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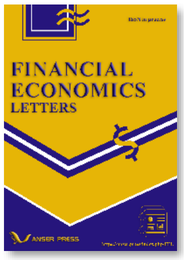

Time to build, financial frictions, and the effectiveness of fiscal stimulus

Zhiming Ao [a,*], Ziyue Chen [b], He Nie [c]

[a] *School of Economics, Jinan University, Guangzhou, China*

[b] *Department of Manufacturing and Civil Engineering, Norwegian University of Science and Technology, Norway*

[c] *Department of Economics, National University of Singapore, Singapore*

ABSTRACT

By introducing time to build, which creates a time-lag between government investment and the accumulation of productive capital, into an analysis of fiscal stimulus to the economy with financial frictions, we find that the effectiveness of fiscal policy is dampened. While the weakening effects of time to build become significantly weaker alongside with a higher fraction of government bonds allocated to leverage-constrained banks, which can be explained by a high correlation between time to build and financial frictions in both worsening balance sheet conditions of banks. Furthermore, the stimulus effects of public investment become stronger associated with shorter time-to-build period.

KEYWORDS

Time-to-build; Financial frictions; Public spending

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* Corresponding author: Zhiming Ao
E-mail address: zhiming_ao@163.com

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1. Introduction

The effectiveness of fiscal policy, especially government investment serving as a tool to stimulate the economy, has been widely debated in recent years (Woodford, 2011; Roulleau-Pasdeloup, 2013; Albertini et al., 2014; Drautzburg and Uhlig, 2015; Ramey and Zubairy, 2018). Due to the sovereign debt crisis in euro area, recent macro-developments have highlighted the interactions between fiscal policy and financial frictions (Gertler and Kiyotaki, 2010; Gertler et al., 2012; Gennaioli et al., 2014; Asimakopoulos and Asimakopoulos, 2019). As the previous literature shows, financial frictions twist the fiscal multiplier into a smaller one through reducing private access to credit. However, given that the time gap between public investment and total capital accumulation, i.e. time to build, which will significantly attenuate the government policy's effect, is ubiquitous, neglecting this property in an assessment of policy is bound to generate a foreseeable estimation bias. Inspired by an urgent need for comprehensively understanding the effects of fiscal stimulus as well as providing more available policy implications, we concern more about whether time to build will have different impacts on the effectiveness of fiscal policy under financial accelerator mechanism.

In this paper, we provide an alternative perspective to evaluate the effect of fiscal stimulus in which we take financial frictions and time to build into consideration simultaneously. Specifically, our analysis framework incorporates into Gertler and Karadi (2011) model a new private capital accumulation function which regards public investment as an exogenous input in the private production technology. We contribute to the previous studies concerning government spending multiplier mainly in two dimensions. First, by referring time-to-build nature to multiple periods that are required for completion of investment projections, rather than the implementation lag after an announcement of policy (Sarkar and Zhang, 2015; Sportelli and De Cesare, 2019), we are enabled with greater possibility to figure out alternative channels by which government expenditure multipliers are affected, with financial intermediaries. Second, departing from studies which only reveal the negative effects of time to build (Li and Li, 2018), we pay attention to the diversified effects of fiscal stimulus influenced by time-to-build feature, when the allocation of government bonds is altered. Additionally, we focus on not only the direction of fiscal stimulus, but also the specific variations of multiplier. It enables government to choose more flexible policy combinations to maximize the fiscal stimulus effects instead of keeping implementations unchanged in a volatile circumstance.

Results show that due to the postpone of capital returns, time to build further weakens the effect of fiscal policy on the basis of MMFs financing case and results in a lower fiscal multiplier by worsening the balance sheet conditions of banks. While the weakening effect of time to build becomes significantly weaker alongside with higher fraction of government bonds allocated to leverage-constrained banks, owing to a high correlation between time to build and financial frictions in reducing private access to investment. In addition, our research also indicates that public investment with shorter time to build is more effective than public consumption in stimulating the economy with financial intermediaries.

2. Methodology

2.1 Household

Following Christiano, Eichenbaum, and Evans (2005), the representative household takes habit formation in consumption into utility function, maximizing expected lifetime utility.

$$E_t \sum_{s=0}^{\infty} \beta^s [log(c_{t+s} - \nu c_{t-1+s}) - (1+\varphi)^{-1} h_{t+s}^{1+\varphi})], \beta \in (0,1), \nu \in [0,1), \varphi \geq 0, \quad (1)$$

subject to the budget constraints $c_t + d_t + \tau_t \leq w_t h_t + (1 + r_t^d) d_{t-1} + \Sigma_t$, where d_{t-1} are the beginning period deposits, r_t^d is deposit rate, τ_t are lump-sum tax payments and Σ_t stand for collections of profits from ownership of firms. ν meassures the degree of habit and φ denotes the inverse Frish elasticity.

2.2 Financial Intermediaries

Financial intermediaries consist of banks and money management funds (MMFs), funding firms and the government as in Kirchner and van Wijnbergen (2016). Banks collect Δ_t portion of new bonds, while the remaining $1-\Delta_t$ is distributed to MMFs. MMFs are just pass-through means of government bonds without any cost and financial frictions, using deposit financed by the households, which means $p_t^{MMF}=d_t^{MMF}$, thus $r_t^{b,MMF}=r_t^d$.

Banks are competitive and located on a continuum indexed by $j\in[0,1]$, using deposits obtained from households to purchase intermediate goods firms' claims and government bonds. Total assets of intermediary j at the end of period t are given by $p_{j,t}^B=q_t s_{j,t}^k+s_{j,t}^b$, where $s_{j,t}^k$ denote claims on intermediate firms with relative price $q_t, s_{j,t}^b$ are the shares of government bonds. The balance sheet of bank j follows $p_{j,t}^B=d_{j,t}^B+n_{j,t}$, where $n_{j,t}$ denotes the net worth of bank j, which accumulates as the difference of earnings and payments:

$$n_{j,t+1}=\left(1+r_{t+1}^k\right)q_t s_{j,t}^k+\left(1+r_{t+1}^{b,B}\right)s_{j,t}^b-\left(1+r_{t+1}^d\right)d_{j+t}^B=\left(r_{t+1}^p-r_{t+1}^d\right)p_{j,t}^b+\left(1+r_{t+1}^d\right)n_{j,t},$$

$$\left(1+r_t^p\right)p_{j,t}^b=\left(1+r_t^k\right)q_t s_{j,t}^k+\left(1+r_t^{b,B}\right)s_{j,t}^b \tag{2}$$

where r_t^p means total returns of banks portfolio $p_{j,t}^b$. Banks exit with the probability $1-\theta$ at the beginning of every period. Therefore, banks maximize their discount present values when quit:

$$V_{j,t}=E_{t\sum_{i=0}^{\infty}(1-\theta)\theta^i}\beta^{i+1}\Lambda_{t,t+1+i}n_{j,t+1+i}, \tag{3}$$

where $\Lambda_{t,t+1+i}=\frac{\lambda_{t+1+i}}{\lambda_t}$ represents the stochastic discount factor, and λ_t denotes the Lagrangian multiplier associated with the budget constraint of household. Before payments are made at time t, bankers are able to transfer a fraction of portfolio $\omega^* p_{j,t}^B$ to get sustainable deposits. While the depositors can force the bank into liquidation for the rest of assets $(1-\omega^*)p_{j,t}^B$ if the transfer is happened. Thus an incentive compatibility constraint limits the ability of banks to obtain funds from depositors

$$\max V_{j,t} \quad s.t. \quad V_{j,t}\geq \omega^* p_{j,t}^B. \tag{4}$$

By these settings, our model allows for different credit spreads of government bonds held by banks and MMFs, which are financial frictions in other words. Driven by this, banks prevent the arbitrage activities taken by consumers through holding excess underpriced bonds, and further hinder private savings from transferring into capital investments.

2.3 Firms

Intermediate goods firms produce differentiated goods to maximize the discounted profits.

$$y_{i,t}=a_t\left(\xi_t k_{t-1}^i\right)^{\alpha}h_{i,t}^{1-\alpha}, \tag{5}$$

with TFP a_t and capital quality ξ_t. Capital-producing firms use depreciated capitals and new investments to renew capitals. While in order to introduce the effects of public investment and time-to-build property, we have modified the capital motion function following Bouakez et al. (2017) and Li et al. (2018), which shows as

$$k_t=(1-\delta)\xi_t k_{t-1}+[1-\Psi(\iota_t)]i_t,\ \Psi(\iota_t)=\frac{\gamma}{2}(\iota_t-1)^2,$$

$$\widehat{k_t}=\left\{\omega(k_t)^{\frac{\epsilon-1}{\epsilon}}+(1-\omega)\left(g_{t-T}^i\right)^{\frac{\epsilon-1}{\epsilon}}\right\}^{\frac{\epsilon}{\epsilon-1}}, \tag{6}$$

where $\Psi(\cdot)$ are convex investment adjustment costs in $\iota_t=i_t/i_{t-1}$. $\widehat{k_t}$ refers to the total capital as a combination of private capitals and public investments and their elasticity of substitution is ϵ. Besides, $T \geq 0$ allows for the possibility that several periods may be required for public investments to build new productive capitals, i.e., time to build. Final goods producers package the intermediate goods into final goods using a CES technology $y_t = \left[\int_0^1 y_{i,t}^{\frac{\vartheta-1}{\vartheta}} di\right]^{\frac{\vartheta}{\vartheta-1}}$.

2.4 Government

The government purchases final goods g_t^c and conducts public investment g_t^i $(g_t = g_t^c + g_t^i)$ by levying taxes τ_t and issuing government bonds b_t. The taxes follow the rule

$$\tau_t = \bar{\tau} + \kappa_b(b_{t-1} - b) + \kappa_g(g_t - g),\ \kappa_b > 0,\ \kappa_g \in [0,1],\ \bar{\tau} > 0 \tag{7}$$

for κ_g =0, government spendings are fully financed by deficits.

As in Bouakez et al. (2017), public spending is determined by the following process:

$$g_t = (1-\rho)g + \rho g_{t-1} + \varepsilon_t, \tag{8}$$

and we set public investment by the following policy rule:

$$g_t^i = g^i + \dot{\alpha}(g_t - g) \tag{9}$$

where $0 \leq \{\dot{\alpha}\} \leq 1$ and g^i is the steady-state level of public investment. Parameter $\dot{\alpha}$ measures the fraction of public investment in a fiscal stimulus plan. Thus the budget constraint of government is

$$b_t + \tau_t = g_t + \left(1 + r_t^b\right)b_{t-1} \tag{10}$$

Finally, to close the model, we suppose that the monetary authority sets risk-free rate according to a regular Taylor rule:

$$r_t^n = (1-\rho_r)\left[r^n + \kappa_\pi(\pi_t - \bar{\pi}) + \kappa_y \log(y_t/y_{t-1})\right] + \rho_r r_{t-1}^n + \varepsilon_{r,t}, \tag{11}$$

where κ_π and κ_y are the feedback parameters on inflation and output, as well as the interest rate smooth parameter ρ_r.

By making aggregate demand and aggregate supply equal, we get the good market clearing condition:

$$y_t = c_t + i_t + g_t \tag{12}$$

We calibrate the model following the Gertler and Karadi (2011) as shown in table 1, and the steady state values as well.

3. Effectiveness of government spending shocks

3.1. Role of time to build

We first examine the varying responses to a government spending shock under two differ- ent financing allocation situations, both with and without time-to-build property. Fig.1 shows the responses of selected variables to an increase in government spending gt through full MMF financing (Δt = 0), compared with full bank financing (Δt = 1) in Fig.2. For simplification, we set c = 0.5, ϵ = 1, and T = 4. The dash lines in both Fig.1 and Fig.2 are the replication results of the Kirchner and van Wijnbergen (2016) model. They explain the different influences triggered by financing ways through tightening up the banks' leverage constraints. Instead, the solid lines describe the responses of economy with time to build. When the government issues bonds through MMFs, its large posi- tive effects on output are weakened due to time to build as shown in Fig.1. In MMFs case, time to build will postpone the build up of productive capital and alleviate the appreciation of capital price, which consequently contribute to an offset effect in easing banks' leverage constraints. Lower improvement of banks net worth leads to relatively a lower reduce in borrowing cost, and reasonably a less investment promotion. Combining with a crowding-out effect, public investment twists the investment movement turning to negative. Returns on bonds increase immediately but fall back in later periods, initiating less consumption and an inverse sign in the future as shown in Fig.1. Accordingly, the accelerator mechanism will absolutely make a smaller difference contrast to the case without time to build, leading to a lower effectiveness of government spending.

Table 1. Model parameters and steady state values.

Parameters	Value	Definition
Households		
β	0.990	Subjective discount factor
ν	0.815	Degree of habit formation
ϕ	0.275	Inverse Frisch elasticity
Goods-Producing Firms		
ϑ	4.165	Elasticity of substitution
ψ	0.775	Calvo probability
α	0.330	Capital share in production
δ	0.025	Depreciation rate of capital
γ	1.725	Adjustment cost parameter
c	0.5	Fraction of two investment
Financial Intermediaries		
λ^*	0.22	Transfer portion of assets
θ	0.935	Banker survival probability
Policy Parameters		
κ_b	0.015	Government debt feedback on taxes
$\kappa_p i$	1.500	Interest rate smoothing parameter
κ_y	0.125	Inflation feedback parameter
ρ_r	0.790	Output feedback parameter
$\dot{\alpha}$	0.500	Fraction of public investment
Steady State Values		
r^d	0.010	Households' return on deposits
r^{bMMF}	0.010	MMFs' return on government bonds
r^{bB}	0.013	Banks' return on government bonds
r^k	0.013	Banks' return on capital
g/y	0.230	Government-spending-to-GDP ratio
b/y	2.4	Government-debt-to-GDP ratio

Furthermore, the weakening effects that time to build imposes on fiscal multiplier seem small through a full banking financing channel compared to the MMFs case, as shown in Fig. 2. As illustrated in Fig. 1, time to build dampens government spending multiplier by prolonging capital accumulation, which tightens the banks leverage due to the decrease of investment. However, in banks financing case, few firm claims are included in banks' portfolio due to the government deficit policy, meaning investment can hardly reduce in that low level. Therefore, the decline pressure of fiscal effects which time to build exerts on will definitely be limited, indicating a high correlation between time to build and financial frictions. While for the private sector, the negative effects of time to build aggravate banks leverage conditions and lower banks net worth, reasonably triggering less improvement on deposits, consequently less decrease in consumption.

We then explore the dynamic roles of time to build by changing the government financing allocations from $\Delta t = 0$ (full MMFs financing case) to $\Delta t = 1$ (full bank financing case) shown in Fig.3. Despite the weakening effects time to build brings about on public spending multiplier, the weakening itself varies, more specifically, reduces over the increasing trend in Δt, both on impact and accumulative response multipliers. Impact multiplier means an immediate response of output to the government spending shock. Accumulative multiplier refers to the ratio between aggregate movements of output and total public spending changes. In terms of impact multiplier, it suffers

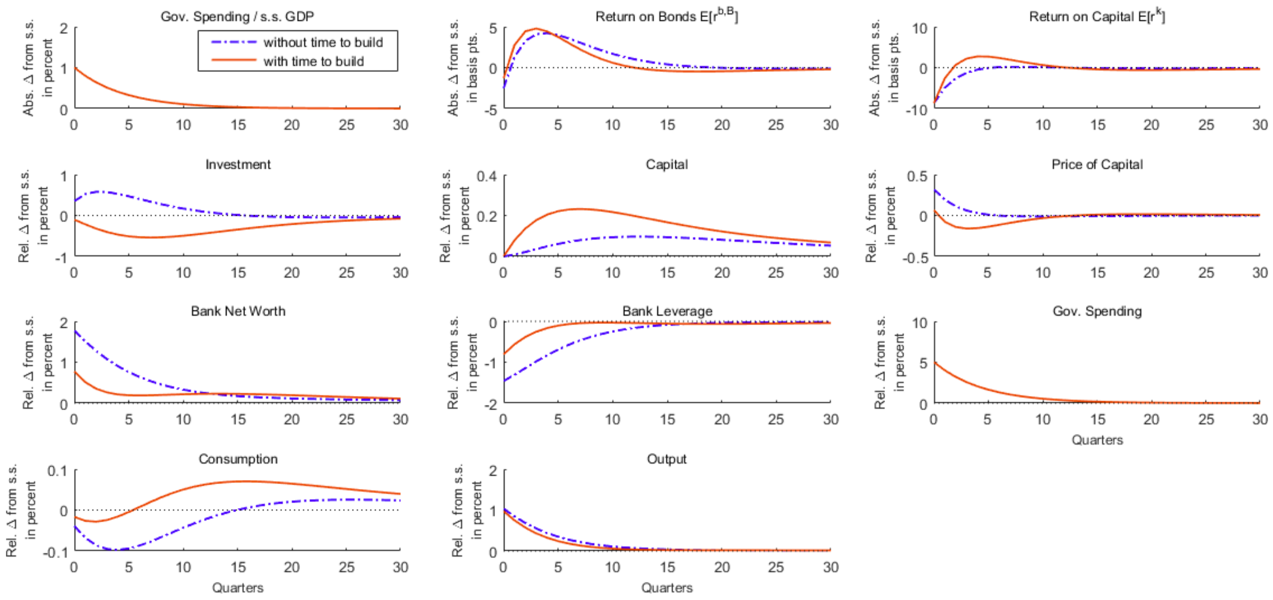

Figure 1. Impulse responses to a spending shock under MMF financing.

Note: A rise in government spending by 1% of GDP in steady state.

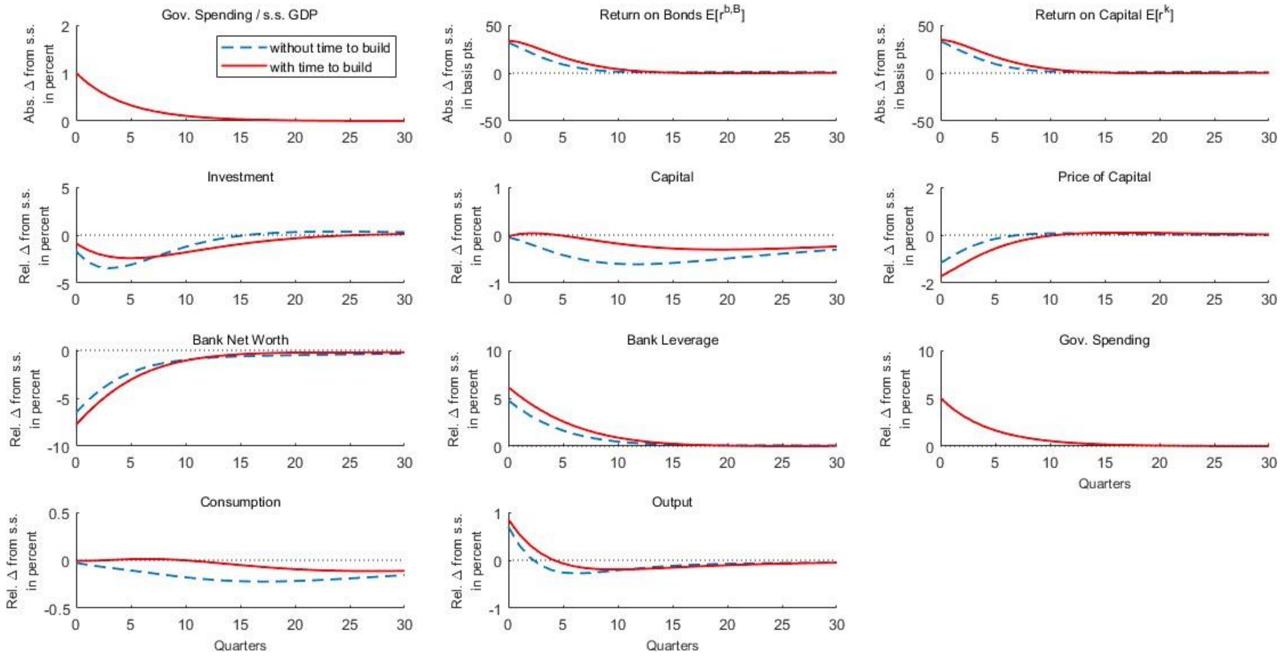

Figure 2. Impulse responses to a spending shock under bank financing case.

Note: A rise in government spending by 1% of GDP in steady state.

the largest decrease in MMFs financing case. A decrease of government spending multiplier from 1.03 to around 0.97 indicates a strong weakening effect resulting from time to build. As Δt rises up, the multiplier spread between with and without time-to-build feature gradually narrows down and almost converges in a full banks financing case ($\Delta t = 1$), from 0.955 to 0.95 or so. As for the accumulative multiplier, a severer crowding out effect also appears in MMFs financing case than in banks, resulting in a larger decrease from 0.22 to 0.18. The explanations of these phenomenons are just argued above, showing the heterogeneous negative impacts that time to build imposes on fiscal stimulus in different financing cases.

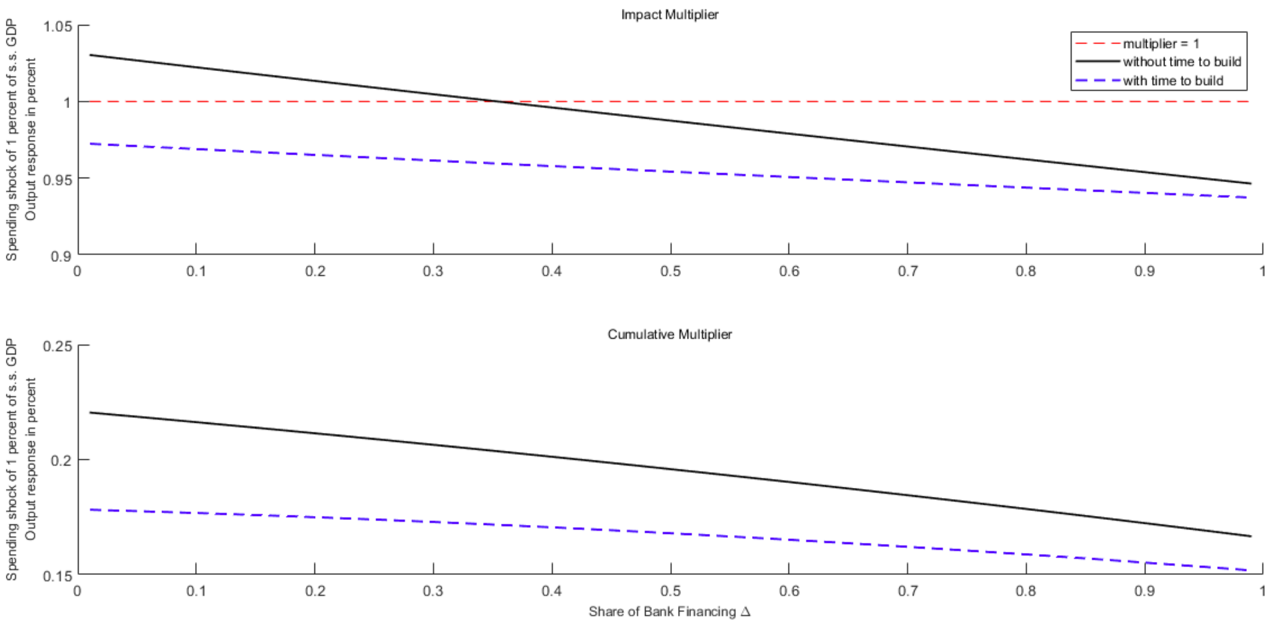

Figure 3. Fiscal multiplier range.

Notes: Impact multiplier is an immediate response of output to a rise of government spending by 1% of GDP in steady state. Cumulative multiplier is the aggregate output responses divided by sum of spending shocks over 1000 periods.

3.2. Policy effects under different time-to-build delays

For further clarification of the effects that time-to-build exerts on fiscal policy under a financial friction circumstance, we execute a government spending shock for $\dot{\alpha}$ = 0, ($\dot{\alpha}$ = 1, T = 4), and ($\dot{\alpha}$ = 1, T = 16), as depicted in Fig. 4. Specifically, the policy multiplier increases as $\alpha^{\cdot}$ changes from 0 to 1 in the short time-lag condition, which is consistent with Bouakez et al. (2017). Larger public investments accelerate the accumulation of total capitals and play an equivalent role as productivity evolution when time-lag is shorter. Fewer reductions of investments further alleviate the negative accelerator mechanism, which can't be achieved by the public consumption stimulus ($\dot{\alpha}$ = 0). As for a longer time-to-build case, however, public investment crowds private capital out for multiple periods, leading to a weaker alleviation of negative financial frictions effects. Consumption reduces to a lower level corresponding to higher returns on government bonds, implying a smaller multiplier. No matter how long the time to build is, public investment policy ($\dot{\alpha}$ = 1) always brings about a higher multiplier than public consumption stimulus ($\dot{\alpha}$ = 0) does, mainly by alleviating the negative impact, which is triggered by financial accelerator mechanism.

4. Conclusion

The primary lesson from this paper is that time to build serves as a latent factor that mitigates the effect of fiscal stimulus on the economy where financial frictions exist. By postponing the accumulation of total capital, time to build tightens up the banks leverage constraints, leading to fewer investments and consequently a lower fiscal multiplier together with the crowding-out effect. However, time to build has a weaker negative effect on policy in the bank financing case, which means it has a high correlation with financial frictions in affecting the fiscal multiplier. While no matter how government bond is allocated, time-to-build feature causing government spending multiplier to fall below.

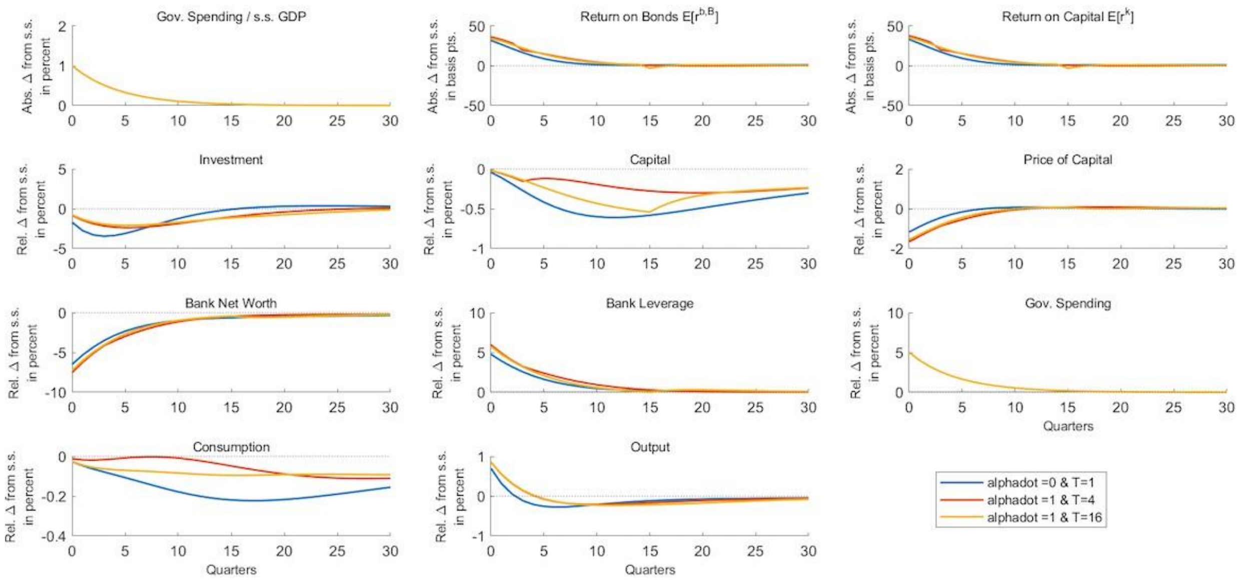

Figure 4. Dynamic effects of stimulus.

Note: A rise in government spending by 1% of GDP in steady state.

Additionally, public investment acts as a more effective tool than public consumption in stimulating the economy with relatively short time to build. Further study is left to figure out how time-to-build feature interacts with other properties which promote the effect of fiscal policy.

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Declaration of Competing Interest

All the authors claim that the manuscript is completely original. The authors also declare no conflict of interest.

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