Dynamic Effects of Government Investment

Eric Leeper, Todd Walker, and Shu-Chun Yang

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The views expressed in this talk are those of authors and should not be interpreted as those of the Congressional Budget Office.
Conventional Analysis about $G$

In analysis with neoclassical growth models

- $G$ is often assumed to be non-productive and financed by lump-sum taxes.
- An exogenous, unanticipated $G \uparrow$, $C \downarrow$, $L \uparrow$, and $Y \uparrow$ because of negative wealth effects.
- $I \uparrow \text{ or } \downarrow$, depending the persistence of the $G$ increase.
**Productive $G$**

- When $G$ is productive, such as government investment ($G^I$), it forms public capital $K^G$, which enters the production function.
- In contrast to non-productive $G$, $C \uparrow$ in later periods, and $Y \uparrow$ because of more productive $K^G$.
- The analysis generally supports the idea of increasing $G^I$ as a countercyclical tool.
  - It stimulates aggregate demand through higher $G$ and $C$, and promotes economic growth through higher productivity, as shown in Baxter and King (1993) and Kamps (2004).
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Two factors neglected

- $G^I$ is subject to substantial implementation delays.
  - They require coordination among federal, state, and local governments and have to go through a long process of planning, bidding, contracting, construction, and evaluation.
- Deficit-financed $G^I$ induces future fiscal adjustments that may not be lump-sum.
  - The quickly deteriorated federal budget and the projection of an unsustainable path suggest that some future policy must adjust.
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We examine these two issues in DSGE models calibrated to U.S. data.

  
  
  - Foresight about productive $G$ generates positive wealth effects, and agents postpone increasing $L$ and $I$. The combination of these two effects can discourage saving and work initially.

- Consider various delayed fiscal adjustments: $T$ or $G^C \downarrow$, or $\tau^K$ or $\tau^L \uparrow$. 
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What We Find

- Implementation delays can result in little or negative labor and output responses during the beginning periods after the enactment of a spending bill.

- Financing instruments and productiveness of public capital matter qualitatively for the long-run growth effects.
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- Financing instruments and productiveness of public capital matter qualitatively for the long-run growth effects.
The Private Sector: Agents

The agent derives utility from consumption \((C_t)\) and leisure \((1 - L_t)\).

\[
U_t \equiv \frac{1}{1 - e} \left( \frac{C_t}{C_{t-1}^b} \right)^{1-e} + \chi \frac{(1 - L_t)^{1-\theta} - 1}{1 - \theta},
\]

The infinitely lived agent maximizes expected lifetime utility

\[
E_t \sum_{t=0}^{\infty} \beta^t U_t (C_t, C_{t-1}, L_t),
\]

subject to

\[
C_t + I_t + B_t + \psi(u_t)K_{t-1} = (1 - \tau^K_t) r_t u_t K_{t-1} + (1 - \tau^L_t) w_t L_t + R_{t-1} B_{t-1} + T_t,
\]

\[
K_t = (1 - \delta) K_{t-1} + \Omega (I_t, I_{t-1}).
\]
The Private Sector: Firms

The economy produces goods according to

\[ Y_t = A (u_t K_{t-1})^{\alpha_K} (L_t)^{\alpha_L} (K_{t-1}^G)^{\alpha_G}, \]

The representative firm rents private capital and labor at the rates of \( r_t \) and \( w_t \) to maximize profit

\[ Y_t - r_t u_t K_{t-1} - w_t L_t. \]
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\[ Y_t - r_t u_t K_{t-1} - w_t L_t. \]
The flow government budget constraint is

\[ \tau^K_t r_t u_t K_{t-1} + \tau^L_t w_t L_t + B_t = G^C_t + G^I_t + R_{t-1} B_{t-1} + T_t. \]
We separate budget authority ($A^I$) from outlays ($G^I$).

Government investment decisions follow

$$\hat{A}_t^I = \rho I \hat{A}_{t-1}^I + \varepsilon_t.$$  

The law of motion for $K^G$ is

$$K_t^G = (1 - \delta_G) K_{t-1}^G + A_{t-N+1}^I,$$

Government investment implemented (outlays) is

$$G_t^I = \sum_{n=0}^{N-1} \phi_n A_{t-n}^I, \quad \sum_{n=0}^{N-1} \phi_n = 1$$
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Implementation Delays: Example I

Estimated costs for highway construction in Title XII of the American Recovery and Reinvestment Act of 2009

<table>
<thead>
<tr>
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<tr>
<td>Budget Authority</td>
<td>27.5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>27.5</td>
</tr>
<tr>
<td>Estimated Outlay</td>
<td>2.75</td>
<td>6.875</td>
<td>5.5</td>
<td>4.125</td>
<td>3.025</td>
<td>2.75</td>
<td>1.925</td>
<td>.55</td>
<td>27.5</td>
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</table>

Implementation Delays: Example II

Estimated costs for the National Highway Bridge Reconstruction and Inspection Act of 2008 (not enacted)

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2009-2013</th>
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<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>1,049</td>
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<tr>
<td>Estimated Outlay</td>
<td>280</td>
<td>425</td>
<td>169</td>
<td>56</td>
<td>46</td>
<td>976</td>
</tr>
</tbody>
</table>

Debt Financing

- Financing rules

\[ x_t = c^x + \rho^x x_{t-1} + q_t^x s_t^B, \]

where \( x \in \{T, \tau^K, \tau^L, G^C\} \)

- Time-varying fiscal adjustment parameters.

\[ q_t^i = d^i \log s_{t-1}^B, \quad i \in \{T, L, K, C\}, \]

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## Calibration

<table>
<thead>
<tr>
<th>Param</th>
<th>Value</th>
<th>Param</th>
<th>Value</th>
<th>Param</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha^K$</td>
<td>.36</td>
<td>$\tau^L$</td>
<td>.21</td>
<td>$\psi''(1)/\psi'(1)$</td>
<td>.18</td>
</tr>
<tr>
<td>$\alpha^L$</td>
<td>.64</td>
<td>$\tau^K$</td>
<td>.39</td>
<td>$A$</td>
<td>1</td>
</tr>
<tr>
<td>$\alpha^G$</td>
<td>[.05, 0.1]</td>
<td>$s^T$</td>
<td>.07</td>
<td>$\gamma$</td>
<td>2</td>
</tr>
<tr>
<td>$\delta$</td>
<td>.025</td>
<td>$s^GI$</td>
<td>.04</td>
<td>$u$</td>
<td>1</td>
</tr>
<tr>
<td>$\delta_D$</td>
<td>.02</td>
<td>$s^{GC}$</td>
<td>.16</td>
<td>$\phi_0$</td>
<td>0</td>
</tr>
<tr>
<td>$e, \theta$</td>
<td>2</td>
<td>$q_T$</td>
<td>$-0.0006$</td>
<td>$\phi_1 \sim \phi_3$</td>
<td>.083</td>
</tr>
<tr>
<td>$b$</td>
<td>.25</td>
<td>$q_L$</td>
<td>.0013</td>
<td>$\phi_4 \sim \phi_7$</td>
<td>.105</td>
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<tr>
<td>$\chi$</td>
<td>6.63</td>
<td>$q_K$</td>
<td>.0035</td>
<td>$\phi_8 \sim \phi_{11}$</td>
<td>.083</td>
</tr>
<tr>
<td>$\beta$</td>
<td>.99</td>
<td>$q_C$</td>
<td>$-0.0004$</td>
<td>$\rho_I, \rho_T, \rho_C, \rho_K, \rho_L$</td>
<td>.9</td>
</tr>
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</table>

**Table 3:** Benchmark calibration, $N = 12$
**Basic Effects about \( G^I \)**

- Crowding-out effects: *ceteris paribus*, a higher \( G \) means fewer goods available for \( C \) and \( I \).
- Negative wealth effects: higher \( G \) implies higher taxes, so cut \( C \) and increase \( L \).
- Positive wealth effects when \( G \) is productive: expecting higher \( K^G \) discourages work and saving.
- Finally, when \( K^G \) is gradually built up, higher MPK and MPL encourage \( I \) and \( L \) in later periods.
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A Permanent Increase in $G^I$

**Figure 1:** Dashed-dotted lines: $\alpha^G = 0$; solid lines: $\alpha^G = 0.05$; dashed lines: $\alpha^G = 0.1$. 
A Transitory Increase in $G^I$

**Figure 2:** Dashed-dotted lines: $\alpha^G = 0$; solid lines: $\alpha^G = 0.05$; dashed lines: $\alpha^G = 0.1$. 
Effects of Implementation Delays

**Figure 3**: Dashed lines: 1q ttb; dotted lines: 1y ttb; solid lines: 3y ttb.
Effects of Fiscal Adjustments

**Figure 4:** $\alpha^G = 0.1$. Dashed lines: 1q ttb; dotted lines: 1y ttb; solid lines: 3y ttb.
ALTERNATIVE MODEL SPECIFICATIONS

- Government consumption generates utility
  \[ \tilde{C}_t = \left[ \phi C_t^{\frac{v-1}{v}} + (1 - \phi) \left( G_t^{C'} \right)^{\frac{v-1}{v}} \right]^{\frac{v}{v-1}}, \text{ with } 0 \leq \phi \leq 1, v > 0. \]

- One year to build private capital
- A two-sector model with government production

None of these variations change the key message of the paper: productive government investment needs not always be expansionary. The longer the implementation delays, the later labor and output turn positive.
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## Cumulative output multipliers

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<thead>
<tr>
<th></th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
<th>M4</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha^G = 0.1$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Q delay</td>
<td>2.63</td>
<td>1.40</td>
<td>2.25</td>
<td>2.47</td>
</tr>
<tr>
<td>1Y delay</td>
<td>2.61</td>
<td>1.44</td>
<td>2.31</td>
<td>2.62</td>
</tr>
<tr>
<td>3Y delay</td>
<td>2.37</td>
<td>1.29</td>
<td>2.23</td>
<td>2.34</td>
</tr>
<tr>
<td>$\alpha^G = 0.05$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1Q delay</td>
<td>−0.06</td>
<td>−0.57</td>
<td>0.20</td>
<td>−0.52</td>
</tr>
<tr>
<td>1Y delay</td>
<td>−0.01</td>
<td>−0.47</td>
<td>0.28</td>
<td>−0.28</td>
</tr>
<tr>
<td>3Y delay</td>
<td>−0.08</td>
<td>−0.51</td>
<td>0.28</td>
<td>−0.37</td>
</tr>
</tbody>
</table>

**Table 4:** M1: main model; M2: $G^C$ is a complement to $C$; M3: TTB for $K$; M4: $G$ production.
**Conclusion**

- When including implementation delays, productive $G^I$ may not expand employment and output in the short run.

- In the longer horizons, the choice of fiscal adjustment instruments is important for minimizing the negative effects from stabilizing government debt. When $K^G$ is not sufficiently productive, productive $G^I$ can be contractionary in out years.
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- In the longer horizons, the choice of fiscal adjustment instruments is important for minimizing the negative effects from stabilizing government debt. When $K^G$ is not sufficiently productive, productive $G^I$ can be contractionary in out years.
Caveats

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• The models we use have a neoclassical framework, which does not have a frozen credit market or insufficient demand as in the current recession.
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