The Growth Asymmetries of Chinese Private firms and State-owned Firms

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Abstract: This paper provides detailed analysis of growth asymmetries of two sectors in China, private firms and state-owned firms. I examine the effects of three exogenous shocks on Chinese macro economy. The productivity shock to one certain sector will increase its production but decrease the production of the other sector. The final output increases for the shock to private firms and decreases for the shock to state-owned firms since Chinese private firms hire more people and produce more goods. The collateral constraint shock to the sector of state-owned firms increases its debt and reduce the debt of the sector of private firms. These difference between sectors can be explained by resource misallocation between two sectors.

1. Introduction

With the rapid development of China's economy, China has received more and more attention. Compared with other developed economies, China's economic development process is distinct and special, and Chinese state-owned firms play a very important role. However, with the implementation of the reform and opening up policy in China, private firms have taken a leap forward and accounted for more than half of the economy. More and more scholars are beginning to study China's two-sector economy. Song et al. (2011) construct a dynamic model in order to analyze the distinct feature of the growth in China: high growth rate but with a large trade surplus. They define that the state-owned firms are low-productive and have access to the credit market, while the private firms are high-productive but have credit constraint. The factor relocation from state-owned firms to private firms induces a sustained foreign surplus.

Due to the differences in the size and financing capacity of firms, high-productivity firms may not be able to get enough funds, and a large amount of funds may flow to low-productivity firms, which will cause misallocation problems. If resources are unreasonably distributed among Chinese state-owned firms and private firms, they will also cause resource misallocation. Hsieh and Klenow (2009) empirically prove that resource misallocation will reduce total factor productivity (TFP), and in China there are large gaps for the differences in both marginal products of labor and capital within industries. Therefore, if China can make more rational allocation of capital and labor, it will greatly increase the manufacturing TFP. Gopinath et al. (2017) argue that the model of corporate lending capacity and its size portrays a decline in interest rates that leads to a decline in TFP, because capital flows to companies with large net worth but not necessarily high productivity, which leads to resource

misallocation. Specifically, they create a small open economy model and assume that borrowing constraints depend on the size of firms. The model generates an increase in capital, borrowing and marginal revenue product of capital when TFP relative to its efficient level is decreasing.

Other papers also study two-sector economy, such as Tiryaki (2014), Zetlin-Jones and Shourideh (2017) etc. Tiryaki (2014) builds a two-sector model contains nontradable and tradable sectors. As the result of some shocks, nontradable sector is less volatile, and less volatile to the change of imported price and real interest rate since its production is labor-intensive. Zetlin-Jones and Shourideh (2017) focus on the use of external funds among private firms and publics firms, distinguished by whether they provide dividends to households.

In this paper, I study the growth asymmetries of China's economy under the change in TFP and borrowing constraints. The main objective is to use dynamic stochastic general equilibrium (DSGE) model to analyze some key macroeconomic variables in two sectors: private firms and state-owned firms. Section 2 provides the model descriptions. Section 3 presents quantitative results. Section 4 concludes.

2. Model Details

The dynamic model contains intermediate good firms, final good firms, households and banks. Consider an economy where final good firms produce only one single consumption good and use intermediate goods as inputs. Additionally, there is no trade activity with outside economies. Our model is based on the benchmark model introduced by Iacoviello (2015) and Zetlin-Jones and Shourideh (2017). Compared with Zetlin-Jones and Shourideh (2017), the main difference is that their two-sector model relates to private firms and public firms while ours contains two types of intermediate good firms in China: private firms (P) and state-owned firms (S), each of which has a monopoly in producing a differentiated intermediate good. Following Iacoviello (2015), I also consider the bank sector, because bank sector plays a vital role in Chinese economy.

I use $f \in [0,1]$ to denote the proportion of the private firms. Time is discrete in our model, indexed by t=1,2,3,… The production function for each firm is in the form of Cobb-Douglas function:

$$q_{it} = z_{it} k_{it}^{\alpha} l_{it}^{1-\alpha} \qquad i \in \{P, S\} \tag{1}$$

where z_{it}, k_{it}, $l_{it}$are the firm i's productivity, capital and labor at t. For simplicity, we make two assumptions of this function. First, labor is a mobile factor. All workers can move between two sectors, so the wage levels of two types of firms should be the same. Second, the productivity follows AR(1) process.

Since there is only one consumption good, the final good firms are in a competitive market. They produce a composite final good Q_t as:

$$Q_t = \left[f q_{pt}^{\frac{\rho-1}{\rho}} + (1-f) q_{st}^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}} \tag{2}$$

where ρ is the elasticity of substitution for the final good. f represents the proportion of the private firms and I use it to weight intermediate goods final goods composition. By solving the profit-maximization problem of final good firms, we obtain the inverse demand curves with respect to intermediate goods and final goods:

$$P_{pt} = f Q_t^{\frac{1}{\rho}} q_{pt}^{\frac{-1}{\rho}} \tag{3}$$

$$P_{st} = (1-f)Q_t^{\frac{1}{\rho}} q_{st}^{\frac{-1}{\rho}} \tag{4}$$

From the above two equations, the price of intermediate goods for each sector is positively correlated to the final goods and negatively correlated to the quantity of intermediate goods in each sector

2.1 Private Firms

Private firms maximize the expected discounted dividends. Bankruptcy happens due to poor entrepreneurship, failure of investment plans and other reasons, so we set the exit rate of the firms is ζ. One essential feature of the private firms is that the ownership shares cannot be traded publicly, so the bankruptcy risk cannot be fully diversified. In each period, the private firms decide how much to produce and the wage level of labor in order to maximize the dividends d_{pt}. Private firms' expected present value of lifetime utility is given by:

$$E_0 \sum_{t=0}^{\infty} \left[\beta_p (1-\zeta)\right]^t \log\left(d_{pt}\right) \tag{5}$$

I assume that intermediate good firms have limited access to capital market. Therefore, the capital they gain is proportional to their total financial assets:

$$k_{pt} \leq \lambda_p a_{pt} \tag{6}$$

where k_{pt} is the private firms' capital and a_{pt} is the financial asset. The private firms' budget constraint should be satisfied as:

$$d_{pt} + a_{pt+1} = P_{pt} z_{pt} k_{pt}^{\alpha} l_{pt}^{1-\alpha} - w_t l_{pt} - \left(r_{pt} + \delta\right) k_{pt} + \left(1 + r_{pt}\right) a_{pt} \tag{7}$$

Capital accumulation process of private firms is given by:

$$k_{pt+1} = (1-\delta) k_{pt} + I_{pt} \tag{8}$$

where δ is the depreciation rate of capital and I_{pt} represents private firms' investment.

2.2 State-owned Firms

The conditions of state-owned firms are different from those of private firms. One main feature of state-owned firms is that they are wholly or partially by the government. Hence the bankruptcy risk is trivial (ζ=0). The value function now becomes:

$$E_0 \sum_{t=0}^{\infty} \beta_s^t \mathrm{d}_{st} \tag{9}$$

Although the government can provide subsidy to support state-owned firms, we omit it for simplicity. The budget constraint of state-owned firms should be exactly the same as that of private firms:

$$d_{st} + a_{st} = P_{st} z_{st} k_{st-1}^{\alpha} l_{st}^{1-\alpha} - w_t l_{st} - (r_{st-1} + \delta) k_{st-1} + (1 + r_{st-1}) a_{st-1} \tag{10}$$

Similarly, the capital cumulation process and the restriction of capital access are the same as the conditions of private firms.

2.3 Households

All households in our model are identical, the lifetime utility for the representative household is

$$E_0 \sum_{t=0}^{\infty} \beta_h^t \mathrm{U}(C_{ht}, L_{ht}) \tag{11}$$

U(C,L) is the household utility function. We assume that $\mathrm{U}_{ch}(C_h, L_h) > 0$ and $\mathrm{U}_{lh}(C_h, L_h) < 0$. The assumptions are satisfied if the utility function take the form of $[\log(C_h) - \psi \frac{{L_h}^{1+\frac{1}{\varepsilon}}}{1+\frac{1}{\varepsilon}}]$.

Considering the situation that only state-owned firms can issue equity to the public, we set the budget constraint for the representative household as:

$$C_{ht} + a_{ht} = w_t L_{ht} + (1 + r_{t-1}) a_{ht-1} + \mathrm{d}_{st} - T_t \tag{12}$$

Here T_t is a lump sum tax, which is endogenous. a_h is households' net savings instead of financial assets. $a_h > 0$ if the household saves, $a_h < 0$ if the household borrows money to consume. Consumption and net savings are constrained by the after-tax labor income, gains from last-period net savings and dividends from state-owned firms.

The role of government in our model is to gather tax revenue, T_t, from households and to spend the amount T. The government budget constraint is:

$$G_t \leq T_t \tag{13}$$

The expenditure of government also follow the AR(1) process: $\log G_{gt} = c + \eta_g log G_{gt-1} + v_{gt}$. c is a constant and v_{gt} is the white noise, $v_{gt} \sim N(0,1)$. If $T < 0$, then T can be treated as a subsidy.

2.4 Banking

The last sector in the model is banking sector. Banks are financial intermediaries and offer loans to private firms and state-owned firms. They maximize dividends, defined by the net sum of deposits and loans.

$$E_0 \sum_{t=0}^{\infty} \beta_b^t \log(d_{bt}) \tag{14}$$

In order to capture the function of the banking sector, we first define the firms' debt as the difference between capital and financial assets. If firms require capital that surpass the financial assets to produce, then they have to borrow money; if firms' assets surpass the capital they use, they become net savors. In China, it is hard for small and middle level firms to finance their enterprise through issuing stocks and bonds. Thus in the model we assume that borrowing from the banks is the only channel to finance. The constrain of the banks can be written as:

$$(1 + r_{t-1}) a_{ht-1} + b_{pt} + b_{st} + d_{bt} = \left(1 + r_{pt-1}\right) b_{pt-1} + (1 + r_{st-1}) b_{st-1} + a_{ht} \tag{15}$$

where b_{it} is the debt of firm i and r_{it} is i's interest rate in the period t, $i \in \{P, S\}$.

Meanwhile, the banks cannot use up their funds to make loans due to required reserve and other investment projects. Therefore, the amounts of loans that provide to both type of firms must satisfy:

$$\theta\left(b_{pt}+b_{st}\right)\leq b_{pt}+b_{st}-a_{ht} \tag{16}$$

θ is a parameter that determines the level of loans can be provided.

3. Calibration and Quantitative Results

3.1 Calibration

Table 1: Calibrated Parameters

Parameter	Description	Value
β_p	Discount factor of private firms	0.9
β_s	Discount factor of state-owned firms	0.81
β_h	Discount factor of households	0.96
β_b	Discount factor of banks	0.9
α	Share of capital	0.33
ρ	The elasticity of substitution for the consumption good	4
f	Share of private firms	0.55
ψ	Disutility of labor	1.35
ε	Elasticity of labor supply	2.6
ζ	Bankruptcy rate	0.1
λ_p	Collateral constraint of private firms	3
δ	Depreciation rate	0.07
θ	Loan constraint	0.8
η_p	Persistence of private firms' TFP	0.9
η_s	Persistence of state-owned firms' TFP	0.9
η_g	Persistence of government expenditure	0.9
η_λ	Persistence of collateral constraint	0.9

The model contains 16 parameters to be calibrated. These parameters are from constraints in each sector, utility functions and predetermined moving process. The value is based on the combination of Zetlin-Jones and Shourideh (2017) and the economy structure of China.

One important parameter is u, the share of private firms. In China, the state-owned firms play a pivotal role in most commercial activities. The share of state-owned firms is higher in China than in most other countries. Therefore, we set u to be 0.55, implying the share of private firms is just a little bit higher than the share of state-owned firms. Additionally, the bankruptcy rate of private firms, ζ, is 0.1, which is analogous to the exit risk of private firms in Zetlin-Jones and Shourideh (2017).

As mentioned in Section 2, in order to make the utility of consumption concave and the disutility of labor convex, the household's preference function takes the form [log$Ch-\psi Lh1+1\varepsilon 1+1\varepsilon$]. We set the disutility of labor ψ to be 1.35 and the labor supply elasticityε to be 2.6.

We consider three kinds of shocks: productivity shock to the sector of private firms, productivity shock to the sector of state-owned firms, and collateral constraint shock to the sector of state-owned firms. All three shocks follow the AR(1) process. The process of productivity is log$zit=\eta ilogzit-1+eit$, $i\in\{P,S\}$ with eit being the white noise. ηi represents the persistence of TFP and must be less than 1, otherwise the process has a unit root. The last shock that we want to analyze is the collateral constraint shock, log$\lambda st=c+\eta\lambda log\lambda st-1+dst$. $\eta\lambda$ is the persistence of collateral constraint and less than 1 as before. dst is the white noise. When the collateral constraint of one sector, λ, increases, it means that the firms in this sector have higher ability to obtain loans. In the model we only consider the sector of state-owned firms since the endorsement of government to state-owned firms makes them easier to obtain loans from the banks and the collateral constraint shock on it can correctly reflect how the change of state-owned firms' debt level affects the whole economy.

Given the calibrated value of parameters, we can analyze the impulsive response of certain variables that closely connected to China's economy under three different shocks.

3.2 Productivity Shocks

We begin by examining the effects of productivity shocks to both types of firms: shock to the private firms' production and shock to the state-owned firms' production. The standard deviation of each shock is 1%.

I first consider the positive productivity shock to the private firms' production. Figure 1.(a) and Figure 1.(b) show the impulsive responses of 17 variables: final goods output, wage, consumption, total labor, government expenditure and intermediate goods, capital, labor, investment, price, debt for both firms. On the impact of the shock, the quantity of intermediated goods produced by private firms increases, followed by a reduction in price. However, the quantity and price of state-owned firms move to the opposite direction compare to those of private firms. Furthermore, this shock causes capital, investment and debt of private firms to move the same direction as the quantity of private firms' intermediate goods since an increase in productivity raises production level and leads to higher investment that requires more debts. As for state-owned firms, the capital, investment and debt also follow the similar paths of their quantity of intermediate goods.

Next, we focus on the positive productivity shock to the sector of state-owned firms. Figure 2. (a) and Figure 2. (b) present the results. Not surprisingly, contrary to the shock to private firms' productivity, the production of state-owned firms' intermediate goods improves and the price of goods decreases.

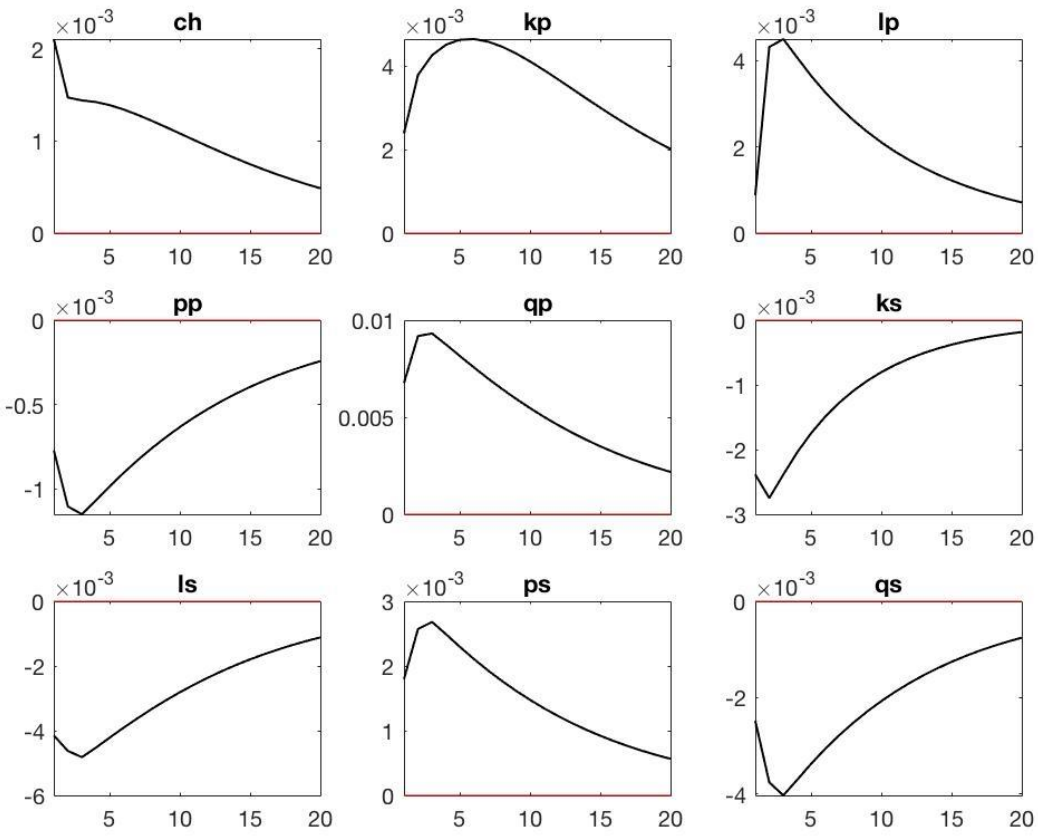

Figure 1. (a) Impulse responses to the positive private firms' productivity shock

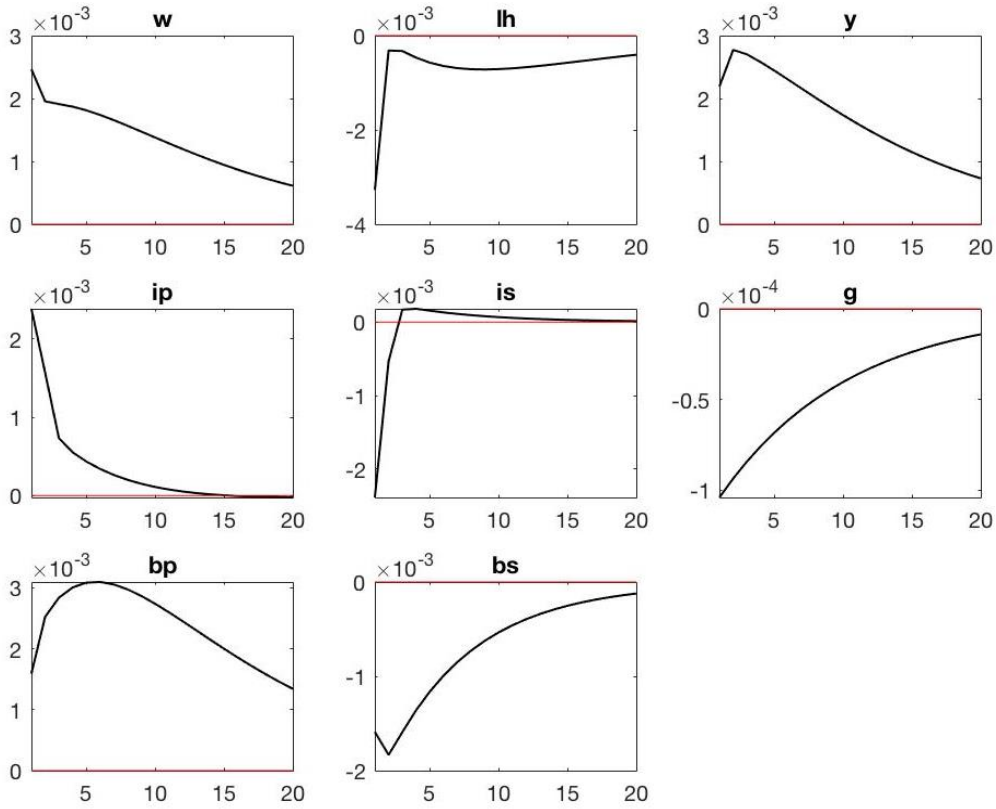

Figure 1. (b) Impulse responses to the positive private firms' productivity shock

In both cases, consumption of households increases since wage is higher under the productivity shocks. Observe that the productivity shock to one sector has positive impact on this sector's production, while has negative impact on the other one, there are two plausible explanations. First, since we have already assumed that the wage level is the same in both private firms and state-owned firms, an increase in total factor productivity of one sector will raise up the wage level in both sectors. The cost of production for both will increase, inducing the one without the productivity shock to lower the level of production. Second, the production of intermediate goods can be influenced through the channel of debts. For instance, TFP shock to private firms causes the private firms to borrow more money from banks for investing. When private firms obtain more loans from banks, state-owned firms, on the other hand, have less ability to borrow. Therefore, the loans that state-owned firms obtain may not even achieve the level before the shock and the quantity of goods that they produce decreases.

The output of final goods acts differently under the productivity shocks to different sectors: output increases for the shock to private firms and decreases for the shock to state-owned firms. In the model, private firms hire more people and produce more intermediate goods compare to state-owned firms. The relocation of private firms to state-owned firms reduces the level of output since the rise of the level of state-owned firms' intermediate goods cannot offset the effect caused by the decrease in the quantity of private firms' intermediate goods.

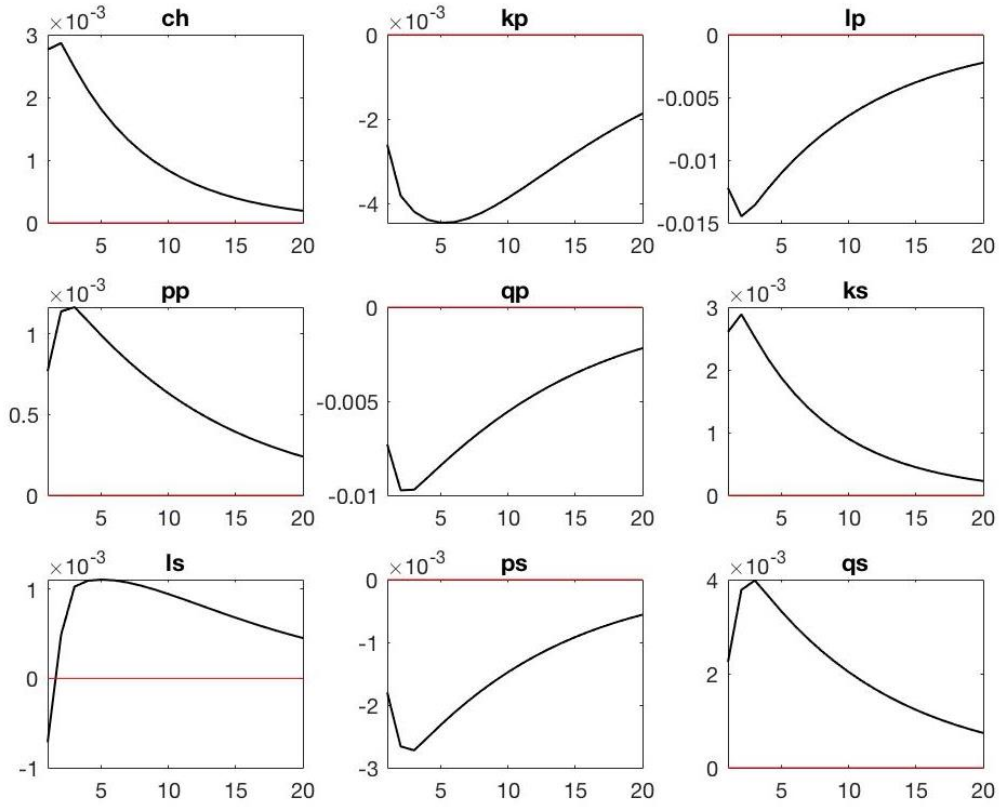

Figure 2. (a) Impulse responses to the positive state-owned firms' productivity shock

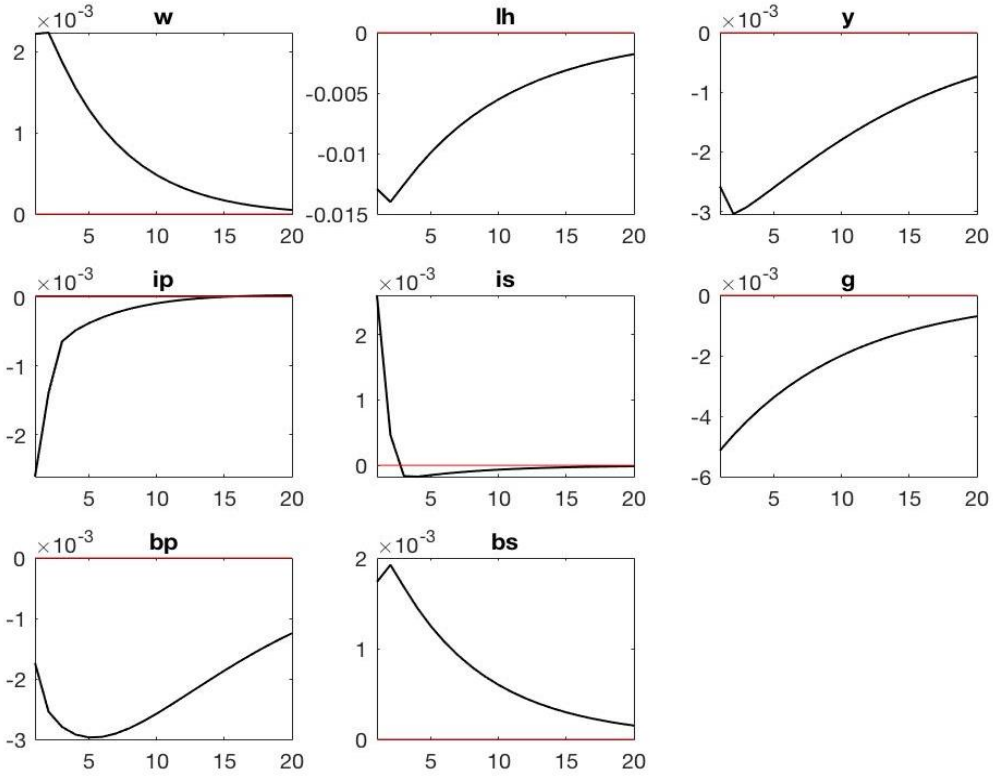

Figure 2. (b) Impulse responses to the positive state-owned firms' productivity shock

3.3 Collateral Constraint Shock

Finally, I examine the effect of collateral constraint shock to the sector of state-owned firms. Figure 3. (a) and 3. (b) display impulsive responses of the same variables from previous section except now there is a shock to λ_s.

The collateral constraint of the sector of state-owned firms is relaxed after the shock. state-owned firms can get more debts for investment. The price of private firms' intermediate goods increases but the price of state-owned firms' decreases. The quantity of both sectors' intermediate goods, consumption of households, capital and investment of state-owned firms also increases immediately after the shock, while both the capital and investment of private firms move to the opposite path.

Furthermore, the total output decreases due to resource misallocation. It is possible that there are not enough investment projects for state-owned firms by using up the loans. Thus the remaining loans will transfer to consumers' hands and the level of consumption rises up. Production inefficiency leads to a lower level of goods production for state-owned firms. Meanwhile, high borrowings of state-owned firms from banks drives down the amount of loans that private firms can obtain thereby reducing the quantity of private firms. Low quantity of intermediate goods of two sectors cause the final composite goods to be at lower level until the effect of the collateral constraint shock phases out.

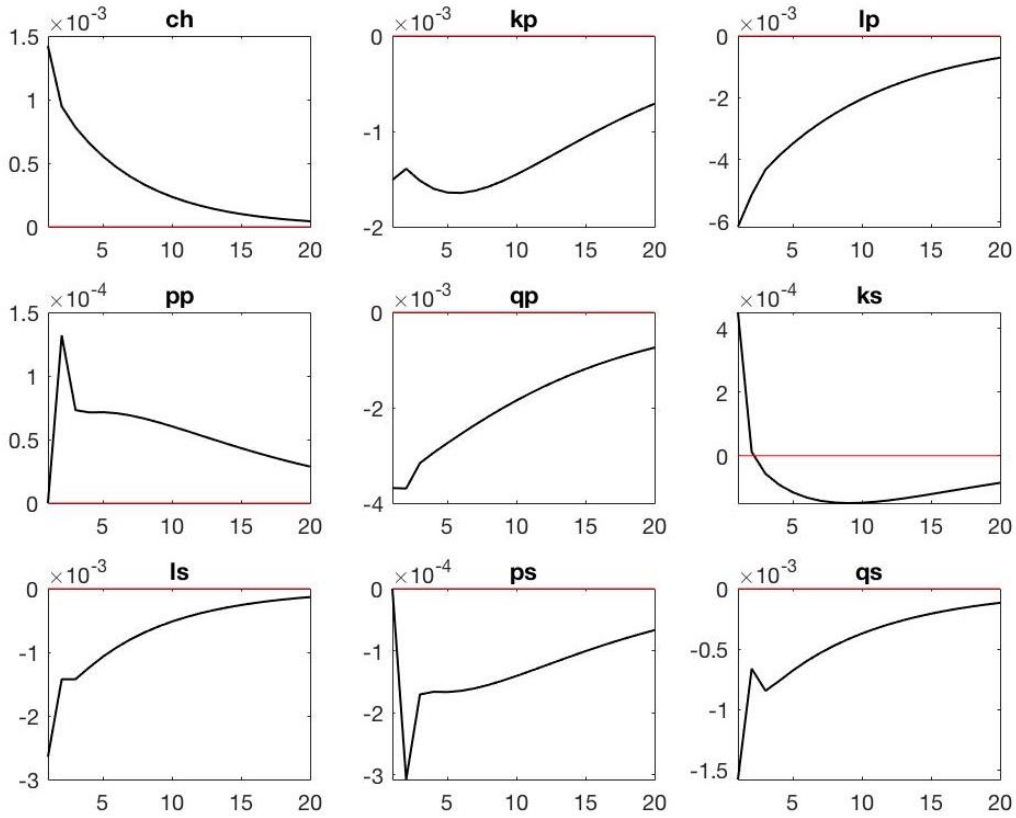

Figure 3. (a) Impulse responses to the positive state-owned firms' collateral constraint shock

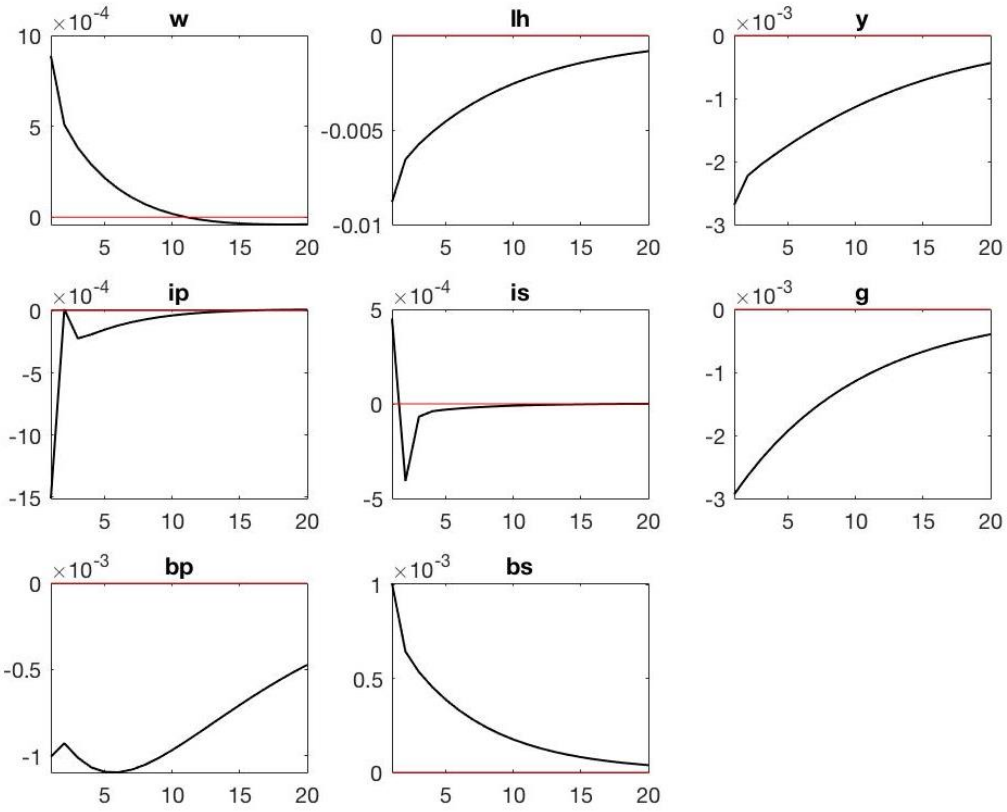

Figure 3. (b) Impulse responses to the positive state-owned firms' collateral constraint shock

4. Conclusion

Following the work of Iacoviello (2015) and Zetlin-Jones and Shourideh (2017), I build the two-sector DSGE model to match China's economy. I divide the production sector of intermediate goods into two parts, private firms and state-owned firms, and examine the effect of three shocks: productivity shock to the sector of private firms, productivity shock to the sector of state-owned firms, and collateral constraint shock to the sector of state-owned firms. The productivity shock to one certain sector will increase its production but decrease the production of the other sector. The collateral constraint shock to the sector of state-owned firms increases its debt and reduce the debt of the sector of private firms. Moreover, it reduces the production of both sectors and decreases output. Resource misallocation is the major cause behind the growth asymmetries in China.

Future researches are required and can focus on model extension to more general situation. In this paper, I assume that the wage levels are the same in two sectors for simplicity. Dividing labor into skilled and unskilled groups can be a reasonable step. Additionally, using different production functions to distinguish the sector of low-productivity firms and the sector of high-productivity firms may also be a novel but challengeable approach.

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