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Abstract

This paper studies the effectiveness of government-backed credit guarantees to the infrastructure sector, a policy tool adopted by a range of countries during recessions. We propose a two-sector model with financial intermediary frictions so that infrastructure producers rely on bank loans to finance their risky production. Governments can intervene in the credit market by providing a partial guarantee on those bank loans. We find that a credit guarantee increases infrastructure production, leading to a high fiscal multiplier in the longer run. In the near term, however, higher wages in the infrastructure sector crowd out labor supply in the private sector, dampening economic activity. Importantly, the higher leverage associated with credit expansion raises non-performing loans, and this channel is particularly pronounced if the government-backed credit guarantee lingers for a long period of time.

JEL classification: E62, E44
Keywords: Fiscal multiplier, credit guarantee, bailout policy, financial friction

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1 Introduction

In response to the 2008 Global Financial Crisis, many emerging market economies sought to boost their economies through government-backed credit expansion targeting to specific sectors, in particular related to infrastructure. The persistence associated with those credit expansion, however, varied across countries, leading to different patterns in non-performing bank loans. Credit guarantees that lingered well beyond the crisis led to a surge in non-performing bank loans in countries like India and China, while short-lived credit expansions were associated with stable non-performing loans in countries like South Korea.

Although the credit guarantee has been widely used by policy makers, the literature has yet to explore the impact of the persistence of those programs on the economy, which is at the heart of our paper. We propose a two-sector model with financial intermediary frictions to study the transmission channels of government-backed credit expansion to infrastructure sector. We find that credit guarantee increases infrastructure production, leading to a high fiscal multiplier in the longer run. In the near term, however, higher wages in the infrastructure sector crowd out labor supply in the private sector, dampening economic activities. Importantly, higher leverage associated with credit expansion raises non-performing loans, and this channel is particularly pronounced if the government-backed credit guarantee lingers for a long period of time.

Specifically, our model consists of a private sector and an infrastructure sector, with imperfect substitutability of labor supply in the two sectors. Infrastructure goods are converted into public capital, which poses positive externality on the productivity of private sector. Importantly, infrastructure producers face a working capital constraint and borrow from banks to finance their operation costs before production takes place. Those infrastructure projects, however, are risky and producers may default on their loans if their idiosyncratic productivity turns out to be lower than the break-even threshold. Financial intermediaries set the loan contract to balance the trade-off between loan returns and non-performing loans. The government credit guarantee program, which provides partial guarantee or bailout on bank loans to infrastructure producers, changes the incentives for banks to lend and, therefore, the loan contract. For a given productivity break-even level, a more generous bailout policy makes banks willing to lend more and accept higher leverage. In turn, the change in the loan contract motivates infrastructure producers to accept a higher break-even threshold, raising the non-performing loans (NPLs).

We find that government credit guarantee affects the macro economy through three offsetting channels, and the macroeconomic impacts of government credit guarantee change over time. Credit easing relaxes the working capital constraint for infrastructure firms, boosting infrastructure production. Higher infrastructure capital raises the productivity of private sector over time, through the positive externality channel, and therefore boost economic growth. In the near term, however, higher wages in the infrastructure sector can crowd out labor supply to the private sector through the wage spillover channel, dampening economic activities. Finally, a higher leverage associated with credit expansion increases the NPL ratio for infrastructure firms, raising bailout costs for the government. In the short run, the wage spillover and the bailout cost channels dominate, leading to a negative fiscal multiplier on impact. Over the longer run, however, the positive externality channel prevails over the bailout cost channel, as higher infrastructure capital makes private firms more productive and raise fiscal multipliers in the median term.

We also find that the effectiveness of government credit guarantee crucially depends on the persistence of credit expansion. A transitory and well-targeted credit expansion has a much higher fiscal multiplier than a government-backed credit guarantee that lingers for several years. Specifically, a transitory credit expansion can generate a fiscal multiplier close to 2 over the medium and long run, as positive externality associated with higher public investment dominates the relatively low bailout costs as well as the short-term crowding-out effects. A persistent credit expansion, on the other hand, can have negative fiscal multipliers both on impact and over time. Significantly higher NPLs lead to elevated bailout costs, weighing on economic activities.

In addition, we compare the fiscal multiplier of targeted credit easing with those associated with other conventional fiscal instruments. In the near term, the credit guarantee has a lower fiscal multiplier when compared to stimulus measures through higher government consumption or investment. Over time, a well-targeted credit expansion becomes more effective in stimulating the economy. Also, the effectiveness of credit guarantee also depends on fiscal financing schemes, as fiscal multipliers are notably lower if government has to collect distortionary taxes, instead of lump-sum taxes, to finance spending.

Our paper is closely related to the literature of fiscal multipliers and public investment. Leeper, Walker, and Yang (2010) conduct a positive analysis of infrastructure investment by modeling implementation delays associated with infrastructure spending and also differentiating fiscal financing schemes. They find that long implementation delays, as well as distortionary fiscal financing, can significantly dampen the stimulative effects of infrastructure spending. Chang, Lin, Traum, and Yang (2021) study how fiscal policy changes in the public sector spillover to private sector. Our paper extends this literature by studying government-backed credit expansion that specifically targets the infrastructure sector.

In addition, our paper is related to the broad literature of financial frictions. In particular, we extend the framework in Bernanke, Gertler, and Gilchrist (1999) to incorporate potential government bailouts on non-performing bank loans. Chang, Liu, Spiegel, and Zhang (2019) uses a similar framework to study optimal reserve requirement policy in China. We differ from their paper by focusing on government-backed credit guarantee as an unconventional fiscal instrument. Specifically, the government uses this policy tool to target the infrastructure sector, as adopted by many countries following the 2008 crisis. We highlight that the effectiveness of credit guarantee depends on the persistence of credit policy and also its associated fiscal financing schemes.

Finally, recent studies suggest that the stimulus impacts of the federal credit programs in the U.S. were likely to have been similar in magnitude to what was provided by the American Recovery and Reinvestment Act of 2009, but there is a lack of understanding of the mechanism, see Lucas (2016). Correia, Fiore, Teles, and Tristani (2018) show that credit subsidies can overcome the zero lower bound constraint on interest rate policy. Our paper adds to the discussion by exploring the transmission channels through which credit policy affects economic activities.

The paper proceeds as follows. We start by describing the background of credit expansions in India, China and South Korea following the 2008 crisis. Section 3 develops the baseline model with government-backed credit expansion targeting the infrastructure sector. Section 4 introduces the calibration and quantifies the impact of credit easing. Finally, Section 5 concludes.

2 Background on Credit Expansion

The 2008 Global Financial Crisis hit emerging market economies through a collapse in demand, and governments took aggressive fiscal stimulus packages with some actions specifically targeting the infrastructure sector. Below we briefly discuss credit expansions in India, China and South Korea during this period.[1]

In India, the central government adopted credit program that lingered well beyond the outbreak of the crisis. It passed three successive fiscal stimulus packages between 2008 and 2009, including credit expansion for infrastructure investment and core industries.[2] As shown in the top panel of Figure 1, the credit extended by banks grew rapidly following the crisis with credit growth reaching 20 percent in 2010. The persistent credit growth following the crisis gave rise to a rapid increase in the NPL ratio, which rose from 2.25 percent in 2010 to 11.2 percent in 2018. Importantly, the recent increase in the NPL ratio was largely driven by infrastructure and core industries according to Chavan and Gambacort (2016). By March 2015, the two industries accounted for a quarter of the total non-performing loans of Indian banks, while their production accounted for less than 15 percent of GDP.

Following the 2008 crisis, China also adopted a massive and persistent stimulus package, including a targeted credit expansion to sectors related to infrastructure investment. The government utilized off-balance-sheet companies, known as the "Local Government Financing Vehicles" (LGFVs), and borrowed 3.6 trillion RMB to finance the stimulus programs in 2009 and 2010 (see Bai, Hsieh, and Song (2016)). The top panel in Figure 2 shows that, after posting a sharp increase right after the crisis, the total debt of LGFV as a share of GDP continued trending up between 2013 and 2019. In addition, the government doubled lending targets for commercial banks from 2008 to 2009 through a range of conventional policy tools. The bottom panel of Figure 2 shows that loan growth from the three largest Chinese banks to key industries, including the infrastructure sector, peaked at more than 30 percent in fiscal year 2009.[3] The credit support remained elevated in 2010 and 2011 at levels well above 15 percent, even though economic activities had rebounded. In the following years, credit growth declined gradually.

Even though the stimulus package was viewed by many as boosting the Chinese economy, the persistent credit expansion has also given rise to NPLs. The bottom panel in Figure 2 shows that

[1]The online appendix provides more details in the background of credit expansion policy in the three countries.

[2]The core industries mainly includes iron and steel, mining and quarrying, and textiles.

[3]The three Chinese banks are the Industrial and Commercial Bank of China, China Construction Bank, and Bank of China. We exclude the Agriculture Bank of China due to the lack of data in 2009. The key industries include construction, mining, manufacturing, wholesale and retail sectors.

the NPL ratio for key industries was low following the 2008 crisis, but increased steadily after 2012. Importantly, this conventional measure of NPL ratios was likely to significantly underestimate the scope of non-performing assets in the infrastructure sector. According to the China Banking Association, about 70 percent of LGFV infrastructure projects had to defer repayment of bank loans, but weren't declared as non performing. Moreover, the default risk associated with the mounting LGFV debt was masked by the stimulus loan hangover effect as termed by Chen, He, and Liu (2020).

Turning to South Korea, the government implemented two fiscal stimulus packages and rapidly extended bank credit as the economic growth grounded to a halt following the Global Financial Crisis. The GDP growth dropped from 7 percent in 2007Q4 to -2 percent in 2009Q1; during this period, bank loans grew rapidly during this period as shown in the top panel of Figure 3. In particular, special banks, which provide funds to industrial sectors with government priority and limited profitability, saw its growth peak at 28 percent in the second half of 2008. Despite the initial ramp-up, bank credit growth declined sharply in 2009 and reached a near zero level in 2010, while the economic activities rebounded and the GDP growth returned to 8 percent in 2010Q3.

The transitory credit expansion in Korea, which stood in sharp contrast to the persistent credit expansions in India and China, was associated with stable NPL ratios. The bottom panel of Figure 3 shows that the NPL ratios fluctuated within the range of 0.6 to 1.3 percent between 2007 and 2015 with no significant uptick, while India and China saw rapid increases in their bank NPL ratios. As documented in Lee (2019), South Korea adopted a structural reform in the financial sector following the Asian financial crisis, with counter-cyclical credit guarantee policy contributing to its financial soundness in the banking sector. The tool of guided credit expansion was used not only during the Global Financial Crisis, but also in previous crisis episodes including the dot-com bubble burst in the early 2000s.

3 Baseline Model

In this section, we lay out the baseline model by modifying an otherwise standard New Keynesian model with fiscal policy to include: (1) a public infrastructure sector that faces working capital constraints; (2) financial intermediaries that lend to infrastructure firms; (3) labor mobility between public infrastructure and private firms; (4) and the government providing partial guarantee on bank loans to infrastructure production.

Households provide capital to private intermediate firms and deposit their savings with financial intermediaries. They work in both public infrastructure and private sectors and receive sector-specific wages. Public infrastructure firms use labor as inputs for production and receive idiosyncratic shocks on their productivity. Facing a working capital constraint, each public firm finances its wage payment prior to production, using both internal net worth and external debt obtained from the financial intermediaries. As in Bernanke, Gertler, and Gilchrist (1999), external debt financing is subject to a costly state verification problem. Depending on the realizations of the idiosyncratic shocks on productivity, some firms may be unable to repay their loans. The government, however, can provide partial guarantee on bank loans, which change the incentives for financial intermediaries to lend and firms to borrow.

3.1 HOUSEHOLD The economy is populated with a continuum of identical households. Every household consumes, provides labor to both infrastructure and private firms, invests in physical capital, and deposits at financial intermediaries. The preference is given by

$$\max \quad \mathrm{E}_0 \sum_{t=0}^{\infty} b_t (\ln c_t - \chi \frac{l_t^{1+\eta}}{1+\eta}),$$

where $\frac{1}{\eta}$ is the Frisch elasticity of labor supply. We define $b_t = \prod_{j=1}^{t} \beta_j$ for $t > 0$, and $b_0 = 1$, where β_j is a time-varying discount factor that follows an AR(1) process:

$$\ln \frac{\beta_t}{\beta} = \rho^\beta \ln \frac{\beta_{t-1}}{\beta} + \varepsilon_t^\beta, \qquad \varepsilon_t^\beta \sim N(0, (\sigma^\beta)^2). \tag{3.1}$$

Similar to Bouakez, Cardia, and Ruge-Murcia (2009) and Chang, Lin, Traum, and Yang (2021), we allow for imperfect substitutability of labor inputs across public infrastructure and private firms to capture frictions in labor mobility. The labor supply is a constant elasticity of substitution composite of hours worked in each sector.

$$l_t = \left(\mu l_{G,t}^{1+\sigma_L} + (1-\mu) l_{p,t}^{1+\sigma_L} \right)^{\frac{1}{1+\sigma_L}}, \tag{3.2}$$

where μ is the steady-state share of composite labor worked in public infrastructure firms, and σ_L is the inverse of intratemporal elasticity of substitution between the public and private labors.

The household maximizes the lifetime utility by choosing consumption, c_t, investment, i_t, labor supply, $l_{G,t}$ and $l_{p,t}$, and deposits, d_t, subject to the budget constraint

$$c_t + i_t + d_t = w_{G,t} l_{G,t} + w_{p,t} l_{p,t} + R_t^k k_{t-1} + \frac{R_{t-1} d_{t-1}}{\pi_t} + \Upsilon_t - T_t. \tag{3.3}$$

Households receive sector-specific wages of $w_{G,t}$ and $w_{p,t}$ in infrastructure and private firms. They also rent their private capital to the intermediate good firms with the real return of R_t^k. Financial intermediary pays the risk-free nominal interest rate R_t on deposits. Households receive a lump-sum transfer Υ_t from various sources, including monopoly profits from retailers, and net worth transfers from infrastructure firms that don't survive. They also pay lump-sum taxes T_t to government. In the alternative scenario, we also explore a case with households paying distortionary taxes.

In addition, private investment in new capital incurs an adjustment cost, $\frac{\Omega_k}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 i_t$. Ω_k characterizes the size of the cost. Capital evolves with a depreciation rate of δ following the law of motion

$$k_t = (1-\delta) k_{t-1} + \left(1 - \frac{\Omega_k}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 \right) i_t. \tag{3.4}$$

3.2 Retailers There is a continuum of retailers indexed by $i \in [0,1]$ in the economy. They purchase intermediate goods at the price of P_t^p and produce differentiated retail goods $y_t^p(i)$. Final goods y_t^p used for consumption and investment are CES aggregates of retail goods such that

$$y_t^p = \left(\int_0^1 y_t^p(i)^{\frac{\epsilon-1}{\epsilon}} di \right)^{\frac{\epsilon}{\epsilon-1}}, \tag{3.5}$$

where ϵ is the elasticity of substitution among retail goods. The demand curve for each retail good $y_t^p(i)$ is thus given by

$$y_t^p(i) = \left(\frac{P_t(i)}{P_t} \right)^{-\epsilon} y_t^p. \tag{3.6}$$

Retailers face Rotemberg adjustment costs in changing prices of the form, $\frac{\Omega_p}{2}\left(\frac{P_t(i)}{P_{t-1}(i)}\frac{1}{\pi} - 1\right)^2 y_t^p$, such that price changes in excess of steady-state inflation rates are costly. The retail firm i maximizes

$$E_t \sum_{j=0}^{\infty} \beta^j \Lambda_{t+j} \left(\frac{P_{t+j}(i) - P_{t+j}^p}{P_{t+j}} y_{t+j}^p(i) - \frac{\Omega_p}{2} \left(\frac{P_{t+j}(i)}{P_{t+j-1}(i)} \frac{1}{\pi} - 1 \right)^2 y_{t+j}^p \right),$$

subject to the demand function (3.6). The first-order condition is

$$\frac{1}{x_t} = \frac{(\epsilon-1)}{\epsilon} + \frac{\Omega_p}{\epsilon}\left(\frac{\pi_t}{\pi} - 1\right)\frac{\pi_t}{\pi} - \frac{\Omega_p}{\epsilon} E_t \beta_{t+1} \frac{c_t}{c_{t+1}} \left(\frac{\pi_{t+1}}{\pi} - 1\right) \frac{\pi_{t+1}}{\pi} \frac{y_{t+1}^p}{y_t^p}, \tag{3.7}$$

where $\frac{1}{x_t} \equiv \frac{P_t^p}{P_t}$ is the relative price of intermediate goods with respect to final goods. Equation (3.7) represents the New Keynesian Phillips curve under Rotemberg pricing. Monopoly profits, which are transferred to households, are given by

$$\Upsilon_t^p = y_t^p - \frac{1}{x_t} y_t^p - \frac{\Omega_p}{2}\left(\frac{\pi_t}{\pi} - 1\right)^2 y_t^p. \tag{3.8}$$

3.3 Private Intermediate Goods Producers This sector includes a continuum of competitive intermediate goods producers. They use private capital $k_{p,t}$ and labor $l_{p,t}$ as input for production. Importantly, public capital in the form of infrastructure facilities enters the intermediate goods production, similar as Leeper, Walker, and Yang (2010).

$$y_t^p = A_p k_{p,t-1}^{\alpha} l_{p,t}^{1-\alpha} (k_{G,t-1})^{\alpha^G}.$$

α^G is the elasticity of private output with respect to public capital. If $\alpha^G = 0$, government investment is unproductive. Even though public capital enters intermediate goods production, private firms don't pay direct rents on public capital and therefore face the following cost minimization problem:

$$\min \quad R_t^k k_{p,t} + w_{p,t} l_{p,t}.$$

They pay sector-specific wage and capital rental according to the following first-order conditions:

$$w_{p,t} = \frac{1}{x_t}(1-\alpha)A_p k_{p,t-1}^{\alpha} l_{p,t}^{-\alpha} (k_{G,t-1})^{\alpha^G} \tag{3.9}$$

$$R_t^k = \frac{1}{x_t}\alpha A_p k_{p,t-1}^{\alpha-1} l_{p,t}^{1-\alpha} (k_{G,t-1})^{\alpha^G}. \tag{3.10}$$

3.4 Public Infrastructure Firms

A continuum of public infrastructure producers indexed by j use labor $l_{G,t}^j$ as input for production. Besides the common productivity of A_G, each producer j faces an idiosyncratic productivity shock ω_t^j at the firm level that is an i.i.d drawn from a log normal distribution $F(\cdot)$ with a mean of 1. As a result, each producer's output can vary depending on the realization of ω_t^j.

$$y_{G,t}^j = \omega_t^j A_G l_{G,t}^j. \tag{3.11}$$

Importantly, infrastructure producers face working capital constraints, as they pay wages before the production takes place. Since idiosyncratic shocks are i.i.d, all public infrastructure producers face the same ex-ante cost minimization problem as such

$$\begin{aligned} \min \quad & w_{G,t} l_{G,t} \\ s.t. \quad & y_{G,t} = E_j(\omega_t^j) A_G l_{G,t}. \end{aligned}$$

Let ν_t be the Lagrangian multiplier associated with the production function, the optimality condition is

$$w_{G,t} = \nu_t A_G. \tag{3.12}$$

In a model without the working capital constraint, the competitive market drives profits to zero for infrastructure producers and therefore ν_t is the relative price between infrastructure goods and final goods $\frac{P_{G,t}}{P_t}$. In this model, however, the working capital constraint renders a wedge between ν_t and the relative price.

To finance the wage payment, firms resort to their own beginning-of-period net worth N_{t-1} and in addition borrow from financial intermediaries B_t. All firms would borrow the same amount of debt B_t for the given state of economy, as the idiosyncratic productivity shock is i.i.d..

$$\frac{N_{t-1} + B_t}{P_t} = w_{G,t} l_{G,t}. \tag{3.13}$$

Let $\tilde{A}_t = \frac{P_{G,t}}{P_t}\frac{1}{\nu_t}$, then the firm's balance sheet can be re-written as

$$P_{G,t} y_{G,t} = \tilde{A}_t (N_{t-1} + B_t). \tag{3.14}$$

$\tilde{A}_t$ can be interpreted as the overall return on working capital.

3.5 Financial Intermediaries We model financial intermediaries in a similar way as Bernanke, Gertler, and Gilchrist (1999) and Chang, Liu, Spiegel, and Zhang (2019). At the beginning of each period, a risk-neutral financial intermediary (FI) obtains household deposit D_t at the interest rate of R_t. At the interest rate of Z_t, the FI lends to public infrastructure firms, which choose the level of debt prior to the realization of idiosyncratic firm-specific productivity shocks.

The optimal contract is then characterized by a threshold on idiosyncratic productivity, $\bar{\omega}_t$, such that the infrastructure firm with the cutoff productivity is just able to repay the external debt B_t.

$$\bar{y}_{G,t} P_{G,t} = Z_t B_t,$$

where $\bar{y}_{G,t}$ is the firm production with the cutoff idiosyncratic productivity,

$$\bar{y}_{G,t} \quad = \quad \bar{\omega}_t A_G l_{G,t}.$$

All infrastructure firms face the same ex-ante cost minimization problem and make the same resource allocation decisions. The threshold productivity level is given by

$$\bar{\omega}_t = \frac{Z_t B_t}{\tilde{A}_t \left(N_{t-1} + B_t\right)}. \tag{3.15}$$

When $\omega_t \geq \bar{\omega}_t$, the firm repays the loan and FI receives the payoff of $Z_t B_t$. When $\omega_t < \bar{\omega}_t$, the firm cannot pay the contractual return and has to default. In this case, the FI pays a monitoring cost, defined as a fraction m_t of the firm's realized total revenue, to observe the realized idiosyncratic productivity shock and collect the firm's revenue.

The government can partially guarantee bank loans, in which case the FI receives a fraction of the monitoring costs, $s_t^b m_t \tilde{A}_t \omega_t (N_{t-1} + B_t)$, from the government bailout funds. When $s_t^b = 1$, the government fully reimburses the FI's monitoring cost. Overall, the expected nominal income for the lender is given by

$$\begin{aligned} & (1 - F(\bar{\omega}_t)) Z_t B_t + \int_0^{\bar{\omega}_t} \Big((1 - m_t) \tilde{A}_t \omega_t (N_{t-1} + B_t) + s_t^b m_t \tilde{A}_t \omega_t (N_{t-1} + B_t) \Big) \, dF(\omega) \\ = \quad & \tilde{A}_t (N_{t-1} + B_t) \underbrace{\left(\left[1 - F(\bar{\omega}_t)\right] \bar{\omega}_t + (1 - m_t + s_t^b m_t) \int_0^{\bar{\omega}_t} \omega dF(\omega) \right)}_{g(\bar{\omega}_t)}. \end{aligned} \tag{3.16}$$

As a result, the FI would lend to firms if the expected income can at least cover the payments to households.

$$\tilde{A}_t (N_{t-1} + B_t) g(\bar{\omega}_t) \geq R_t B_t, \tag{3.17}$$

which illustrates the FI's supply of debt.

Given the participation constraint, firms choose $\bar{\omega}_t$ and B_t to maximize their expected income

$$\tilde{A}_t(N_{t-1}+B_t)\underbrace{\left(\int_{\bar{\omega}_t}^{\infty}\omega dF(\omega)-(1-F(\bar{\omega}_t))\bar{\omega}_t\right)}_{f(\bar{\omega}_t)}. \tag{3.18}$$

$\tilde{A}_t f(\bar{\omega}_t)$ can be interpreted as firms' expected return on their total asset $N_{t-1}+B_t$. The following first order condition characterizes the optimal contract:

$$\frac{N_{t-1}}{N_{t-1}+B_t}=-\frac{g'(\bar{\omega}_t)}{f'(\bar{\omega}_t)}\frac{\tilde{A}_t f(\bar{\omega}_t)}{R_t}, \tag{3.19}$$

which illustrates firms' demand for external debt.

In addition, we follow the literature and assume that only a share ζ of intermediate goods firms survive at each period. This assumption ensures that firms won't accumulate enough net worth such that they do not need to resort to external debt for financing. The end-of-period aggregate net worth N_t depends on profits from surviving firms as follows:

$$N_t=\zeta\tilde{A}_t(N_{t-1}+B_t)f(\bar{\omega}_t). \tag{3.20}$$

The net worth for firms that don't survive, $(1-\zeta)\tilde{A}_t(N_{t-1}+B_t)f(\bar{\omega}_t)$, is transferred to households in a lump-sum way.

3.6 Government Policy and Aggregate Resource Constraints

The central bank conducts monetary policy following a standard Taylor rule

$$\frac{R_t}{R}=(R_{t-1})^{\rho_R}\left(\left(\frac{\pi_t}{\pi}\right)^{\psi_\pi}\left(\frac{y_t}{y}\right)^{\psi_y}\right)^{1-\rho_R}\epsilon_t^M. \tag{3.21}$$

where ψ_π and ψ_y capture the magnitude of monetary policy reaction, and ρ^R measures the degree of interest rate inertia.

The government collects taxes from households to finance government spending on final goods consumption g_t^c, investment g_t^I, and also bailout costs g_t^s. We assume that the government collects lump-sum taxes in the baseline case and will explore distortionary taxes in an alternative scenario.

$$P_t g_t^c+P_t g_t^I+\underbrace{\tilde{A}_t(N_{t-1}+B_t)s_t^b m_t\int_0^{\bar{\omega}_t}\omega dF(\omega)}_{g_t^s P_t}=P_t T_t. \tag{3.22}$$

At the price of $P_{G,t}$, the government purchases public infrastructure goods $y_{G,t}$ and use it to build up public capital k_t^G that is part of the production function of private intermediate good firms.

$$P_t g_t^I = P_{G,t} y_{G,t} \tag{3.23}$$
$$K_{t+1}^G = y_{G,t} + (1-\delta^G) K_t^G. \tag{3.24}$$

We consider the following countercyclical credit rule, as the government adjusts the bailout ratio s_t^b when the GDP deviates from its steady state level.

$$\ln \frac{s_t^b}{s^b} = \rho_s \ln \frac{s_{t-1}^b}{s^b} - \rho_y \ln \frac{y_t}{y} + \epsilon_t^s, \tag{3.25}$$

where $\rho_y > 0$. The government-backed credit programs expand in a recession and roll back during an expansion. Importantly, the persistence of those credit actions ρ_s captures the observation that different countries have adopted different credit expansion paths. In section 4, we discuss how the persistence of the credit rule affects the dynamics of NPL ratio and macroeconomic activities.

The overall output includes productions from both public infrastructure and private firms, while the GDP includes both private and government consumption and investment. The wedge between the output and GDP consists of monitoring costs, as well as investment and price adjustment costs.

$$P_t y_t = P_{p,t} y_{p,t} + P_{G,t} y_{G,t} \tag{3.26}$$
$$c_t + i_t + g_t^c + g_t^I = y_t - \tilde{A}_t \frac{N_{t-1} + B_t}{P_t} m_t \int_0^{\bar{\omega}_t} \omega dF(\omega) - \frac{\Omega_p}{2}\left(\frac{\pi_t}{\pi} - 1\right)^2 y_{p,t} - \frac{\Omega_k}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2 i_t. \tag{3.27}$$

4 Quantitative Analysis

4.1 Calibration The model is calibrated to an emerging economy, as shown in table 1. Some parameters are standard in the literature. The quarterly discount factor is 0.9925, implying a real interest rate of 3% annually. The inverse of the Frisch elasticity is set to 2. The elasticity of substitution among intermediate goods ϵ is 10, yielding an average markup of 11%. The price adjustment cost parameter Ω_p is calibrated in such a way that retailers change prices approximately once every 4 quarters on average. The Taylor rule coefficients, ψ_π and ψ_y, are set to be 1.5 and 0.5/4 respectively. The steady-state inflation rate is calibrated to 6 percent, the average inflation between 2000 and 2021 for emerging market and developing economies from the World Economic Outlook database at the International Monetary Fund (April 2022).

Turning to parameters related to the two-sector setup, the intratemporal elasticity of substitution between public and private labor, $1/\sigma_L$, is set to 1.33. We calibrate this parameter to China using the employment data at industry level from the China's National Bureau of Statistics as well as corresponding wage data from the Ministry of Labor and Social Security for the period of 2010

- 2020.[4] The calibration is within the estimate range in the literature of 1.0 from Horvath (2000) and 1.5 from Chang, Lin, Traum, and Yang (2021) albeit different data sets we use.

The output elasticity with respect to public capital, α_G, is a critical parameter for assessing the output effects of fiscal policy. Calderón, Moral-Benito, and Servén (2015) offers a comprehensive evaluation on this topic using a panel data set covering a wide range of advanced and developing countries that include China, India and Korea. They estimate the output elasticity of infrastructure lying in the range $0.07 - 0.10$, and we set α_G to 0.1 in the baseline.[5] The private capital share α is calibrated to 0.5, following Gertler, Gichrist, and Natalucci (2007) and consistent with empirical evidences in Zhu (2012). The depreciation rate for both private and public capital is set to 0.025, such that the average annual depreciation rate is 10 percent, following Leeper, Walker, and Yang (2010). The investment adjustment cost parameter Ω_I is given a value of 2, following Chang, Lin, Traum, and Yang (2021).

For other parameters that are specific to our model, the ratio of infrastructure capital over private capital is 22 percent in China and 16 percent in India.[6] We calibrate the productivity of the infrastructure producer, A_G, to match the ratio of public infrastructure capital to private capital $K_G/K_p = 0.2$ in the steady state. The labor share in public infrastructure sector, μ, is set to match $L_G/L_p = 0.2$, in line with the share of population employed in the public infrastructure sector out of the overall employed urban population in China between 2003 and 2018.[7] The share of government spending to GDP is set to 0.14 and government investment to GDP ratio is 0.04, in line with average shares of government spending over GDP between 1980 and 2016 in both China and India.

Following Bernanke, Gertler, and Gilchrist (1999), we assume the idiosyncratic productivity shocks for infrastructure firms are drawn from a log normal distribution. We calibrate the standard deviation of the idiosycrantic productivity shock σ_ω to 0.4, firm survival rate ζ to 0.975, monitoring cost m_t to 0.18. Those parameters are chosen to match the following three targets: 1) a spread between risky return Z and risk-free rate $\frac{R}{\pi}$ of close to 200 bps; 2) an annualized business failure rate $F(\bar{\omega})$ of 7.9 percent; 3) a leverage ratio $\frac{n+b}{n}$ of 1.7. Those targets are in line with the historical averages in Indian and Chinese data. For instance, the local government financing vehicle bond spreads are around 210 bps according to Liu, Lyu, and Yu (2021). The leverage ratio is about 1.6 in China following Zhong, Xie, and Liu (2019), and 1.5 for non-financial firms in India following Chauhan (2017).

Given the limited empirical guidance on parameters characterizing the bailout shock, we set

[4] We split industries into two groups, those related to infrastructure and the rest, and then run a OLS regression between log employment ratio and log wage ratio. σ_L is estimated to be 0.75 (=1/1.33).

[5] Calderón, Moral-Benito, and Servén (2015) found little evidence of heterogeneity across countries in the estimates of α_G, and the long-run output elasticity of infrastructure does not seem to vary with countriesâ level of per capital income, their infrastructure endowment or the size of their population. In the online appendix, we further explore alternative calibrations of α_G as robustness check.

[6] We define the sectors of "construction" and "electricity, gas, water supply and other utility services" as public infrastructure in India, and those of "construction", "production and supply of electricity, heat, gas and water", and "management of water, conservancy, environment and public facilities" in China.

[7] Sector-specific employment data is unavailable for India.

the steady-state bailout ratio s^b to 0.2, which implies that the FIs can recover 20 percent of the monitoring costs from the government at the steady state. In the online appendix, we show robustness checks with alternative calibrations of s^b and show that the key transmission channel remains unchanged. We calibrate the degree of counter-cyclicality of credit policy, ρ_y, to match the cyclicality of credit growth in India and South Korea. The correlations between credit growth and GDP growth are around -0.2 in India and South Korea between 2007 and 2019. We calibrate $\rho_y = 900$ such that the correlations between credit and GDP in the simulated moments match the correlations in the data.[8]

4.2 Key Mechanism through Loan Demand and Supply

Before we proceed with the numerical simulations, this section explains how a government-backed credit expansion through a higher bailout ratio s^b_t changes FIs' incentive to lend and infrastructure firms' incentive to borrow.

In a competitive market for FIs, the zero profit condition implies that the following loan supply constraint has to hold for any loan contract:

$$\tilde{A}_t(N_{t-1} + B_t)g(\bar{\omega}_t) = R_t B_t.$$

The risk-free rate on deposit, R_t, depends on the average return on infrastructure firms as shown in the definition of $g(\bar{\omega}_t)$. This is a source of inefficiency, as a benevolent planner would prefer that the risk-free rate corresponds to the marginal return on firms.

Let's define the leverage ratio as $lev_t = \frac{N_{t-1}+B_t}{N_{t-1}}$, then the loan supply constraint becomes

$$lev_t = \frac{1}{1 - \frac{\tilde{A}_t}{R_t} g(\bar{\omega}_t)}. \tag{4.1}$$

As $g(\bar{\omega}_t)$ is an increasing function of $\bar{\omega}_t$, a higher cutoff productivity raises the return on working capital relative to the deposit rate, which raises the FI's willingness to lend and therefore the leverage ratio.

Given the FI's participation constraint, on the other hand, infrastructure firms maximize their expected income given by

$$\tilde{A}_t(N_{t-1} + B_t)f(\bar{\omega}_t) = N_{t-1} \underbrace{\frac{1}{1 - \frac{\tilde{A}_t}{R_t} g(\bar{\omega}_t)}}_{\text{leverage}} \underbrace{\tilde{A}_t f(\bar{\omega}_t)}_{\text{firms' expected return}}. \tag{4.2}$$

For the given return on working capital $\tilde{A}_t$ and the existing net worth N_{t-1}, firms' expected income depends on the leverage ratio and the expected return on their assets, both of which depend on the productivity cutoff $\bar{\omega}_t$. Moreover, $f'(.) < 0$ and $g'(.) > 0$, imply that a higher cutoff imposes tradeoff for firms: it raises the leverage but reduces the expected return. Therefore, infrastructure producers choose $\bar{\omega}_t$ optimally to balance the tradeoff and maximize the overall income. Its first-

[8] The seemingly oversized ρ_y is due to the small bailout costs as share of GDP.

order condition, equation (3.19), can be re-written as

$$\underbrace{\frac{\frac{\tilde{A}_t}{R_t} g'(\bar{\omega}_t)}{1 - \frac{\tilde{A}_t}{R_t} g(\bar{\omega}_t)}}_{\text{elasticity of leverage w.r.t } \bar{\omega}_t} = \underbrace{-\frac{f'(\bar{\omega}_t)}{f(\bar{\omega}_t)}}_{\text{elasticity of firms' expected return w.r.t } \bar{\omega}_t}. \tag{4.3}$$

The marginal benefit of increasing $\bar{\omega}_t$ through higher leverage equals to the marginal cost through a lower expected return.

Consider a scenario in which the government raises the bailout ratio s_t^b. For a given productivity cut-off level $\bar{\omega}_t$, a higher bailout ratio makes the FIs willing to lend more and, therefore, increases the elasticity of leverage with respect to $\bar{\omega}_t$. Although the elasticity of firms' expected return with respect to $\bar{\omega}_t$ doesn't directly depend on s_t^b, the higher elasticity of leverage makes firms willing to accept a loan contract with a higher $\bar{\omega}_t$, which leads to a higher non-performing loan ratio.

4.3 Credit Shock Government-guaranteed credit easing can affect the macro economy through three channels. It relaxes the working capital constraint for infrastructure firms, boosting their production. Higher infrastructure capital raises the productivity of private sector over time through the positive externality channel, thus boosting economic growth. In the near term, however, higher wages in the infrastructure sector can crowd out labor supply to the private sector through the wage spillover channel, dampening economic activities. Finally, a higher leverage associated with credit expansion increases the NPL ratio for infrastructure firms, raising bailout costs for the economy. To what extent credit expansion can boost the economy depends on which channel dominates.

To understand the transmission mechanism, we first explore an exogenous credit shock by setting the counter-cyclical coefficient in the credit rule ρ_y to zero, and focus on the following $AR(1)$ process:

$$\ln \frac{s_t^b}{s^b} = \rho_s \ln \frac{s_{t-1}^b}{s^b} + \epsilon_t^s. \tag{4.4}$$

Figure 4 illustrates the responses under a persistent and positive credit shock.

Credit easing generates a boom in the infrastructure sector, which in turn has negative spillover to the private sector in the near term but positive externality over the medium run. As shown in figure 4, a more generous bailout policy incentivizes the financial intermediaries to lend more, relaxing the working capital constraint for infrastructure producers. Those firms hire more workers and produce more public investment goods, leading to upward wage pressures. With labor mobility between the two sectors, higher wage in the infrastructure sector crowds out labor supply in the private sector. On impact, it leads to a decline in output and investment for private firms. Over time, however, higher production in infrastructure channels into to higher public capital, raising the productivity of private sector and therefore private investment over the medium term.[9]

Credit easing also raises the non-performing loan ratios for infrastructure firms, increasing the

[9] A larger output elasticity with respect to public capital (a higher value of α_G) would imply more positive impacts. But the online appendix shows that the results don't change much for alternative and empirically reasonable calibrations on α_G.

bailout costs. As explained in section 4.2, a more generous bailout policy increases the elasticity of leverage with respect to the cut-off productivity level, $\bar{\omega}_t$. The FIs are willing to lend more, and firms are willing to accept a loan contract with a higher cutoff level in productivity. The non-performing loan ratio, $\int_0^{\bar{\omega}_t} \omega dF(\omega)$, increases on impact and reaches its peak after a year. The more generous bailout policy, as well as a larger share of non-performing loans, leads to a sharp increase in the bailout costs on impact.

The bailout costs bring a wedge between what the economy produces, as measured by total output, and what the economy can consume and invest, as measured by GDP. The dynamics of total output follows closely to the production in private sector: it declines on impact but increases over time as public infrastructure raises private firms' productivity. After incorporating the bailout costs, however, the expansionary impact is less pronounced. Compared to the total output, the GDP drops more on impact and increases less over the medium term. In addition, the investment expansion through credit support crowds out household consumption.

Turning to inflation dynamics. Credit expansion is a supply shock to the infrastructure sector, driving down the prices on infrastructure goods. Higher wage in the infrastructure sector, however, raises production costs in the private sector, increasing consumption prices. The central bank responds to higher inflation by raising its nominal policy rate, even though GDP declines in the short run.

Importantly, the negative effects associated with an infrastructure boom weigh more heavily on economic activities, if credit shock is more persistent. Figure 5 compares the impulse responses with different credit shock persistence: the black dashed lines show the case with $\rho_s = 0.5$, and the red dotted lines are for the case with $\rho_s = 0.95$.[10] As a prolonged credit expansion generates a longer boom in the infrastructure sector, higher wages for longer impose a more persistent crowding-out effect in private sector via tighter labor market. In addition, a longer credit expansion also leads to a more persistent rise in NPL ratio, leading to more persistent bailout costs. The crowding out in the private sector and the bailout costs lead to a more persistent decline in GDP in the near term. Over the medium run, however, a persistent credit boom raises infrastructure production for a longer period, accumulating a larger public capital stock and boosting economic activities.

4.4 Bailout Rule The automatic stabilizer effects of government credit expansion can be particularly important during economic downturns. In this section, we replace the $AR(1)$ process in the previous section with the following credit rule:

$$\ln \frac{s_t^b}{s^b} = \rho_s \ln \frac{s_{t-1}^b}{s^b} - \rho_y \ln \frac{y_t}{y}. \tag{4.5}$$

The rule parameters, ρ_s and ρ_y, incorporate specifications for a range of credit policy paths. As explained in section 2, different countries adopted different credit expansion paths to boost economic growth following the Global Financial Crisis. Some countries, like India and China, allowed credit

[10] To keep the total size of government credit guarantee roughly similar across different shock persistence, we adjust the shock sizes by using $\sqrt{1-\rho_s^2}\sigma_{\epsilon^s}$, where ρ_s denotes the shock persistence and σ_{ϵ^s} is the shock standard deviation.

growth to persist well into the post-recession periods, which can be captured by a high ρ_s in the credit rule. On the other hand, South Korea used counter-cyclical credit expansion in a transitory and well-targeted manner, which features a much lower ρ_s.

Since the credit rule is at play only when economic output deviates from its steady state, we introduce an economic downturn through a negative demand shock in the form of higher discount factors, following the literature, for instance Smets and Wouters (2003). A positive shock ε_t^β raises the discount factor β_t and lowers private consumption. Both output and inflation falls, and the central bank cuts its policy rate. Against this backdrop of an economic downturn, we explore the economic impact associated with different credit rules.

We find that a transitory counter-cyclical credit rule can stimulate the economy with relatively low bailout costs. Specifically, we compare an economy with a transitory counter-cyclical credit rule ($\rho_s = 0, \rho_y > 0$), in line of the case of South Korea, to a scenario without a credit rule ($\rho_s = 0, \rho_y = 0$). Both economies receive the same negative demand shock through a higher β_t. The dashed black lines in Figure 6 show the IRF *differences* between the two cases. Compared to the case without policy action, the transitory counter-cyclical credit rule provides credit easing in the near term, which relaxes the working capital constraint and raises labor demand and production in the infrastructure sector. Although higher wages reduce labor supply in the private sector on impact, the crowding-out effect is limited. The NPL ratio, as well as the bailout costs, tick up initially, but quickly stabilize as the transitory credit expansion fades away with economy recovering. This simulation highlights that a transitory and well-targeted credit expansion, as the South Korea executed following the Global Financial Crisis, can stimulate the economy without sowing seeds for future credit delinquency issues.

Persistence credit expansion, on the other hand, bears more financial costs as a persistent credit rule significantly raises the NPL ratio over the medium run. The dotted red lines in Figure 6 show the IRF *differences* between an economy with a persistent credit rule ($\rho_s = 0.95, \rho_y > 0$), similar as India and China, to a scenario without a credit rule ($\rho_s = 0, \rho_y = 0$). Same as the previous exercise, both economies receive the same negative demand shock that scales back private consumption. A prolonged credit easing raises labor demand and production for infrastructure producers in a persistent manner, through relaxing the working capital constraints. Higher infrastructure production leads to the buildup of more public capital, posing extra positive externality on private productivity and investment. On the other hand, enduring government bailout leads to a steady rise in the NPLs, which peak a couple of years following the initial negative demand shock. In addition, persistently high wages in the infrastructure sector crowd out more labor supply in the private sector. The net impact is that, compared with a transitory rule, a persistent credit rule leads to a much more negative output response in the near term, which is partially offset by a more positive response over the medium run.

4.5 Distortionary Taxes

In the baseline calibration, we assume that the government can collect lump-sum taxes to finance credit expansions. In this section, we extend the model to incorporate labor and capital income taxes.[11] The distortionary taxes create wedges in household's optimization conditions, changing their decisions on labor supply and investment.

$$q^k_t = \beta E_t \frac{c_t}{c_{t+1}} \left(q^k_{t+1}(1-\delta) + R^k_{t+1}(1-\tau^k_t) \right) \tag{4.6}$$

$$\frac{w_{G,t}}{c_t}(1-\tau^l_t) = \chi l_t^{\eta-\sigma_L} \mu l_{G,t}^{\sigma_L} \tag{4.7}$$

$$\frac{w_{p,t}}{c_t}(1-\tau^l_t) = \chi l_t^{\eta-\sigma_L} (1-\mu) l_{p,t}^{\sigma_L}. \tag{4.8}$$

In addition, the government collects distortionary taxes to finance fiscal spending. For simplicity, we assume that the government keeps capital tax rate fixed at its steady state and adjusts labor income tax instead.[12] Both tax rates are assume to be 0.18 at the steady state.

$$g^c_t + g^I_t + \tilde{A}_t \left(\frac{n_{t-1}}{\pi_t} + b_t \right) s^b_t m_t \int_0^{\bar{\omega}_t} \omega dF(\omega) = T + \tau^k k_t + \tau^l_t l_t. \tag{4.9}$$

Distortionary taxes depress the stimulus impact associated with persistent credit expansions. Figure 7 compares simulations under distortionary taxes to those under lump-sum taxes. The dashed black lines represented the impulse response differences between a transitory credit rule and no credit rule in response to a negative demand shock, when the government uses distortionary taxes to finance credit spending. The dotted red lines are the same impulse differences but between a persistent credit rule and no credit rule. The green dotted and dashed lines are the counter parties in the model with lump-sum taxes, which are the same as in Figure 6. It is notable that distortionary taxes don't matter much in the case with transitory credit rule, as the black dashed and green dashed lines are very close. With persistent credit rule, however, distortionary taxes lead to higher NPL ratio and bailout costs, as well as lower GDP in the near term.

4.6 Fiscal Multiplier

To quantify the impact of credit expansions on the aggregate economy, we compute present-value fiscal multipliers following Uhlig (2010) and Leeper, Traum, and Walker (2017). The multiplier for credit expansion is defined in a similar way as conventional government spending multipliers. The present value of additional GDP over a $k-$period horizon produced by an exogenous change in the present value of credit expansion is,

$$\text{mul}^s_t(k) = \frac{E_t \sum_{j=0}^{k} \prod_{i=0}^{j} (1+r_{t+i})^{-1} \Delta GDP_{t+j}}{E_t \sum_{j=0}^{k} \prod_{i=0}^{j} (1+r_{t+i})^{-1} \Delta g^s_{t+j}}, \tag{4.10}$$

where g^s_t is government bailout spending. Figure 8 plots the fiscal multipliers under transitory and persistent credit rules, as well as under transitory and persistent credit shocks, when government uses distortionary taxes to finance credit expansions.

[11] The online appendix includes another alternative scenario in which the government issues bond to finance fiscal stimulus, and we show that the results don't change much compared to the baseline case.

[12] Our results are robust under the alternative assumption that the government use both labor and capital taxes to finance spending. The dynamics associated capital taxes, however, might obscure the transmission channel of credit expansion. Therefore, we use labor tax as a financing instrument for government spending.

First, we note that credit expansion is associated with rising fiscal multipliers over time. Regardless whether it is a credit rule or just a credit shock and how persistent it is, credit multipliers increase over time. As discussed above, the negative spill-over effect from the infrastructure sector to the private sector and the bailout costs dominate in the near term. Over time, the positive externality associated with higher public capital pays off, boosting productivity and production in the private sector.

Second, the persistence of credit expansion matters significantly for fiscal multipliers. Figure 8 highlights that a transitory credit rule with $(\rho_s = 0, \rho_y > 0)$ has a much higher credit multiplier than a persistent credit rule with $(\rho_s > 0, \rho_y > 0)$ throughout the horizon. On impact, both credit rules have negative multipliers. Over the medium and long run, the transitory credit rule leads to a multiplier approaching 2, implying that the positive externality associated with higher public investment dominates the bailout costs as well as the short-term crowing-out effects. A highly persistent credit rule, however, have a large negative multiplier for close to 5 years, due to high bailout costs.

Finally, *ceteris paribus*, counter-cyclical credit rules lead to slightly larger fiscal multipliers than credit shocks. The transitory credit rule has the highest fiscal multipliers, while the persistent credit shock has the lowest multipliers. It implies that well-targeted and short-lived stimulus measures are the most effective.

4.7 Comparisons of Different Fiscal Instruments

In this section, we compare three fiscal instruments that the government can deploy: government consumption g_t^c, investment g_t^I, and bailout ratio s_t^b. We assume that all instruments are exogenous and follow $AR(1)$ processes.

$$\ln \frac{g_t^c}{g^c} = \rho_g \ln \frac{g_{t-1}^c}{g^c} + \epsilon_t^c \tag{4.11}$$

$$\ln \frac{g_t^I}{g^I} = \rho_g \ln \frac{g_{t-1}^I}{g^I} + \epsilon_t^I \tag{4.12}$$

$$\ln \frac{s_t^b}{s^b} = \rho_s \ln \frac{s_{t-1}^b}{s^b} + \epsilon_t^s, \tag{4.13}$$

where $\epsilon_t^c \sim N(0, \sigma^c), \epsilon_t^I \sim N(0, \sigma^I), \epsilon_t^s \sim N(0, \sigma^s)$. All the persistence parameters are set at 0.8 in this comparison exercise. To highlight the macroeconomic impact from a credit expansion, we compare the impulse responses from three different fiscal instruments in Figure 9. The solid blue lines are the baseline case with a credit expansion. The dashed black lines are the case with an increase in government investment spending, g_t^I. The dotted red lines represent the responses to an increase in government consumption, g_t^c.

Compared to a credit expansion, an increase in government investment spending generates similar responses in many macro variables, but with notable differences in the dynamics for inflation and total output.[13] A higher demand in infrastructure goods increases labor demand and produc-

[13] To facilitate comparison, we control the shock sizes on government investment and credit guarantee such that the impact on infrastructure output are roughly the same between the two simulations.

tion in infrastructure sector. Higher wage spills over to the private sector and crowds out labor supply. Compared to the baseline with credit expansion, the increase in wage is roughly similar to the response under a government investment shock. However, the higher demand in infrastructure increases its price relative to consumer prices, and therefore the total output increases, rather than decreases, on impact in terms of consumer prices. Importantly, the increases in non-performing loan ratio and bailout costs are much smaller under a higher government investment spending than under a credit expansion.

Relative to credit support and government investment, an increase in government consumption has more limited impact in this model. It has no impact on the infrastructure sector, as it neither relaxes the working capital constraint nor increases the demand for infrastructure. The higher demand in final goods increases private labor supply, but crowds out household consumption even more.

Figure 10 compares the present-value fiscal multipliers at different horizons across the three fiscal instruments. Consistent with the impulse responses in Figure 9, a credit shock has a negative fiscal multiplier in the short run, while government consumption and investment have a positive multiplier on impact. Over time, fiscal multiplier with a higher government investment rises further, and that under a credit shock also increases and approaches 1. This is due to the higher productivity from higher infrastructure production. The stimulus from a higher government consumption, however, declines over time.

It is worthwhile to note that governments often adopt credit expansion policy together with conventional stimulus measures. For instance, China's fiscal stimulus package following the 2008 crisis included the conventional on-balance-sheet spending as well as the off-balance-sheet measure that provided guarantees on bank loans. Given the data limitation, empirical literature in general doesn't distinguish the difference between conventional infrastructure spending and unconventional credit guarantees targeting infrastructure sectors and, therefore, may reflect a weighted average of the multipliers across different fiscal instruments.

5 Conclusion

Our paper studies the effectiveness of government-backed credit expansion. Relative little work has been done on understanding the macroeconomic impacts of this fiscal instrument. Yet, upon a severe negative economic shock, governments' role in providing financial support and access to credit is very important. COVID-19 presented such a scenario of a significant negative economic shock. As a response, governments across the world take aggressive actions to help to limit the economic fallout from the pandemic. We contribute to the discussion by examining the economic benefits and costs of government-supported credit expansion in the sector of infrastructure.

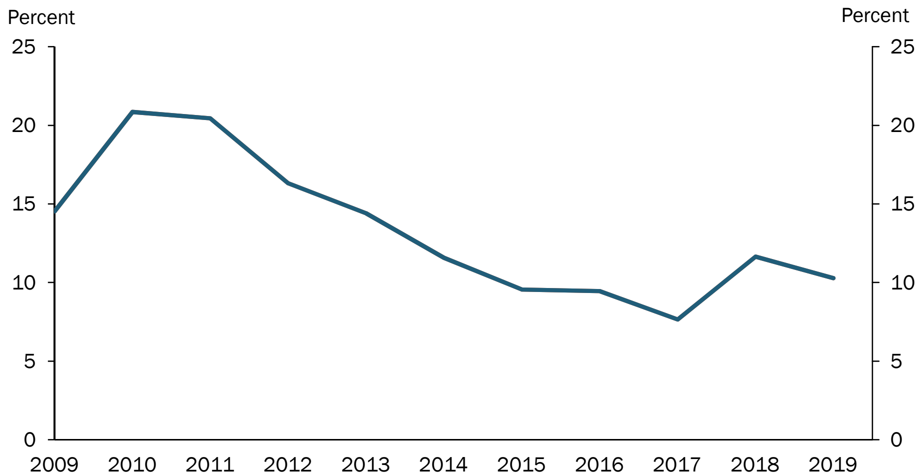
We show that a government-backed credit expansion affects the macro economy through three channels. First, it relaxes the working capital constraint for infrastructure firms, thus boosting both public and private productions over time. Second, higher labor demand in the targeted sector can crowd out labor supply to other segments of the economy. Last but not least, a higher leverage associated with credit expansion increases the NPL ratios, thus raising bailout costs. Our baseline calibration to an emerging economy suggests that the present-value fiscal multiplier of credit expansion is negative in the short run while rising over time. A short-lived credit expansion (as opposed to a persistent one) and a counter-cyclical credit rule (as opposed to a pure credit shock) would lead to larger credit multipliers.

Table 1: Parameter Calibration and Some Steady-state Values

Parameter	Description	Values
	Households	
β	Discount factor	0.9925
l	Steady-state labor supply	0.33
η	Inverse elasticity of labor supply	2
σ_L	Intratemporal elasticity of labor substitution	0.75
l_G/l_p	Labor ratio between two sectors	0.2
δ	Private capital depreciation rate	0.025
δ_G	Public capital depreciation rate	0.025
Ω_k	Capital adjustment cost	2
	Firms	
ϵ	Elasticity of substitution between retail goods	10
Ω_p	Price adjustment cost	117
α	Capital income share	0.5
α^G	Public capital share	0.1
K_G/K_p	Ratio of infrastructure capital to private capital	0.2
σ_ω	Std for log-normal distribution	0.4
m	FI monitoring cost	0.18
ζ	Firm survival rate	0.975
	Government	
ρ^R	Lagged interest rate in Taylor rule	0
ψ_π	Response coefficient to inflation in Taylor rule	1.5
ψ_y	Response coefficient to GDP growth in Taylor rule	0.5/4
G^c/GDP	Government consumption-GDP ratio	0.14
G^I/GDP	Government investment-GDP ratio	0.04
s^b	Steady state government bailout ratio	0.2
	Shocks	
ρ_g^c	Persistence of government consumption shock	0.8
ρ_g^I	Persistence of government investment shock	0.8
ρ_l	Persistence of government bailout shock	0.8
ρ_β	Persistence of discount factor shock	0
ρ_y	counter-cyclicality of credit policy	900

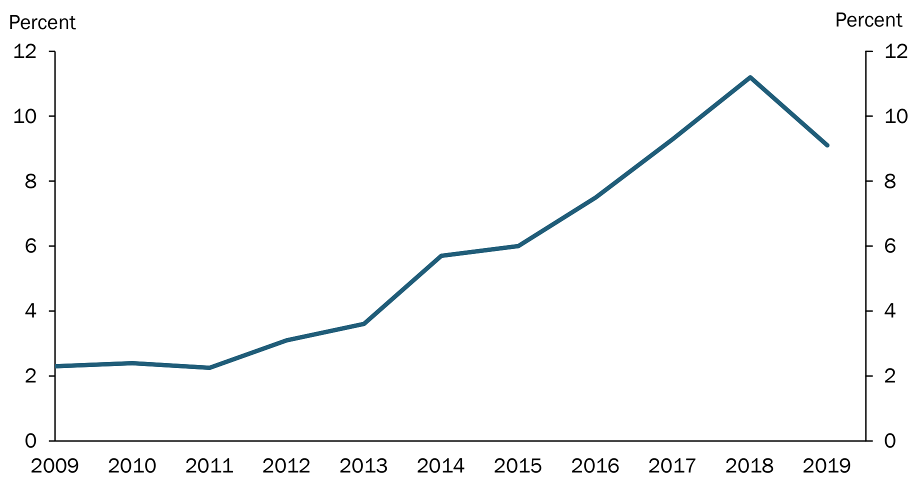
Figure 1: India: bank credit growth and non-performing loans following the 2008 Global Financial Crisis

(a) Bank credit growth



Source: Reserve Bank of India.

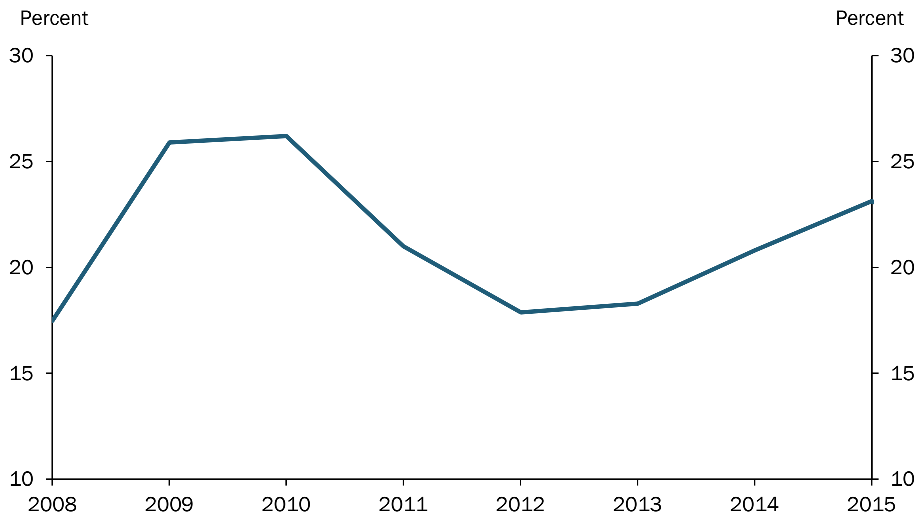
(b) NPL ratio



Source: Reserve Bank of India.

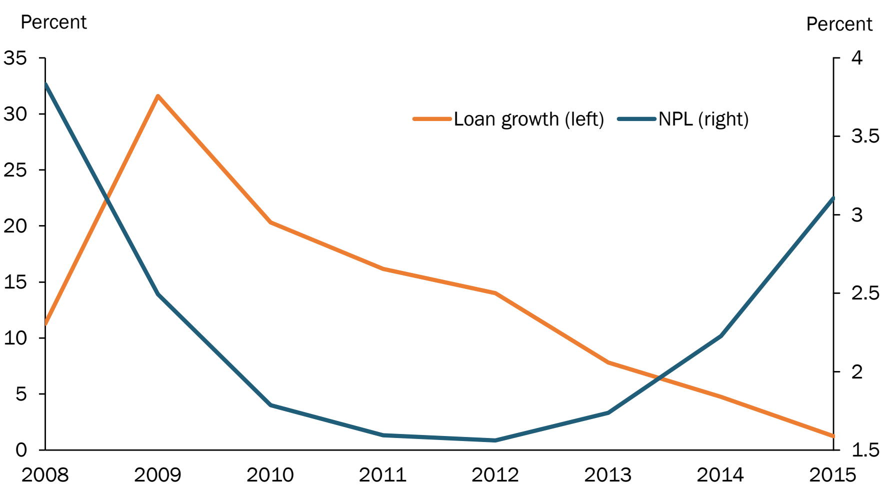
Figure 2: China: credit expansion and non-performing loans following the 2008 Global Financial Crisis

(a) LGFV debt as a share of GDP



Source: The National Audit Office (NAO) of China, Ministry of Finance of China, authors' calculation

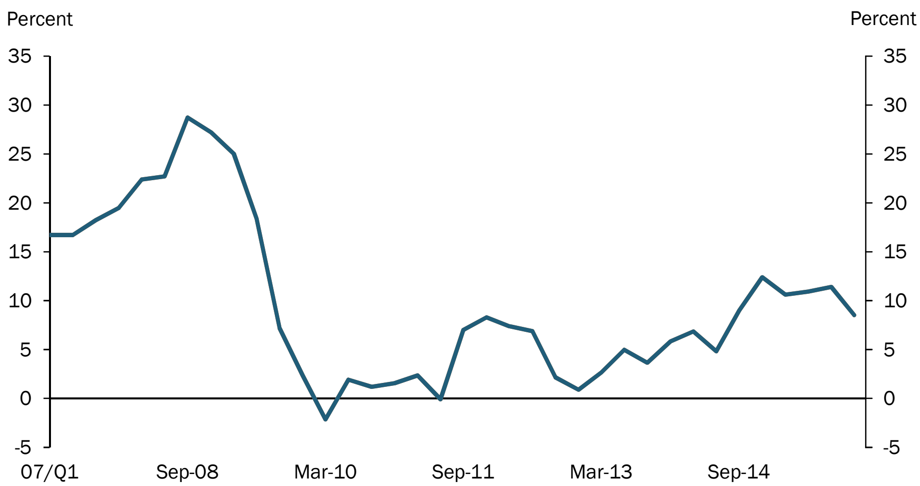
(b) Bank loan growth and NPL ratio to key sectors



Source: Bloomberg, annual bank reports from the Commercial and Industrial Bank of China and Bank of China. The key sectors include construction, mining, manufacturing, wholesale and retail sectors.

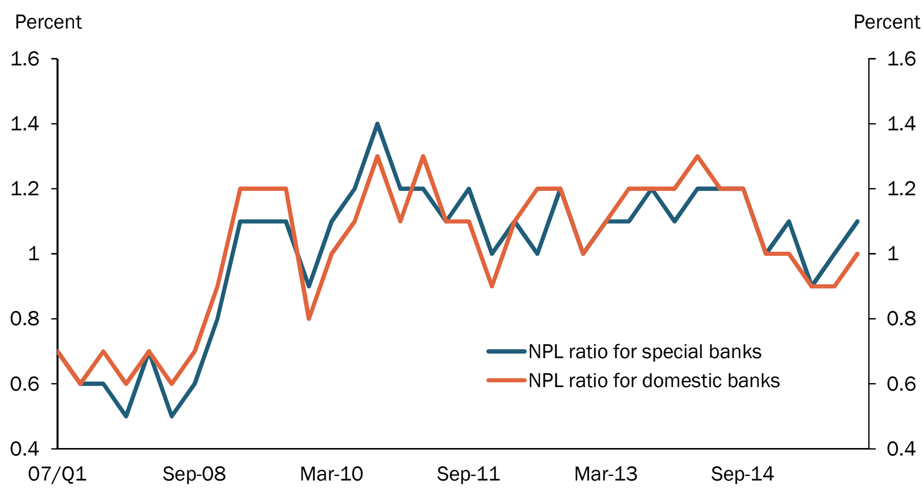
Figure 3: Korea: credit expansion and non-performing loans following the 2008 Global Financial Crisis

(a) Loan growth for the Special banks



Source: Korea Federation of Banks, Bank of Korea.

(b) Bank NPL ratios



Source: Korea Federation of Banks.

Figure 4: Impulse responses under a credit shock with persistence of $\rho_s = 0.8$.

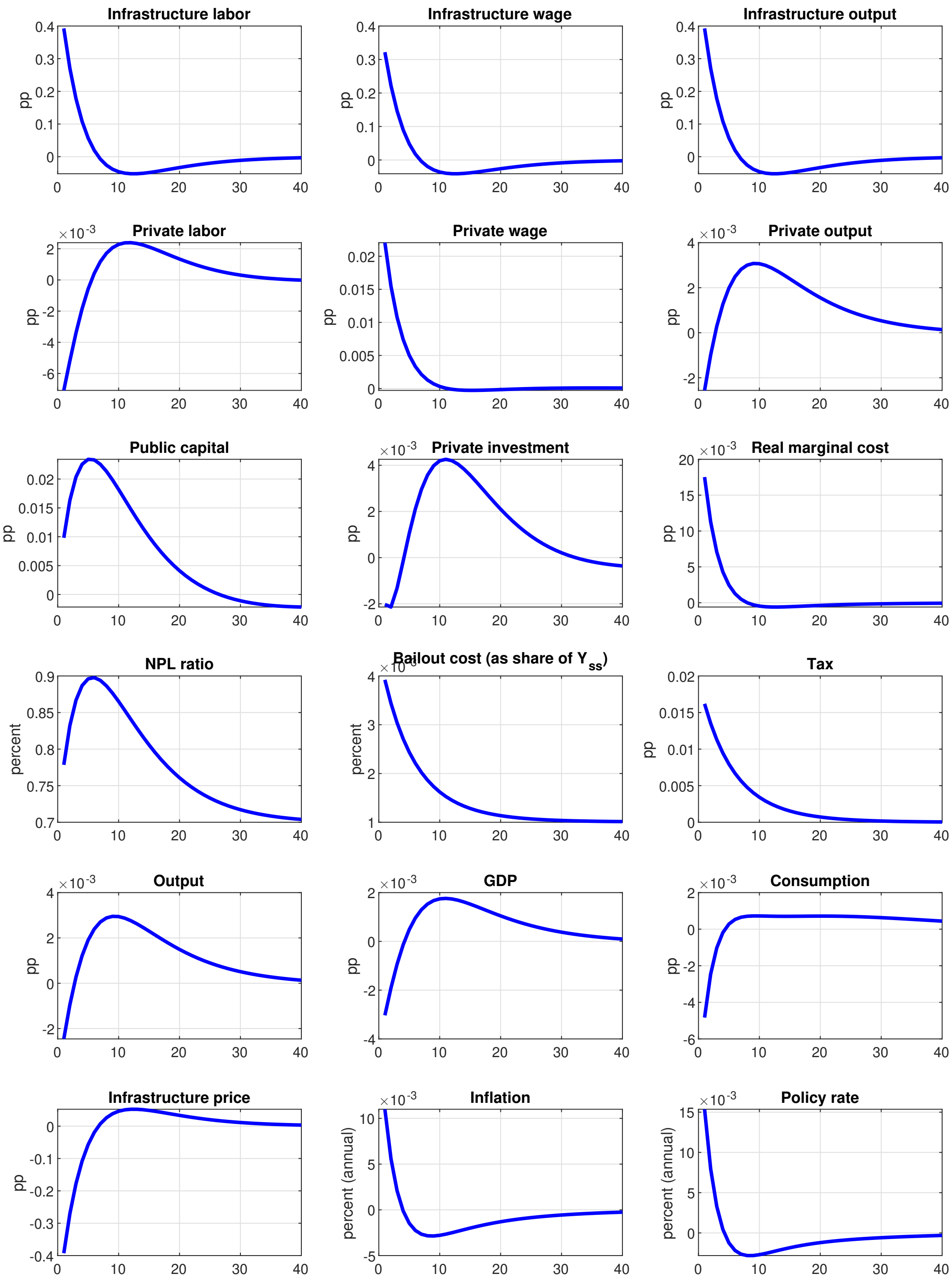


Figure 5: Impulse responses with different credit shock persistence: the black dashed lines are for the case with $\rho_s = 0.5$, and the red dotted lines are for the case with $\rho_s = 0.95$.

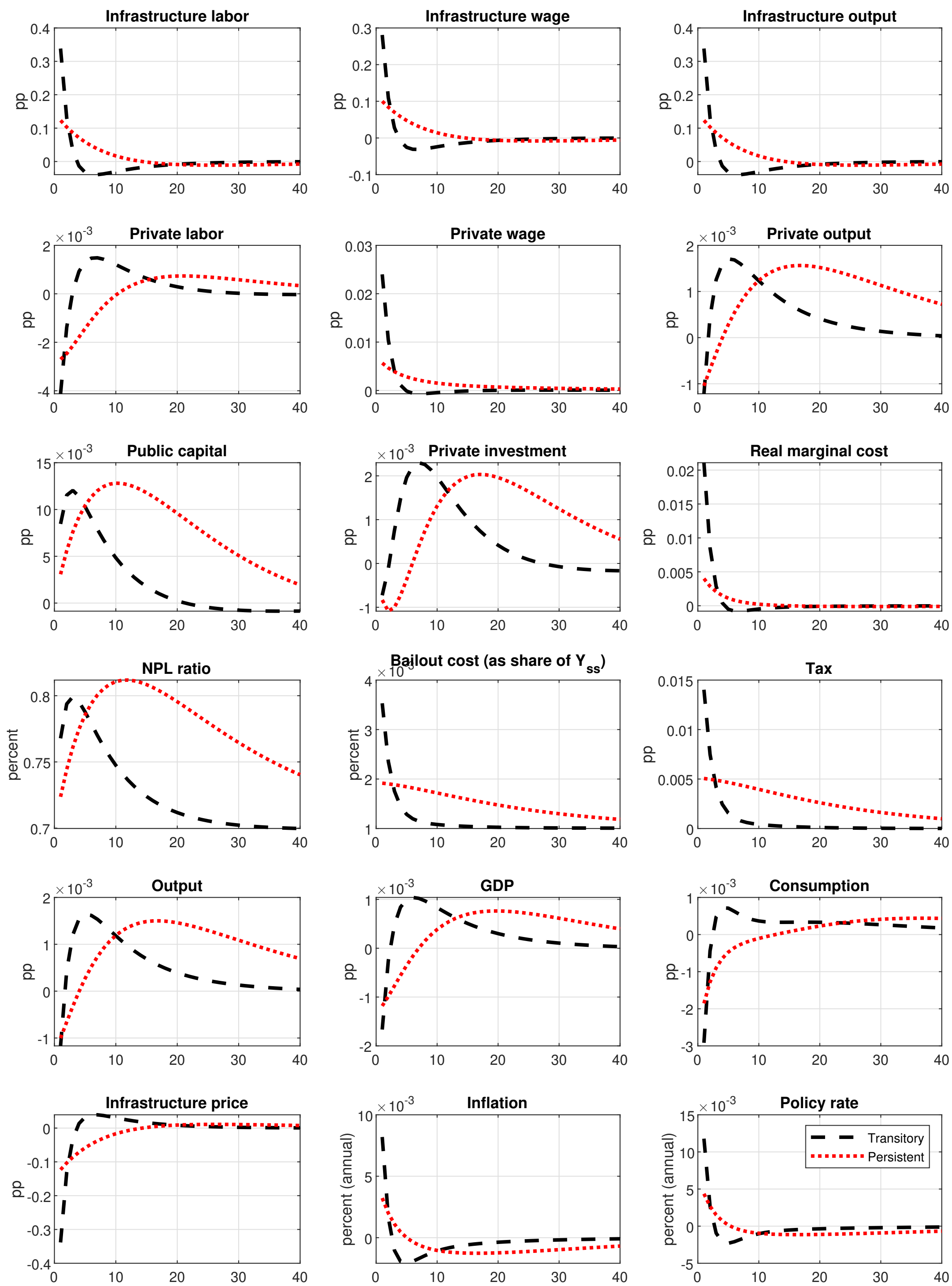


Figure 6: Comparisons of different credit rules: the dashed black lines show the impulse response differences between an economy with a transitory counter-cyclical credit rule ($\rho_s = 0, \rho_y > 0$) and one without a credit rule ($\rho_s = 0, \rho_y = 0$) in response to a negative demand shock; and the dotted red lines show the impulse response differences between an economy with a persistent counter-cyclical credit rule ($\rho_s = 0.95, \rho_y > 0$) and one without a credit rule under the same demand shock.

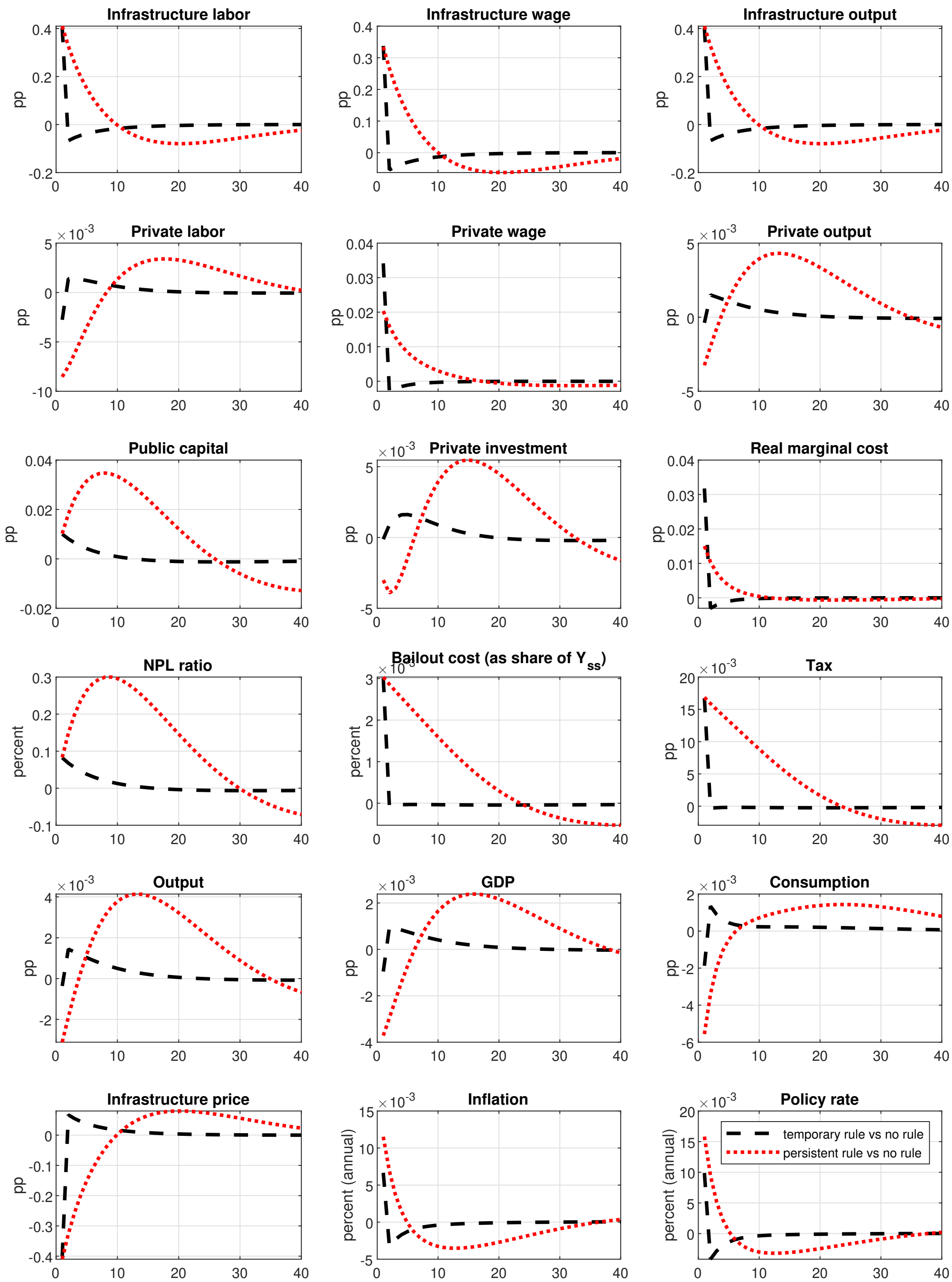


Figure 7: Impact of distortionary taxes: the dashed black lines show the impulse response differences between a transitory counter-cyclical credit rule ($\rho_s = 0, \rho_y > 0$) and one without a credit rule in response to a negative demand shock in the case *with distortionary taxes*; and the dotted red lines show the impulse response differences between a persistent counter-cyclical credit rule ($\rho_s = 0.95, \rho_y > 0$) and one without a credit rule. The green dashed and dotted lines represent the same simulations in the case *with lumpsum taxes*.

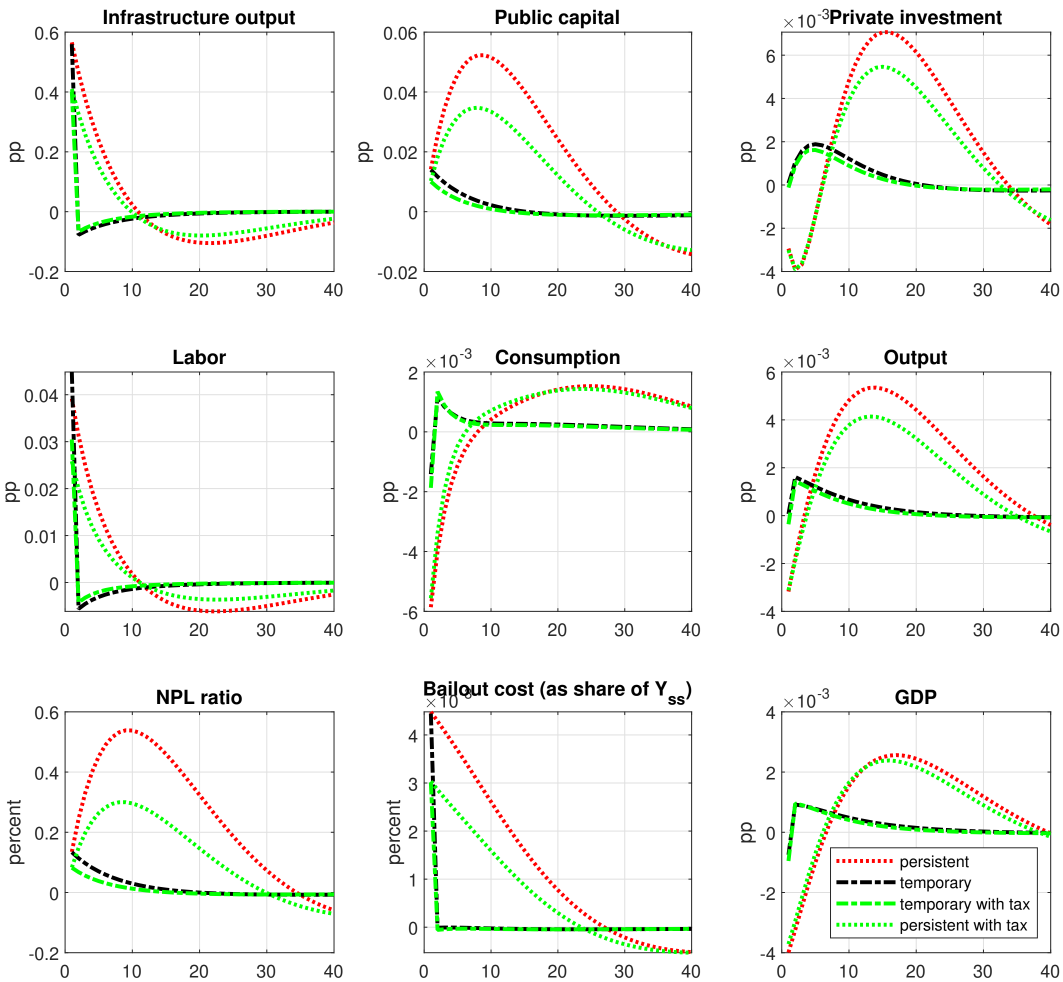


Figure 8: Fiscal multipliers across different credit rules and shocks: the solid black line shows the present-value fiscal multiplier under a transitory counter-cyclical credit rule ($\rho_s = 0, \rho_y > 0$), the solid red line shows the multiplier path with a persistent counter-cyclical credit rule ($\rho_s = 0.95, \rho_y > 0$), the dashed black line shows the case with a transitory credit shock ($\rho_s = 0$), and the dashed red line represents the case with a persistent credit shock ($\rho_s = 0.95$).

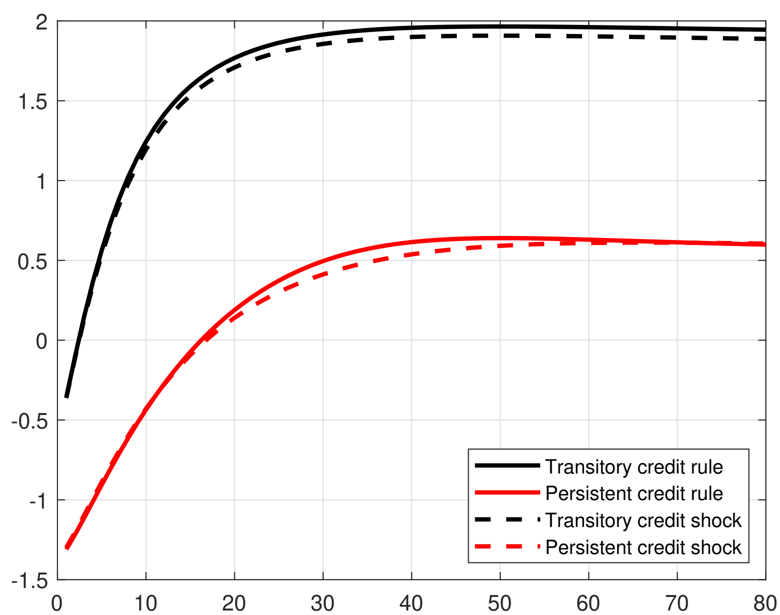


Figure 9: Impulse responses with different fiscal instruments: the solid blue line shows the simulations under a credit shock s_t^b, the dotted red line shows the case with a government spending shock g_t^c, and the dashed black line shows the case with a government investment shock g_t^I. All shocks have the persistence of $\rho_s = 0.8$.

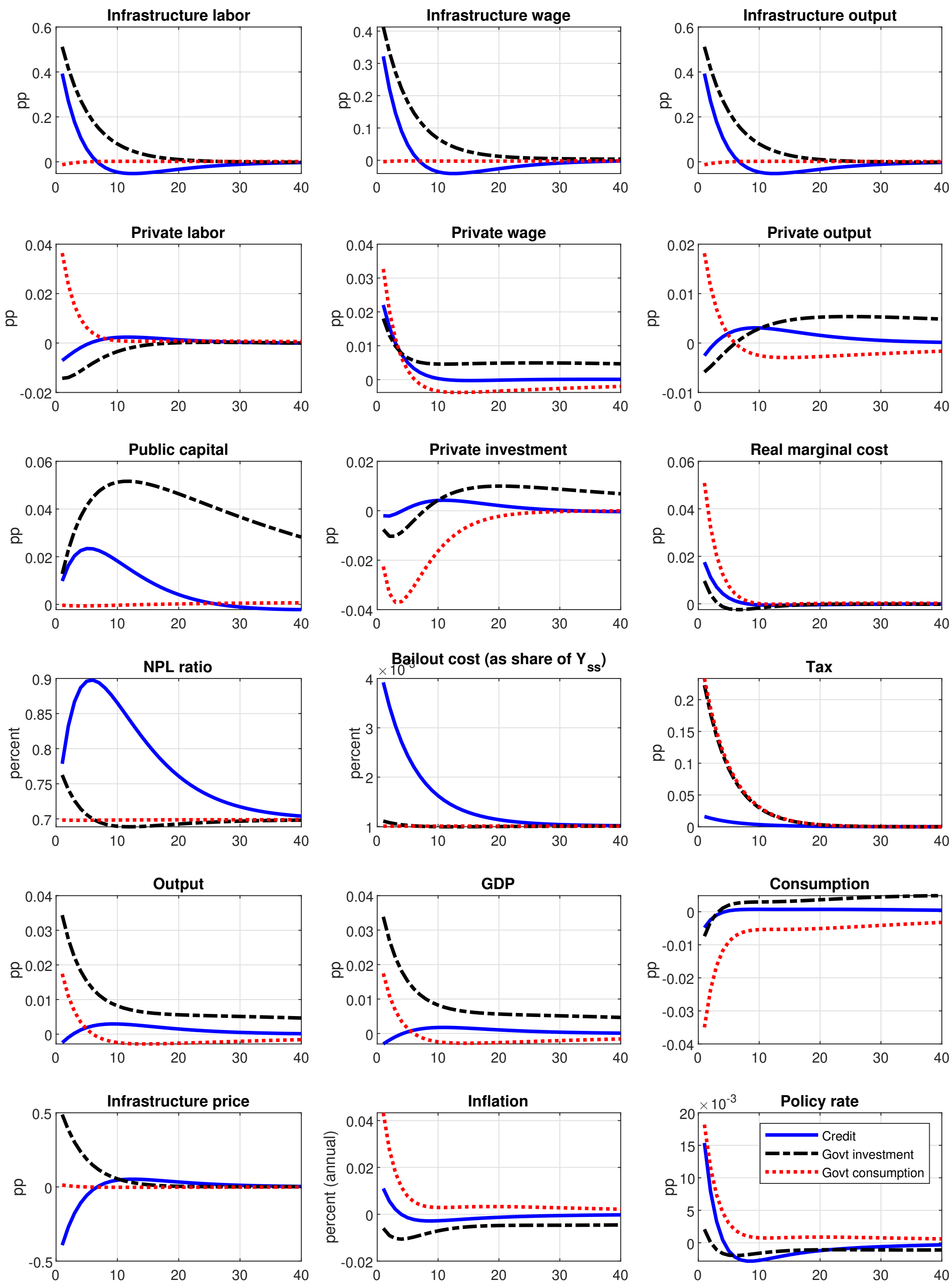
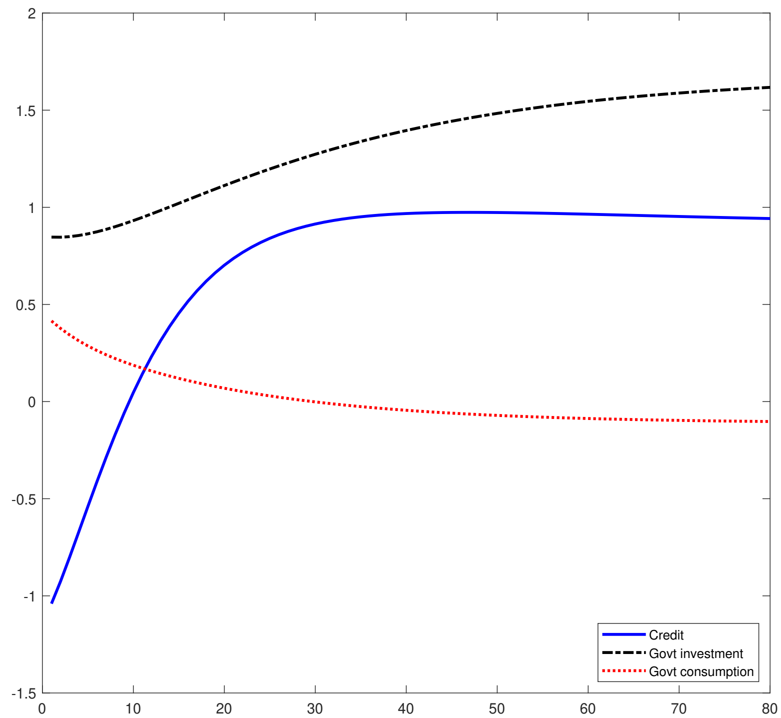


Figure 10: Fiscal multipliers under different fiscal instruments: the solid blue line shows the present value of fiscal multiplier under a credit shock, the dotted red line shows the multiplier path under a government spending shock, and the dashed black line shows the multiplier path under a government investment shock. All shocks have the persistence of $\rho_s = 0.8$.



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Online Appendix for "Credit Guarantee and Fiscal Costs"*

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*The views expressed in this paper are those of the authors and do not represent those of the Bank of Canada, the IMF, its Executive Board or IMF management, the Federal Reserve Bank of Kansas City or the Federal Reserve System.

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A Model Summary

This section summarizes the equilibrium conditions for the baseline model in the paper.

Households

$$l_t = \left(\mu l_{G,t}^{1+\sigma_L} + (1-\mu) l_{p,t}^{1+\sigma_L}\right)^{\frac{1}{1+\sigma_L}} \tag{A.1}$$

$$k_t = (1-\delta)k_{t-1} + \left(1 - \frac{\Omega_k}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2\right) i_t \tag{A.2}$$

$$\frac{1}{c_t} = \beta \mathrm{E}_t \frac{R_t}{\pi_{t+1} c_{t+1}} \tag{A.3}$$

$$\frac{w_{G,t}}{c_t} = \chi l_t^{\eta-\sigma_L} \mu l_{G,t}^{\sigma_L} \tag{A.4}$$

$$\frac{w_{p,t}}{c_t} = \chi l_t^{\eta-\sigma_L} (1-\mu) l_{p,t}^{\sigma_L} \tag{A.5}$$

$$q_t^k = \beta E_t \frac{c_t}{c_{t+1}} \left(q_{t+1}^k (1-\delta) + R_{t+1}^k\right) \tag{A.6}$$

$$\begin{aligned} 1 = {} & q_t^k \left(1 - \frac{\Omega_k}{2}\left(\frac{i_t}{i_{t-1}} - 1\right)^2 - \Omega_k \left(\frac{i_t}{i_{t-1}} - 1\right) \frac{i_t}{i_{t-1}}\right) + \\ & \beta E_t q_{t+1}^k \frac{c_t}{c_{t+1}} \Omega_k \left(\frac{i_{t+1}}{i_t} - 1\right) \left(\frac{i_{t+1}}{i_t}\right)^2 \end{aligned} \tag{A.7}$$

Private Firms

$$\frac{1}{x_t} = \frac{(\epsilon-1)}{\epsilon} + \frac{\Omega_p}{\epsilon}\left(\frac{\pi_t}{\pi} - 1\right)\frac{\pi_t}{\pi} - \beta \frac{\Omega_p}{\epsilon} E_t \frac{c_t}{c_{t+1}} \left(\frac{\pi_{t+1}}{\pi} - 1\right) \frac{\pi_{t+1}}{\pi} \frac{y_{p,t+1}}{y_{p,t}} \tag{A.8}$$

$$w_{p,t} = \frac{1}{x_t}(1-\alpha) A_{p,t} k_{p,t}^{\alpha} l_{p,t}^{-\alpha} \tag{A.9}$$

$$R_t^K = \frac{1}{x_t} \alpha A_{p,t} k_{p,t}^{\alpha-1} l_{p,t}^{1-\alpha} \tag{A.10}$$

$$A_{p,t} = \left(k_t^G\right)^{\alpha_G} \tag{A.11}$$

$$y_{p,t} = A_{p,t} k_{p,t}^{\alpha} l_{p,t}^{1-\alpha} \tag{A.12}$$

Public Firms

$$y_{G,t} = A_G l_{G,t} \tag{A.13}$$

$$\frac{P_{G,t}}{P_t} y_{G,t} = \tilde{A}_t(\frac{n_{t-1}}{\pi_t} + b_t) \tag{A.14}$$

$$\tilde{A}_t(\frac{n_{t-1}}{\pi_t} + b_t) g(\bar{\omega}_t) = R_t b_t \tag{A.15}$$

$$\frac{\frac{n_{t-1}}{\pi_t}}{\frac{n_{t-1}}{\pi_t} + b_t} = -\frac{g'(\bar{\omega}_t)}{f'(\bar{\omega}_t)} \frac{\tilde{A}_t f(\bar{\omega}_t)}{R_t} \tag{A.16}$$

$$w_{G,t} l_{G,t} = \frac{n_{t-1}}{\pi_t} + b_t \tag{A.17}$$

$$n_t = \zeta \tilde{A}_t(\frac{n_{t-1}}{\pi_t} + b_t) f(\bar{\omega}_t) \tag{A.18}$$

Policy and ARCs

$$\frac{R_t}{R} = (R_{t-1})^{\rho_R} \left(\left(\frac{\pi_t}{\pi}\right)^{\psi_\pi} \left(\frac{y_t}{y}\right)^{\psi_y} \right)^{1-\rho_R} \epsilon_t^M \tag{A.19}$$

$$g_t^c + g_t^I + \tilde{A}_t \left(\frac{n_{t-1}}{\pi_t} + b_t \right) s_t^b m_t \int_0^{\bar{\omega}_t} \omega dF(\omega) = T_t \tag{A.20}$$

$$k_{t+1}^G = y_{G,t} + (1 - \delta^G) k_t^G \tag{A.21}$$

$$g_t^I P_t = P_{G,t} y_{G,t} \tag{A.22}$$

$$y_t = y_{p,t} + \frac{P_{G,t}}{P_t} y_{G,t} \tag{A.23}$$

$$c_t + i_t + g_t^c + g_t^I = y_t - \tilde{A}_t \left(\frac{n_{t-1}}{\pi_t} + b_t \right) m_t \int_0^{\bar{\omega}_t} \omega dF(\omega)$$
$$-\frac{\Omega_p}{2} \left(\frac{\pi_t}{\pi} - 1 \right)^2 y_{p,t} - \frac{\Omega_k}{2} \left(\frac{i_t}{i_{t-1}} - 1 \right)^2 i_t. \tag{A.24}$$

Assume ω_t is drawn from a log-normal distribution distribution, $ln(\omega_t) \sim N(-\frac{1}{2}\sigma_\omega^2, \sigma_\omega^2)$. $\Phi(\cdot)$ and $\phi(\cdot)$ are the standard normal cdf and pdf respectively and $z \equiv (ln(\bar{\omega}) + 0.5\sigma_\omega^2)/\sigma_\omega$ Then,

$$\begin{aligned} f(\bar{\omega}_t) &= \int_{\bar{\omega}_t}^{\infty} \omega dF(\omega) - (1 - F(\bar{\omega}_t))\bar{\omega}_t \\ &= 1 - \Phi(z_t - \sigma_\omega) - \bar{\omega}[1 - \Phi(z)] \end{aligned} \tag{A.25}$$

$$f'(\bar{\omega}_t) = -\frac{\phi(z_t - \sigma_\omega)}{\sigma_\omega \bar{\omega}} - (1 - \Phi(z_t)) + \phi(z_t)/\sigma_\omega \tag{A.26}$$

$$\begin{aligned} g(\bar{\omega}_t) &= [1 - F(\bar{\omega}_t)]\,\bar{\omega}_t + (1 - (1 - l_t)m_t) \int_0^{\bar{\omega}_t} \omega dF(\omega) \\ &= (1 - \Phi(z_t))\,\bar{\omega}_t + (1 - (1 - l_t)m_t)\Phi(z_t - \sigma_\omega) \end{aligned} \tag{A.27}$$

$$g'(\bar{\omega}_t) = 1 - \Phi(z_t) - \phi(z_t)/\sigma_\omega + \frac{(1 - (1 - l_t)m_t)\phi(z_t - \sigma_\omega)}{\sigma_\omega \bar{\omega}_t} \tag{A.28}$$

B Background on Credit Expansion

Following section 2 in the paper, this section provides more details about the background of credit expansions in India, China and South Korea in responses to the 2008 Global Financial Crisis.

B.1 India The 2008 crisis hit India through a collapse in demand and a sudden stop of capital inflows. The central government took aggressive fiscal actions and passed three successive fiscal stimulus packages between 2008 and 2009, including funding for infrastructure investment and core industries. As shown in the top panel of Figure 1 in the paper, the credit extended by banks grew rapidly following the crisis with credit growth reaching 20 percent in 2010.[1]

The persistent credit growth following the crisis gave rise to a rapid increase in the NPL ratio, which rose from 2.25 percent in 2010 to 11.2 percent in 2018. The Indian banking system is characterized by a mix of bank ownerships including public sector banks, private sector banks, and foreign banks. Public sector banks, which amass roughly three quarters of the total assets in the banking system, were main contributors to the post-crisis credit expansion. As shown in Figure 1, the increase in NPL ratios for foreign and private banks were largely muted, while public banks experienced a sharp increase in their NPL ratios. The Asset Quality Review, published by the Reserve Bank of India in December 2015, noted the initial uptick in the non-performing assets in public sector banks, and those risks were fully materialized in the following years with the NPL ratio peaking at 14.6 percent in 2018.

The recent increase in the NPL ratio was largely driven by infrastructure and core industries.[2] According to Chavan and Gambacort (2016), these two industry categories saw much more rapid increases in their NPL ratios compared to other sectors. By March 2015, the two industries accounted for a quarter of the total non-performing loans of Indian banks, while their production accounted for less than 15 percent of GDP. The credit expansion to these industries is notable. Historically the so-called priority sectors – including agriculture, micro and small enterprises, etc. – were a source of stress for the banking sector, as both public and private banks were directed to give a certain percentage of their credit to these sectors given their role in social redistribution and economic growth. Following the 2008 crisis, however, the infrastructure and core industries saw more rapid increases in their loan growth and NPL ratios.

B.2 China Following the 2008 crisis, China adopted a massive stimulus package, including a general credit expansion to the broad economy and also a targeted credit expansion to sectors related to infrastructure investment. On the targeted credit expansion, the government utilized off-balance-sheet companies, known as the "Local Government Financing Vehicles" (LGFVs). Since local governments themselves were prohibited by law from borrowing at the time, the LGFVs were created to circumvent the restriction and borrow from banks to fund local infrastructure projects.[3]

[1] India also witnessed a period of fast credit growth in the early 2000s as a result of financial deepening and other factors (Hilbers, Otker, Pazarbasioglu, and Johnsen (2005)).

[2] The core industries mainly includes iron and steel, mining and quarrying, and textiles.

[3] The 1994 Budget Law prohibited local governments from incurring budget deficits, and the newly introduced tax sharing system in the same year also significantly lowered revenues for local government. As a result, LGFVs

Between 2009 and 2010, the LGFVs borrowed 3.6 trillion RMB to finance the stimulus programs (see Bai, Hsieh, and Song (2016)). Although the stimulus program concluded at the end of 2010, the local government financing programs continue to grow. The top panel in Figure 2 in the paper shows that, after posting a sharp increase in 2009 and 2010, the total debt of LGFV as a share of GDP continued trending up between 2013 and 2019.[4] In addition, the government doubled lending targets for commercial banks from 2008 to 2009 through a range of conventional policy tools. The bottom panel of Figure 2 in the paper shows that credit growth from the three largest Chinese banks to key industries, including the infrastructure sector, peaked at more than 30 percent in fiscal year 2009.[5] The credit support remained elevated in 2010 and 2011 at levels well above 15 percent, even though economic activities had rebounded. In the following years, credit growth declined gradually.

Even though the stimulus package was viewed by many as boosting the Chinese economy, the persistent credit expansion has also given rise to NPLs. The bottom panel in Figure 2 in the paper shows that the NPL ratio for key industries was low following the 2008 crisis, but increased steadily after 2012. Importantly, this conventional measure of NPL ratios was likely to significantly underestimate the scope of non-performing assets in the infrastructure sector. According to the China Banking Association, about 70 percent of LGFV infrastructure projects initially funded by stimulus bank loans were unlikely to generate enough revenue to repay their bank loans in full. In those cases, the central government allowed local governments to defer repayment of bank loans, which were not declared as non performing.

Moreover, the default risk associated with the mounting LGFV debt was masked by the stimulus loan hangover effect as termed by Chen, He, and Liu (2020). As stimulus bank loans in general mature in 3 to 5 years, LGFVs had to repay those loans and searched for alternative ways to continue financing long-term infrastructure projects. This vast financing demand is met by LGFVs' issuance of municipal corporate bonds, which have implicit guarantees from the local governments and are tightly linked to the shadow banking sector. In 2015, more than half of the total municipal corporate bonds were issued with proceeds being used for repaying stimulus bank loans.

B.3 South Korea As the economic growth grounded to a halt following the Global Financial Crisis, the South Korea government implemented two fiscal stimulus packages and rapidly extended bank credit. The top panel of Figure 3 in the paper shows that as the GDP growth dropped from 7 percent in 2007Q4 to -2 percent in 2009Q1, bank loans grew rapidly during this period. In particular, special banks, which provide funds to industrial sectors with government priority and

emerged in the 1990s as local government searched ways to meet their financing needs.

[4] The National Audit Office (NAO) of China reported the auditing results of the LGFVs' total stock of debt in each year from 2006 to 2013. China Ministry of Finance released the local government debt figures since 2015. We impute the stock of debt in 2014 by setting the number equal to the average of that in 2013 and 2015.

[5] The three Chinese banks are the Industrial and Commercial Bank of China, China Construction Bank, and Bank of China. We exclude the Agriculture Bank of China due to the lack of data in 2009. The key industries include construction, mining, manufacturing, wholesale and retail sectors.

limited profitability, saw its growth peak at 28 percent in the second half of 2008.[6]

However, the Korean credit expansion was transitory, which stood in contrast to the persistent credit expansions in India and China that lingered following the outbreak of the crisis. Despite the initial ramp-up, bank credit growth declined sharply in 2009 and reached a near zero level in 2010, while the economic activities rebounded and the GDP growth returned to 8 percent in 2010Q3. A similar counter-cyclical and transitory pattern is evident for public credit funds, for instance, the Korea Technology Finance Corporation (KOTEC) doubled their new credit guarantees from 2008 to 2009, but the flow in new loan guarantee was quickly stabilized in 2010 as the economy recovered.

The transitory credit expansion in Korea has been associated with stable NPL ratios. The NPL ratios fluctuated within the range of 0.6 to 1.3 percent between 2006 and 2015 with no significant uptick, while India and China saw rapid increases in their bank NPL ratios. As documented in Lee (2019), South Korea adopted a structural reform in the financial sector following the Asian financial crisis, with counter-cyclical credit guarantee policy contributing to its financial soundness in the banking sector. The tool of guided credit expansion was used not only during the Global Financial Crisis, but also in previous crisis episodes including the dot-com bubble burst in the early 2000s.

C Alternative Scenarios

This section provides a range of robustness checks by using alternative calibrations and model setups.

C.1 Alternative Bailout Ratios Given the limited empirical guidance on parameters characterizing the bailout shock, we set the steady-state bailout ratio s^b to 0.2 in the baseline, which implies that the FIs can recover 20 percent of the monitoring costs from the government at the steady state. In this section, we show robustness checks with alternative calibrations of s^b and show that the key transmission channel remains unchanged.

Figure 2 compares the impulse responses with $s^b = 0.2$ (solid lines for the baseline case), $s^b = 0.15$ (dash-dotted lines for a lower bailout ratio), and $s^b = 0.25$ (dotted lines for a higher bailout ratio). It shows that a larger credit shock through a higher bailout ratio leads to larger fluctuations in GDP, with a more pronounced decline on impact as well as a more notable increase over the medium term. Please note that the shock sizes, which is a function of the variance of s^b, are different across the three scenarios in figure 2.

Credit multipliers in figure 3 may provide a better comparison of the impact of s^b on the economy as they are normalized by the present value of government bailout spending and thus control the

[6] Specialized banks were established during the 1960s primarily to supplement the commercial banks in areas where they could not supply sufficient funds due to limited capital, profitability, and expertise and also to support specific industrial sectors that were given priority by the government in its economic development plans. Under the law, five banking organizations are recognized as specialized banks: Korea Development Bank, Export-Import Bank of Korea, Industrial Bank of Korea; NongHyup Bank of the National Agricultural Cooperative Federation, and Suhyup Bank of the National Federation of Fisheries Cooperatives.

shock sizes. This chart shows that a smaller bailout ratio leads to a higher credit multiplier over the medium term, implying the near-term negative impact from non-performing loans dominates the expansionary impact on GDP over the medium term. The message is consistent with the key transmission channel identified in the paper.

C.2 Alternative α_G The output elasticity with respect to public capital, α_G, is an important parameter for assessing the output effects of fiscal policy. Calderón, Moral-Benito, and Servén (2015) offers a comprehensive evaluation of the output contribution of infrastructure using a panel data set that includes a wide range of advanced and developing countries (including China, India and Korea). They estimate the output elasticity of infrastructure lying in the range $0.07 - 0.10$ and find their estimates robust to the use of alternative econometric specifications and alternative synthetic measures of infrastructure. More importantly, they found little evidence of heterogeneity across countries in the output elasticity of the inputs in the aggregate production function. The long-run output elasticity of infrastructure does not seem to vary with countriesâ level of per capital income, their infrastructure endowment or the size of their population. Thus, we assume $\alpha_G = 0.1$ in the baseline calibration of our paper.

For robustness check, we consider alternative calibrations to α_G. Figure 4 compares the impulse responses with different values of α_G: the black lines are the baseline case with $\alpha_G = 0.1$, the blue lines are for the case with $\alpha_G = 0.08$, and the red dotted lines are for the case with $\alpha_G = 0.12$. The value of α_G does not change how the infrastructure sector reacts to a credit shock, as public infrastructure firms don't internalize the impact of public infrastructure capital on private intermediate goods production. However, the larger the output elasticity with respect to infrastructure, the more positive impacts public capital has on private production and investment. Therefore a higher α_G leads to more positive output and GDP responses. Figure 5 compares the fiscal multipliers associated with different values of α_G. Consistent with the impulse responses, larger output elasticity with respect to public capital leads to higher multipliers at all horizons.

C.3 Bond-financing Model In the baseline calibration, we assume that the government faces a balanced budget requirement. In this section, we assume that the government collects lump-sum taxes and issues bond to finance its investment and consumption spending as well as credit expansion. To ensure the model has determinacy, we follow Leeper (1991) and assume that the government adjusts taxes in response to changes in government debt, as shown below.

$$g_t^c + g_t^I + \frac{R_{t-1} b_{t-1}^G}{\pi_t} + \tilde{A}_t \left(\frac{n_{t-1}}{\pi_t} + b_t \right) s_t^b m_t \int_0^{\bar{\omega}_t} \omega dF(\omega) = b_t^G + T_t \tag{C.1}$$

$$T_t = T \left(\frac{b_t^G y}{y_t b^G} \right)^{\rho_G} \tag{C.2}$$

Figure 6 shows that bond-financing scheme doesn't change the impact from credit guarantee. The results don't change much if we assume that the government adjusts distortionary taxes in response to changes in government debt.

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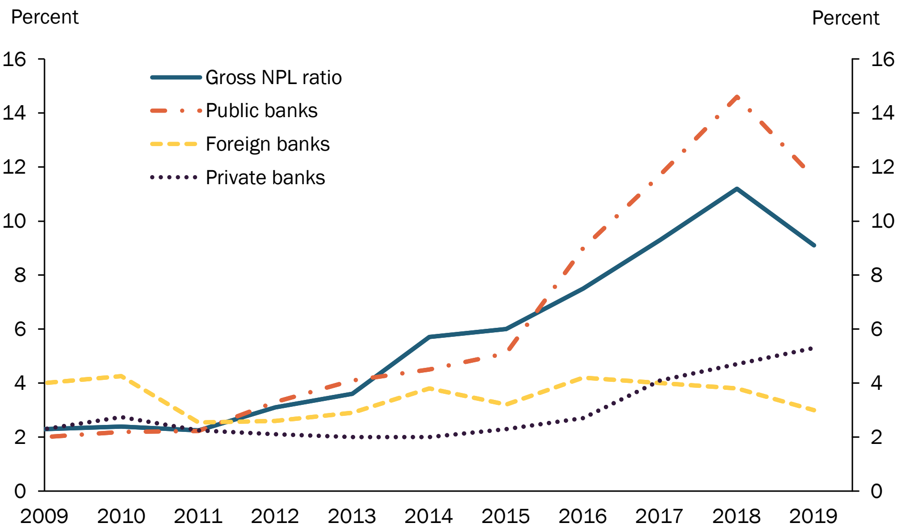
Figure 1: NPL ratio across different types of banks in India



Source: Reserve Bank of India.

Figure 2: Impulse responses with different value of s^b: the solid lines are the baseline case with $s^b = 0.2$, the dash-dotted lines are for the case with $s^b = 0.15$, and the dotted lines are for the case with $s^b = 0.25$.

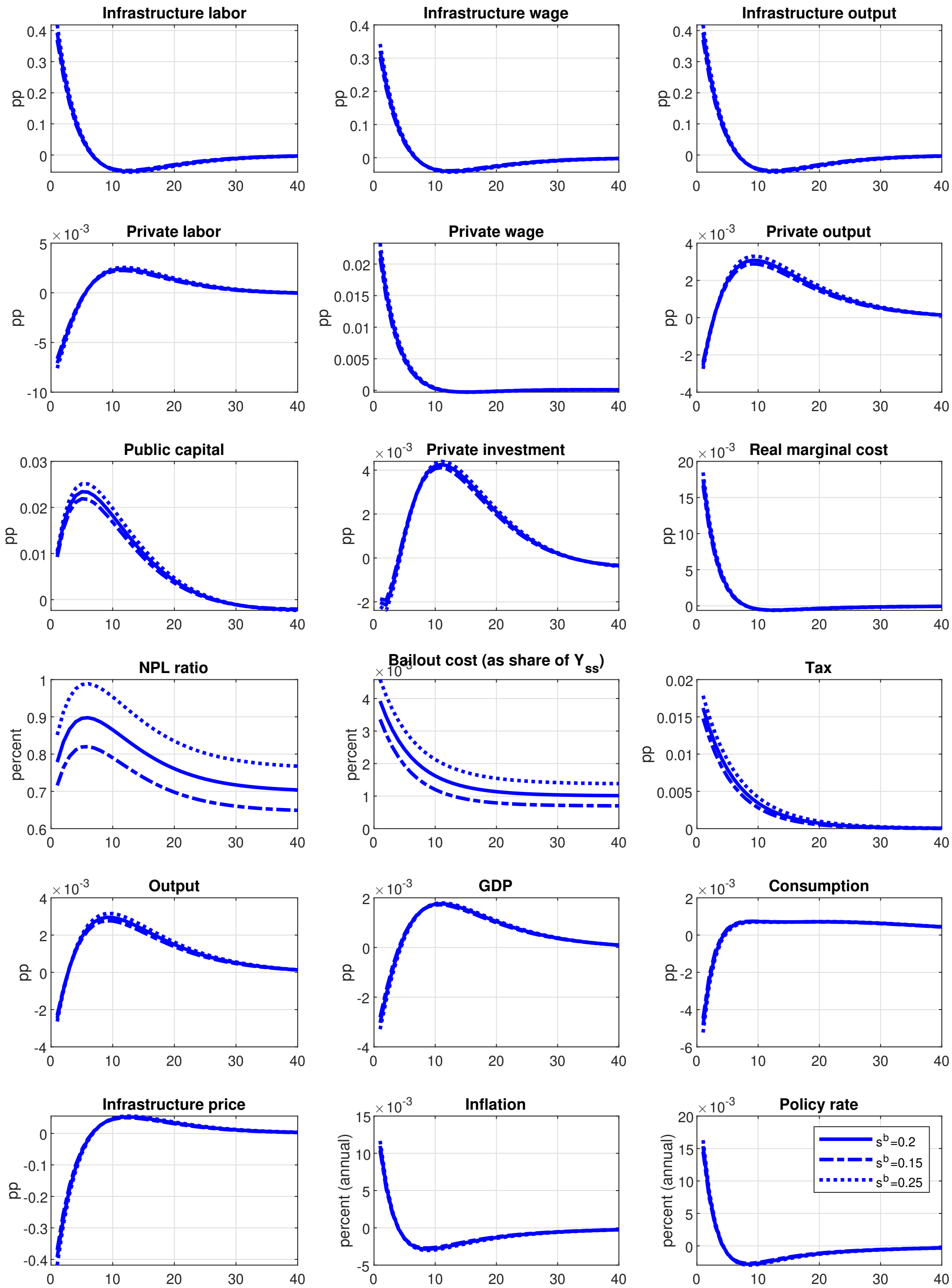


Figure 3: Fiscal multipliers associated with different value of s^b: the solid lines are the baseline case with $s^b = 0.2$, the dash-dotted lines are for the case with $s^b = 0.15$, and the dotted lines are for the case with $s^b = 0.25$. (For comparison, the dashed black lines are the case with an increase in government investment spending, g_t^I. The dotted red lines represent the responses to an increase in government consumption, g_t^c.)

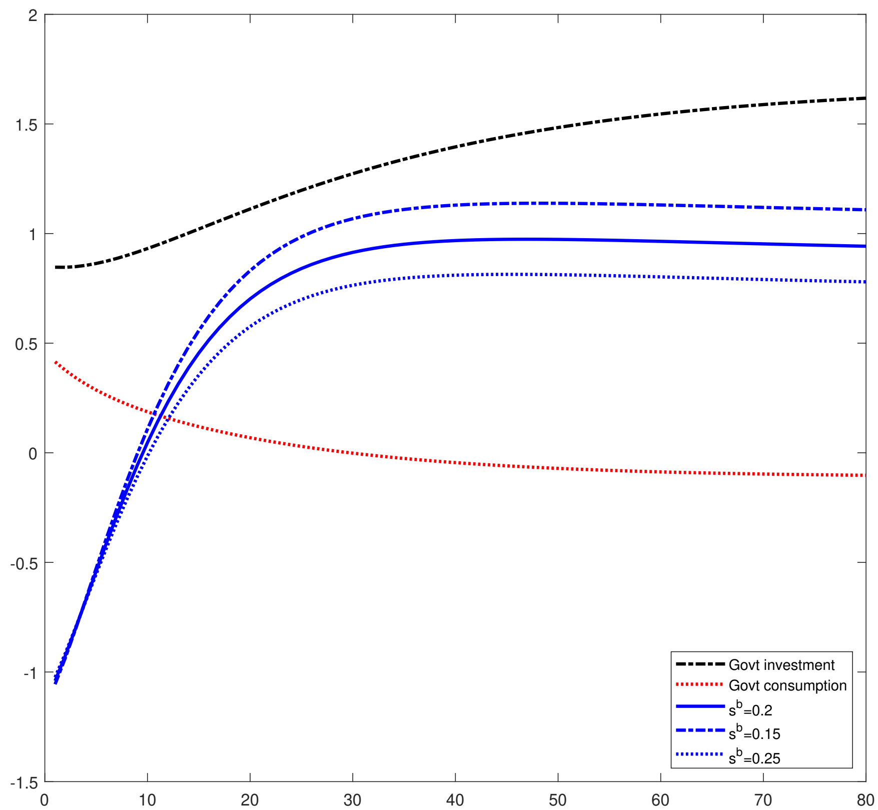


Figure 4: Impulse responses with different value of α_G: the black lines are the baseline case with $\alpha_G = 0.1$, the blue lines are for the case with $\alpha_G = 0.08$, and the red dotted lines are for the case with $\alpha_G = 0.12$.

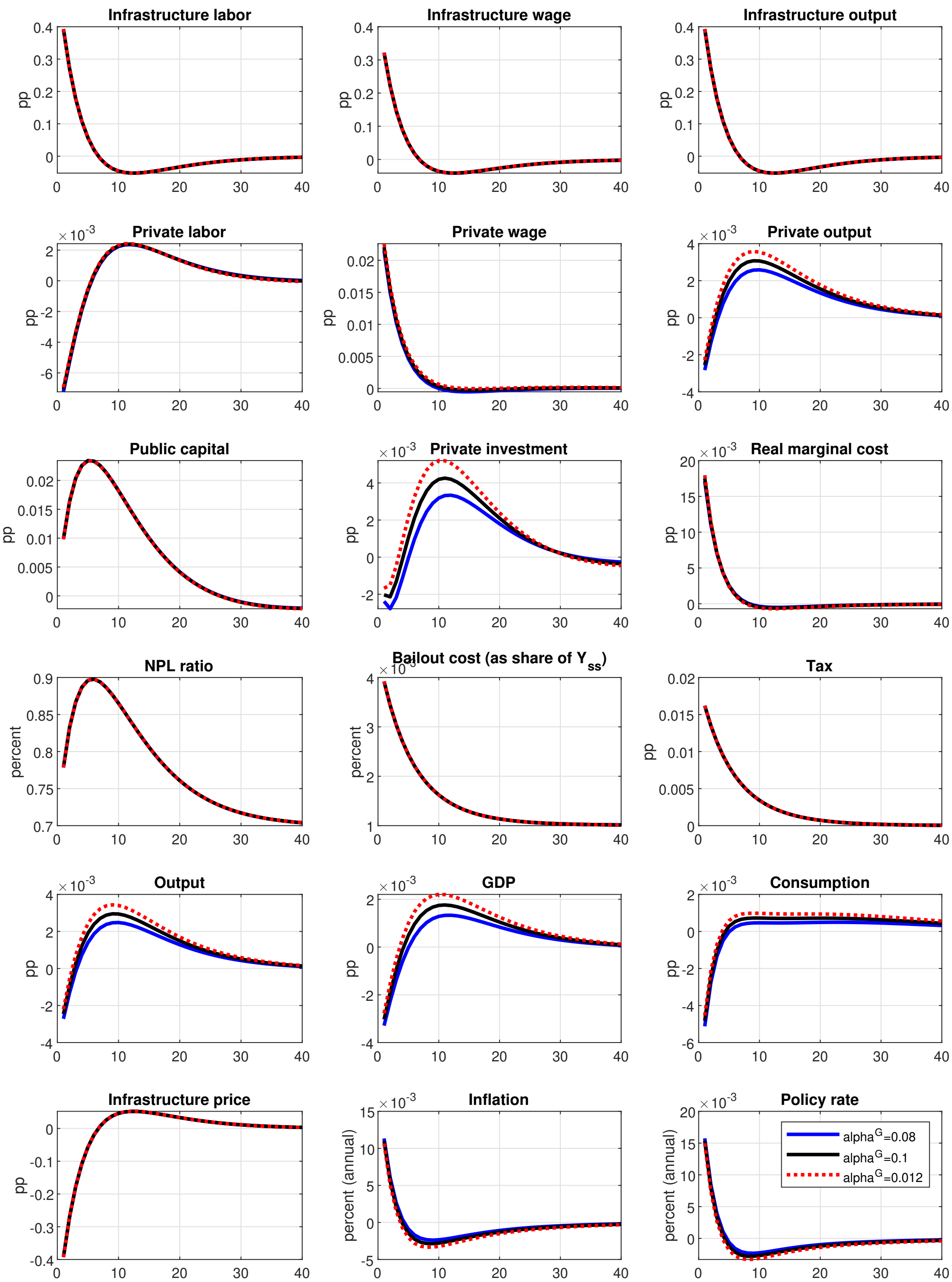


Figure 5: Fiscal multipliers associated with different value of α_G: the black lines are the baseline case with $\alpha_G = 0.1$, the blue lines are for the case with $\alpha_G = 0.08$, and the red dotted lines are for the case with $\alpha_G = 0.12$.

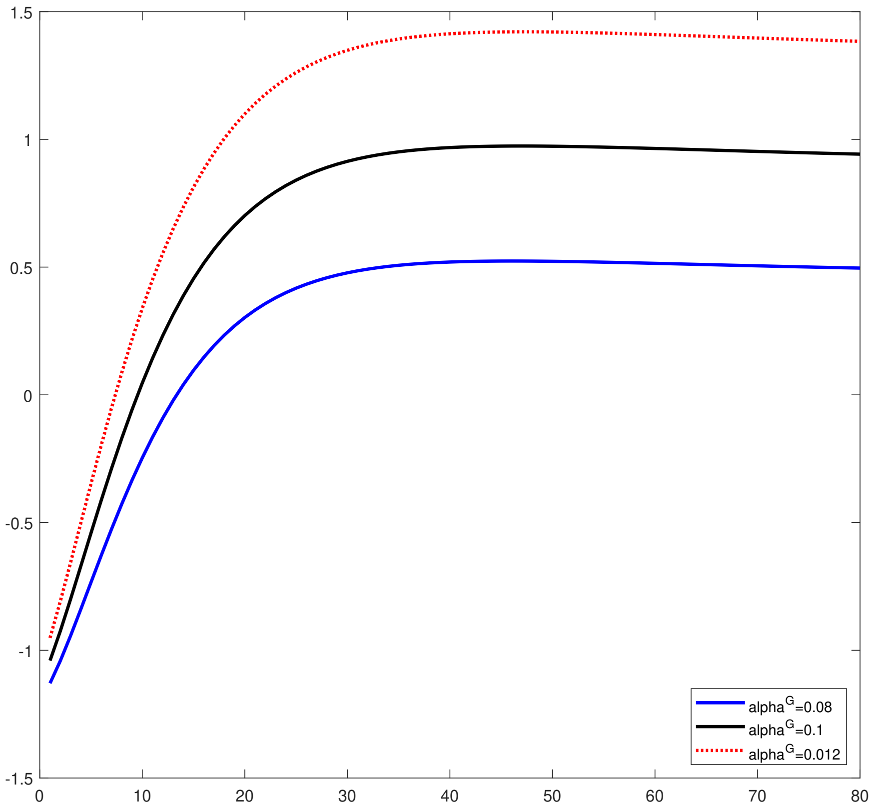


Figure 6: Impulse responses in the alternative scenario with bond financing under a credit shock with persistence of $\rho_s = 0.8$.