine whether an unlisted firm is an SOE or not. For listed firms, in addition to the merged information, we also use the ultimate controller information. Taken together, a listed firm is an SOE if the firm's ultimate controller is the central government or a local government, or if the firm's registration type equals "110" (i.e. state-controlled enterprises) or "151" (i.e. solely state-owned enterprises). Within the category of SOEs, we categorize bank loans further into two subgroups: loans to LGFVs and those to non-LGFVs. Since our database includes the official list of LGFVs, we manually cross-check each firm's business type or its scope within the NECIPS, and identify LGFVs whose firm names match their 9-digit corporate organization code.

[17]See also Brandt, Van Biesebroeck, and Zhang (2012), Yu (2015), Ma, Qiao, and Xu (2015), Wang and Wang (2015), Bai, Lu, and Tian (2016), Berkowitz, Ma, and Nishioka (2017), and Wu (2018) for using information of a firm's registration type to define SOE.

III.2. **Summary statistics.** The top panel of Figure 3 displays the ratio of aggregated newly issued bank loans to GDP. This ratio was, on average, 5.65% during 2007-2008. During the 2009 monetary stimulus, it increased sharply to 17.24% in 2009Q2 before it declined afterwards. The increase of newly issued loans was concentrated in the first three quarters of 2009, a period identified by Chen, Ren, and Zha (2018) as monetary stimulus. The bottom panel of Figure 3 displays a net increase in the ratio of newly issued bank loans to GDP for both the aggregate economy and the infrastructure sector relative to their 2007Q1-2008Q4 average levels. For the aggregate economy, the net quarterly increase of newly issued loans from the 2007Q1-2008Q4 average level was on average 9.07% (3.76%) of GDP during 2009Q1-Q3 (2009Q4-2010Q4), with a peak value of almost 12% of GDP in 2009Q2. Thus, the net increase of total newly issued loans during 2009Q1-2010Q4 was 4.97 trillion RMB, consistent with the Chinese government's original 4 trillion RMB investment plan. The net quarterly increase of newly originated bank loans for infrastructure had a similar pattern during the stimulus period, peaking at 6% of GDP in 2009Q2 relative to the 2007Q1-2008Q4 average level. From 2009Q1 to 2010Q4, the net increase of bank loans to infrastructure from the 2007Q1-2008Q4 average level was 2.28 trillion RMB or 45.9% (2.28/4.97) of the total net increase of bank loans to the entire economy, consistent with the share of infrastructure investment in the 4 trillion RMB investment plan.

Most of the literature on China focuses exclusively on the manufacturing sector. Since the infrastructure sector drew far more investment and bank loans than any other sector during the stimulus, it is necessary to conduct a detailed empirical analysis for the economy beyond the manufacturing sector. We characterize the entire Chinese economy by its four key sectors: manufacturing, infrastructure, real estate, and the rest of the economy. The rest of the economy includes wholesale and retail trades, health care, public administration, education, and environmental management. Table 1 provides a mapping between our four major sectors and NBS's one-digit sectors.

Figure 4 displays the share of newly issued bank loans in each of these four sectors. Clearly, loans to the infrastructure sector were the largest among all bank loans during the stimulus period, contributing to between 40% and 50% of all newly issued loans for most years in 2007-2013. Only $20\% - 27\%$ of total loans were allocated to manufacturing, $10\% - 20\%$ to real estate, and the remaining $12\% - 21\%$ to the rest of the economy.

Figure 5 displays a net increase of newly issued bank loans (as a percent of GDP) to all firms and to LGFVs from the 2007-2008 average level for each of the four major sectors. Infrastructure, together with the rest of the economy (i.e., excluding manufacturing and real estate), accounted for about 70% of the net increase in newly issued bank loans. By contrast, manufacturing accounted for 18% of the net increase in newly issued bank loans and real estate only 12%. The total volume for LGFV loans in 2009 was around 1.58 trillion

RMB.[18] The increase of LGFV loans, however, was unevenly distributed across the four major sectors. The largest increase in LGFV loans occurred in the infrastructure sector, which reflected the government's intended purpose of creating LGFVs.

Table 2 provides summary statistics for our firm-quarter loan sample (see Appendix A for detailed definitions of variables). Both the mean and median of newly issued bank loans in the entire economy were considerably higher than those in manufacturing. The mean and median of assets for an average economy-wide firm, however, were lower than those for an average manufacturing firm, revealing that an average economy-wide firm is more leveraged than an average manufacturing firm. For instance, the average loan size was 143.71 million RMB for an average economy-wide firm with 3,438.37 million RMB assets, in comparison to 121.68 million RMB for an average manufacturing firm with 3821.78 million RMB assets. The guaranteed loan ratio for an average economy-wide firm was lower than an average manufacturing firm. In particular, the median guaranteed loan ratio for an economy-wide firm was only 2.90%, compared to 39.40% for a manufacturing firm.

A comparison of summary statistics shows significant heterogeneity across the four major sectors. The median value of a guaranteed fraction of loans for manufacturing firms was over 39%, while the median value was close to zero for firms in other sectors. A loan guarantee by a third party was typically used by a borrower with poor credit to obtain a particular loan from a bank. Thus, a high fraction of loans guaranteed by third parties suggests that manufacturing firms had more financing difficulties than firms in other sectors. The infrastructure sector had on average the largest loan size (196.94 million RMB), a value significantly higher than that in other sectors. The average loan size (i.e., the loan size per firm-quarter) in the manufacturing sector (121.68 million RMB) was slightly higher than that in the real estate sector (116.96 million RMB), but the opposite was true for the median loan size (60 milion RMB versus 80 million RMB), indicating that the loan distribution in the real estate sector had a right tail fatter than that in the manufacturing sector. On average, the infrastructure sector had the largest total assets, the highest leverage ratio, and the highest non-performing loan ratio.

The credit spree in the infrastructure sector influences how bank credit was allocated to non-SOEs not just in manufacturing but also in other parts of the economy. Table 3 compares the summary statistics of non-SOEs between the infrastructure sector and the other major sectors. The average size of newly originated loans to non-SOEs was the largest in the infrastructure sector, with 138.83 million RMB per firm-quarter, followed by the real estate sector. Since non-SOEs in infrastructure and real estate are more capital intensive than those in other sectors, these summary statistics indicate that bank loans were more likely to be allocated to capital-intensive non-SOEs than labor-intensive ones. For total assets, leverage, non-performing loans, and the loans-to-assets ratio, non-SOEs in the infrastructure sector

[18]According to our data, when short-term loans were included, the total volume of LGFV loans was 3.17 trillion RMB in 2019.

had the highest values and the differences between non-SOEs in infrastructure and other sectors was statistically significant at the 0.01 level.

Non-SOEs in sectors other than infrastructure exhibited several distinct facts. Non-SOEs in real estate had the largest median sizes of both bank loans and total assets, but the smallest mean size of total assets. Thus, the distribution of non-SOEs' assets in real estate had a fat right tail. By contrast, the median loan size for non-SOEs in manufacturing is the smallest in all four major sectors, consistent with the fact that nearly half of bank loans received by manufacturing non-SOEs were guaranteed by third parties. Clearly, non-SOEs in manufacturing tended to have poorer credit than those in other sectors.

IV. The two-stage dynamic empirical framework

In this section, we develop a two-stage empirical framework to assess the impacts of monetary stimulus on loan allocation between SOEs and non-SOEs and the role of infrastructure spending in the monetary transmission mechanism. Our framework establishes the nexus between a dynamic panel model and a dynamic macro model. We show that this linkage is essential for estimating the effects of aggregate policy shocks on credit allocation at the firm level. The dynamic panel model in the second stage requires proper controls for aggregate shocks other than monetary policy changes, which are extracted by the dynamic macro model in the first stage. We discuss first the dynamic panel model, which constitutes the core of our empirical framework, and then the dynamic macro model in the first stage.

IV.1. **The dynamic panel model in the second stage.** We begin with key right-hand variables in the dynamic panel model. We denote exogenous monetary policy changes by $\varepsilon_{m,t}$, whose construction is discussed in Section IV.2. The quarterly growth of infrastructure investment, denoted by $g_{\text{infra},t}$, is equal to

$$g_{\text{infra},t} = \log i_{\text{infra},t} - \log i_{\text{infra},t-1}, \tag{1}$$

where $i_{\text{infra},t}$ represents investment in the infrastructure sector. An individual firm's loan amount, $\mathfrak{b}_{i,j,t}$, is affected by both infrastructure investment growth $g_{\text{infra},t}$ and the monetary policy shock $\varepsilon_{m,t}$. Because $\varepsilon_{m,t}$ simultaneously affects $g_{\text{infra},t}$, we need to separate the effects of monetary policy changes on infrastructure investment from the effects of other aggregate shocks in the first stage of our analysis. This separation allows one to assess how the interaction between infrastructure investment and monetary stimulus influences individual loans $\mathfrak{b}_{i,j,t}$. In Section IV.2, we provide an analysis of the first stage of our empirical framework and show how to use a structural macro model to decompose $\log i_{\text{infra},t}$ into

$$\log i_{\text{infra},t} = \log i^m_{\text{infra},t} + \log i^o_{\text{infra},t}, \tag{2}$$

where $\log i^m_{\text{infra},t}$ is the series of infrastructure investment driven only by exogenous monetary policy changes and $\log i^o_{\text{infra},t}$ is the log series of infrastructure investment driven by all other

aggregate shocks such as fiscal shocks. Combining equations (1) and (2), we decompose a quarterly change of infrastructure investment into two components:

$$g_{\text{infra},t} = g^{m}_{\text{infra},t} + g^{o}_{\text{infra},t}, \tag{3}$$

where $g^{m}_{\text{infra},t}$ is affected by monetary stimulus only and $g^{o}_{\text{infra},t}$ is affected by aggregate shocks other than monetary policy changes.

With these decompositions obtained in the first stage, we estimate the following *quarterly* dynamic panel regression for the j^{th} type of firm:

$$\mathfrak{b}_{i,j,t} = c^{i,j} + \rho^{j}\mathfrak{b}_{i,j,t-1} + \sum_{k=0}^{\ell}\left[d^{j}_{k}\varepsilon_{m,t-k} + b^{j}_{k}g^{o}_{\text{infra},t-k}\varepsilon_{m,t-k}\right] + c^{j\prime}_{\chi}\chi^{o}_{t} + c^{j\prime}_{z}z_{i,j,t-1} + \eta_{i,j,t}, \tag{4}$$

where $j \in \{\text{SOEs}, \text{non-SOEs}, \text{all firms}\}$ is a firm type, $\mathfrak{b}_{i,j,t} = \frac{L_{i,j,t}}{N_{i,j,t-1}}$ denotes the borrowings of an individual firm i within the j^{th} type of firms at time t, measured as newly issued bank loans ($L_{i,j,t}$) in period t to be divided by the firm's total nominal assets ($N_{i,j,t-1}$) in period $t-1$,[19] χ^{o}_{t} denotes a vector of aggregate control variables that are driven by aggregate factors other than monetary policy changes,[20] ℓ is the lag length, the coefficient $c^{i,j}$ represents the firm-fixed effect for sector j, the vector $z_{i,j,t}$ controls for an array of firm specific characteristics such as the size and leverage of a firm, and the random residual $\eta_{i,j,t}$ is iid distributed. The firm-fixed effects control for the unobserved time-invariant firm heterogeneity (e.g. location and industry), which allows one to explore the time variation of bank loans within the same firm. The estimate of d^{j}_{k} measures the main effect of monetary stimulus and b^{j}_{k} measures the interaction effect of monetary policy with infrastructure investment that is driven by non-monetary aggregate shocks such as fiscal policy shocks. Thus, the interaction effect takes into account a possible spillover of infrastructure investment on the transmission of monetary stimulus to credit allocation among different types of firms, while the main effect is purged from such spillover and captures the effect of monetary policy alone. Since a firm can borrow from multiple banks, our firm-level estimation allows one to obtain the effect of monetary stimulus on a firm's total credit.

IV.2. **The macro model in the first stage.** As stressed in the macro-finance literature (Christiano, Eichenbaum, and Evans, 1999; Morais, luis Peydro, Roldan-Pena, and Ruiz-ortega, 2019; Brunnermeier, Palia, Sastry, and Sims, 2019, for example), identification of exogenous monetary policy changes is a first-order issue when assessing the impacts of monetary policy on the real economy in general and the banking system in particular. To obtain exogenous monetary policy changes, we use Chen, Ren, and Zha (2018)'s regime-switching

[19]We seasonally adjust both new borrowings and assets for each individual firm in the sample. See Appendix A for a detailed description.

[20]We discuss the construction of χ^{o}_{t} in Section IV.2.

monetary policy equation specified as[21]

$$g_{m,t} = \gamma_0 + \gamma_m g_{m,t-1} + \gamma_\pi(\pi_{t-1} - \pi^*) + \gamma_{y,t}\left(g_{y,t-1} - g^*_{y,t-1}\right) + \sigma_{m,t}\xi_{m,t}, \tag{5}$$

where $\xi_{m,t}$ is a serially independent random shock with the standard normal distribution, $g_{m,t} = \Delta \log M_t$ is quarterly growth of M2 denoted by M_t, $\pi_t = \Delta \log P_t$ is quarterly inflation measured by the consumer price index (CPI) and denoted by P_t, π^* is the average inflation rate targeted by the government,[22] $g_{y,t} = \Delta \log y_t$ is quarterly growth of real GDP denoted by y_t, and $g^*_{y,t} = \Delta \log y^*_t$ is targeted GDP quarterly growth. The time-varying coefficients take the form of

$$\gamma_{y,t} = \begin{cases} \gamma_{y,a} & \text{if } g_{y,t-1} - g^*_{y,t-1} \geq 0 \\ \gamma_{y,b} & \text{if } g_{y,t-1} - g^*_{y,t-1} < 0 \end{cases}, \ \sigma_{m,t} = \begin{cases} \sigma_{m,a} & \text{if } g_{y,t-1} - g^*_{y,t-1} \geq 0 \\ \sigma_{m,b} & \text{if } g_{y,t-1} - g^*_{y,t-1} < 0 \end{cases}.$$

The subscript "a" stands for "above the target" and "b" for "below the target." During the global financial crisis, growth of China's GDP plummeted from 13.6% in 2007Q2 to 6.4% in 2009Q1 (top chart of Figure 1). As discussed in the introduction, the Chinese government announced a 4-trillion RMB investment plan to combat the sharp fall of aggregate output and this plan was supported through monetary stimulus, which turned out to be larger than the original plan. M2 increased by 4.2 trillion RMB in 2009Q1 alone and by a total of 11.5 trillion RMB during the 2009Q1-Q3 period. These three crucial quarters of massive monetary injections are identified by Chen, Ren, and Zha (2018) as a regime-switching period of the monetary policy rule, and the exogenous 2009 monetary stimulus is measured by a sum of policy shocks and the magnitude of a switch of monetary policy to being extraordinarily expansionary. Even though monetary policy is endogenous, the estimated magnitude of its change is exogenous. As reported in Chen, Ren, and Zha (2018), the estimated coefficients, $\gamma_m = 0.391, \gamma_\pi = -0.397, \gamma_{y,a} = 0.183, \gamma_{y,b} = -1.299, \sigma_{m,a} = 0.005$, and $\sigma_{m,b} = 0.010$, are all statistically significant at the 0.01 level. From these estimates, one can construct a measure of total exogenous monetary policy changes, which is composed of three components:

$$\varepsilon_{m,t} = \varepsilon^{\text{Norm}}_{m,t} + \varepsilon^{\text{PolCh}}_{m,t} + \varepsilon^{\text{Extra}}_{m,t}, \tag{6}$$

where $\varepsilon^{\text{Norm}}_{m,t} = \sigma_{m,a}\,\xi_{m,t}$, $\varepsilon^{\text{Extra}}_{m,t} = (\sigma_{m,b} - \sigma_{m,a})\xi_{m,t}$, and $\varepsilon^{\text{PolCh}}_{m,t}$ is calculated as the difference between actual quarterly M2 growth and counterfactual quarterly M2 growth assuming that monetary policy, represented by the response coefficient $\gamma_{y,t}$, had not changed. The magnitude of the policy change $\varepsilon^{\text{PolCh}}_{m,t}$ during the 2009Q1-2009Q3 stimulus period does not depend

[21]For many advanced countries, interest rates are the main instrument used by monetary policy. A common misperception is that this is also true in China. As discussed in Section II.1 and shown in Chen, Ren, and Zha (2018), the PBC implemented the targeted M2 growth rates on a quarterly basis; no other policy variable employed by the PBC, not even market interest rates, was used as the main instrument or target of monetary policy. In fact, because China was an emerging-market economy during our sample period, the exclusive instrument of its quantity-based monetary policy was M2 growth, which was explicitly specified and targeted by the central government.

[22]As in Chen, Ren, and Zha (2018), π^* is set at 0.875% (i.e., an annualized quarterly rate of 3.5%).

on any economic variable (i.e., exogenous) because the coefficient $\gamma_{y,t}$ is not a function of any endogenous variable. Monetary stimulus during 2009Q1-Q3 is therefore measured by

$$\varepsilon_{m,t}^{\text{Stim}} = \varepsilon_{m,t}^{\text{PolCh}} + \varepsilon_{m,t}^{\text{Extra}}. \tag{7}$$

By construction, $\varepsilon_{m,t}^{\text{Extra}} = 0$ and $\varepsilon_{m,t}^{\text{PolCh}} = 0$ for the period prior to 2009Q1.

To obtain quarterly growth of infrastructure investment driven by aggregate shocks other than monetary policy changes, we estimate the following unrestricted system of simultaneous equations

$$A_0 x_t + b_{m,0} \log M_t = c + \sum_{k=1}^{4} A_k x_{t-k} + \sum_{k=1}^{4} b_{m,k} \log M_{t-k} + \xi_t, \tag{8}$$

where c is a 3×1 vector of constant terms, $b_{m,k}$ is a 3×1 coefficient vector, A_k is a 3×3 coefficient matrix, and

$$x_t = \begin{bmatrix} \log y_t & \log P_t & \log i_{\text{infra},t} \end{bmatrix}'.$$

The vector of other aggregate shocks represented by ξ_t is normally distributed with mean zero and identity covariance matrix; these shocks are orthogonal to exogenous monetary policy changes.[23]

The unrestricted subsystem represented by (8) contains an equation in which M2 responds not only to contemporaneous variables such as infrastructure investment but also to all lagged variables. Such an equation, however, shall not be mistakenly regarded as a description of monetary policy. In our multiple-variable system, it represents how demand for M2 adjusts to other variables. As shown in Appendix B, the system composed of (5) and (8) jointly determines the dynamics of $\log M_t$ and x_t and monetary policy represented by equation (5) is identified within this system of equations.[24] Moreover, macroeconomic variables x_t can be uniquely decomposed into two parts:

$$x_t = x_t^m + x_t^o, \tag{9}$$

where x_t^m is driven only by monetary policy changes and x_t^o are driven by all non-monetary aggregate shocks such as fiscal stimulus.[25] We calculate aggregate output excluding the component of infrastructure investment such that

$$\log \tilde{y}_t^m = \log y_t^m - \log i_{\text{infra},t}^m;$$
$$\log \tilde{y}_t^o = \log y_t^o - \log i_{\text{infra},t}^o.$$

From these decompositions, we calculate quarterly growth rates of $\tilde{y}_t^o$ and P_t^o and denote them by $g_{\tilde{y},t}^o$ (output growth not affected by growth of infrastructure investment) and π_t^o.

[23]All our empirical results are robust to including in the vector x_t other aggregate variables such as interest rates and reserves in the banking system.

[24]For a detailed analysis of other macroeconomic dynamics, see the unpublished working paper by Chen, Higgins, Waggoner, and Zha (2017).

[25]For technical details of computing this decomposition, see Appendix B.

From (2), (3), and (9), we obtain $g^o_{\text{infra},t}$. These variables, denoted by the vector

$$\chi^o_t \equiv \left[g^o_{\tilde{\text{y}},t-1} \quad \pi^o_{t-1} \quad g^o_{\text{infra},t} \quad g^o_{\text{infra},t-1} \quad \cdots \quad g^o_{\text{infra},t-\ell} \right]',$$

are used as aggregate controls for the effects of non-monetary aggregate shocks in the second-stage estimation.[26]

IV.3. **Separating monetary impacts from non-monetary effects.** Figure 6 shows that changes in monetary policy played the conspicuous role in implementing the government's stimulus plan, in particular for infrastructure investment. The counterfactual paths in the figure are computed by feeding in the three exogenous shocks $\varepsilon^{\text{Stim}}_{m,t}$ for $t = 2009\text{Q}1, 2009\text{Q}2, 2009\text{Q}3$, identified by the first-stage macro model as described in Section IV.2. It is evident from Figure 6 that the effects of this three-quarter monetary stimulus lasted for almost two years before they became negligible by the beginning of 2011. A comparison of the top chart of Figure 1, Figure 2, and Figure 6 reveals that the monetary stimulus explained 66% of the increase in GDP growth and 54% of the increase in infrastructure investment from 2008Q4 to 2009Q4. The rest of increases in GDP and infrastructure investment were driven by non-monetary factors. Since loan demands move with the general economic condition, they increase with GDP growth driven by these non-monetary factors. We control for this indirect demand effect through GDP growth by including $g^o_{\tilde{\text{y}},t-1}$ as a control variable in panel regression (4) for bank loans.

The variable $g^o_{\text{infra},t-k}$ also enters our panel regression as it captures the infrastructure investment spree spurred by non-monetary shocks. Obtaining $g^o_{\text{infra},t-k}$ in the first stage is necessary for obtaining the unbiased estimate of b^j_k, the coefficient for the interaction between $g^o_{\text{infra},t-k}$ and $\varepsilon_{m,t-k}$, in the second stage. If one simply uses the observed variable $g_{\text{infra},t-k}$ as a proxy for $g^o_{\text{infra},t-k}$ for estimation of model (4), both $g^m_{\text{infra},t-k}$ and $g^m_{\text{infra},t}\,\varepsilon_{m,t-k}$ will enter the regression residual and thus make the residual correlated with interaction terms. To see this crucial point, consider a special case in which $\ell = 0$. Substituting $g_{\text{infra},t}$ for $g^o_{\text{infra},t}$ in regression (4), we have

$$\mathfrak{b}_{i,j,t} = c^{i,j} + \rho^{i,j}\mathfrak{b}_{i,j,t-1} + d^j_0\varepsilon_{m,t} + b^j_0 g_{\text{infra},t}\varepsilon_{m,t} + c^{j\,\prime}_{\chi}\,\chi_t + c^{j\,\prime}_{z} z_{i,j,t-1} + \tilde{\eta}_{i,j,t}, \tag{10}$$

where $\tilde{\eta}_{i,j,t} = \eta_{i,j,t} - b^j_0 g^m_{\text{infra},t}\varepsilon_{m,t} - c^{j\,\prime}_{\chi}\,\chi^m_t$, the aggregate control vector χ_t is

$$\chi_t \equiv \left[g_{\tilde{\text{y}},t-1} \quad \pi_{t-1} \quad g_{\text{infra},t} \quad g_{\text{infra},t-1} \quad \cdots \quad g_{\text{infra},t-\ell} \right]',$$

and χ^m_t is the corresponding vector influenced only by monetary policy shocks (i.e., $\chi^m_t = \chi_t - \chi^o_t$). The presence of $b^j_0 g^m_{\text{infra},t}\varepsilon_{m,t}$ in $\tilde{\eta}_{i,j,t}$ creates an attenuation bias of the estimated coefficient b^j_0 toward zero. The presence of $c^{j\,\prime}_{\chi}\,\chi^m_t$ creates additional downward bias if b^j_0 and $c^{j\,\prime}_{\chi}$ have the same sign. In general, since both regressors $\varepsilon_{m,t}$ and $g_{\text{inf},t}\varepsilon_{m,t}$ are correlated with

[26]The standard lag length for quarterly dynamic models covers one entire year. Because we include the contemporaneous monetary stimulus at $k = 0$, we set $\ell = 3$ so that the effective lag length is four quarters. This lag length is more than sufficient as most estimated coefficients for $\ell \geq 2$ are statistically insignificant.

the error term $\tilde{\eta}_{i,j,t}$, the estimates of d_0^j and b_0^j are biased—a typical endogeneity problem. To resolve this problem, we first obtain $\varepsilon_{m,t}$, $g^o_{\text{infra},t}$, and the aggregate control variables contained in χ_t^o prior to the estimation of model (4). We then use these non-monetary aggregates in the second-stage panel regression.

IV.4. **Computing firm-level dynamic responses to monetary stimulus.** Following the standard practice in the literature on dynamic panel regressions, we take the position that all coefficients in model (4) are time-invariant. What differs from the existing literature, however, is that we allow for a regime-switching coefficient in the monetary policy equation represented by (5) to capture monetary stimulus initiated by a regime shift of monetary policy. We first estimate model (4) and denote the estimated coefficients and firm-specific idiosyncratic shock by $\hat{c}^{i,j}$, ρ^j, $\hat{d}_k^j$, $\hat{b}_k^j$, $\hat{c}_\chi^j$, $\hat{c}_z^j$, and $\hat{\eta}_{i,j,t}$. With the estimates ρ^j, $\hat{d}_k^j$, and $\hat{b}_k^j$, we then compute the dynamic responses of a firm's bank credit by feeding three consecutive shocks $\varepsilon^{\text{Stim}}_{m,\text{2009Q1}}$, $\varepsilon^{\text{Stim}}_{m,\text{2009Q2}}$, and $\varepsilon^{\text{Stim}}_{m,\text{2009Q3}}$ as the values of $\varepsilon_{m,t}$, $\varepsilon_{m,t+1}$, and $\varepsilon_{m,t+2}$ into the following equation

$$\mathfrak{b}_{j,t} = \rho^j \mathfrak{b}_{j,t-1} + \sum_{k=0}^{\ell} \left[d_k^j \varepsilon_{m,t-k} + b_k^j g^o_{\text{infra},t-k} \varepsilon_{m,t-k} \right] \tag{11}$$

with $\varepsilon_{m,t+k} = 0$ for $k > 2$, $\varepsilon_{m,t-k} = 0$ for $k > 0$, $g^o_{\text{infra},t} = g^o_{\text{infra,2009Q1}}$, $g^o_{\text{infra},t+1} = g^o_{\text{infra,2009Q2}}$, and $g^o_{\text{infra},t+2} = g^o_{\text{infra,2009Q3}}$. When computing and reporting the dynamic responses of $\mathfrak{b}_{j,t}$, we set $t = 1$, $t + 1 = 2$, etc., where $t = 1$ corresponds to 2009Q1. In this computation, $\mathfrak{b}_{j,t}$ does not depend on i and we set $\mathfrak{b}_{j,t-1} = 0$ because the dynamic responses are the same regardless of the values of $\mathfrak{b}_{j,t-1}$ in our linear projections. The firm-level dynamic responses to monetary stimulus during the 2009Q1-Q3 period are expressed as percentage changes of newly issued loans over the firm's assets. These responses are decomposed into two components. The first component is the main effect of monetary stimulus that is computed by setting $b_k^j = 0$. The main effect captures the impact of monetary stimulus on credit allocation absent the infrastructure spree spurred by other non-monetary factors such as fiscal shocks. The second component is the effect of the interaction between monetary stimulus and infrastructure investment. This component is obtained by setting $d_k^j = 0$. The total effect of monetary stimulus is a simple sum of these two components.

To generate 90% probability (credible) intervals for dynamic responses, we take the Bayesian approach. Appendix C describes the technical details of how to generate posterior distributions of regression coefficients. Given each random draw of coefficients ρ^j, $\hat{d}_k^j$, $\hat{b}_k^j$, we compute 1500 random paths of dynamic responses and tabulate the 90% probability interval of each dynamic response. Both the estimates and the 90% probability intervals of the firm's loan responses to monetary stimulus are reported and discussed in the following section.

V. The Impacts of Monetary Stimulus on Credit allocation

In this section, we provide empirical evidence on the dynamic impact of the 2009 monetary stimulus on credit allocation. We focus on two key questions. How important was monetary stimulus in credit reallocation between SOEs and non-SOEs? How did infrastructure investment influence the transmission of monetary stimulus to credit allocation? We begin by establishing the evidence that the impact of monetary stimulus on credit allocation in the manufacturing sector was qualitatively and quantitatively different from that in the entire economy. To understand this difference, we analyze the impacts of monetary stimulus on credit allocation in other major sectors of the economy. We then quantify the role of LGFVs in the spillover of the infrastructure investment spree to the transmission of monetary policy. We conclude the section by quantifying the importance of the two-stage empirical framework in our estimated results.

V.1. **How representative the findings for manufacturing are?**

The existing literature estimates the stimulus effects on credit allocation to SOEs versus non-SOEs by first focusing exclusively on the manufacturing sector and then extrapolating the evidence to the entire economy. A first-order question, therefore, is whether this extrapolation approach is empirically supported. In this section, we first report the impacts of monetary stimulus on credit allocation within the manufacturing sector and then compare these results to those for the entire economy.

V.1.1. *Manufacturing.* Table 4 reports our estimated results for the manufacturing sector. Since our dynamic panel regression allows monetary policy to have lagged (dynamic) effects, both contemporaneous and lagged estimates are reported. Column (1) reports the results for all firms.[27] The main effects of a monetary policy shock are statistically significant at the 1% level not only contemporaneously but also in lagged periods. The interaction between monetary policy and infrastructure investment has statistically significant effects in the second and third periods. A negative value indicates that an increase in infrastructure investment weakens the transmission of monetary policy to credit allocation to an average manufacturing firm.

Toward the bottom of each column in the table, we report the cumulative effect as the sum of the estimated coefficients across periods. In column (1), the cumulative main and interaction effects are both statistically significant but with opposite signs. The estimated elasticity of bank credit to a monetary policy shock implies that a one percent increase in quarterly M2 growth translates into a 0.758 percentage-point increase in bank lending to an

[27]Although the persistence coefficient ρ^j is statistically significant in most of our estimation, we do not report its estimate because the magnitude is very small with its half life less than one quarter.

average firm (as a share of its assets) over the first four quarters. An increase in infrastructure investment during the same period, however, dampens the monetary effect.[28]

Columns (2) and (3) report estimated elasticities of loans (allocated to SOEs and non-SOEs) to an increase in quarterly M2 growth. Because the number of non-SOEs dwarfed the number of SOEs in the manufacturing sector (i.e., nearly 90% of firms that have access to bank credit are non-SOEs), the effects of a monetary policy shock on bank lending to an average manufacturing firm are largely driven by the effects on loans to non-SOEs. The estimated coefficient for an average non-SOE is significantly positive for the main effect in all periods, and significantly negative for the interaction effect in the second and third periods (column (3)). Thus, as revealed by the estimated cumulative effects, an increase of infrastructure investment driven by non-monetary shocks attenuates the monetary transmission to bank lending to non-SOEs.

The monetary effect on bank loans to SOEs, as shown in column (2), differs from those to non-SOEs. The main effect of monetary stimulus is positive at the 0.01 significance level both contemporaneously and with a lag, with a magnitude much larger than the effect on non-SOEs. Accordingly, the cumulative main effect of monetary stimulus on SOEs (1.177) is significantly larger than that on non-SOEs (0.716), implying that monetary stimulus alone would have favored SOEs in credit allocation. Moreover, the effect of infrastructure investment on the monetary transmission to SOE loans is statistically insignificant for SOEs, indicating that the infrastructure investment spree has essentially no influence on the monetary impact on bank loans to SOEs.

Figure 7 displays the loan responses to the 2009 monetary stimulus for an average manufacturing firm. The top left panel displays the total monetary effect and its two components (the main and interaction effects); the top right and bottom panels plot the 90% probability interval of each dynamic response. A positive response corresponds to an increase of a firm's bank credit (as a share of its assets) relative to the 2007-2008 average level. The negative effect of interaction dampens the main monetary effect, making the total effect less than the main effect (top left panel). The total monetary impact on bank lending to an average manufacturing firm was hump-shaped, peaking at 1.41 percentage points in 2009Q2 (top right panel). The main impact of monetary stimulus on bank credit peaked in the third quarter (2009Q3), with an average increase of 1.31 percentage points over the first three quarters (bottom left panel). Although our identified monetary stimulus lasted for only three quarters, the dynamic response of newly issued bank loans lasted for at least six quarters due to the the lagged effect of monetary policy. Infrastructure spending, however, reduced the monetary impacts on bank credit to an average manufacturing firm by an average 0.15 percentage point over the first three quarters (bottom right panel), implying that

[28]Although the magnitude of $\sum_k b_k$ is greater than that of $\sum_k d_k$, how much infrastructure investment attenuates the transmission of monetary policy is measured by multiplying each b_k by $g^o_{infra,k}$.

the infrastructure investment spree during this period reduced the transmission of monetary stimulus to bank credit by 12% (0.15/1.31).

Figure 8 displays the dynamic impacts of monetary stimulus on credit reallocation between the two types of firms (left column) and credit allocation to non-SOEs relative to that to SOEs (right column). The estimated monetary effects on bank credit to non-SOEs were quantitatively similar to those on all firms (comparing Figure 7 and the right column of Figure 8), because most manufacturing firms were non-SOEs. But SOEs received, on average, more bank loans than non-SOEs in response to the 2009 monetary stimulus, with an average increase of about 2.36 percentage points in bank credit to SOEs over the first three quarters, almost twice the average increase for non-SOEs (1.19 percentage points). Our results confirm the estimates reported in column (1) of Table D.1 in Appendix D, which show much smaller responses of bank loans to non-SOEs than to SOEs in 2009Q1-Q3. This finding is consistent with Cong, Gao, Ponticelli, and Yang (2019)'s main result that the impact of credit supply on firm borrowings was larger for state-owned firms than private firms during the stimulus period. The top right panel of Figure 8 clearly shows that SOEs enjoyed preferential bank credit during the monetary stimulus period. Implicit government guarantees of bank loans allocated to SOEs were the main reason for such a preferential outcome.

Although the difference in interaction effects on the two ownership types of firms was statistically insignificant (middle right panel of Figure 8), growth in infrastructure investment significantly weakened the monetary effect on bank credit to non-SOEs in the third and fourth quarters, while having no statistically significant effect on credit to SOEs (middle left panel). The asymmetric effect on SOEs versus non-SOEs is consistent with Huang, Pagano, and Panizza (Forthcoming)'s finding that an increase in local government debt, most of which was channeled to infrastructure investment, crowded out private investment in the manufacturing sector.

After summing the main and interaction effects, the total effect drove an even more significant wedge between bank credits to SOEs and non-SOEs in the first two quarters (2009Q1 and 2009Q2), with an average increase of 1.96 percentage points for SOEs but only 1.01 percentage points for non-SOEs (bottom left panel of Figure 8). The wedge peaked at 1.2 percentage points in the second quarter (2009Q2) with an average of 0.94 percentage point over the first four quarters (bottom right panel of the figure and column (3) of Table D.1 in Appendix D). A comparison of the top and bottom right panels of the figure reveals that the interaction effect contributed to widening the gap between bank loans to SOEs and non-SOEs.

Summary. We obtain two main findings for the manufacturing sector: (1) monetary stimulus alone led to preferential credit to SOEs over non-SOEs; and (2) while the difference in bank loans to SOEs and non-SOEs was largely driven by monetary stimulus alone, the dampening effect of infrastructure spending on the monetary transmission to bank credit allocated to non-SOEs widened this difference further.

V.1.2. *Comparing manufacturing and the whole economy.* An important question is whether our findings for the manufacturing sector hold for the economy as a whole. We estimate panel regression (4) for firms in the entire economy and compare the estimated results with those for manufacturing firms.

A comparison of column (1) of Table 4 and column (1) of Table 5 reveals that the effects of a monetary policy shock on an average firm in the whole economy are very different from those on an average firm in the manufacturing sector. The estimated coefficients for the contemporaneous and lagged main effects are all significantly larger. As a result, the cumulative main effect for the whole economy is 1.337, 75% larger than that in the manufacturing sector (0.758). Using the manufacturing sector as a representative sample, therefore, may seriously underestimate the elasticity of bank credit to monetary stimulation alone. On the other hand, for an average firm in the entire economy, only the two-period lagged interaction effect (the estimate of b_2) is significantly negative, resulting in a smaller and less significant cumulative interaction effect than its manufacturing counterpart (1.882 vs. 2.301).

Credit reallocation between the two types of firms in the entire economy is also different from the manufacturing sector in several dimensions (columns (2) and (3) of Table 5). First, the estimated main effects for non-SOEs are larger than those for SOEs contemporaneously and with lags, resulting in a larger cumulative main effect for non-SOEs (1.374 vs. 1.256). This finding is opposite of the finding for the manufacturing sector, where the elasticity of non-SOE bank credit to monetary stimulus is significantly lower than that of SOEs (0.716 vs. 1.177).

Second, the interaction effect on credit reallocation between the two types of firms differs from that in the manufacturing sector: the estimated coefficients for SOEs are significantly positive both contemporaneously and with a one-period lag in the whole economy so that the cumulative interaction effect is 4.774, which is significant at the 0.01 level (column (2) of Table 5). That is, for an average SOE in the entire economy, infrastructure spending significantly increases the elasticity of SOE bank credit to monetary stimulus, in contrast to insignificant interaction effects in the manufacturing sector (column (2) of Table 4).

Third, driven largely by a significantly negative interaction effect with a three-period lag, the cumulative interaction effect on non-SOEs in the entire economy is significantly negative at the 0.01 significance level, with a magnitude almost twice its counterpart in the manufacturing sector (-4.070 vs -2.181, column (3) of Tables 5 and 4). This finding implies that the negative effect of infrastructure investment on the monetary transmission to bank credit allocated to non-SOEs is much larger in the non-manufacturing economy than in the manufacturing sector.

Figure 9 displays the dynamic responses of bank loans and its two response channels for an average firm in the entire economy. The top left panel shows that infrastructure spending driven by non-monetary shocks, though small in magnitude, weakened the monetary transmission to an increase in bank loans, making the total response of bank loans smaller than

that main response, especially in the third quarter (2009Q3). The total response of bank loans peaked in the second quarter (2009Q2) and increased by an average of 2.27 percentage points during the first three quarters (top right panel), in contrast to an average of 1.16 percentage points in the manufacturing sector. An increase of bank credit in response to monetary policy changes alone was higher, with an average of 2.43 percentage points (bottom left panel). That is, growth in infrastructure spending weakened the response to monetary stimulus of bank loans by an average of 0.16 percentage point during the first three quarters (2009Q1-2009Q3).

Figure 10 plots the dynamic responses of bank loans for the two types of firms in the entire economy. Monetary stimulus alone generated an increase in bank credit to non-SOEs at least as strong as SOEs (top left panel), and there was no statistically significant difference between SOE and non-SOE responses (top right panel).[29] The effect of infrastructure spending interacting with monetary policy on bank credit to SOEs was positive for the first four quarters (2009Q1-2009Q4), while the effect was negative for non-SOEs (middle left panel). The resulting difference between bank loans to SOEs and non-SOEs was highly significant statistically in the first four quarters (middle right panel), in contrast to the weaker result for the manufacturing sector (middle row of Figure 8). Taking into account the interaction between monetary stimulus and infrastructure investment driven by non-monetary shocks, the total effect of monetary stimulus on bank credit to SOEs was higher than non-SOEs, with an average increase of 2.71 versus 2.13 percentage points in the first three quarters (bottom row of Figure 10).

Summary. While monetary stimulus increased bank credit to SOEs more than non-SOEs in the economy as a whole, we find that the specific channel for monetary stimulus to drive such a result is fundamentally different from that in the manufacturing sector. First, monetary stimulus alone would have given SOEs an easier credit access than non-SOEs in the manufacturing sector, but there was no such a preferential difference between SOEs and non-SOEs in the entire economy. Second, infrastructure investment had opposite effects on the monetary transmission to bank credit allocations to SOEs and non-SOEs in the whole economy: positive impacts on SOE loans but negative impacts on non-SOE loans. These opposite effects, both economically and statistically significant for the entire economy, were absent in the manufacturing sector.

V.2. **Credit allocation and sectoral heterogeneity.** To understand why the monetary transmission mechanism for credit reallocation between SOEs and non-SOEs in the entire economy differed from that in the manufacturing sector, we provide a detailed analysis of other sectors in the economy. We focus on two relevant questions. Did the 2009 monetary stimulus itself lead to preferential bank credit to SOEs in sectors other than manufacturing?

[29]See also column (1) of Table D.2 in Appendix D, as well as columns (2) and (3) for the later discussions in this paragraph.

And did the infrastructure investment spree spurred by non-monetary aggregate shocks amplify or dampen the monetary transmission to bank credit allocated to SOEs versus non-SOEs?

V.2.1. *Infrastructure.* We begin with the estimation results for the infrastructure sector (Table 6). For an average infrastructure firm, the estimated main effect of monetary policy changes is positive at the 0.01 significance level contemporaneously and with lags, and the estimated interaction effect is also positive at the 0.01 significance level on impact and with one lag (column (1) of the table). The significantly positive cumulative interaction effect (5.483) is in sharp contrast to the significantly negative interaction effect (-2.301) in the manufacturing sector. The estimated cumulative main effect suggests that a one percent increase in quarterly M2 growth alone should increase newly issued bank credit to an average infrastructure firm (as a share of its assets) by 1.376 percentage points.

Unlike manufacturing, monetary policy changes alone do not lead to preferential credit to SOEs over non-SOEs in the infrastructure sector (columns (2) and (3) of Table 6). Except on impact, the estimated main effects of a monetary policy shock on bank credit to non-SOEs are even larger than SOEs, as shown by a larger cumulative main effect for non-SOEs (1.396 versus 1.369).

The estimated interaction effects on bank credit to SOEs are positive at the 0.01 significance level both on impact and with a lag, in contrast to the insignificant effects in the manufacturing sector. And the estimated interaction effects on bank credit to SOEs are almost twice those on SOE loans in the entire economy, implying that infrastructure investment has a much stronger spillover to the monetary transmission to SOE loans in the infrastructure sector than in other parts of the economy. The interaction effects on bank credit to non-SOEs in the infrastructure sector, however, are mixed, with significantly positive effects on impact and with one lag and significantly negative effects with two lags. The resulting cumulative interaction effect is statistically insignificant (column (3) of Table 6).[30]

Figure 11 displays the loan responses to the 2009 monetary stimulus for an average infrastructure firm. The positive interaction effect of monetary stimulus made the total increase of bank credit higher than the loan response to monetary stimulus alone for the first three quarters 2009Q1-Q3 (top left panel). Newly issued bank credit allocated to an average infrastructure firm (as a share of its assets) peaked at 4.19 percentage points in the second quarter (2009Q2), with an average of 3.09 percentage points during the first three quarters 2009Q1-Q3 (top right panel) as compared to bank credit allocated to an average manufacturing firm in 2009Q1-Q3 (1.16 percentage points). During this period, moreover, infrastructure

[30]Our finding that there is no negative spillover of infrastructure investment to non-SOE loans is consistent with Huang, Pagano, and Panizza (Forthcoming), who argue that private investment in industries more exposed to public infrastructure projects is less likely to be crowded out by local government debts than private investment in non-infrastructure projects. Consequently, by participating in infrastructure projects sponsored and supported by the central and local governments, bank credit allocated to non-SOEs in the infrastructure sector is less likely to crowded out by infrastructure spending.

investment amplified the effect of monetary stimulus on bank credit to infrastructure firms by 37% with an average increase of 0.83 percentage point from the interaction channel and an average increase of 2.26 percentage points from the main channel (bottom row of charts in Figure 11).

Dynamic responses to monetary stimulus of credit reallocation between SOEs and non-SOEs in the infrastructure sector are displayed in Figure 12. The effects of monetary stimulus alone on bank credit to SOEs and non-SOEs were very similar in the first four quarters (2009Q1-Q4), with an average of 2.27 versus 2.38 percentage points (top left panel). Unlike the manufacturing sector, monetary stimulus alone did not favor credit to SOEs over non-SOEs in infrastructure (top right panel of Figure 12 and column (1) of Table D.3 in Appendix D). Infrastructure spending had a strong positive impact on the monetary transmission to SOE loans, but its impact on non-SOE loans was mixed: positive in the first two quarters and then negative in the fourth and fifth quarter (middle row of Figure 12 and column (2) of Table D.3 in Appendix D). The resulting total effect of monetary stimulus on bank credit to non-SOEs was as strong as that on SOE loans (bottom row of Figure 12 and column (3) of Table D.3 in Appendix D).

Summary. The effect of monetary policy on credit reallocation between SOEs and non-SOEs in the infrastructure sector differs sharply from that in the manufacturing sector. Unlike the manufacturing sector, the 2009 monetary stimulus alone did not lead to preferential bank credit to SOEs in the infrastructure sector. Infrastructure spending significantly amplified the effect of this monetary stimulus on bank credit to SOEs (and to non-SOEs to a lesser extent) in the infrastructure sector, whereas it had no significant impact on the monetary transmission to SOE loans in the manufacturing sector.

V.2.2. *Real estate.* For an average real estate firm, the estimated effect of a monetary policy shock on bank credit is significantly positive both contemporaneously and with lags (column (1) of Table 7). The cumulative effect implies that a one percent increase in quarterly M2 growth translated into an increase of 2.899 percentage points in bank loans, a magnitude almost four times the cumulative effect on credit to an average manufacturing firm (0.758). Another striking result is the significantly negative interaction effect on bank credit (column (1) of the table), with the resulting cumulative effect that is statistically significant at the 0.01 level.

The most striking result is the impact of a monetary policy shock on credit reallocation between SOEs and non-SOEs in real estate (columns (2) and (3) of Table 7). The estimated effect of monetary policy alone on non-SOE loans is significantly stronger than the effect on SOE loans both contemporaneously and with lags, with the cumulative effect more than three times as large (3.105 versus 0.839). Thus, the elasticity of bank credit allocated to non-SOEs to a monetary policy shock alone (the non-SOE elasticity) is significantly higher than the SOE elasticity, a reversal of the result found for the manufacturing sector. This reversal

is consistent with the fact that non-SOEs in real estate enjoy implicit loan guarantees from local governments because of their strategic importance in the local economy.[31]

Despite a significantly large effect of monetary policy changes on credit allocated to non-SOEs, infrastructure investment hampers this monetary transmission with negative interaction effects estimated at the 0.01 significance level contemporaneously and with two lags. The resulting cumulative interaction effect on non-SOE loans is significantly negative in magnitude (-25.99), while there is no cumulative interaction effect on SOE loans. The fact that infrastructure spending significantly dampens the monetary transmission to bank credit allocated to non-SOEs in real estate drives the result of a negative interaction effect on credit allocated to non-SOEs in the entire economy.

Figure 13 displays the dynamic responses of an average real estate firm to the 2009 monetary stimulus. Since the interaction effect was negative for the first three quarters (2009Q1-Q3), the total increase in bank loans was less than the monetary effect alone (top left panel). The total increase peaked at 3.33 percentage points in the third quarter (2009Q3) with an average of 2.75 percentage points in the first three quarters 2009Q1-Q3 (top left panel). The increase of bank credit to monetary stimulus alone was on average 5.44 percentage points in 2009Q1-Q3, but infrastructure spending driven by non-monetary shocks significantly reduced this monetary effect by 50% (2.69/5.44) with an average decline of 2.69 percentage points in 2009Q1-Q3 (bottom row of charts).

The monetary effect on credit reallocation between SOEs and non-SOEs in the real estate sector is displayed in Figure 14. The 2009 monetary stimulus alone generated significantly more bank credit allocated to non-SOEs than to SOEs (top row of charts) with an average increase of 5.79 percentage points in non-SOE loans versus 1.94 percentage points in SOE loans in 2009Q1-Q3 (top row of charts).[32] Infrastructure spending, on the other hand, significantly reduced the monetary effect on bank credit to non-SOEs by 50% with an average decline of 2.88 percentage points in 2009Q1-Q3, whereas it had no statistically significant effect on the monetary transmission to SOE loans except for the third quarter (middle left panel).[33] Despite this significant dampening effect of infrastructure investment on the monetary transmission to bank loans, however, a one percent increase in M2 growth translated into an increase of 3.05 percentage points in total loans to non-SOEs during 2009 (the first four quarters), in comparison to only an increase of 0.85 percentage point in SOE loans.[34]

[31]A vast majority of real estate firms are non-SOEs. In our sample, we have 13570 non-SOE observations versus 1380 SOE observations.

[32]The change of bank credit to non-SOEs, relative to SOE loans, peaked at 4.61 percentage points in 2009Q2. See the top right panel of Figure 14 and column (1) of Table D.4 in Appendix D.

[33]The interaction effect on non-SOE loans, relative to SOE loans, was significantly negative with an average difference of 2 percentage points (middle right panel of Figure 14 and column (2) of Table D.4 in Appendix D).

[34]Relative to SOE loans, the total monetary effects on non-SOE loans peaked in the fourth quarter at 3.23 percentage points and were significantly positive throughout the first six quarters from 2009Q1 to 2010Q2 (bottom right panel of Figure 14 and column (3) of Table D.4).

Summary. The dynamic impacts of monetary stimulus on credit allocation in the real estate sector have two aspects that are distinct from the manufacturing sector. First, the magnitude of the main monetary effect on bank credit to non-SOEs is considerably larger than that to SOEs. This finding implies that the 2009 monetary stimulus alone provided credit access more favorable to non-SOEs than SOEs, a reversal of the finding for manufacturing firms. Second, an increase of infrastructure investment severely weakened the monetary transmission to bank credit allocation to non-SOEs during 2009Q1-2009Q3, but had no significant effect on SOE loans. Contrary to the finding for the manufacturing sector, this difference between bank loans to non-SOEs and SOEs was large in magnitude and significant statistically.

V.2.3. *The rest of the economy.* For an average firm in the rest of the economy, we estimate the main monetary effects on bank credit to be significantly positive contemporaneously and with all lags and the interaction effects to be significantly negative contemporaneously and with the first two lags (column (1) of Table 8). According to the estimated cumulative effect, a one percent increase in quarterly M2 growth leads to an increase of bank loans by 1.645 percentage points, a magnitude in between the infrastructure sector (1.376) and the real estate sector (3.105). Notwithstanding this positive transmission of monetary policy changes, the interaction effect is estimated to be statistically negative at the 0.1 significance level, indicating that infrastructure investment weakens the monetary transmission to bank credit in the rest of the economy. Columns (2) and (3) of Table 8 report how credit is allocated between SOEs and non-SOEs and show that expansionary monetary policy itself does not lead to an easier access to bank credit by SOEs than by non-SOEs. On the contrary, the estimated main effects of monetary policy changes on non-SOE loans are larger than those on SOE loans on impact and with two lags. As a result, the cumulative main effect on non-SOE loans is larger than that on SOE loans (2.024 vs. 1.244). These positive monetary impacts on bank credit to non-SOEs, however, are eclipsed by an increase of infrastructure investment driven by non-monetary shocks. The interaction effects on non-SOE loans are estimated to be significantly negative at the 0.01 level on impact and with two lags, and the estimated cumulative effect is negative (-11.332) also at the 0.01 significance level, in contrast to the statistically insignificant cumulative effect on SOE loans.

The negative interaction effects on non-SOEs in the rest of the economy are similar to the finding for real estate. An increase of infrastructure spending in 2009 significantly reduced the monetary impact on bank credit to an average firm in this sector (top left and bottom right panels of Figure 15). As a result, the total effect of the 2009 monetary stimulus was weaker than the effect of monetary stimulus itself (an average of 2.61 versus 3.14 percentage points during the first three quarters from 2009Q1 to 2009Q3, almost one fifth smaller (2.60/3.14) according to top right and bottom left panels). This dampening effect was entirely driven by the interaction effect on non-SOE loans, with an average of 1.38 negative percentage points

in 2009Q1-Q3 and a reduction of the main effect by almost 35% (1.38/3.99, first two rows of Figure 16 and Table D.5 in Appendix D). By contrast, the interaction effects of monetary stimulus with infrastructure investment on bank credit to SOEs were positive but with a much smaller magnitude. Taking into account these opposite interaction effects on bank credit to non-SOEs versus SOEs, the 2009 monetary stimulus had similar effects on bank credit to both non-SOEs and SOEs (an increase of 2.62 and 2.61 percentage points during the first four quarters (2009Q1-Q4)), despite much stronger effects of monetary stimulus alone on bank credit to non-SOEs than SOEs (comparing the top and bottom rows of Figure 16, as well as columns (2) and (3) of Table D.5 in Appendix D).

Summary. Similar to our findings for other non-manufacturing sectors, the 2009 monetary stimulus alone did not lead to favorable access to bank credit by SOEs over non-SOEs in the rest of the economy. As in the real estate sector, moreover, the infrastructure investment spree spurred by non-monetary shocks in 2009 significantly dampened the monetary transmission to bank credit allocation to non-SOEs so that there was no statistically significant difference between the total effects of monetary stimulus on bank credit to SOEs and to non-SOEs.

V.3. **Understanding the empirical results.** To understand the empirical findings obtained in the previous sections, we first analyze why monetary stimulus alone did not lead to credit allocation in favor of SOEs over non-SOEs in the non-manufacturing sector. We then estimate and compare the impacts of monetary stimulus for two subgroups of SOEs within each major sector: LGFVs and non-LGFVs. This comparison helps us to understand why infrastructure spending dampened the strong impact of monetary policy on credit to non-SOEs. In a final subsection, we highlight the quantitative importance of our two-stage empirical framework by comparing our benchmark empirical results with those obtained without the first-stage estimation.

V.3.1. *Preferential credit to capital intensive firms.* Since the late 1990s, the Chinese government has viewed most of capital intensive industries strategically and nationally important, and supported them with preferential credit. In particular, the government's "Grasp the large and let go the small" program for manufacturing industries was designed to retain capital intensive SOEs but encourage small labor-intensive SOEs to be privatized. The government also granted capital intensive firms implicit guarantees for their bank loans. The fact that many non-SOEs were more labor intensive than SOEs in the manufacturing sector explains why bank credit allocated to this sector favored SOEs over non-SOEs in response to the 2009 monetary stimulus itself (i.e., without interaction with infrastructure investment).

Except for the manufacturing sector, however, there was no evidence that the 2009 monetary stimulus itself generated favorable access to bank credit by SOEs over non-SOEs. In fact, the dynamic responses of non-SOE loans to monetary stimulus alone were at least as strong as those of SOE loans in the entire economy, contrary to the empirical finding for

the manufacturing sector only. To understand this important difference, we provide relevant institutional facts. Infrastructure and real estate have always been the government's two *strategic* sectors since the late 1990s, and most firms in these sectors are capital intensive. In the rest of the economy, moreover, about 60% of bank lending to non-SOEs was allocated to wholesale and retail trades (Table 9), which were capital intensive sectors (Chang, Chen, Waggoner, and Zha, 2016), and this large loan share remained stable over time. Bank lending to SOEs in the rest of the economy, on the other hand, was dispersed among subsectors—only 16.87% of SOE lending was allocated to wholesale and retail trades while a large share of SOE lending was allocated instead to labor-intensive services (Table 9). Most non-SOEs in wholesale and retail trades were capital intensive and large firms that generated more sales, provided more tax revenues, and boosted more output of the local economy than did firms in labor intensive sectors. They were therefore favored by local governments with special deals and exemptions. These institutional facts support our empirical finding that the 2009 monetary stimulus itself did not lead to credit allocation in favor of SOEs over non-SOEs in infrastructure, real estate, and the rest of the non-manufacturing economy.

V.3.2. *A role of LGFVs in the monetary transmission.* The strong impact of monetary policy itself on credit to non-SOEs, however, is eclipsed by the infrastructure investment spree spurred by non-monetary factors. In this subsection, we show that bank credit channeled to LGFVs is the driving force in our finding that an increase of infrastructure investment amplifies the monetary transmission to bank credit allocation to SOEs.

We re-estimate regression (4) for two subgroups of SOEs within each major sector: LGFVs and non-LGFVs. The difference in estimated interaction effects between LGFVs and non-LGFVs is striking.[35] On impact, the estimated interaction effect for LGFVs in the infrastructure sector is positive at the 0.01 significance level, but statistically insignificant for non-LGFVs (columns (1) and (2) of Table 10). Overall, the cumulative interaction effect is estimated to be positive at the 0.01 significance level for LGFV loans (10.887) but statistically insignificant for non-LGFV loans. Thus, the positive interaction effect on bank credit to SOEs in the infrastructure sector (column (2) of Table 6) is entirely driven by LGFVs. Because LGFVs enjoy explicit guarantees of their loans from local governments as discussed in Section II.3, infrastructure investment and bank loans allocated to LGFVs increase together by reinforcing each other.

For the entire economy, we also find the reinforcing effect of infrastructure investment on the monetary transmission to LGFV loans (columns (3) and (4) of Table 10).[36] The cumulative interaction effect is estimated to be positive at the 0.01 significance level (8.591).

[35]The estimated interaction effects on bank credit to non-SOEs remain the same because LGFVs are part of SOEs.

[36]We find no statistically significant interaction effects on LGFV loans in sectors other than infrastructure (Table D.6 in in Appendix D).

By contrast, the cumulative interaction effect on credit to non-LGFV loans is statistically insignificant, even though the non-cumulative effect is significantly positive with one lag.

The reinforcing effect of LGFVs on the monetary transmission to bank credit to the infrastructure sector at large was arguably well intended by the government. As Xiong (2019)'s model implies, LGFV debt enabled local governments to promote otherwise underinvestment in infrastructure. Since LGFV loans were exclusively guaranteed by local governments, bank credit was disproportionately allocated to the infrastructure sector. The total loan volume made by any commercial bank, on the other hand, was severely constrained by the PBC's regulation that the total amount of loans could not exceed 75% of total deposits. It is not surprising, therefore, that an increase of infrastructure spending dampens the expansionary monetary effect on bank credit to non-SOEs in sectors other than infrastructure. This result accords with Huang, Pagano, and Panizza (Forthcoming)'s finding. Our finding that infrastructure spending financed by bank loans to LGFVs crowded out the expansionary monetary effect on bank credit to non-SOEs in sectors other than infrastructure is consistent with the PBC's regulatory contraint on the total loan volume an individual commercial bank was able to make.

V.3.3. *Two-stage regressions.* In Section IV.3, we argue that if we do not separate monetary and non-monetary effects on growth of infrastructure investment in the first stage, the estimated interaction effect will be biased. We now assess the magnitude of this endogeneity bias in the infrastructure sector. If we omit the first stage, we can directly estimate second-stage regression (4) by replacing $g^o_{\text{infra},t}$ with $g_{\text{infra},t}$ and χ^o_t with χ_t.

One can see from Table 11 that the estimated interaction effects on bank credit to all firms, SOEs, and non-SOEs are biased downward from those for our benchmark regression (cf. Table 6). As a result, the cumulative interaction effects on loans to all firms or SOEs are estimated to be statistically insignificant, contrary to the cumulative interaction effects in our benchmark regression that are estimated to be significantly positive. Without correcting for the endogeneity bias, therefore, we would erroneously conclude that infrastructure spending driven by non-monetary shocks (e.g., a fiscal stimulation) would *not* enhance the positive effect of monetary stimulus on bank credit to infrastructure firms.

VI. The transmission of monetary stimulus to investment

In the preceding sectors, we analyze the impacts of monetary stimulus and its interaction with infrastructure investment on bank credit to all firms, SOEs, and non-SOEs. How important is this credit channel in the transmission of monetary policy to firm investment? In this section, we address this question in two steps. We first estimate the elasticity of investment to bank credit, using a merged data set that incorporates investment information in CSMAR and our loan-level information for individual firms. We then provide a back-of-the-envelope calculation of the response of investment to monetary stimulus, taking into

account both the elasticity of investment to bank credit and the elasticity of bank credit to monetary stimulus.

VI.1. **Elasticity of investment to bank credit.** We merge our loan-level data with the CSMAR firm-level data and estimate the response of investment to changes in bank credit with the regression:

$$\mathfrak{i}_{i,j,t} = c^{i,j} + \alpha^j_{\mathcal{L}} \Delta \log \mathcal{L}_{i,j,t} + \alpha^j_{\mathcal{I}} \mathcal{I}_{09-10} \Delta \log \mathcal{L}_{i,j,t} + c^{j\prime}_{\chi} \chi_{t-1} + c^{j\prime}_{z} z_{i,j,t-1} + \eta_{i,j,t}, \tag{12}$$

where $\mathfrak{i}_{i,j,t}$ is firm i's investment (divided by the firm's total nominal assets in the previous period), $j \in \{\text{SOEs}, \text{non-SOEs}, \text{all firms}\}$, $\mathcal{L}_{i,j,t}$ represents the outstanding credit to firm i (approximately equal to the ratio of newly issued loans to the outstanding credit in the previous period), and $\mathcal{I}_{09-10}$ is an indicator function that returns one when time t falls within the years 2009-2010 and zero otherwise. The inclusion of this dummy variable allows us to obtain the potential nonlinear effects of bank credit to firm investment during the stimulus period and at the same time makes it comparable to the existing findings in the literature. The coefficient $c^{i,j}$ represents the firm-fixed effect, the vector $\chi_{t-1} = [g_{y,t-1}, \pi_{t-1}]'$ controls for macroeconomic effects (i.e. the effects of quarterly inflation (π_{t-1}) and a quarterly change of output ($g_{y,t-1}$) in the previous period), the vector $z_{i,j,t}$ controls for an array of firm specific characteristics such as the size and leverage of a firm, and the random residual $\eta_{i,j,t}$ is iid distributed.

Since a majority of listed firms are in the manufacturing sector, it is infeasible to accurately estimate the elasticity of investment to bank credit for each of the four major sectors. We are able to compare, however, the elasticity of investment to bank credit between the manufacturing sector and the entire economy. This comparison allows us to shed light on the potential heterogeneity in investment sensitivity to bank loans between the manufacturing and other major sectors in the economy. Table 12 reports the estimated results of regression (12). For an average manufacturing firm, column (1) reports the estimated elasticity of investment to bank credit in both normal and stimulus periods. In the normal period, it is positive at the 0.01 significance level; in the stimulus period, it is postive at the 0.1 significance level. Columns (2) and (3) reveal that investment sensitivity is heterogeneous across two types of firms. In the normal period, the elasticity of SOE investment to bank credit is statistically insignificant, suggesting that the financial constraints for SOEs are largely unbinding. By contrast, the elasticity of investment to bank credit to non-SOEs is estimated to be positive at the 0.01 significance level. According to our estimate, a one percent increase of bank credit increases investment by non-SOEs, on average, by about 0.1 percentage point (as a share of assets). This result implies that non-SOEs, on average, are more credit-constrained than SOEs during the normal period, which makes their investment more sensitive to bank credit.

In the stimulus period, however, the result of investment sensitivity to bank credit is reversed. The estimated coefficient for SOEs is positive at the 0.05 significance level. Its magnitude reveals that a one percent increase of bank credit would increase investment by 0.2 percentage points. Summing the estimated coefficients for both normal and stimulus periods, one can see that during the stimulus period, a one percent increase of bank credit would lead to a total increase of 0.22 percentage point in SOE investment (as a share of total assets). For non-SOEs, the estimated coefficient for the interaction term between bank loans and the stimulus period dummy is insignificant, suggesting that during the stimulus period, an increase in bank credit would not lead to an extra increase of investment. The overall (total) elasticity of non-SOE investment to bank credit, however, is statistically significant at the 0.01 level, implying that during the stimulus period, a one percent increase of bank credit would increase investment of non-SOEs by 0.176 percentage point. Taken together, the overall elasticity of SOE investment to bank credit during the stimulus period is higher than the non-SOE counterpart, a result opposite of the finding for the normal period. Our estimates are consistent with the existing evidence that in response to the financial crisis, the government allocated more credit to SOEs than non-SOEs in the manufacturing sector and "artificially directed state-owned firms to sustain investment" (Cong, Gao, Ponticelli, and Yang, 2019).

Do the findings for the manufacturing sector carry over to the entire economy? This question is particularly relevant because non-SOEs in non-manufacturing sectors such as infrastructure may enjoy implicit government guarantees as discussed in preceding sections. Columns (4) to (6) of Table 12 report the estimated results for the entire economy. For an average firm in the entire economy, as shown in Column (4), the estimated investment sensitivity to bank credit during the normal period is close to the estimate for the manufacturing sector (0.097 versus 0.106). The investment elasticity for the entire economy during the stimulus period, however, differs substantially from the estimate for the manufacturing sector (0.231 versus 0.077). Moreover, the estimate 0.231 is statistically significant at the 0.01 level while 0.077 is only significant at the 0.1 level.

Columns (5) and (6) compare SOEs and non-SOEs for the entire economy. The estimated elasticity of investment to bank credit for both SOEs and non-SOEs is similar in magnitude to that in the manufacturing sector during the normal period: the investment sensitivity is insignificant for SOEs but significant at the 0.01 level for non-SOEs so that a one percent increase of bank credit translates into an increase of 0.103 percentage point in investment of non-SOEs (cf. 0.114 percentage point for the manufacturing sample).

While the estimated investment sensitivity for SOEs in the entire economy is similar to the manufacturing counterpart during the stimulus period (0.181 versus 0.197), the estimate for non-SOEs in the entire economy differs substantially from the manufacturing sample (0.243 versus 0.062). Consequently, the overall investment elasticity to bank credit is 0.346 for non-SOEs, higher than that for SOEs (0.212). This finding is opposite of the result for

the manufacturing sector and reveals that non-SOEs, on average, play a more important role in translating bank credit into physical investment than do SOEs in the economy as a whole.

VI.2. **Response of investment to monetary stimulus.** This section calculates the investment response to monetary stimulus by different ownership types of firms. For each type of firms, we decompose the investment response to monetary stimulus into the response to monetary stimulus alone and the response to the effect of monetary stimulus interacting with infrastructure investment.

The effect of monetary stimulus on investment through the credit channel is calculated according to

$$\frac{\partial \mathfrak{i}_{j,t}}{\partial \varepsilon^{\text{Stim}}_{m,t}} \approx \frac{\partial \mathfrak{b}_{j,t}}{\partial \varepsilon^{\text{Stim}}_{m,t}} \frac{\partial \mathfrak{i}_{j,t}}{\partial \Delta \log \mathcal{L}_{j,t}} \frac{\mathcal{A}_{j,t-1}}{\mathcal{L}_{j,t-1}}, \tag{13}$$

where $j \in \{\text{SOEs}, \text{non-SOEs}, \text{all firms}\}$, the left-hand derivative is the average investment response of firms of type j to monetary stimulus, $\partial \mathfrak{b}_{j,t}$ is the average change in newly issued bank loans to firms of type j (as a share of total assets), $\frac{\partial \mathfrak{i}_{j,t}}{\partial \Delta \log \mathcal{L}_{j,t}}$ is $\alpha^j_{\mathcal{L}} + \alpha^j_{\mathcal{I}}$ (the estimated overall investment elasticity to bank credit to firms of type j during the stimulus period), $\mathcal{A}_{j,t-1}$ is the average assets of firms of type j in time $t-1$ (2008Q4), and $\mathcal{L}_{j,t-1}$ is the average outstanding amount of credit to firms of type j in time $t-1$ (2008Q4). The first right-hand term in equation (13) is obtained from the numerical values corresponding to Figures 7 to 8 and the second right-hand term is reported at the "Overall investment sensitivity" row of Table 12. The ratio $\frac{\mathcal{A}_{j,t-1}}{\mathcal{L}_{j,t-1}}$ is an adjustment term for obtaining the percentage increase in investment (as a share of firm assets) in response to monetary stimulus.

Table 13 reports the annualized percentage changes of investment in response to the 2009Q1-Q3 monetary stimulus in the manufacturing sector versus the entire economy. For the manufacturing sector, monetary stimulus led to an increase of investment, on average, by 2.689 percentage points for all firms on a annual basis ($1.157 \times 0.183 \times 3.176 \times 4$). The increase of SOE investment ($8.393 = 2.018 \times 0.223 \times 4.664 \times 4$), however, was more than four times the increase of non-SOE investment ($1.978 = 1.071 \times 0.176 \times 2.624 \times 4$).

In the entire economy, an average firm's investment increased by 8.763 ($2.270 \times 0.328 \times 2.947 \times 4$) percentage points on an annual basis in response to the 2009Q1-Q3 monetary stimulus, more than triple the investment increase in the manufacturing sector (2.689). Two factors explain this result: a larger response of bank credit to monetary stimulus (2.270 versus 1.157) and a larger elasticity of investment to bank credit (0.328 versus 0.183) than those estimates for the manufacturing sector. The entire economy was also different from the manufacturing sector for SOEs versus non-SOEs. Although the response of SOE investment to monetary stimulus was still stronger than the response of non-SOE investment ($9.217 = 2.709 \times 0.212 \times 4.017 \times 4$ versus $7.410 = 2.132 \times 0.346 \times 2.515 \times 4$), the difference was much reduced in comparison to the manufacturing sector. Moreover, the investment response of

non-SOEs to monetary stimulus in the entire economy was close to four times stronger than the response in the manufacturing sector (7.410 versus 1.978).[37]

Table 14 reports the decomposition of the investment response to the 2009Q1-Q3 monetary stimulus on an annual basis for the entire economy. For an average firm, monetary stimulus alone increased investment by 9.393 ($2.433 \times 0.328 \times 2.947 \times 4$) percentage points (column (2)), while its interaction with infrastructure spending reduced the investment response by 0.630 ($(-0.163) \times 0.328 \times 2.947 \times 4$) percentage point (column (3)). Thus, the postive response of investment was entirely attributable to monetary stimulus alone. Absent its interaction with infrastructure spending, the 2009 monetary stimulus would have spawned an increase of non-SOE investment by 8.714 ($2.507 \times 0.346 \times 2.515 \times 4$) percentage points, larger than an increase of SOE investment ($7.630 = 2.242 \times 0.212 \times 4.017 \times 4$).

The presence of infrastructure investment had opposite impacts on the monetary transmission to investment of SOEs versus non-SOEs. Interacting with infrastructure spending, the 2009 monetary stimulus brought an additional increase of SOE investment by 1.587 ($0.466 \times 0.212 \times 4.017 \times 4$) percentage points, but reduced investment of non-SOEs by 1.304 ($(-0.375) \times 0.346 \times 2.515 \times 4$) percentage points (column (3)). As a result, the 2009 monetary stimulus generated a total response of SOE investment larger than that of non-SOE investment (9.217 versus 7.410 in column (1)).

Summary. While the 2009 monetary stimulus itself generated higher investment of non-SOEs, infrastructure spending amplified the monetary effect on investment of SOEs but dampened this effect on investment of non-SOEs, resulting in a total response of SOE investment larger than that of non-SOE investment. The 2009 monetary stimulus caused both credit and capital reallocations from non-SOEs to SOEs; the infrastructure investment spree, spurred by non-monetary shocks, played a central role in these reallocations.

VII. Conclusion

We construct a firm-quarter dataset from our comprehensive loan-level data and use this unique micro dataset to estimate the effects of monetary policy and its interaction with infrastructure spending on bank credit as well as investment. A two-stage estimation approach is developed to avoid endogeneity bias of the estimated interaction effect of infrastructure investment on the monetary transmission mechanism. Our main findings are twofold. First, except for the manufacturing sector, monetary stimulus by itself did not favor credit access by SOEs over non-SOEs. Second, infrastructure investment driven by non-monetary factors such as fiscal shocks, while enhancing the monetary transmission to bank credit allocated to LGFVs in infrastructure, significantly hampered the impacts of the 2009 monetary stimulus on bank credit to non-SOEs in sectors other than infrastructure.

[37]The response to monetary stimulus of bank credit to non-SOEs and the investment elasticity to bank credit in the entire economy were also larger than those in the manufacturing sector (2.132 versus 1.071 and 0.346 versus 0.176).

In recent years, there has been a resurgence of interest in using infrastructure investment to boost economic growth both in the U.S. and in China. How to make infrastructure spending a priority in investment plans of local governments was discussed in a series of Chinese government meetings in the first half of 2020. The recent RGW called for "pursuing a more proactive and impactful fiscal policy" for financing infrastructure investment and set the tone for loosening monetary policy through "a variety of tools ... to enable M2 money supply and aggregate financing to grow at notably higher rates than last year." Under the PBC's current law, credit demands by local governments for purposes of infrastructure investment must be funded either by commercial banks' loans to local governments via LGFVs or through issuance of local governments' special bonds. As long as implicit or explicit government guarantees continue to exist, our empirical findings suggest that infrastructure investment stimulated by non-monetary factors such as fiscal policy may undermine the effectiveness of monetary policy in channeling funds from commercial banks into private firms in sectors other than infrastructure. It is our hope that our current work provides a concrete step toward further research on how the interaction between monetary and fiscal policies can influence the credit channel in particular and the banking system in general.

TABLE 1. One-digit industry classifications for each of the four major sectors

Sector	One-digit industry classification	NBS code
Manufacturing	Manufacturing	C
Infrastructure	Production and supply of electricity, gas and water	D
	Transportation, storage, postal service	G
	Information transmission, computer services and software	I
	Management of water conservancy,environment and public facilities	N
Real estate	Real estate	K
The remaining economy	Agriculture, forestry, animal husbandry, and fishery	A
	Mining	B
	Construction	E
	Wholesale and retail trades	F
	Hotels and catering services	H
	Leasing and business services	L
	Scientific research, technical service and geologic prospecting	M
	Education	P
	Health, social security, and social welfare	Q
	Culture, sports, and entertainment	R
	Public management and social organization	S

Notes: The one-digit industries within each sector are classified according to China's National Bureau of Statistics (NBS).

TABLE 2. Loan size and firm-specific characteristics for all firms in the loan-level data

	Mean	Median	Std. dev.	P25	P75
	The entire economy				
Loan size	143.71	74.90	275.16	30.00	183.34
Assets	3438.37	914.43	5974.40	335.30	3077.50
Leverage	61.43%	59.97%	26.14%	44.42%	75.06%
NPL	0.42%	0.00%	5.98%	0.00%	0.00%
Guarantee	32.26%	2.90%	40.18%	0.00%	69.62%
	Manufacturing				
Loan size	121.68	60.00	193.19	30.00	150.00
Assets	3821.78	970.00	6463.82	331.00	3497.68
Leverage	61.42%	59.77%	24.05%	46.59%	72.52%
NPL	0.28%	0.00%	4.82%	0.00%	0.00%
Guarantee	44.65%	39.40%	41.07%	0.00%	91.41%
	Infrastructure				
Loan size	196.94	99.00	398.67	40.00	200.00
Assets	4367.05	1316.57	6713.50	391.73	4602.29
Leverage	66.14%	64.97%	26.75%	49.28%	79.77%
NPL	0.70%	0.00%	7.71%	0.00%	0.00%
Guarantee	29.89%	1.06%	39.26%	0.00%	61.53%
	Real estate				
Loan size	116.96	80.00	126.52	40.00	170.00
Assets	1920.56	698.36	3729.43	320.85	1702.20
Leverage	57.37%	56.12%	25.66%	40.20%	71.84%
NPL	0.18%	0.00%	3.99%	0.00%	0.00%
Guarantee	24.10%	0.00%	38.27%	0.00%	43.96%
	The rest of the economy				
Loan size	102.11	57.60	146.04	25.00	131.25
Assets	2575.59	697.03	5010.70	291.12	1991.46
Leverage	56.62%	54.15%	26.47%	38.40%	70.77%
NPL	0.31%	0.00%	5.08%	0.00%	0.00%
Guarantee	27.56%	0.00%	38.69%	0.00%	55.19%

Notes: "NPL" stands for non-performing loans as a fraction of the total loans, "Guarantee" is a fraction of total loans guaranteed by third-parties, "Std. dev." stands for standard deviation, P25 is the 25th percentile, and P75 is the 75th percentile. Loan size is in million RMB. Assets are total assets in million RMB. Leverage is expressed as a ratio of total liabilities over total assets.

TABLE 3. Loan size and firm-specific characteristics in the loan-level data: the relative importance of non-SOEs in infrastructure

	Infrastructure			Manufacturing			Infrastructure vs. manufacturing	
	Mean	Median	Std. dev.	Mean	Median	Std. dev.	Mean difference	t-statistic
Loan size	138.83	71.91	225.57	99.40	50.00	165.27	39.43***	18.78
Assets	2275.08	576.64	4620.73	2112.22	533.05	4528.06	162.86***	3.29
Leverage	64.62%	63.47%	26.98%	59.33%	57.06%	24.65%	5.29%***	18.90
NPL	0.70%	0.00%	8.02%	0.24%	0.00%	4.52%	0.46%***	6.71
Guarantee	32.73%	0.00%	42.29%	46.50%	43.50%	42.54%	-13.77%***	-30.08
Loans/assets	20.03%	10.79%	23.35%	15.96%	8.39%	20.08%	4.06%***	17.35
	Real estate			The rest of the economy			Infrastructure vs. real estate	
	Mean	Median	Std. dev.	Mean	Median	Std. dev.	Mean difference	t-statistic
Loan size	108.10	74.00	114.51	96.71	60.00	121.79	30.73***	14.88
Assets	1354.31	586.41	2730.42	1506.51	471.46	3505.21	920.77***	20.88
Leverage	56.32%	54.83%	25.45%	60.40%	58.32%	26.43%	8.30%***	27.33
NPL	0.16%	0.00%	3.74%	0.19%	0.00%	4.08%	0.55%***	7.54
Guarantee	22.02%	0.00%	37.84%	34.66%	0.00%	42.70%	10.71%***	23.21
Loans/assets	18.23%	12.13%	18.70%	19.39%	11.87%	21.48%	1.79%***	7.34

Notes: "NPL" stands for non-performing loans as a fraction of the total loans, "Guarantee" is a fraction of total loans guaranteed by third-parties, "Std. dev." stands for standard deviation, P25 is the 25th percentile, and P75 is the 75th percentile. Loan size is in million RMB. Assets are total assets in millions of RMB. Leverage is expressed as a ratio of total liabilities over total assets. The superscript *** represents the 0.01 significance level.

TABLE 4. Estimation results for dynamic panel regression (4): manufacturing

	All firms	SOEs	Non-SOEs
	(1)	(2)	(3)
d_0: main effect	0.255***	0.470***	0.232***
	(0.033)	(0.129)	(0.034)
d_1: main effect	0.240***	0.506***	0.211***
	(0.035)	(0.138)	(0.036)
d_2: main effect	0.181***	0.123	0.189***
	(0.029)	(0.115)	(0.030)
d_3: main effect	0.082***	0.078	0.084***
	(0.025)	(0.097)	(0.025)
b_0: interaction effect	-0.243	0.512	-0.303
	(0.354)	(1.396)	(0.361)
b_1: interaction effect	-0.136	-1.786	0.061
	(0.448)	(1.758)	(0.456)
b_2: interaction effect	-1.187***	-2.066	-1.067**
	(0.447)	(1.757)	(0.455)
b_3: interaction effect	-0.736*	1.488	-0.972**
	(0.387)	(1.519)	(0.394)
$\sum_k d_k$: main effect	0.758***	1.177***	0.716***
	(0.065)	(0.259)	(0.067)
$\sum_k b_k$: interaction effect	−2.301**	−1.853	−2.181**
	(1.033)	(4.058)	(1.052)
Number of Observations	55499	5773	49726
Fixed effects	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes
Aggregate controls	Yes	Yes	Yes

Notes: This table reports the results of regressions in which the dependent variable is a firm-quarter observation of newly issued bank credit to a firm scaled by its total nominal asset. The right-hand variables include contemporaneous and lagged monetary policy shocks and their interactions with the respective growth rates of infrastructure investment driven by non-monetary factors. These variables are obtained from the first-stage estimation. The firm-level control variables include the NPL ratio, the guarantee ratio, assets, and the leverage ratio, all lagged by one period. The aggregate control variables include lagged GDP growth net of infrastructure investment, lagged inflation, and contemporaneous and lagged growth rates of infrastructure investment driven by non-monetary factors, all of which are obtained from the first-stage estimation. Column (1) reports the estimates using the sample of all manufacturing firms; columns (2) and (3) report the estimates based on the subsamples of manufacturing SOEs and non-SOEs. The values in parentheses are standard errors. The superscript * represents the 0.1 significance level, ** 0.05, and *** 0.01.

TABLE 5. Estimation results for dynamic panel regression (4): the entire economy

	All firms	SOEs	Non-SOEs
	(1)	(2)	(3)
d_0: main effect	0.485***	0.444***	0.501***
	(0.032)	(0.058)	(0.038)
d_1: main effect	0.493***	0.478***	0.501***
	(0.034)	(0.061)	(0.041)
d_2: main effect	0.191***	0.174***	0.199***
	(0.029)	(0.052)	(0.034)
d_3: main effect	0.168***	0.160***	0.173***
	(0.024)	(0.043)	(0.029)
b_0: interaction effect	-0.135	1.534**	-0.688*
	(0.346)	(0.622)	(0.413)
b_1: interaction effect	0.097	2.483***	-0.696
	(0.435)	(0.780)	(0.520)
b_2: interaction effect	-1.800***	-0.119	-2.341***
	(0.437)	(0.784)	(0.522)
b_3: interaction effect	-0.043	0.876	-0.345
	(0.379)	(0.681)	(0.452)
$\sum_k d_k$: main effect	1.337***	1.256***	1.374***
	(0.064)	(0.115)	(0.076)
$\sum_k b_k$: interaction effect	-1.882^*	4.774***	-4.070^{***}
	(1.010)	(1.812)	(1.205)
Number of Observations	157895	40549	117346
Fixed effects	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes
Aggregate controls	Yes	Yes	Yes

Notes: This table reports the results of regressions in which the dependent variable is a firm-quarter observation of newly issued bank credit to a firm scaled by its total nominal asset. The right-hand variables include contemporaneous and lagged monetary policy shocks and their interactions with the respective growth rates of infrastructure investment driven by non-monetary factors. These variables are obtained from the first-stage estimation. The firm-level control variables include the NPL ratio, the guarantee ratio, assets, and the leverage ratio, all lagged by one period. The aggregate control variables include lagged GDP growth net of infrastructure investment, lagged inflation, and contemporaneous and lagged growth rates of infrastructure investment driven by non-monetary factors, all of which are obtained from the first-stage estimation. Column (1) reports the estimates using the sample of all firms in the entire economy; columns (2) and (3) report the estimates based on the subsamples of SOEs and non-SOEs in the entire economy. The values in parentheses are standard errors. The superscript * represents the 0.1 significance level, ** 0.05, and *** 0.01.

TABLE 6. Estimation results for dynamic panel regression (4): infrastructure

	All firms	SOEs	Non-SOEs
	(1)	(2)	(3)
d_0: main effect	0.389***	0.448***	0.362***
	(0.070)	(0.104)	(0.091)
d_1: main effect	0.493***	0.461***	0.515***
	(0.074)	(0.110)	(0.096)
d_2: main effect	0.222***	0.218**	0.230***
	(0.062)	(0.092)	(0.081)
d_3: main effect	0.272***	0.242***	0.290***
	(0.052)	(0.077)	(0.067)
b_0: interaction effect	3.106***	3.196***	3.117***
	(0.752)	(1.111)	(0.972)
b_1: interaction effect	4.447***	4.028***	4.646***
	(0.944)	(1.394)	(1.221)
b_2: interaction effect	-1.353	0.485	-2.206*
	(0.951)	(1.402)	(1.231)
b_3: interaction effect	-0.716	1.095	-1.563
	(0.826)	(1.220)	(1.069)
$\sum_k d_k$: main effect	1.376***	1.369***	1.396***
	(0.139)	(0.206)	(0.179)
$\sum_k b_k$: interaction effect	5.483**	8.803***	3.993
	(2.194)	(3.239)	(2.840)
Number of Observations	52486	16721	35765
Fixed effects	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes
Aggregate controls	Yes	Yes	Yes

Notes: This table reports the results of regressions in which the dependent variable is a firm-quarter observation of newly issued bank credit to a firm scaled by its total nominal asset. The right-hand variables include contemporaneous and lagged monetary policy shocks and their interactions with the respective growth rates of infrastructure investment driven by non-monetary factors. These variables are obtained from the first-stage estimation. The firm-level control variables include the NPL ratio, the guarantee ratio, assets, and the leverage ratio, all lagged by one period. The aggregate control variables include lagged GDP growth net of infrastructure investment, lagged inflation, and contemporaneous and lagged growth rates of infrastructure investment driven by non-monetary factors, all of which are obtained from the first-stage estimation. Column (1) reports the estimates using the sample of all firms in the infrastructure sector; columns (2) and (3) report the estimates based on the subsamples of SOEs and non-SOEs in the infrastructure sector. The values in parentheses are standard errors. The superscript * represents the 0.1 significance level, ** 0.05, and *** 0.01.

TABLE 7. Estimation results for dynamic panel regression (4): real estate

	All firms	SOEs	Non-SOEs
	(1)	(2)	(3)
d_0: main effect	1.203***	0.343*	1.288***
	(0.121)	(0.201)	(0.132)
d_1: main effect	1.129***	0.551***	1.190***
	(0.129)	(0.212)	(0.140)
d_2: main effect	0.287***	0.029	0.313***
	(0.108)	(0.180)	(0.118)
d_3: main effect	0.279***	-0.085	0.314***
	(0.090)	(0.149)	(0.097)
b_0: interaction effect	-7.087***	-1.514	-7.673***
	(1.299)	(2.160)	(1.413)
b_1: interaction effect	-10.74***	-1.989	-11.69***
	(1.635)	(2.722)	(1.778)
b_2: interaction effect	-7.261***	-5.515**	-7.486***
	(1.646)	(2.716)	(1.791)
b_3: interaction effect	0.776	-0.145	0.858
	(1.423)	(2.356)	(1.548)
$\sum_k d_k$: main effect	2.899***	0.839**	3.105***
	(0.241)	(0.400)	(0.262)
$\sum_k b_k$: interaction effect	−24.31***	−9.164	−25.99***
	(3.796)	(6.299)	(4.130)
Number of Observations	14950	1380	13570
Fixed effects	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes
Aggregate controls	Yes	Yes	Yes

Notes: This table reports the results of regressions in which the dependent variable is a firm-quarter observation of newly issued bank credit to a firm scaled by its total nominal asset. The right-hand variables include contemporaneous and lagged monetary policy shocks and their interactions with the respective growth rates of infrastructure investment driven by non-monetary factors. These variables are obtained from the first-stage estimation. The firm-level control variables include the NPL ratio, the guarantee ratio, assets, and the leverage ratio, all lagged by one period. The aggregate control variables include lagged GDP growth net of infrastructure investment, lagged inflation, and contemporaneous and lagged growth rates of infrastructure investment driven by non-monetary factors, all of which are obtained from the first-stage estimation. Column (1) reports the estimates using the sample of all firms in the real estate sector; columns (2) and (3) report the estimates based on the subsamples of SOEs and non-SOEs in the real estate sector. The values in parentheses are standard errors. The superscript * represents the 0.1 significance level, ** 0.05, and *** 0.01.

TABLE 8. Estimation results for dynamic panel regression (4): the rest of the economy

	All firms	SOEs	Non-SOEs
	(1)	(2)	(3)
d_0: main effect	0.670***	0.440***	0.882***
	(0.067)	(0.082)	(0.105)
d_1: main effect	0.670***	0.496***	0.833***
	(0.071)	(0.087)	(0.111)
d_2: main effect	0.180***	0.176**	0.187**
	(0.060)	(0.073)	(0.094)
d_3: main effect	0.126**	0.131**	0.123
	(0.050)	(0.060)	(0.078)
b_0: interaction effect	-1.583**	0.600	-3.530***
	(0.723)	(0.879)	(1.126)
b_1: interaction effect	-1.643*	2.645**	-5.554***
	(0.908)	(1.100)	(1.415)
b_2: interaction effect	-1.799**	0.411	-3.770***
	(0.914)	(1.108)	(1.424)
b_3: interaction effect	1.025	0.532	1.522
	(0.792)	(0.961)	(1.233)
$\sum_k d_k$: main effect	1.645***	1.244***	2.024***
	(0.134)	(0.162)	(0.208)
$\sum_k b_k$: interaction effect	−4.000*	4.187	−11.332***
	(2.109)	(2.561)	(3.283)
Number of Observations	34960	16675	18285
Fixed effects	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes
Aggregate controls	Yes	Yes	Yes

Notes: This table reports the results of regressions in which the dependent variable is a firm-quarter observation of newly issued bank credit to a firm scaled by its total nominal assets. The right-hand variables include contemporaneous and lagged monetary policy shocks and their interactions with the respective growth rates of infrastructure investment driven by non-monetary factors. These variables are obtained from the first-stage estimation. The firm-level control variables include the NPL ratio, the guarantee ratio, assets, and the leverage ratio, all lagged by one period. The aggregate control variables include lagged GDP growth net of infrastructure investment, lagged inflation, and contemporaneous and lagged growth rates of infrastructure investment driven by non-monetary factors, all of which are obtained from the first-stage estimation. Column (1) reports the estimates using the sample of all firms in the rest of the economy; column (2) and (3) report the estimates based on the subsamples of SOEs and non-SOEs in the rest of the economy. The values in parentheses are standard errors. The superscript * represents the 0.1 significance level, ** 0.05, and *** 0.01.

TABLE 9. Loan shares (%) in subsectors within the rest of the economy

Subsectors	The sample period		Year 2009	
	SOE	Non-SOE	SOE	Non-SOE
Agriculture, forestry, animal husbandry, and fishery	1.393	2.155	1.085	2.101
Mining	17.06	9.753	13.25	9.931
Construction	15.13	12.15	15.24	12.42
Wholesale and retail trades	23.99	60.90	16.87	58.08
Hotels and catering services	0.807	2.728	0.575	3.385
Leasing and business services	20.09	9.599	26.65	10.61
Other services	21.53	2.725	26.33	3.473

Notes: Other services include scientific research, technical service, geologic prospecting, education, health, social security, social welfare, culture, sports, entertainment, public management, and social organization. All these services are labor-intensive.

TABLE 10. Estimation results for dynamic panel regression (4) for LGFVs

	Infrastructure		The entire economy	
	LGFVs	Non-LGFVs	LGFVs	Non-LGFVs
	(1)	(2)	(3)	(4)
d_0: main effect	0.528***	0.364**	0.507***	0.409***
	(0.123)	(0.171)	(0.096)	(0.072)
d_1: main effect	0.513***	0.414**	0.588***	0.407***
	(0.130)	(0.182)	(0.102)	(0.077)
d_2: main effect	0.285***	0.153	0.281***	0.112*
	(0.110)	(0.152)	(0.086)	(0.064)
d_3: main effect	0.273***	0.210*	0.206***	0.140***
	(0.091)	(0.126)	(0.071)	(0.053)
b_0: interaction effect	5.894***	0.167	5.375***	-0.903
	(1.326)	(1.835)	(1.035)	(0.774)
b_1: interaction effect	1.417	7.041***	2.310*	2.709***
	(1.659)	(2.301)	(1.297)	(0.971)
b_2: interaction effect	1.440	-0.695	-0.076	-0.110
	(1.663)	(2.320)	(1.298)	(0.978)
b_3: interaction effect	2.136	0.010	0.981	0.748
	(1.451)	(2.014)	(1.131)	(0.848)
$\sum_k d_k$: main effect	1.598***	1.141***	1.583***	1.068***
	(0.246)	(0.339)	(0.192)	(0.143)
$\sum_k b_k$: interaction effect	10.887***	6.522	8.591***	2.444
	(3.855)	(5.349)	(3.011)	(2.257)
Number of Observations	8924	7797	15755	24794
Fixed effects	Yes	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes	Yes
Aggregate controls	Yes	Yes	Yes	Yes

Notes: This table reports the results of regressions for two subgroups of SOEs: LGFV and non-LGFVs. The dependent variable is a firm-quarter observation of newly issued bank credit to a firm scaled by its total nominal assets. The right-hand variables include contemporaneous and lagged monetary policy shocks and their interactions with the respective growth rates of infrastructure investment driven by non-monetary factors. These variables are obtained from the first-stage estimation. The firm-level control variables include the NPL ratio, the guarantee ratio, assets, and the leverage ratio, all lagged by one period. The aggregate control variables include lagged GDP growth net of infrastructure investment, lagged inflation, and contemporaneous and lagged growth rates of infrastructure investment driven by non-monetary factors, all of which are obtained from the first-stage estimation. Columns (1) and (2) report the estimates using the subsamples of LGFVs and non-LGFVs in the infrastructure sector; columns (3) and (4) report the estimates based on the subsamples of LGFVs and non-LGFVs in the entire economy. The values in parentheses are standard errors. The superscript * represents the 0.1 significance level, ** 0.05, and *** 0.01.

TABLE 11. Estimation results for dynamic panel regression without the first-stage estimation: infrastructure

	All firms	SOEs	Non-SOEs
	(1)	(2)	(3)
d_0: main effect	0.376***	0.443***	0.345***
	(0.075)	(0.111)	(0.097)
d_1: main effect	0.510***	0.471***	0.535***
	(0.084)	(0.124)	(0.109)
d_2: main effect	0.291***	0.298***	0.295***
	(0.074)	(0.110)	(0.096)
d_3: main effect	0.268***	0.221**	0.293***
	(0.060)	(0.089)	(0.078)
b_0: interaction effect	2.397***	2.243**	2.503***
	(0.601)	(0.887)	(0.777)
b_1: interaction effect	2.313***	2.278**	2.319***
	(0.727)	(1.073)	(0.941)
b_2: interaction effect	-3.731***	-1.869*	-4.601***
	(0.704)	(1.039)	(0.911)
b_3: interaction effect	-1.009	0.441	-1.682**
	(0.656)	(0.971)	(0.849)
$\sum_k d_k$: main effect	1.446***	1.433***	1.469***
	(0.176)	(0.260)	(0.227)
$\sum_k b_k$: interaction effect	-0.031	3.093	-1.462
	(1.637)	(2.415)	(2.119)
Number of Observations	52762	16790	35972
Fixed effects	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes
Aggregate controls	Yes	Yes	Yes

Notes: This table reports the results of regressions in which the dependent variable is a firm-quarter observation of newly issued bank credit to a firm scaled by its total nominal assets. The right-hand variables include contemporaneous and lagged monetary policy shocks and their interactions with the respective growth rates of infrastructure investment without the first-stage estimation. The firm-level control variables include the NPL ratio, the guarantee ratio, assets, and the leverage ratio, all lagged by one period. The aggregate control variables include lagged GDP growth net of infrastructure investment, lagged inflation, and contemporaneous and lagged growth rates of infrastructure investment. Column (1) reports the estimates using the sample of all firms in the infrastructure sector; columns (2) and (3) report the estimates based on the subsamples of SOEs and non-SOEs in the infrastructure sector. The values in parentheses are standard errors. The superscript * represents the 0.1 significance level, ** 0.05, and *** 0.01.

TABLE 12. Estimated investment sensitivity to bank loans for listed firms in CSMAR

	Investment ($\mathfrak{i}_{i,t}$) in manufacturing			Investment ($\mathfrak{i}_{i,t}$) in all sectors		
	All firms	SOEs	Non-SOEs	All firms	SOEs	Non-SOEs
	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta \log \mathcal{L}_{i,t}$	0.106***	0.026	0.114***	0.097***	0.031	0.103***
	(0.020)	(0.042)	(0.023)	(0.021)	(0.039)	(0.024)
$\mathcal{I}_{09-10} \Delta \log \mathcal{L}_{i,t}$	0.077*	0.197**	0.062	0.231***	0.181***	0.243***
	(0.043)	(0.087)	(0.051)	(0.044)	(0.068)	(0.053)
Overall investment sensitivity $\alpha_{\mathcal{L}} + \alpha_{\mathcal{I}}$	0.183**	0.223***	0.176***	0.328***	0.212***	0.346***
	(0.039)	(0.079)	(0.045)	(0.039)	(0.057)	(0.047)
Number of Observations	12599	3750	8849	15510	4242	11268
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Quarterly dummy	Yes	Yes	Yes	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Aggregate controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table reports the results of regressions in which the dependent variable is a firm-quarter observation of a firm's investment scaled by its total nominal assets. The right-hand variable is the quarterly growth of the firm's outstanding loan balance. The firm-level control variables include lagged total assets and the lagged leverage ratio. The aggregate control variables include lagged GDP growth, lagged inflation, and quarter dummies. Column (1) reports the estimates using the sample of all listed manufacturing firms; columns (2) and (3) report the estimates based on the subsamples of listed manufacturing SOEs and non-SOEs. Columns (4)-(6) report the estimates using the sample of all listed CSMAR firms and the subsamples of listed CSMAR SOEs and non-SOEs. The values in parentheses are standard errors. The superscript * represents the 0.1 significance level, ** 0.05, and *** 0.01.

TABLE 13. Impacts of the 2009Q1-2009Q3 monetary stimulus on investment

	Manufacturing	The entire economy
Average firm	2.689	8.763
SOE	8.393	9.217
Non-SOE	1.978	7.410

Notes: The values, expressed in percentage points, represent increases of investment as a share of the firm's assets.

TABLE 14. Decomposition of the monetary effect on investment in the entire economy

	Total effect (1)	Main effect (2)	Interaction effect (3)
Average firm	8.763	9.393	-0.630
SOE	9.217	7.630	1.587
Non-SOE	7.410	8.714	-1.304

Notes: The values, expressed in percentage points, represent increases of investment as a share of the firm's assets.

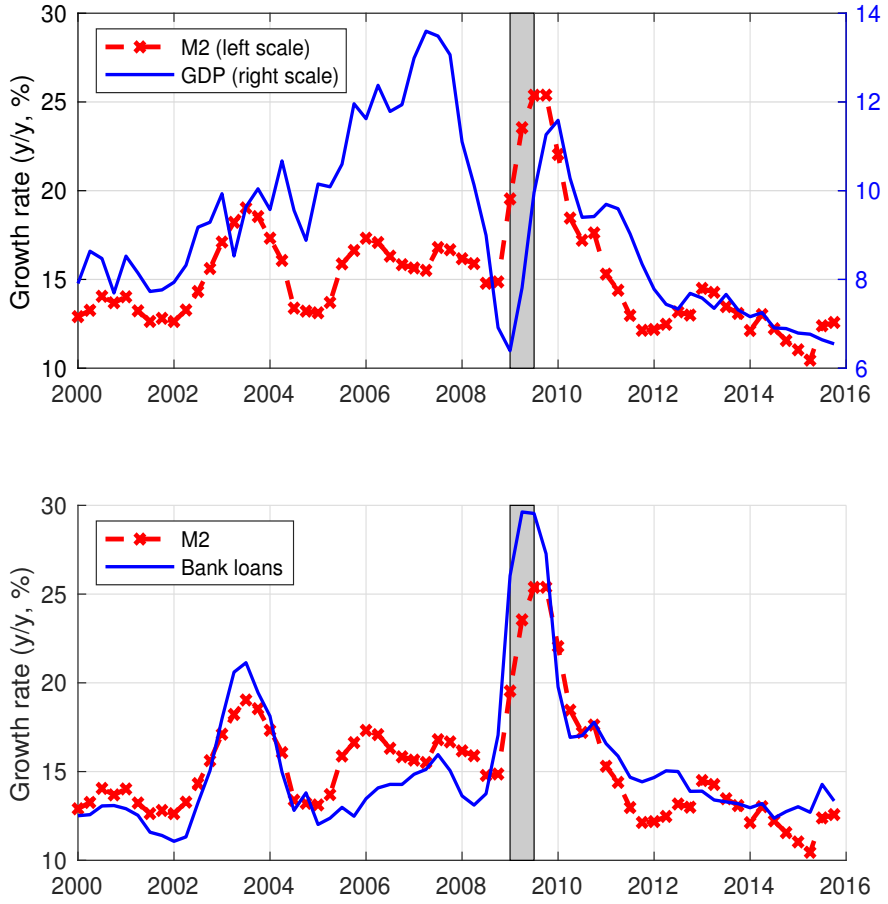

FIGURE 1. The time series of annual growth rates of GDP, M2, and bank lending. *Notes*: The shaded bar marks the monetary stimulus period of 2009Q1-Q3.

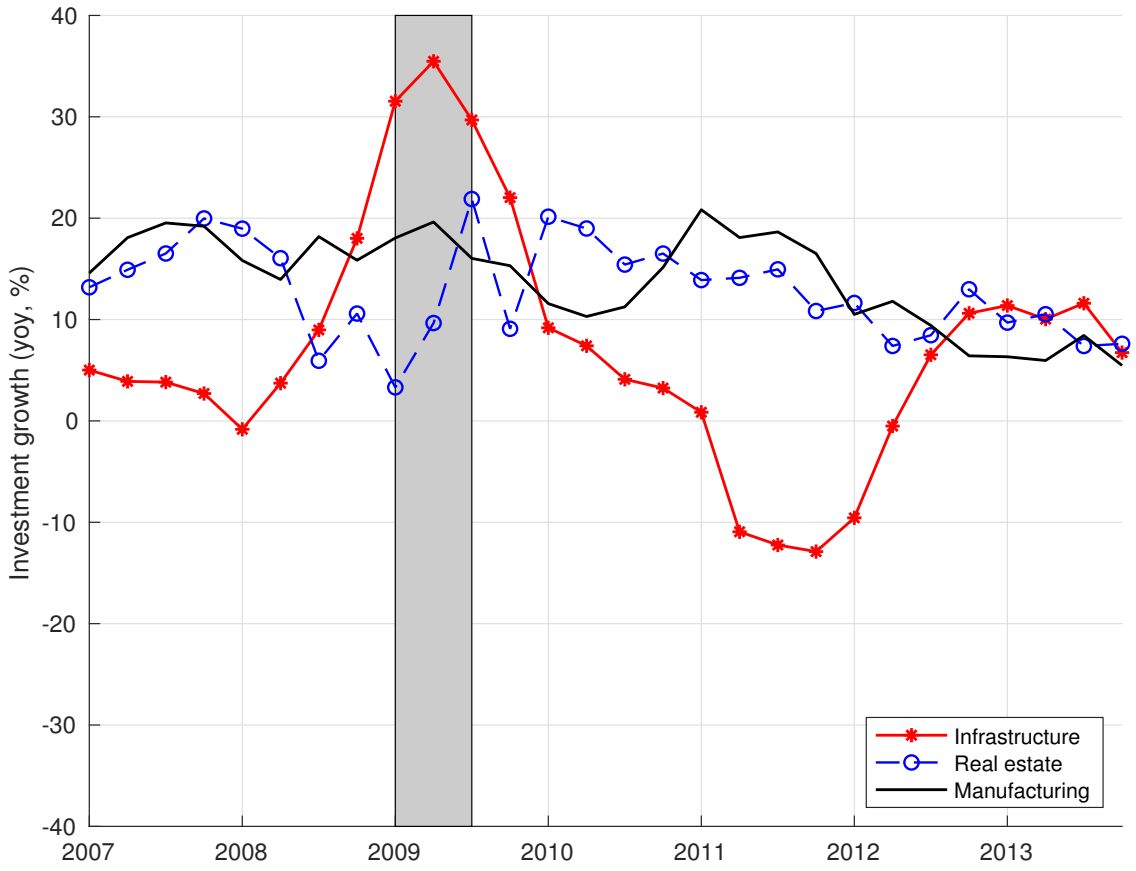

FIGURE 2. Real investment in various sectors. *Notes*: All series are deflated by the GDP deflator. The shaded bar marks the monetary stimulus period of 2009Q1-Q3.

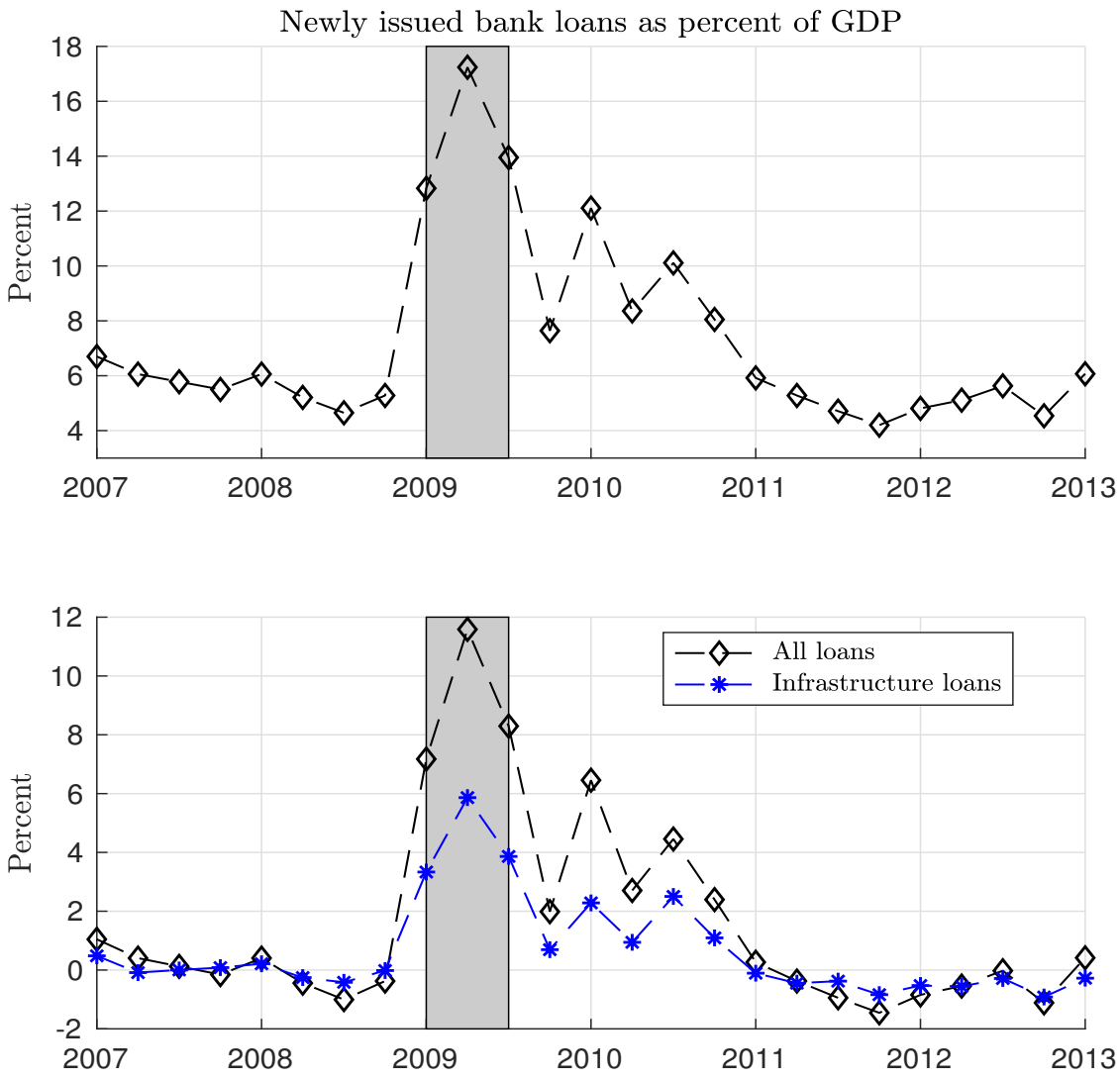

FIGURE 3. Newly originated bank loans as a percent of GDP. *Notes*: The top chart shows all newly issued loans as a percent of GDP. The bottom chart displays the increase of loan volumes (as a percent of GDP) from the average level in 2007Q1-2008Q4. Each time series is aggregated up from the loan-level data. The shaded bar marks the monetary stimulus period of 2009Q1-Q3.

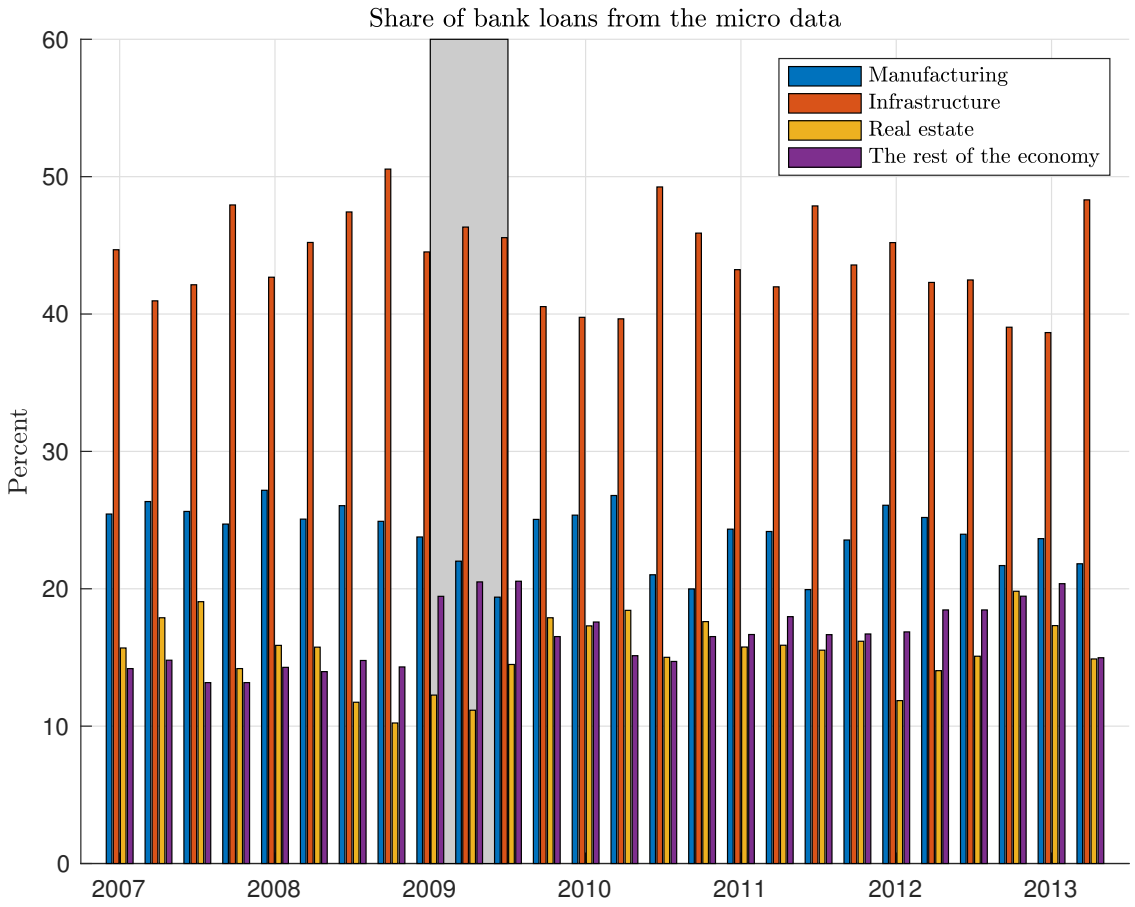

FIGURE 4. Share of bank loans allocated to the four key sectors in 2007-2013 from the micro loan data. *Notes*: The wide shaded bar marks the period of 2009Q1-Q3 during which the monetary policy rule was changed to be more stimulative.

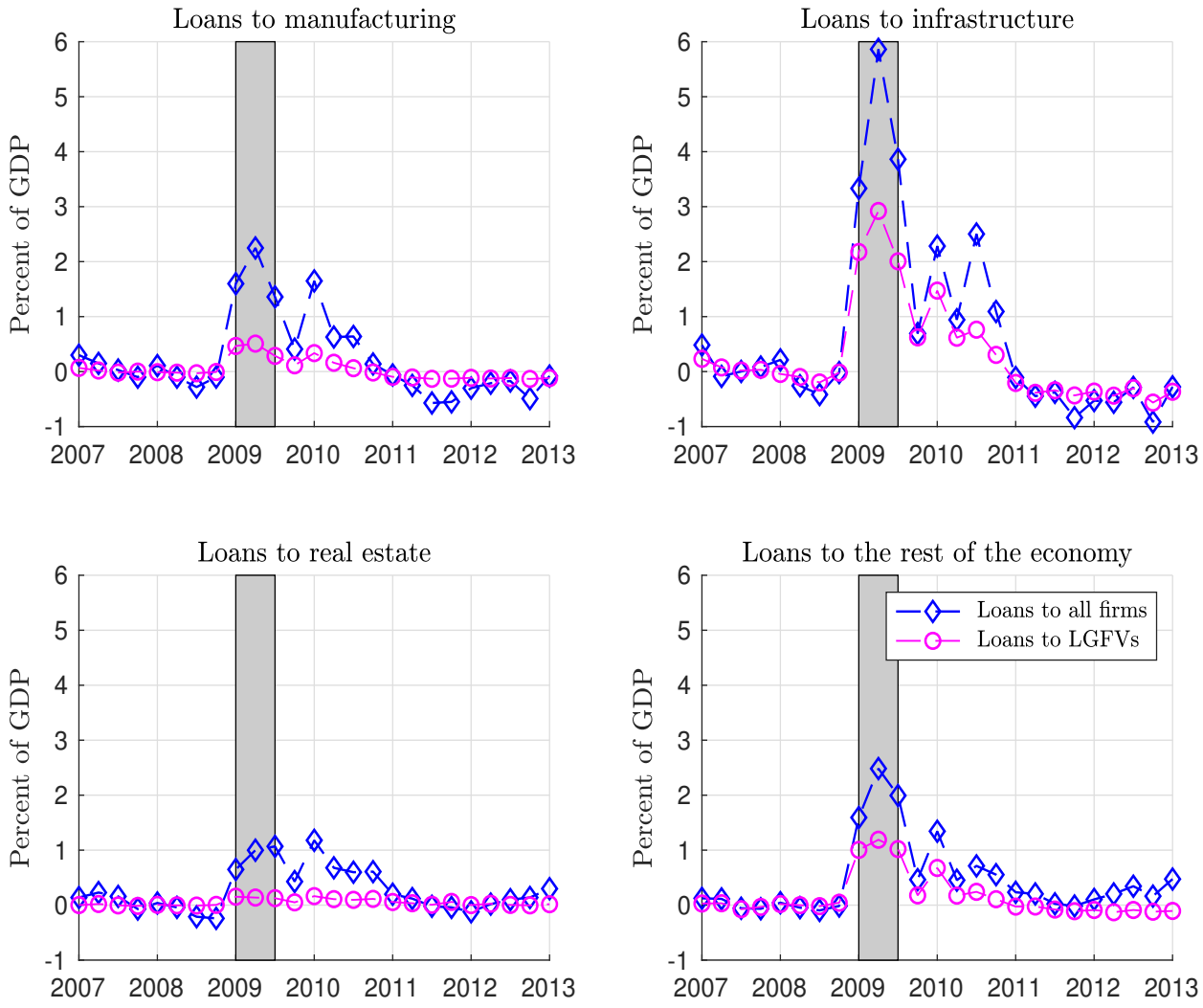

FIGURE 5. Newly originated bank loans to all firms and to LGFVs as a percent of GDP in each of the four key sectors. *Notes*: The time series for each sector is aggregated up from the firm-quarter data for that sector. Each loan value (as a percent of GDP) is the increase from the average loan value in 2007Q1-2008Q4. The shaded bar marks the monetary stimulus period of 2009Q1-Q3.

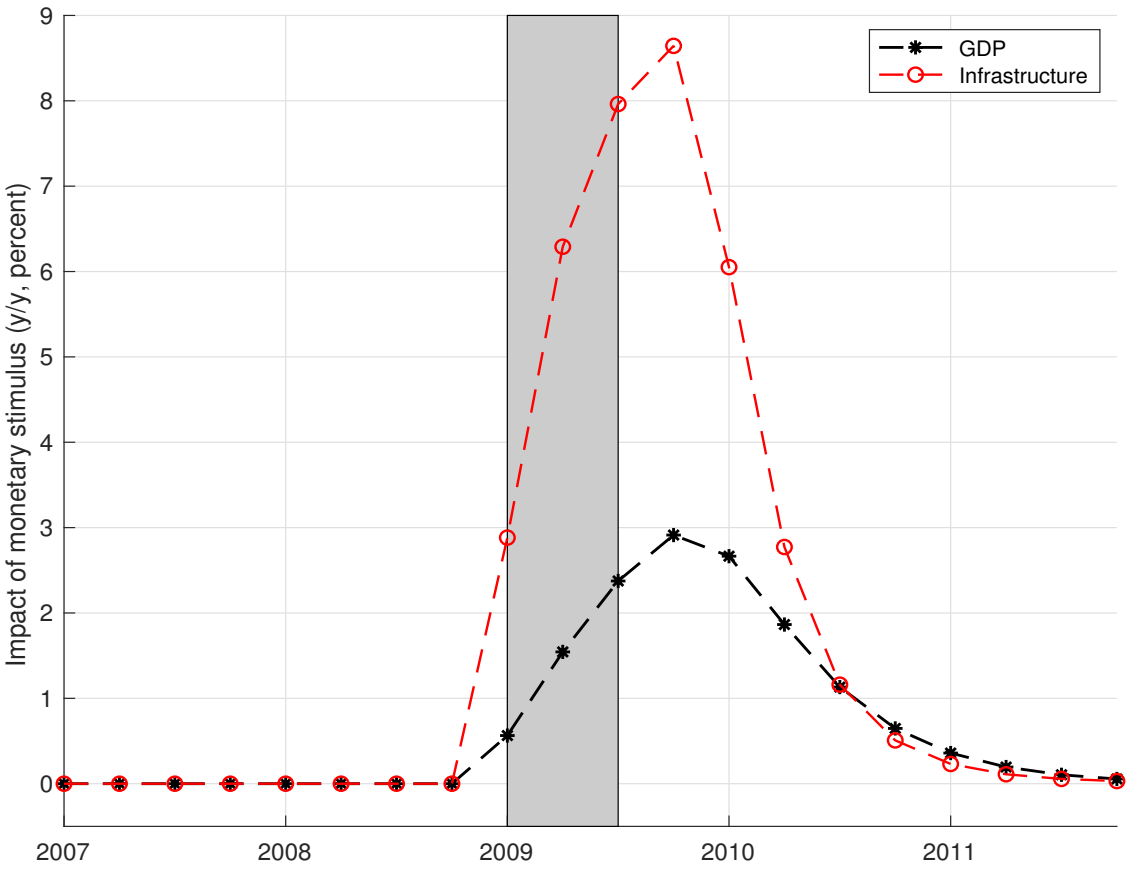

FIGURE 6. Counterfactual historical paths of year-over-year growth rates of real GDP and real infrastructure investment from the first-stage macro model. *Notes*: Both series are deflated by the GDP deflator. The shaded bar marks the monetary stimulus period of 2009Q1-Q3. The counterfactual path is driven by exogenous monetary changes only.

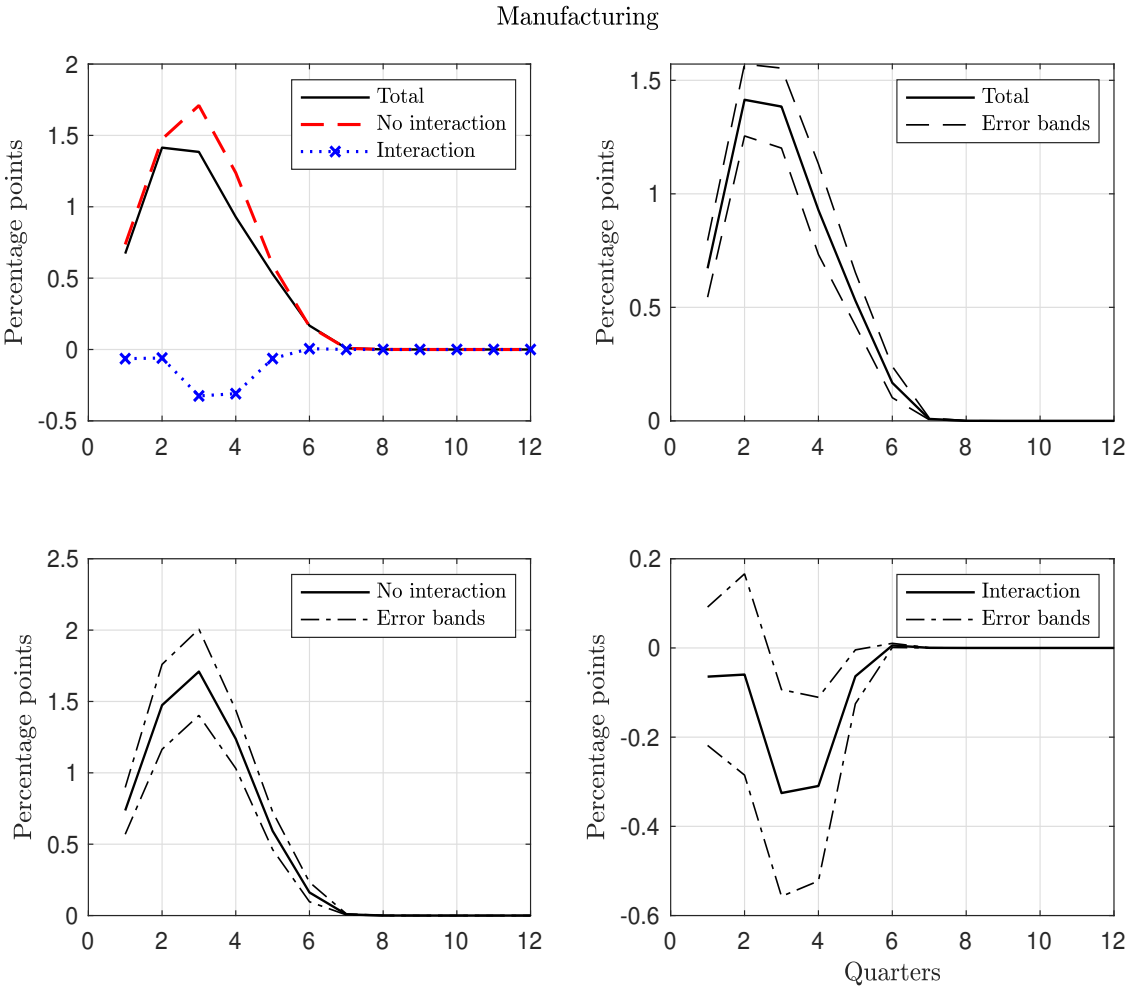

FIGURE 7. Dynamic impacts of main monetary stimulus (no interaction) and its interaction with infrastructure investment on bank loans to the average firm. *Notes*: The dynamic responses are expressed as percentage changes from the initial quarter 0 (i.e., changes from the pre-stimulus period). Dash-dotted lines represent the corresponding .90 probability bands. Quarter 1 corresponds to 2009Q1 and quarter 12 corresponds to 2011Q4.

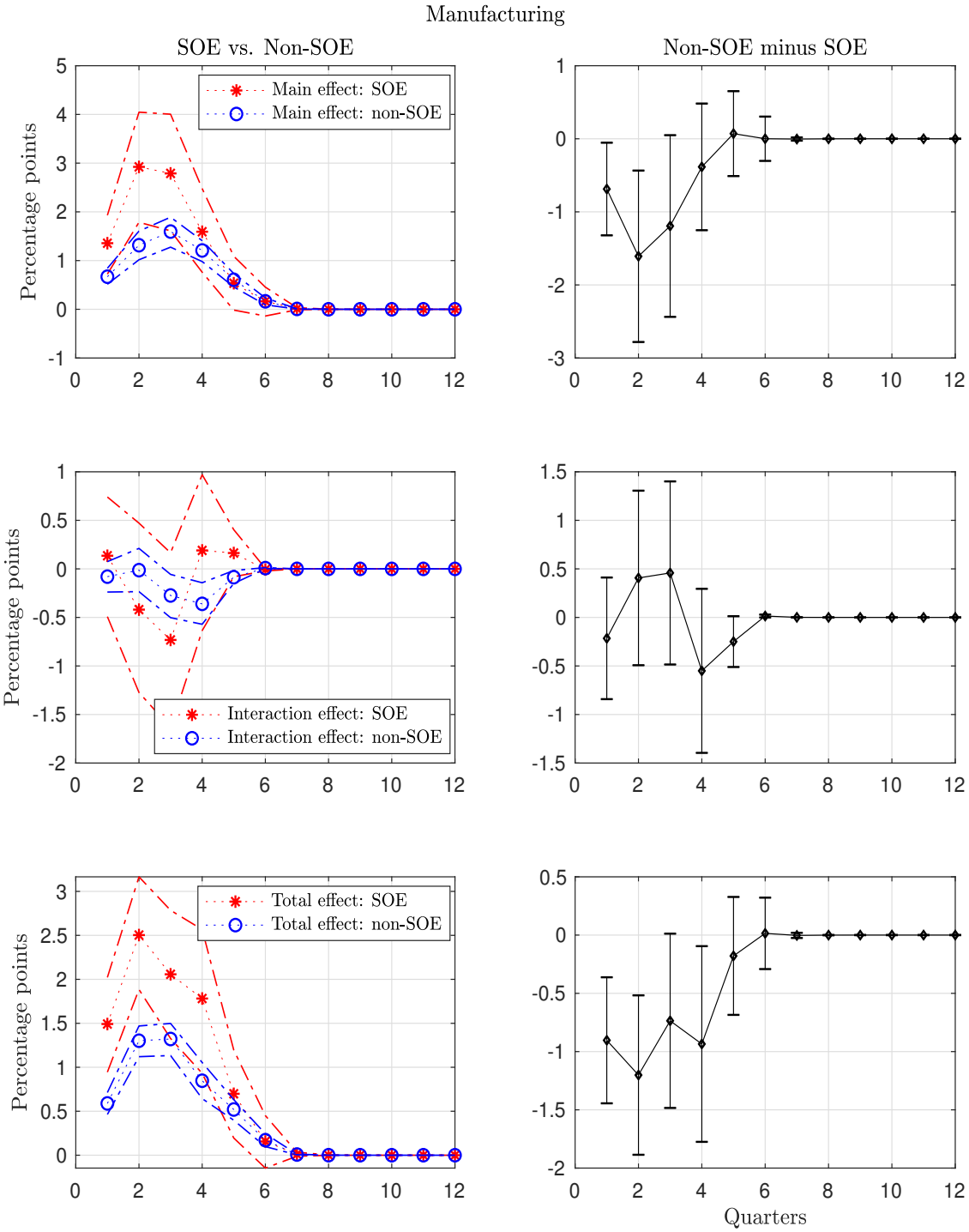

FIGURE 8. Dynamic impacts of main monetary stimulus (no interaction) and its interaction with infrastructure investment on bank loans to the average SOE firm and the average non-SOE firm. The right column displays the non-SOE loan response relative to the SOE loan response. *Notes*: The dynamic responses are expressed as percentage changes from the initial quarter 0 (i.e., changes from the non-stimulus period). Dash-dotted lines and error bars represent the corresponding .90 probability bands. Quarter 1 corresponds to 2009Q1 and quarter 12 corresponds to 2011Q4.

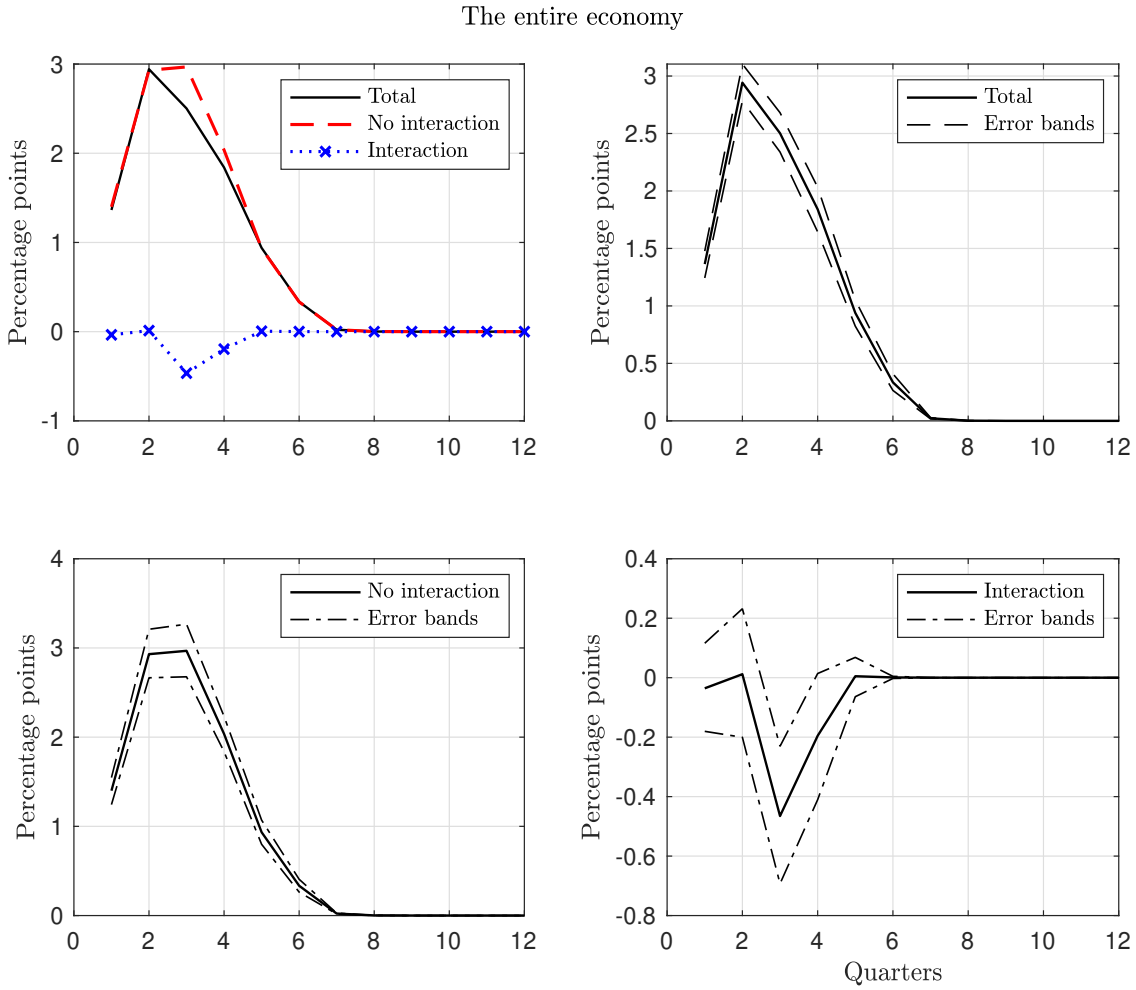

FIGURE 9. Dynamic impacts of main monetary stimulus (no interaction) and its interaction with infrastructure investment on bank loans to the average firm. *Notes*: The dynamic responses are expressed as percentage changes from the initial quarter 0 (i.e., changes from the pre-stimulus period). Dash-dotted lines represent the corresponding .90 probability bands. Quarter 1 corresponds to 2009Q1 and quarter 12 corresponds to 2011Q4.

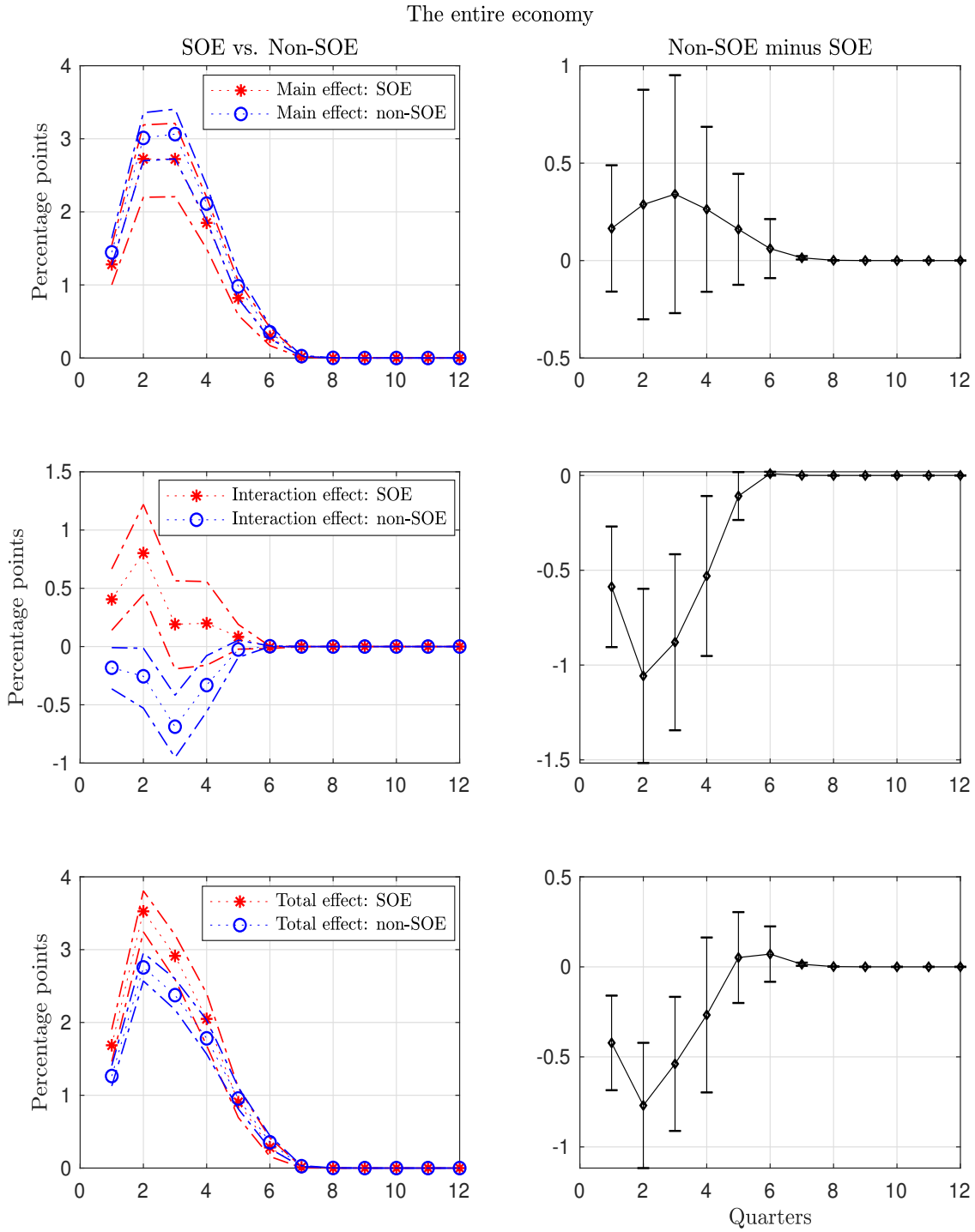

FIGURE 10. Dynamic impacts of main monetary stimulus (no interaction) and its interaction with infrastructure investment on bank loans to the average SOE firm and the average non-SOE firm. The right column displays the non-SOE loan response relative to the SOE loan response. *Notes*: The dynamic responses are expressed as percentage changes from the initial quarter 0 (i.e., changes from the non-stimulus period). Dash-dotted lines and error bars represent the corresponding .90 probability bands. Quarter 1 corresponds to 2009Q1 and quarter 12 corresponds to 2011Q4.

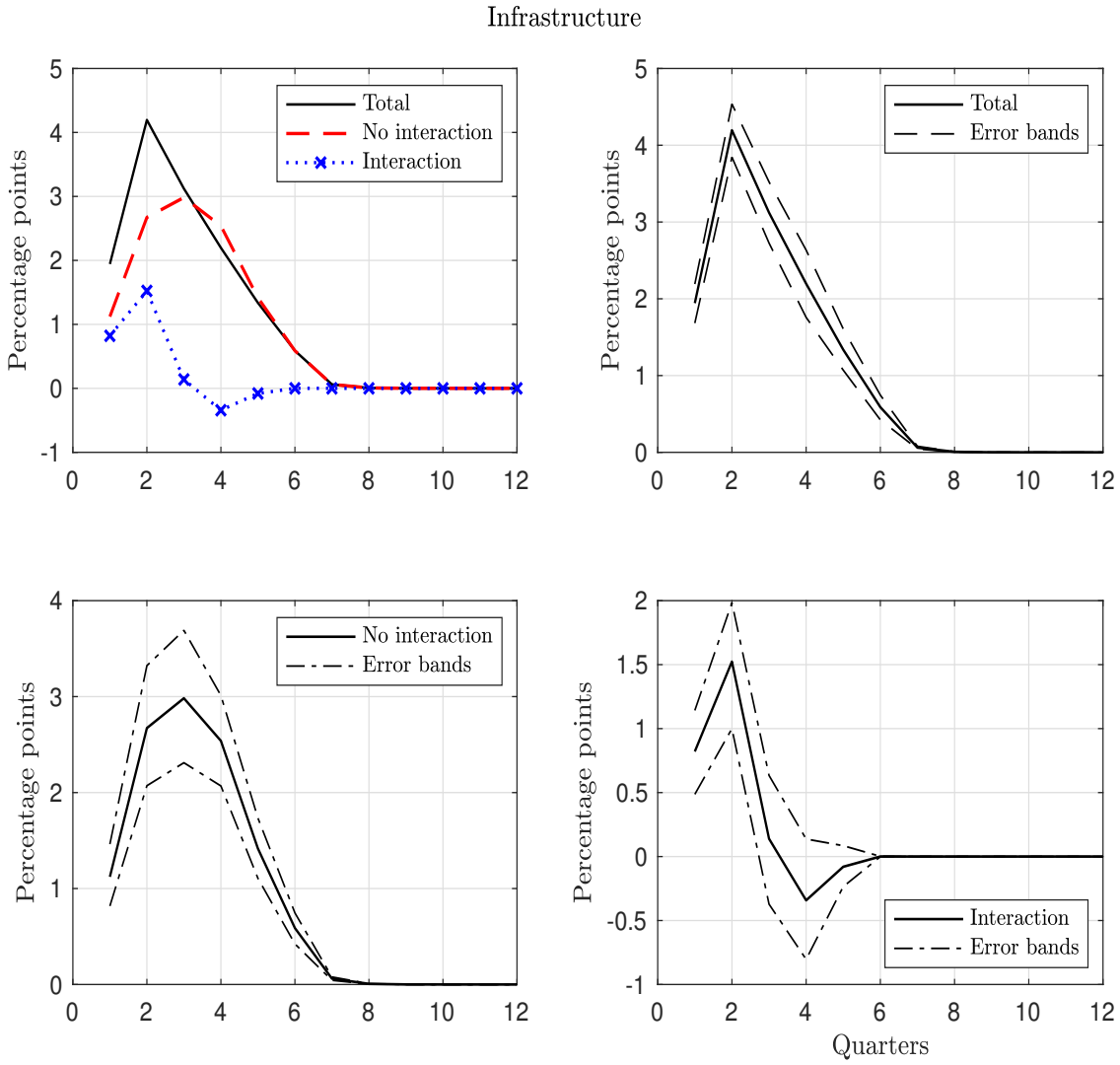

FIGURE 11. Dynamic impacts of main monetary stimulus (no interaction) and its interaction with infrastructure investment on bank loans to the average firm. *Notes*: The dynamic responses are expressed as percentage changes from the initial quarter 0 (i.e., changes from the pre-stimulus period). Dash-dotted lines represent the corresponding .90 probability bands. Quarter 1 corresponds to 2009Q1 and quarter 12 corresponds to 2011Q4.

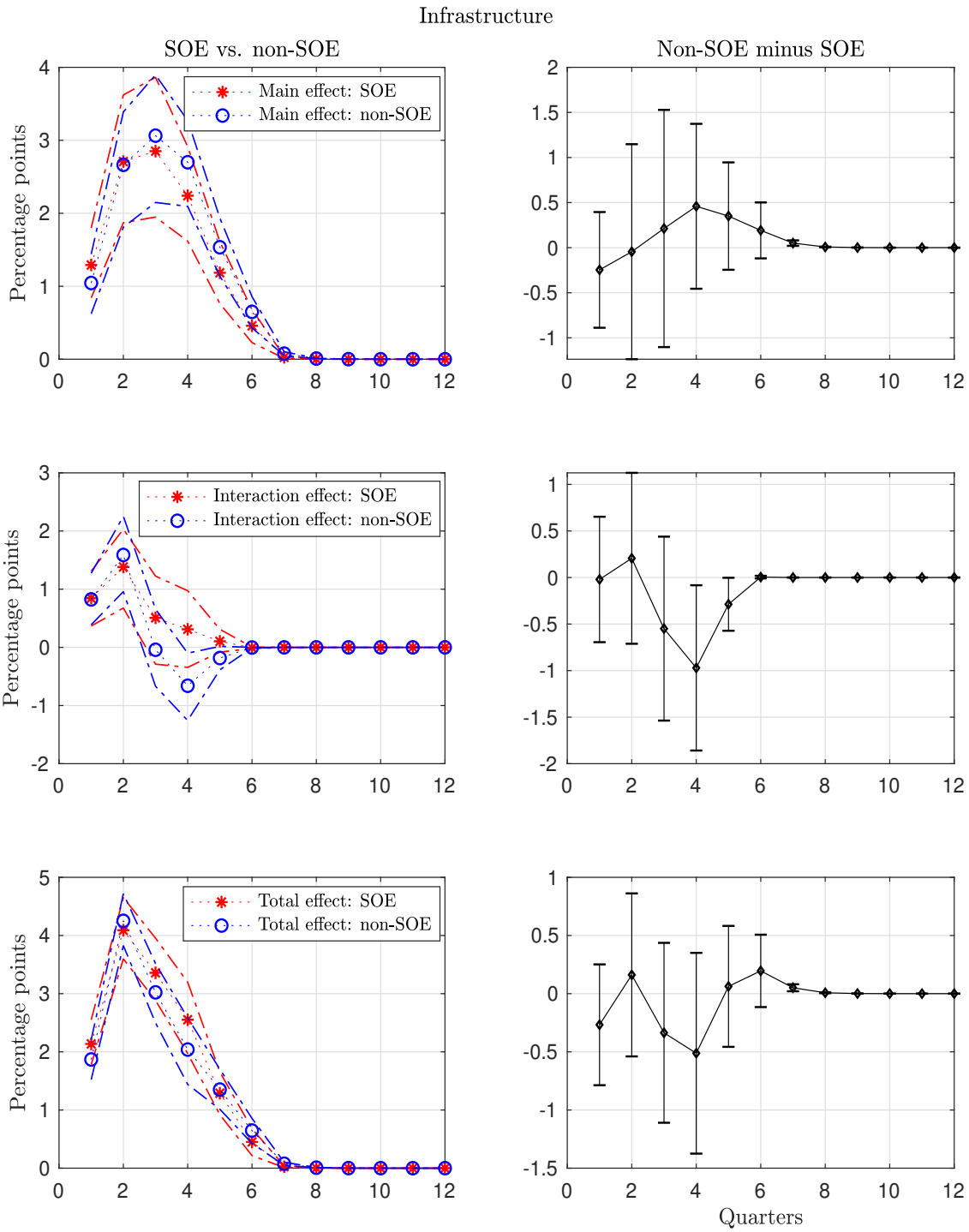

FIGURE 12. Dynamic impacts of main monetary stimulus (no interaction) and its interaction with infrastructure investment on bank loans to the average SOE firm and the average non-SOE firm. The right column displays the non-SOE loan response relative to the SOE loan response. *Notes*: The dynamic responses are expressed as percentage changes from the initial quarter 0 (i.e., changes from the non-stimulus period). Dash-dotted lines and error bars represent the corresponding .90 probability bands. Quarter 1 corresponds to 2009Q1 and quarter 12 corresponds to 2011Q4.

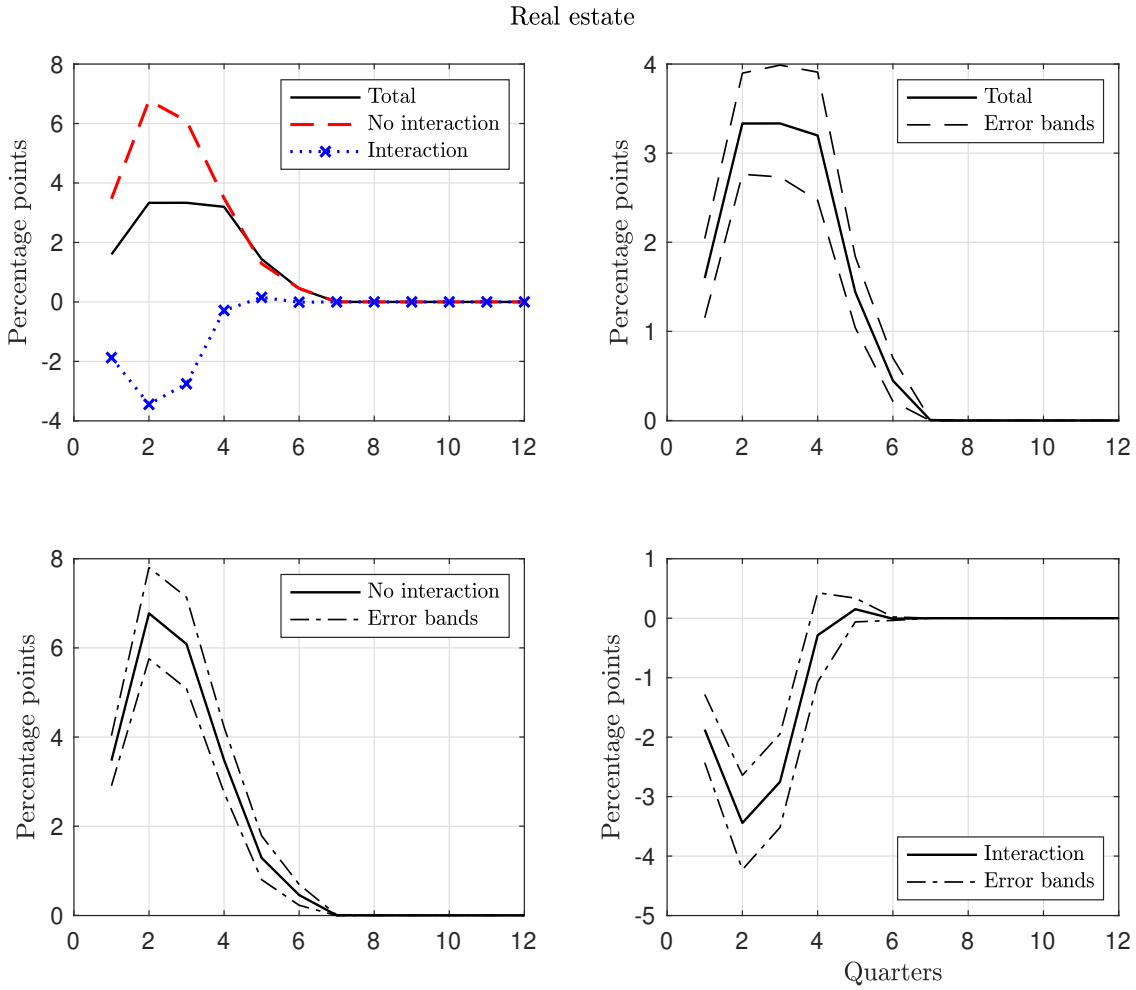

FIGURE 13. Dynamic impacts of main monetary stimulus (no interaction) and its interaction with infrastructure investment on bank loans to the average firm. *Notes*: The dynamic responses are expressed as percentage changes from the initial quarter 0 (i.e., changes from the pre-stimulus period). Dash-dotted lines represent the corresponding .90 probability bands. Quarter 1 corresponds to 2009Q1 and quarter 12 corresponds to 2011Q4.

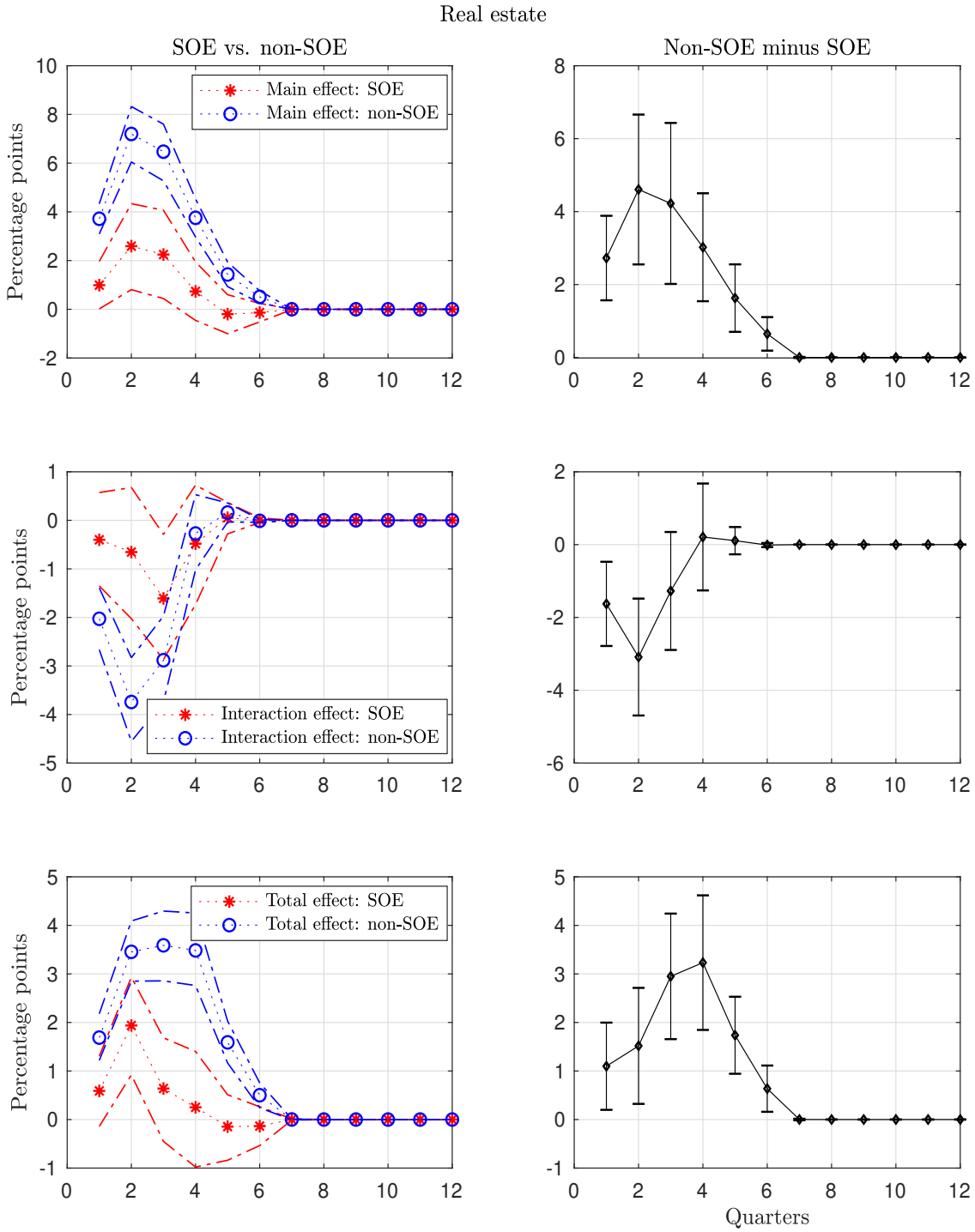

FIGURE 14. Dynamic impacts on bank loans to the average SOE firm and the average non-SOE firm in response to main monetary stimulus (no interaction) and its interaction with infrastructure investment. The right column displays the non-SOE loan response relative to the SOE loan response. *Notes*: The dynamic responses are expressed as percentage changes from the initial quarter 0 (i.e., changes from the non-stimulus period). Dash-dotted lines and error bars represent the corresponding .90 probability bands. Quarter 1 corresponds to 2009Q1 and quarter 12 corresponds to 2011Q4.

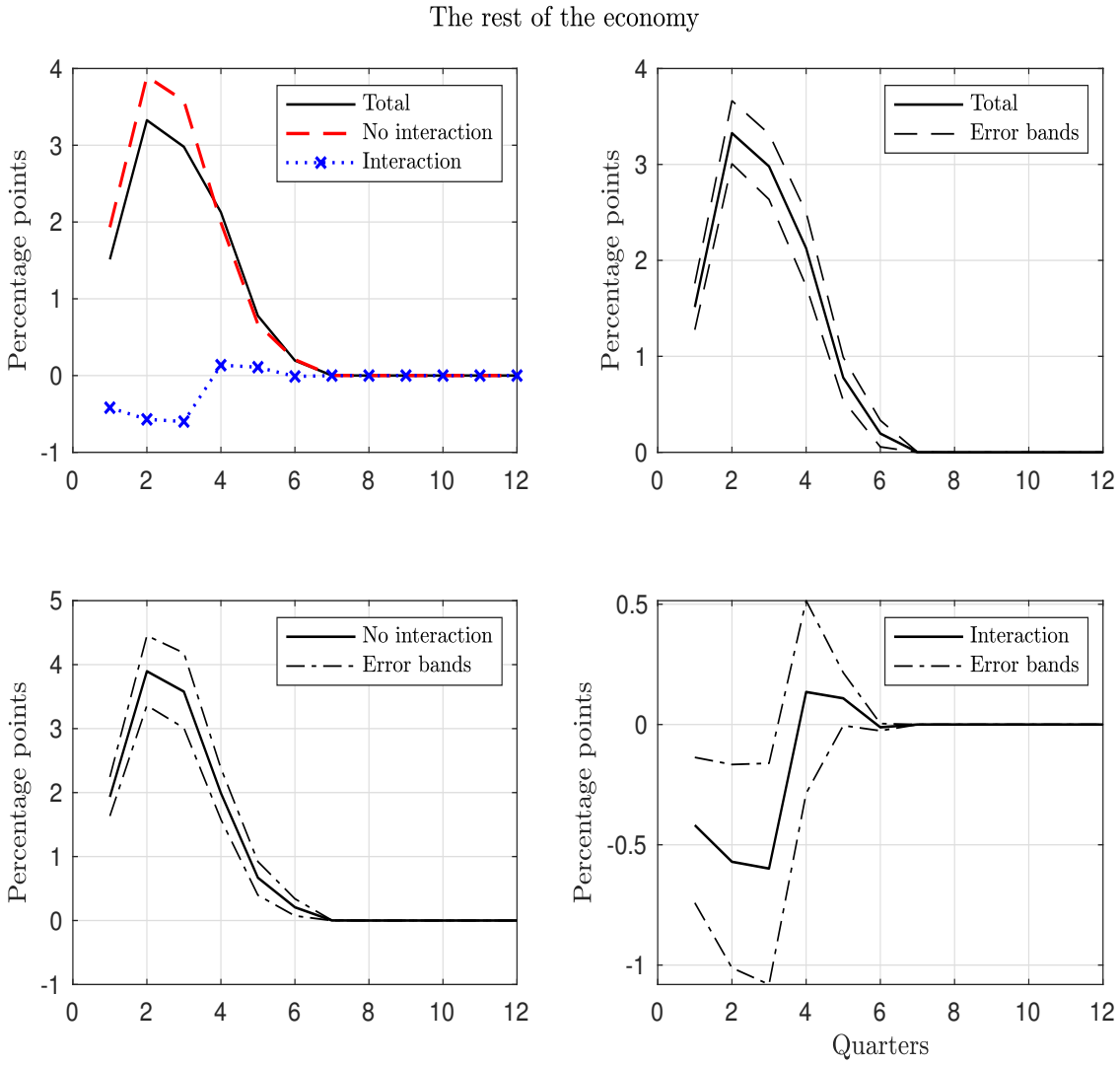

FIGURE 15. Dynamic impacts of main monetary stimulus (no interaction) and its interaction with infrastructure investment on bank loans to the average firm. *Notes*: The dynamic responses are expressed as percentage changes from the initial quarter 0 (i.e., changes from the pre-stimulus period). Dash-dotted lines represent the corresponding .90 probability bands. Quarter 1 corresponds to 2009Q1 and quarter 12 corresponds to 2011Q4.

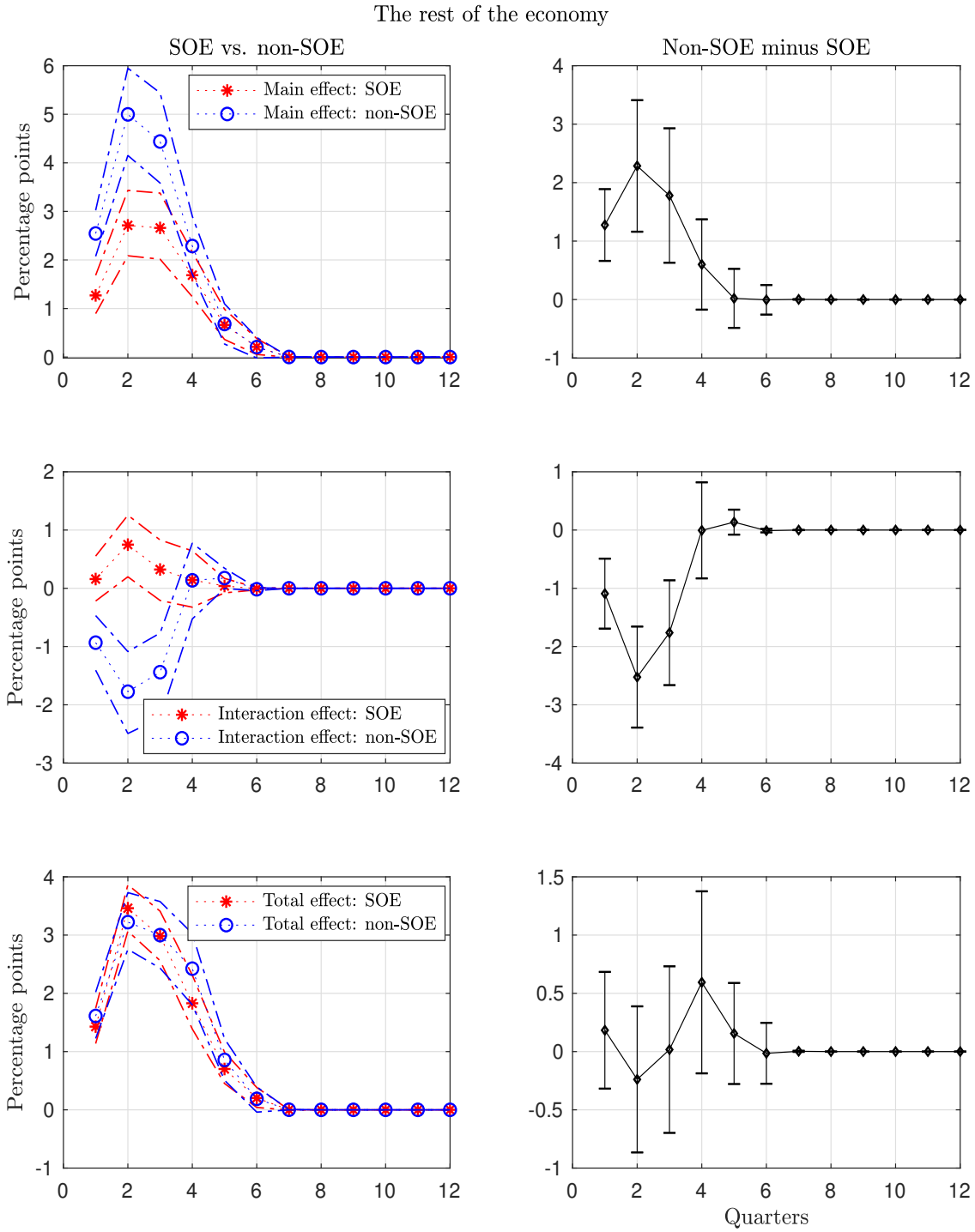

FIGURE 16. Dynamic impacts of main monetary stimulus (no interaction) and its interaction with infrastructure investment on bank loans to the average SOE firm and the average non-SOE firm. The right column displays the non-SOE loan response relative to the SOE loan response. *Notes*: The dynamic responses are expressed as percentage changes from the initial quarter 0 (i.e., changes from the non-stimulus period). Dash-dotted lines and error bars represent the corresponding .90 probability bands. Quarter 1 corresponds to 2009Q1 and quarter 12 corresponds to 2011Q4.

Appendix A provides the data description and the sources. Appendix B provides technical details of the first-stage macro model. Appendix C provides technical details of how to compute 90% probability intervals of dynamic responses. Appendix D provides additional results for the impacts of monetary stimulus.

Appendix A. Data description and sources

The methodology of collecting and constructing the quarterly aggregate series is based on Higgins and Zha (2015) and Chang, Chen, Waggoner, and Zha (2016). The main data sources are China's National Bureau of Statistics, the People's Bank of China, and CEIC. The proc X-12 procedure in the SAS software package is used for seasonal adjustment. In our firm-quarter dataset, we seasonally adjust aggregated new loans and total assets for each sector and each type of firm (e.g., a manufacturing-SOE combination). We then multiply each firm-level variable by the ratio of the seasonally adjusted aggregate to the non-seasonally adjusted aggregate. This method allows us to obtain seasonally adjusted firm-quarter data. Because the sample is short in the time dimension, we use the seasonal ARIMA$(0,1,1)(0,1,1)_4$ model to perform seasonal adjustments. This model is similar to the seasonal ARIMA$(0,1,1)(0,1,1)_{12}$ model, known as the airline model, that Box, Jenkins, Reinsel, and Ljung (2015) used to seasonally adjust monthly airline passenger data. Results without seasonal adjustments are similar to those with seasonal adjustments. We provide, below, a detailed description of the aggregate and firm-quarter variables used in the main text as well as in appendices.

M2: Supply of M2, quarterly average of the monthly series (billions of RMB). For the last monthly observation, we use the level of M2 (CEIC ticker CKSAAC). The 12 monthly observations prior to the last observation are constructed recursively from the month-over-month gross growth rates of CKSAAC each multiplied by a constant adjustment factor. The adjustment factor is chosen so that the 12-month growth rate of the last observed value of our constructed series is equal to the last published 12-month growth rate (CEIC ticker CKSAACA). Once these last 13 observations are determined, we recursively construct the level series back to 1996M4 with the published year-over-year growth rate, back to 1994M12 with the year-over-year growth rate provided by the PBC, and back to 1990M3 with an interpolated year-over-year growth rate derived from the quarterly level of M2 (CEIC ticker CKAAC). Sources: NBS, CEIC, People's Bank of China, and Chang, Chen, Waggoner, and Zha (2016).

GDP: Real GDP by value added (billions of 2008 RMB), seasonally adjusted with SAS proc X12. Sources of raw data: NBS and CEIC. Detailed method of construction described in Higgins and Zha (2015).

GDP growth target: Real GDP growth target set by the central government of China. Sources: NBS and CEIC.

CPI: Consumer price index, seasonally adjusted. Constructed by splicing together gross 1-month (CEIC ticker CIAHJZ) and 12-month (CEIC ticker CIEA) inflation rates, converting to a quarterly index, and seasonally adjusting with SAS proc X12. Sources: NBS and CEIC.

Infrastructure investment: Gross capital formation for the infrastructure sector. The series, based on the expenditure side of national domestic product, is interpolated by fixed-asset investment and deflated by the investment price index. Sources: NBS and CEIC.

Investment price: The price index of fixed asset investment. Seasonally adjusted with SAS proc X12. Sources of raw data: NBS and CEIC. Primarily based on quarterly CEIC series "CIAHQA: CN: Fixed Asset Inv Price Index: Overall (PY=100)," which starts in 2004Q1. The 2003Q1-Q4 levels use corporate goods investment price, which is derived from CEIC ticker CIACWZ "(DC)Corporate Goods Price Index: Investment Goods; Dec1993=100" and CEIC ticker CIQDBAA "CN: Corporate Goods Price Index: Investment Goods; Prev Year=100," with a very small adjustment such that the adjusted 2004Q1 4-quarter growth rate is consistent with CIAHQA.

Assets: A firm's total physical and financial assets. CSMAR item A001000000.

Investment: Cash paid to acquire and construct fixed assets; intangible assets and other long-term assets. CSMAR item C002006000 after undoing year-to-date operation.

Leverage: A firm's leverage defined as a ratio of the firm's total liabilities to its total assets. Ratio of CSMAR item A002000000 to CSMAR item A001000000.

NPL: Non-performing loans. A firm's credit quality defined as the ratio of the firm's outstanding bank loans in lower rating categories (i.e., substandard, doubtful, and loss categories) to its total outstanding bank loans. The international standard loan classification consists of five categories: normal, special-purpose, substandard, doubtful, and loss.

Guarantee: The ratio of a firm's outstanding bank loans with at least one third-party credit guarantor to its total outstanding bank loans. This ratio serves as a proxy to enhancement of the firm's existing credit. According to the contract, a credit guarantor guarantees to pay a borrower's debt if the borrower defaults on a loan obligation.

Appendix B. The first-stage macro model

We do not impose any restrictions on subsystem (8) to avoid the "incredible restrictions" criticism of Sims (1980). Without any restrictions, subsystem (8) is unidentified because the transformed system

$$(QA_0)x_t + (Qb_{m,0}) \log M_t = (Qc) + \sum_{k=1}^{4} (QA_k)x_{t-k} + \sum_{k=1}^{4} (Qb_{m,k}) \log M_{t-k} + Q\xi_t,$$

where Q is any orthogonal matrix, generates the same dynamics of x_t as does the original system (8).

Although subsystem (8) is unidentified, the following propositions show that the monetary policy equation is identified.

Proposition B.1. When the system represented by (5) and (8) is jointly estimated, monetary policy represented by equation (5) is identified, even though subsystem (8) itself is unidentified.

Proof. Consider the complete system composed of (5) and (8), which can be written in the SVAR form of

$$\underbrace{\begin{bmatrix} \frac{1}{\sigma_{m,t}} & 0 \\ b_{m,0} & A_0 \end{bmatrix}}_{\widetilde{A}_{0,t}} \begin{bmatrix} \log M_t \\ x_t \end{bmatrix} = \underbrace{\begin{bmatrix} \frac{\gamma_0 - \gamma_\pi \pi^* - \gamma_{y,t} g^*_{y,t-1}}{\sigma_{m,t}} \\ c \end{bmatrix}}_{\widetilde{c}_t}$$
$$+ \underbrace{\begin{bmatrix} \frac{1+\gamma_m}{\sigma_{m,t}} & \begin{bmatrix} \frac{\gamma_{y,t}}{\sigma_{m,t}} & \frac{\gamma_\pi}{\sigma_{m,t}} & 0 \\ & & 1\times(n-2) \end{bmatrix} \\ b_{m,1} & A_1 \end{bmatrix}}_{\widetilde{A}_{1,t}} \begin{bmatrix} \log M_{t-1} \\ x_{t-1} \end{bmatrix} + \underbrace{\begin{bmatrix} \frac{-\gamma_m}{\sigma_{m,t}} & \begin{bmatrix} \frac{-\gamma_{y,t}}{\sigma_{m,t}} & \frac{-\gamma_\pi}{\sigma_{m,t}} & 0 \\ & & 1\times(n-2) \end{bmatrix} \\ b_{m,2} & A_2 \end{bmatrix}}_{\widetilde{A}_{2,t}} \begin{bmatrix} \log M_{t-2} \\ x_{t-2} \end{bmatrix}$$
$$+ \underbrace{\begin{bmatrix} 0 & 0 \\ & 1\times n \\ b_{m,3} & A_3 \end{bmatrix}}_{\widetilde{A}_3} \begin{bmatrix} \log M_{t-3} \\ x_{t-3} \end{bmatrix} + \underbrace{\begin{bmatrix} 0 & 0 \\ & 1\times n \\ b_{m,4} & A_4 \end{bmatrix}}_{\widetilde{A}_4} \begin{bmatrix} \log M_{t-4} \\ x_{t-4} \end{bmatrix} + \begin{bmatrix} \xi_{m,t} \\ \xi_t \end{bmatrix}. \quad \text{(B.1)}$$

For system (B.1), we first show that the first equation (the monetary policy equation) is identified. According to Theorem 2 of Rubio-Ramírez, Waggoner, and Zha (2010), this equation is identified if the following statement is true: if $\widetilde{Q}\widetilde{A}_{0,t} = \widehat{A}_{0,t}$, where $\widetilde{Q}$ is an orthogonal matrix, and $\widehat{A}_{0,t}$ maintains the form of

$$\begin{bmatrix} \widehat{A}^{11}_{0,t} & \widehat{A}^{12}_{0,t} \\ \widehat{A}^{21}_{0,t} & \widehat{A}^{22}_{0,t} \end{bmatrix} = \begin{bmatrix} \widehat{A}^{11}_{0,t} & 0 \\ & 1\times n \\ \widehat{A}^{21}_{0,t} & \widehat{A}^{22}_{0,t} \end{bmatrix},$$

then $\widetilde{Q}$ must be of the form

$$\begin{bmatrix} \widetilde{Q}^{11} & \widetilde{Q}^{12} \\ \widetilde{Q}^{21} & \widetilde{Q}^{22} \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ & 1\times n \\ 0 & \widetilde{Q}^{22} \\ n\times 1 & \end{bmatrix}. \quad \text{(B.2)}$$

To show that the above statement is true, note that $\widetilde{Q}\widetilde{A}_{0,t} = \widehat{A}_{0,t}$ is equivalent to

$$\begin{bmatrix} \widetilde{Q}^{11}\widetilde{A}^{11}_{0,t} + \widetilde{Q}^{12}\widetilde{A}^{21}_{0,t} & \widetilde{Q}^{12}\widetilde{A}^{22}_{0,t} \\ \widetilde{Q}^{21}\widetilde{A}^{11}_{0,t} + \widetilde{Q}^{22}\widetilde{A}^{21}_{0,t} & \widetilde{Q}^{22}\widetilde{A}^{22}_{0,t} \end{bmatrix} = \begin{bmatrix} \widehat{A}^{11}_{0,t} & 0 \\ & 1\times n \\ \widehat{A}^{21}_{0,t} & \widehat{A}^{22}_{0,t} \end{bmatrix}.$$

Since $\widetilde{A}^{22}_{0,t}$ is invertible for the system and $\widetilde{Q}^{12}\widetilde{A}^{22}_{0,t} = 0$, we have $\widetilde{Q}^{12} = 0$. Because $\widetilde{Q}$ is an orthogonal matrix, it must be that $\widetilde{Q}^{21} = 0$ and $\widetilde{Q}^{11} = 1$. This proves (B.2). □

Let θ denote a collection of all the parameters for the system represented by (5) and (8) and $\hat{\theta}$ be its posterior estimate. Conditional on $\hat{\theta}$ and the actual data of $\log M_t$ and x_t for all t, we compute the estimated shocks denoted by $\hat{\xi}_{m,t}$ and $\hat{\xi}_t$. The variables driven only by monetary policy changes, x^m_t, and by non-monetary aggregate shocks, x^o_t, are computed as follows.

- Set $\hat{\xi}_t = 0$ for all t.

- Compute the decomposed paths of $\log M_t$ and x_t with $\hat{\xi}_{m,t}$ through the system represented by (5) and (8).
- Denote the decomposed path of x_t by x_t^m.
- Compute x_t^o as $x_t^o = x_t - x_t^m$.

This decomposition is unique as stated in the following proposition.

Proposition B.2. While subsystem (8) itself is unidentified, the decomposed variables x_t^m and x_t^o, conditional on $\hat{\theta}$ and the data, are uniquely determined.

Proof. From the proof of Proposition B.1, one can see that if we multiply system (B.1) by an orthogonal matrix $\widetilde{Q}$ to obtain an observationally equivalent system, $\widetilde{Q}$ must be of the form given by (B.2). Multiplying B.1 by such an orthogonal matrix, the resulting reduced-form system will be

$$z_t = \widetilde{A}_{0,t}^{-1}\widetilde{c}_t + \widetilde{A}_{0,t}^{-1}\widetilde{A}_{1,t}z_{t-1} + \widetilde{A}_{0,t}^{-1}\widetilde{A}_{2,t}z_{t-2} + \widetilde{A}_{0,t}^{-1}\widetilde{A}_3 z_{t-3} + \widetilde{A}_{0,t}^{-1}\widetilde{A}_4 z_{t-4} + \widetilde{A}_{0,t}^{-1}\begin{bmatrix}\xi_{m,t}\\ \widetilde{Q}_{22}'\xi_t\end{bmatrix} \quad \text{(B.3)}$$

where $z_t = [\log M_t \;\; x_t']'$. The estimated shocks, $\hat{\xi}_{m,t}$ and $\hat{\xi}_t$, are obtained from B.3, given $\hat{\theta}$ and the data. The monetary policy shock $\hat{\xi}_{m,t}$ does not depend on $\widetilde{Q}_{22}$, while $\hat{\xi}_t$ does. But since this decomposition sets $\hat{\xi}_t$ to zero, the decomposition is uniquely defined (i.e., does not depend on $\widetilde{Q}_{22}$). □

Appendix C. Computing the 90% probability intervals of dynamic responses

We first generate random draws of the coefficients in regression (4). Conditional on each random draw of the coefficients, we then compute a random path of dynamic responses using equation (11). Specifically, we begin with grouping the regression coefficients in regression (4) into the vectors

$$\Phi^j = \begin{bmatrix}\rho^j & d_0^j & \cdots & d_\ell^j & b_0^j & \cdots & b_\ell^j\end{bmatrix}'$$

and

$$\Psi^j = \begin{bmatrix}c^{1,j} & \cdots & c^{N,j} & \Phi^{j\prime} & c_\chi^{j\prime} & c_z^{j\prime}\end{bmatrix}' \quad \text{(C.1)}$$

and the regressors into the vectors

$$\boldsymbol{x}_{j,t} = \begin{bmatrix}\mathfrak{b}_{j,t-1} & \varepsilon_{m,t} & \cdots & \varepsilon_{m,t-\ell} & g^o_{\text{infra},t}\varepsilon_{m,t} & \cdots & g^o_{\text{infra},t-\ell}\varepsilon_{m,t-\ell}\end{bmatrix}'$$

and

$$\boldsymbol{x}_{i,j,t} = \begin{bmatrix}\boldsymbol{c}_{i,j,t}' & \boldsymbol{x}_{j,t}' & \chi_t^{o\prime} & z_{i,j,t-1}'\end{bmatrix}'$$

where $j \in \{\text{SOEs}, \text{non-SOEs}, \text{All firms}\}$ and $\boldsymbol{c}_{i,j,t}'$ is a vector of firm dummies whose i^{th} element is 1 and remaining elements are 0. The fitted values for Equation (4) can be rewritten in compact form as

$$\mathfrak{b}_{i,j,t} = \hat{\Psi}^{j\prime}\boldsymbol{x}_{i,j,t},$$

while the fitted values for equation (11) can be rewritten as

$$\mathfrak{b}_{j,t} = \hat{\Phi}^{j\prime} \boldsymbol{x}_{j,t}. \tag{C.2}$$

We stack firm-specific residuals in regression (4) into the $T \times 1$ vector

$$\boldsymbol{\eta}_j = \Big[\eta_{1,j,2007\text{Q2}+\ell+1} \quad \cdots \quad \eta_{1,j,2013\text{Q2}} \quad \cdots \quad \eta_{N,j,2007\text{Q2}+\ell+1} \quad \cdots \quad \eta_{N,j,2013\text{Q2}}\Big]',$$

where 2013Q2 is the last data point in the time dimension and $T = N(21-\ell)$. Letting N_x denote the length of $\boldsymbol{x}_{i,j,t}$, we define $\boldsymbol{\Omega}_j = \boldsymbol{\eta}_j'\boldsymbol{\eta}_j'$, denote the $\mathfrak{h}^{\text{th}}$ random draw from the inverse Wishart (IW) distribution $\text{IW}(\boldsymbol{\Omega}_j, T+2-N_x)$ by $\boldsymbol{\Gamma}_j^{(\mathfrak{h})}$, denote the $\mathfrak{h}^{\text{th}}$ random draw of $\Psi^j + \boldsymbol{\nu}^{(\mathfrak{h})\prime}\text{chol}(\boldsymbol{\Gamma}_j^{(\mathfrak{h})}(X^{j\prime}X^j)^{-1})$ by $\hat{\Psi}^{j,(\mathfrak{h})}$, where chol represents the Choleski decomposition of the enclosed matrix

$$X_j = \Big[\boldsymbol{x}_{1,j,2007\text{Q2}+\ell+1} \quad \cdots \quad \boldsymbol{x}_{1,j,2013\text{Q2}} \quad \cdots \quad \boldsymbol{x}_{N,j,2007\text{Q2}+\ell+1} \quad \cdots \quad \boldsymbol{x}_{N,j,2013\text{Q2}}\Big]',$$

and $\boldsymbol{\nu}^{(\mathfrak{h})}$ is an $N_x \times 1$ vector randomly drawn from the iid Gaussian distribution $N(\mathbf{0}, \boldsymbol{I}_{N_x})$ (see Bańbura, Giannone, and Reichlin (2010) for technical details).

For Φ^j in equation (C.2), we extract the subvector $\Phi^{j,(\mathfrak{h})}$ from the $\mathfrak{h}^{\text{th}}$ draw $\Psi^{j,(\mathfrak{h})}$, using equation (C.1) for $1 \leq \mathfrak{h} \leq \mathcal{H}$ ($\mathcal{H}$ is the number of random draws). A random draw of the dynamic response function $\boldsymbol{f}^{(\mathfrak{h})} = [f^{(\mathfrak{h})}(1,j), \ldots, f^{(\mathfrak{h})}(12,j)]'$ for $j \in \{\text{SOE}, \text{non-SOE}, \text{All firms}\}$ in sector j is generated by feeding in three consecutive shocks and interaction terms

$$\varepsilon^{\text{Stim}}_{m,2009\text{Q1}}, \varepsilon^{\text{Stim}}_{m,2009\text{Q2}}, \varepsilon^{\text{Stim}}_{m,2009\text{Q3}}, g^{o}_{\text{infra},2009\text{Q1}}\varepsilon^{\text{Stim}}_{m,2009\text{Q1}}, g^{o}_{\text{infra},2009\text{Q2}}\varepsilon^{\text{Stim}}_{m,2009\text{Q2}}, g^{o}_{\text{infra},2009\text{Q3}}\varepsilon^{\text{Stim}}_{m,2009\text{Q3}}.$$

The 5^{th} and 95^{th} percentiles of the set $\{f^{\mathfrak{h}}(t,j)\}_{\mathfrak{h}=1}^{\mathcal{H}}$ deliver the .90 probability bands of dynamic responses at time t.[38]

Appendix D. Additional results for the impacts of monetary stimulus

In this section, we report additional estimated results that supplement the discussion in the main text. Tables D.1-D.5 report the numerical values for relative impacts of the 2009 monetary stimulus on bank credit to non-SOEs *relative to* SOEs. The positive values indicate that non-SOEs received more loans than SOEs, and vice versa. Tables D.7-D.10 report additional results when the first-stage regression is omitted. The impacts of monetary stimulus on bank credit to LGFVs and non-LGFVs in non-infrastructure sectors are reported in Table D.6. Detailed discussion of all these supplemental tables is in the main text.

In all these regressions, the dependent variable is a firm-quarter observation of newly issued bank credit to a firm scaled by its total nominal assets. The right-hand variables include contemporaneous and lagged monetary policy shocks and their interactions with the respective growth rates of infrastructure investment. The firm-level control variables include the NPL ratio, the guarantee ratio, assets, and the leverage ratio, all lagged by one

[38]We set $\mathcal{H} = 1000$. Since all the random draws are iid, 1000 draws are sufficient for achieving accuracy. Note that the dynamic response results do not depend on particular values of t and other variables.

period. The aggregate control variables include lagged GDP growth, lagged inflation, and contemporaneous and lagged growth rates of infrastructure investment.

TABLE D.1. Relative impacts of monetary stimulus on loans to non-SOEs: manufacturing

	Main effect (1)	Interaction effect (2)	Total effect (3)
2009Q1	-0.69*	-0.22	-0.90***
	(0.38)	(0.38)	(0.32)
2009Q2	−1.61**	0.40	-1.20***
	(0.71)	(0.54)	(0.41)
2009Q3	−1.19	0.46	-0.74
	(0.75)	(0.57)	(0.45)
2009Q4	−0.38	-0.55	-0.93
	(0.52)	(0.51)	(0.51)
2010Q1	0.07	-0.25	-0.18
	(0.35)	(0.16)	(0.31)
2010Q2	0.00	0.01	-0.01
	(0.18)	(0.01)	(0.19)

Notes: Impacts relative to those on SOE loans (we take monetary impacts on loans to SOEs as a benchmark for comparison). The superscript * represents the 0.1 significance level, ** 0.05, and *** 0.01. Each panel regression has both firm-level controls and aggregate controls.

TABLE D.2. Relative impacts of monetary stimulus on loans to non-SOEs: the entire economy

	Main effect (1)	Interaction effect (2)	Total effect (3)
2009Q1	0.17	-0.59***	-0.42***
	(0.20)	(0.19)	(0.16)
2009Q2	0.29	-1.06***	-0.77***
	(0.36)	(0.28)	(0.21)
2009Q3	0.34	-0.88***	-0.54**
	(0.37)	(0.28)	(0.23)
2009Q4	0.26	-0.53**	-0.27
	(0.26)	(0.26)	(0.26)
2010Q1	0.16	-0.11	0.05
	(0.17)	(0.08)	(0.15)
2010Q2	0.06	0.01	0.07
	(0.09)	(0.01)	(0.09)

Notes: Impacts relative to those on SOE loans (we take monetary impacts on loans to SOEs as a benchmark for comparison). The superscript * represents the 0.1 significance level, ** 0.05, and *** 0.01. Each panel regression has both firm-level controls and aggregate controls.

TABLE D.3. Relative impacts of monetary stimulus on loans to non-SOEs: infrastructure

	Main effect (1)	Interaction effect (2)	Total effect (3)
2009Q1	−0.25	-0.02	-0.27
	(0.39)	(0.41)	(0.31)
2009Q2	−0.05	0.21	0.16
	(0.72)	(0.56)	(0.42)
2009Q3	0.21	-0.55	-0.34
	(0.80)	(0.60)	(0.47)
2009Q4	0.46	-0.97*	-0.51
	(0.55)	(0.54)	(0.52)
2010Q1	0.35	-0.29*	0.06
	(0.36)	(0.17)	(0.31)
2010Q2	0.19	0.00	0.20
	(0.19)	(0.01)	(0.19)

Notes: Impacts relative to those on SOE loans (we take monetary impacts on loans to SOEs as a benchmark for comparison). The superscript * represents the 0.1 significance level, ** 0.05, and *** 0.01. Each panel regression has both firm-level controls and aggregate controls.

TABLE D.4. Relative impacts of monetary stimulus on loans to non-SOEs: real estate

	Main effect (1)	Interaction effect (2)	Total effect (3)
2009Q1	2.73***	-1.63**	1.10**
	(0.70)	(0.70)	(0.54)
2009Q2	4.61***	-3.09***	1.52**
	(1.25)	(0.97)	(0.72)
2009Q3	4.22***	-1.27	2.95***
	(1.34)	(0.98)	(0.78)
2009Q4	3.02***	0.21	3.23***
	(0.90)	(0.89)	(0.84)
2010Q1	1.63***	0.11	1.74***
	(0.56)	(0.22)	(0.48)
2010Q2	0.65**	-0.01	0.64**
	(0.28)	(0.03)	(0.29)

Notes: Impacts relative to those on SOE loans (we take monetary impacts on loans to SOEs as a benchmark for comparison). The superscript * represents the 0.1 significance level, ** 0.05, and *** 0.01. Each panel regression has both firm-level controls and aggregate controls.

TABLE D.5. Relative impacts of monetary stimulus on loans to non-SOEs: the remaining economy

	Main effect	Interaction effect	Total effect
2009Q1	1.27***	-1.09***	0.18
	(0.37)	(0.36)	(0.30)
2009Q2	2.29***	-2.52***	-0.24
	(0.68)	(0.53)	(0.38)
2009Q3	1.78**	-1.76***	0.02
	(0.70)	(0.55)	(0.43)
2009Q4	0.60	-0.01	0.59
	(0.47)	(0.50)	(0.47)
2010Q1	0.02	0.14	0.16
	(0.31)	(0.13)	(0.26)
2010Q2	−0.00	-0.01	-0.01
	(0.15)	(0.02)	(0.16)

Notes: Impacts relative to those on SOE loans (we take monetary impacts on loans to SOEs as a benchmark for comparison). The superscript * represents the 0.1 significance level, ** 0.05, and *** 0.01. Each panel regression has both firm-level controls and aggregate controls.

TABLE D.6. Estimation results for dynamic panel regression (4) for LGFVs in non-infrastructure sectors

	Manufacturing		Real estate		Other non-infrastructure sectors	
	LGFVs	Non-LGFVs	LGFVs	Non-LGFVs	LGFVs	Non-LGFVs
d_0: main effect	1.018	0.349***	0.146	0.868	0.474***	0.441
	(0.621)	(0.108)	(0.173)	(0.582)	(0.176)	(0.088)
d_1: main effect	1.418**	0.311***	0.456**	0.795	0.652***	0.450**
	(0.655)	(0.115)	(0.183)	(0.616)	(0.187)	(0.094)
d_2: main effect	0.312	0.091	−0.023	0.076	0.361**	0.121
	(0.551)	(0.096)	(0.156)	(0.518)	(0.158)	(0.079)
d_3: main effect	0.236	0.067	0.029	−0.459	0.108	0.150
	(0.459)	(0.081)	(0.129)	(0.430)	(0.131)	(0.065)
b_0: interaction effect	8.168	−1.063	−0.440	−4.218	5.401***	−1.325
	(6.638)	(1.163)	(1.868)	(6.251)	(1.913)	(0.949)
b_1: interaction effect	8.538	−2.976**	−3.715	2.052	3.613	2.138
	(8.464)	(1.462)	(2.359)	(7.829)	(2.389)	(1.188)
b_2: interaction effect	−12.364	−0.251	−2.091	−14.327*	−0.724	0.788
	(8.439)	(1.463)	(2.346)	(7.879)	(2.391)	(1.200)
b_3: interaction effect	1.271	1.002	−0.494	0.922	−0.628	1.064
	(7.360)	(1.263)	(2.033)	(6.865)	(2.079)	(1.039)
$\sum_k d_k$: main effect	2.984**	0.817***	0.608*	1.281	1.596***	1.162*
	(1.222)	(0.216)	(0.346)	(1.153)	(0.353)	(0.175)
$\sum_k b_k$: interaction effect	5.612	−3.288	−6.740	−15.572	7.661	2.665
	(19.567)	(3.374)	(5.447)	(18.243)	(5.559)	(2.768)
Number of Observations	805	4968	1012	368	5014	11661
Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Aggregate controls	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Values in parentheses are standard errors. The superscript * represents the 0.1 significance level, ** 0.5, and *** 0.01.

TABLE D.7. Estimation results for the dynamic panel regression without the first-stage estimation: manufacturing

	All firms	SOEs	Non-SOEs
d_0: main effect	0.267***	0.484***	0.243***
	(0.035)	(0.139)	(0.036)
d_1: main effect	0.252***	0.573***	0.216***
	(0.040)	(0.156)	(0.040)
d_2: main effect	0.214***	0.170	0.220***
	(0.035)	(0.137)	(0.036)
d_3: main effect	0.080***	0.059	0.084***
	(0.029)	(0.113)	(0.029)
b_0: interaction effect	−0.401	0.402	−0.476*
	(0.283)	(1.113)	(0.288)
b_1: interaction effect	−0.352	−2.165	−0.150
	(0.345)	(1.357)	(0.352)
b_2: interaction effect	−1.639***	−3.001**	−1.475***
	(0.331)	(1.299)	(0.337)
b_3: interaction effect	−0.645**	0.977	−0.813***
	(0.308)	(1.210)	(0.313)
$\sum_k d_k$: main effect	0.813***	1.286***	0.763***
	(0.083)	(0.326)	(0.084)
$\sum_k b_k$: interaction effect	−3.036***	−3.787	−2.914***
	(0.769)	(3.019)	(0.783)
Number of Observations	55499	5773	49726
Fixed effects	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes
Aggregate controls	Yes	Yes	Yes

Notes: Values in parentheses are standard errors. The superscript * represents the 0.1 significance level, ** 0.05, and *** 0.01.

TABLE D.8. Estimation results for the dynamic panel regression without the first-stage estimation: real estate

	All firms	SOEs	Non-SOEs
d_0: main effect	1.297***	0.349	1.391***
	(0.130)	(0.215)	(0.141)
d_1: main effect	1.295***	0.577**	1.371***
	(0.145)	(0.240)	(0.158)
d_2: main effect	0.466***	0.084	0.505***
	(0.129)	(0.213)	(0.140)
d_3: main effect	0.273***	−0.117	0.310***
	(0.104)	(0.173)	(0.113)
b_0: interaction effect	−6.045***	−1.134	−6.557***
	(1.037)	(1.723)	(1.128)
b_1: interaction effect	−8.033***	−1.091	−8.776***
	(1.259)	(2.086)	(1.370)
b_2: interaction effect	−7.120***	−4.548**	−7.403***
	(1.218)	(2.012)	(1.326)
b_3: interaction effect	0.255	0.271	0.253
	(1.129)	(1.872)	(1.228)
$\sum_k d_k$: main effect	3.331***	0.895*	3.577***
	(0.305)	(0.504)	(0.331)
$\sum_k b_k$: interaction effect	−20.942***	−6.502	−22.483***
	(2.829)	(4.682)	(3.078)
Number of Observations	14950	1380	13570
Fixed effects	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes
Aggregate controls	Yes	Yes	Yes

Notes: Values in parentheses are standard errors. The superscript * represents the 0.1 significance level, ** 0.05, and *** 0.01.

TABLE D.9. Estimation results for the dynamic panel regression without the first-stage estimation: the rest of the economy

	All firms	SOEs	Non-SOEs
d_0: main effect	0.705^{***}	0.451^{***}	0.940^{***}
	(0.072)	(0.088)	(0.112)
d_1: main effect	0.733^{***}	0.510^{***}	0.941^{***}
	(0.081)	(0.098)	(0.126)
d_2: main effect	0.202^{***}	0.184^{**}	0.220^{**}
	(0.072)	(0.087)	(0.111)
d_3: main effect	0.087	0.092	0.084
	(0.058)	(0.070)	(0.090)
b_0: interaction effect	-1.289^{**}	0.432	-2.834^{***}
	(0.578)	(0.702)	(0.899)
b_1: interaction effect	-1.641^{**}	1.656^{*}	-4.663^{***}
	(0.699)	(0.846)	(1.091)
b_2: interaction effect	-2.751^{***}	-1.058	-4.273^{***}
	(0.677)	(0.821)	(1.054)
b_3: interaction effect	0.809	0.327	1.284
	(0.628)	(0.762)	(0.979)
$\sum_k d_k$: main effect	1.727^{***}	1.238^{***}	2.185^{***}
	(0.169)	(0.205)	(0.264)
$\sum_k b_k$: interaction effect	-4.873^{***}	1.356	-10.486^{***}
	(1.572)	(1.909)	(2.449)
Number of Observations	34960	16675	18285
Fixed effects	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes
Aggregate controls	Yes	Yes	Yes

Notes: Values in parentheses are standard errors. The superscript * represents the 0.1 significance level, ** 0.05, and *** 0.01.

TABLE D.10. Estimation results for the dynamic panel regression without the first-stage estimation: the entire economy

	All firms	SOEs	Non-SOEs
d_0: main effect	0.502***	0.449***	0.522***
	(0.035)	(0.062)	(0.041)
d_1: main effect	0.532***	0.497***	0.546***
	(0.039)	(0.069)	(0.046)
d_2: main effect	0.247***	0.219***	0.258***
	(0.034)	(0.061)	(0.041)
d_3: main effect	0.154***	0.130***	0.164***
	(0.028)	(0.050)	(0.033)
b_0: interaction effect	−0.244	1.084**	−0.687**
	(0.277)	(0.497)	(0.330)
b_1: interaction effect	−0.424	1.326**	−1.012**
	(0.335)	(0.600)	(0.401)
b_2: interaction effect	−3.002***	−1.801***	−3.397***
	(0.324)	(0.581)	(0.387)
b_3: interaction effect	−0.254	0.462	−0.492
	(0.301)	(0.541)	(0.359)
$\sum_k d_k$: main effect	1.435***	1.296***	1.490***
	(0.081)	(0.145)	(0.097)
$\sum_k b_k$: interaction effect	−3.924***	1.071	−5.588***
	(0.753)	(1.351)	(0.898)
Number of Observations	157895	40549	117346
Fixed effects	Yes	Yes	Yes
Firm-level controls	Yes	Yes	Yes
Aggregate controls	Yes	Yes	Yes

Notes: Values in parentheses are standard errors. The superscript * represents the 0.1 significance level, ** 0.05, and *** 0.01.

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