Government Investment and Fiscal Stimulus

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Abstract: This paper studies the effects of government investment in an estimated neoclassical growth model. The analysis focuses on two dimensions that are critical for understanding government investment as a fiscal stimulus: **implementation delays**[1] for building public capital and **expected fiscal adjustments**[2] to deficit-financed spending. Results of this paper are: (1) Implementation delays for government investment can lead private investment to fall more and labor and output to rise less (or even decline slightly) in the short run. (2) Anticipated fiscal adjustments matter both quantitatively and qualitatively for long-run growth effects. (3) When public capital is insufficiently productive, distorting financing can make government investment contractionary at longer horizons.

1 Motivation

- In response to the recession, the U.S. Congress passed several fiscal stimulus bills, including the $787 billion American Recovery and Reinvestment Act (ARRA) of 2009. Similarly, China also launched a stimulus package of 4 trillion RMB.

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[1]One common scenario of implementation delay is the fact that large-scale fiscal stimulus projects take years to complete.

[2]Common fiscal adjustments include government consumption(reduction), capital tax, income tax, lump-sum transfer/ tax etc.

- The packages are of large-scale, and rely more on spending increases (infrastructure, transportation, housing etc) and less on tax cuts.
- Debate over government investment for counteracting recession: neoclassical view vs. debt issue.
- This paper contributes by shedding light on two critical issues that are often overlooked: implementation delays and future fiscal financing adjustments.
- Many projects, especially infrastructure, require coordination among federal, state, and local governments and have to go through a long process of planning, bidding, contracting, construction, and evaluation. (see Table 1)

Table 1
Cost estimation by the Congressional Budget Office.

	2009	2010	2011	2012	2013	2014	2015	2016	2009–16
ARRA, Highway Construction in Title XII (billions)									
Budget Authority	27.5	0	0	0	0	0	0	0	27.5
Estimated Outlay	2.75	6.875	5.5	4.125	3.025	2.75	1.925	0.55	27.5
	2009	2010	2011	2012	2013				2009–13
National Highway Bridge Reconstruction and Inspection Act (millions)									
Budget Authority	1029	5	5	5	5				1049
Estimated Outlay	280	425	169	56	46				976

Top panel: highway construction in Title XII of the American Recovery and Reinvestment Act of 2009. Bottom panel: the National Highway Bridge Reconstruction and Inspection Act of 2008.

- How deficit spending is ultimately financed matters for the effects of government investment at longer horizons. Debt-financed fiscal expansions will trigger expected adjustments in spending and taxes to ensure policy is sustainable.

2 Model

The model allows for implementation delays and distorting fiscal adjustments.
The model incorporates several real frictions – habit formation in consumption, investment adjustment costs, and variable capital utilization.

2.1 Household

Life-time utility function is given by:

$$E_t \sum_{t=0}^{\infty} \beta^t u_t^b \left[\frac{(c_t - hC_{t-1})^{1-\gamma}}{1-\gamma} - u_t^l \frac{l_t^{1+\kappa}}{1+\kappa} \right], \tag{1}$$

subject to budget constraint,

$$(1+\tau_t^C)c_t + i_t + b_t = (1-\tau_t^K) r_t^K v_t k_{t-1} + (1-\tau_t^L) w_t l_t + r_{t-1} b_{t-1} + z_t, \tag{2}$$

law of motion of private capital,

$$k_t = [1-\delta(v_t)]k_{t-1} + \left[1 - s\left(\frac{u_t^i i_t}{i_{t-1}} \right) \right] \times i_t, \tag{3}$$

and depreciation process

$$\delta(v_t) = \delta_0 + \delta_1 (v_t - 1) + (\delta_2/2)(v_t - 1)^2. \tag{4}$$

2.2 Firm

Competitive firms produce with technology:

$$y_t = u_t^a (v_t k_{t-1})^{\alpha} (l_t)^{1-\alpha} (K_{t-1}^G)^{\alpha^G}, \tag{5}$$

2.3 Government

Flow budget constraint of government is given by:

$$\tau_t^C C_t + \tau_t^K r_t^K v_t K_{t-1} + \tau_t^L w_t L_t + B_t = G_t^C + G_t^I + r_{t-1} B_{t-1} + Z_t, \tag{7}$$

where G^c is unproductive government consumption, and G^I is implemented government investment, which differs from authorized government investment, A_t.

$$G_t^I = \sum_{n=0}^{N-1} \phi_n A_{t-n}, \tag{10}$$

where $\sum_{n=0}^{N-1} \phi_n = 1$ [3].

The law of motion for public capital is:

$$K_{t-1}^G = (1-\delta_G) K_{t-2}^G + A_{t-N}, \tag{9}$$

[3] N and ϕ_n are normally difficult to identify. In the later part of this paper, three scenarios are compared: N=1, or one quarter delay as typically assumed in literature; N=4, or one-year delay (in this case, $\phi_0 = 0$ and $\phi_1 = \phi_2 = \phi_3 = 1/3$); N=12, or three-year delay(in this case, $\phi_0 = 0$, $\phi_1 = \phi_2 = \phi_3 = 0.25/3$,$\phi_4 = ... = \phi_{11} = 0.75/8$).

The equation implies that an infrastructure project authorized at period t-N will be completed at period t-1, transforming into public capital.

2.4 Debt Financing

In log-linearized form, fiscal rules are:

$$\hat{Z}_t = -\psi_Z \hat{Y}_t - \gamma_Z \hat{s}^B_{t-8} + u^Z_t, \quad \hat{u}^Z_t = \rho_Z \hat{u}^Z_{t-1} + \sigma_Z \varepsilon^Z_t, \tag{12}$$

$$\hat{\tau}^i_t = \psi_i \hat{Y}_t + \gamma_i \hat{s}^B_{t-8} + u^i_t, \; \hat{u}^i_t = \rho_i \hat{u}^i_{t-1} + \sigma_i \varepsilon^i_t \quad i \in \{K,L\}, \tag{13}$$

$$\hat{\tau}^C_t = u^C_t, \quad \hat{u}^C_t = \rho_C \hat{u}^C_{t-1} + \sigma_C \varepsilon^C_t, \tag{14}$$

$$\hat{G}^C_t = -\gamma_G \hat{s}^B_{t-8} + u^G_t, \quad \hat{u}^G_t = \rho_G \hat{u}^G_{t-1} + \sigma_G \varepsilon^G_t, \tag{15}$$

where $s^B_{t-8} = \frac{B_{t-8}}{Y_{t-8}}$, and $\epsilon_t \; N(0,1)$.

Parameters in fiscal rules are estimated using the post-1960 sample (see Table 2).

Table 2
Prior and posterior distributions for the estimated parameters.

Parameters	Prior			Posterior			
	Func.	Mean	Std.	Mean	5%	95%	Std.
Structural							
γ, risk aversion	G	1.75	0.5	3.46	2.7	4.3	0.51
κ, inverse Frisch labor elast.	G	2	0.5	1.89	1.3	2.5	0.37
h, habit formation	B	0.5	0.2	0.31	0.22	0.41	0.06
δ_2, capital utilization	B	0.7	0.5	0.067	0.041	0.1	0.021
s, investment adj. cost	N	5	0.25	5.21	4.8	5.6	0.25
Fiscal policy							
γ_{GC}, govt consumption resp. to debt	N	0.15	0.1	0.072	0.022	0.12	0.031
γ_K, capital tax resp. to debt	N	0.15	0.1	0.095	0.033	0.16	0.037
γ_L, labor tax resp. to debt	N	0.15	0.1	0.051	−0.023	0.12	0.045
γ_Z, transfers resp. to debt	N	0.15	0.1	0.15	0.047	0.27	0.066
φ_K, capital resp. to output	G	1	0.3	1.2	0.91	1.5	0.19
φ_L, labor resp. to output	G	0.5	0.25	0.53	0.24	0.84	0.18
φ_Z, transfers resp. to output	G	0.2	0.1	0.23	0.082	0.43	0.11

2.5 Exogenous Processes

Authorization of government investment are assumed to follow the process:

$$\ln A_t = \rho_A \ln A_{t-1} + \sigma_A \varepsilon^A_t, \quad \varepsilon^A_t \sim N(0,1). \tag{11}$$

All shocks follow AR(1) process:

$lnu^j_t = \rho_j lnu^j_{t-1} + \epsilon^j_t$

3 Impact of Government Investment

Government investment is often argued to boost employment and promote economic growth, making it an ideal candidate to counteract business cycles.Implementation delays and distortionary fiscal financing of debt can alter this sanguine view of the short-run stimulative effects and long-run growth effects of government investment.

3.1 Implementation Delay

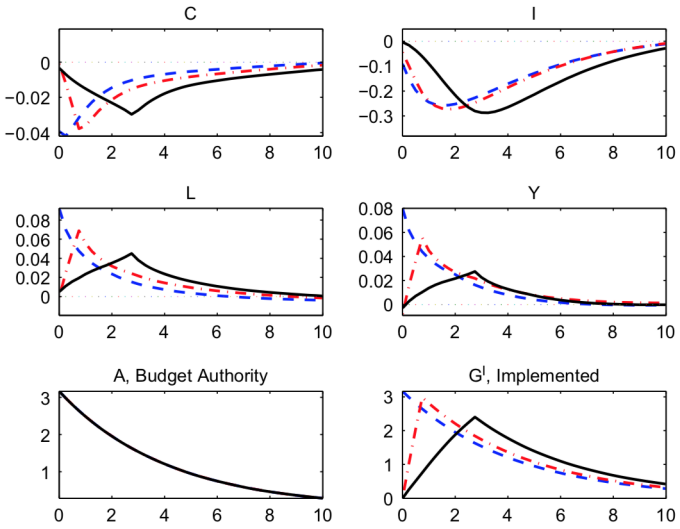

Fig. 1. Impulse responses to higher government investment under various lengths of implementation delays. Dashed lines: one-quarter delay; dotted-dashed lines: one-year delay; solid lines: three-year delay. Variables include consumption (C), private investment (I), hours worked (L), and output (Y), along with budget authority (A) and implemented government investment (G^I). All variables are in percentage deviations from the steady state. X-axis is in years.

- One-quarter delay (blue dashed lines): the short-run responses are consistent with the neoclassical view: consumption and investment fall but output and labor rise immediately.
- Longer delay (red dashed lines and solid lines): the immediate jump in output and labor is replaced by slightly negative responses on impact and muted responses during initial periods.
- Generally, the longer the implementation delays, the smaller the positive responses in output and labor in the short run.

- Under a three-year delay, it takes two periods longer for investment to begin to rise.

3.2 Debt-Financing Schemes

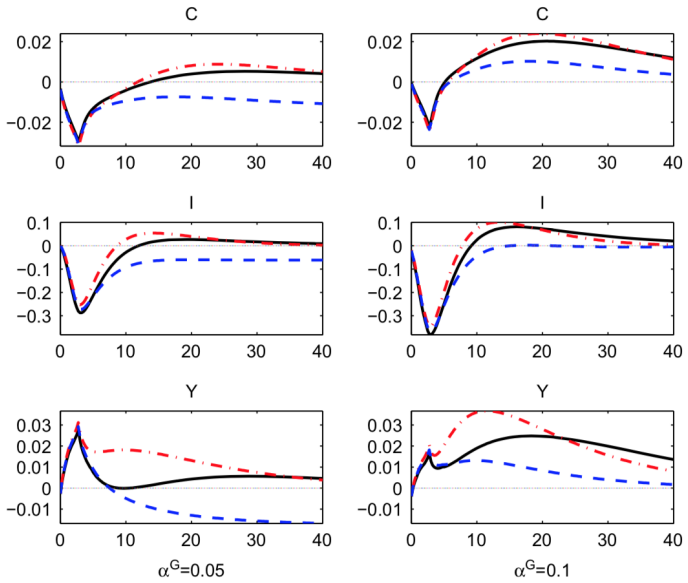

Fig. 2. Impulse responses to an increase in government investment under various financing methods. Solid lines: all adjust under mean estimated debt financing parameters (as in Table 2); dotted-dashed lines: only transfers adjust ($\gamma_Z = 0.154, \gamma_{GC} = \gamma_K = \gamma_L = 0$); dashed lines: only income taxes adjust ($\gamma_K = 0.142, \gamma_L = 0.077, \gamma_{GC} = \gamma_Z = 0$). The total increase in government investment is one unit of good. Variables include consumption (C), private investment (I), and output (Y). All variables are in percentage deviations from the steady state. X-axis is in years.

- Among the three methods of financing, government investment is most expansionary when non-distorting transfers are reduced and is least expansionary – in fact, can be contractionary – when government raises income tax rates.

- When public capital is weakly productive (left panel), consumption, investment, and output are persistently negative at long horizons when income tax rates alone adjust to stabilize debt.

- The analysis in a model with homogeneous household overlooks the distributional effects of government investment. (*A significant portion of transfers go to households with low-income, debt-financing through transfers reductions can substantially reduce the welfare of some segments of the population.*)

- The productivity of public capital, α^G, is critical to determine the effects of government investment. (*Unfortunately, it is difficult to pin down.*)

4 Summary and Conclusions

Macroeconomic effects of government investment hinge critically on implementation delays and distorting fiscal adjustments. (1) In the short-run, a substantial time-to-build lag in a standard neoclassical model can make expansionary government investment contractionary, at worst, and have a muted impact, at best. (2)Over longer horizons, the choice of fiscal adjustment instruments is important for minimizing the negative effects from stabilizing government debt. (3) The productivity of government investment is also critical.

Three dimensions of the issue that this paper has highlighted: implementation delays, productivity of public capital, and fiscal financing schemes.