The Short-Run Employment Effects of Public Infrastructure Investment

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Introduction

Motivation

- A central question in macroeconomics: How does government spending affect output and employment? $\rightsquigarrow$ fiscal multiplier
- Plans to expand infrastructure investment in EU, UK, US
- Permanent increase in infrastructure investment leads to long-run productivity gains (e.g. Bom and Ligthart 2014; Cubas 2020)
- What are the short-run employment effects, i.e. within one year? Can expansion of public investment stabilize employment in recession?

Short-Run Employment Effects of Public Investment

Like government consumption, public investment could

- raise labor demand directly $\rightsquigarrow$ construction workers
  (Michaillat 2014)
- raise employment through wealth effect on labor supply
  (Barro and King 1984; Baxter and King 1993; Brinca et al. 2016; Ferriere and Navarro 2018)
- raise aggregate demand and thereby labor demand
  (Christiano, Eichenbaum, and Rebelo 2011; Hagedorn, Manovskii, and Mitman 2019)

This paper studies a different mechanism specific to public investment, which I call the **anticipation effect on labor demand**.

The Anticipation Effect on Labor Demand

- Permanent increase in infrastructure investment gradually raises productivity
- Future labor productivity, labor demand & market tightness increase
- Hiring in the future becomes more difficult, future recruiting costs rise
- Firms substitute hiring over time, expand hiring today when workers are easy to find, hoard labor

This Paper

Anticipation effect on labor demand in model w/ matching labor market and private and public capital

- Public capital is production factor $\rightsquigarrow$ public investment raises future labor productivity
-
- Matches last multiple periods $\rightsquigarrow$ firms hoard labor

Anticipation effect on labor supply

- Unemployed workers choose search effort
- Higher long-run productivity could reduce effort & offset anticipation effect on labor demand

Results

1. **Theoretically:** fixed effort to focus on anticipation effect on labor demand
   - Employment multiplier of public investment is positive in the short-run, even if zero in the long run
   - Multiplier is larger when public investment is more productive
   - Anticipation effect can improve labor market efficiency

Results

1. **Theoretically:** fixed effort to focus on anticipation effect on labor demand
   - Employment multiplier of public investment is positive in the short-run, even if zero in the long run
   - Multiplier is larger when public investment is more productive
   - Anticipation effect can improve labor market efficiency
2. **Quantitatively:** with search effort response
   - Anticipation effect on labor demand is dominant effect
   - Employment rises by 0.4 pp. one year after permanent increase of public investment by 1% of GDP
   - Effect 40% larger in recession than in boom

Matching Model with Public Capital

Model Overview

Workers

- Work or unemployed
- Unemployed choose search effort (intensive margin)

Firm owners

- Do not work
- Own private capital stock
- Own firm equity

Firms and labor market

- Random matching
- Exogenous separations
- Nash bargaining with wage inertia
- Rent private capital

Government

- Invests in public capital stock K_t^G
- Determines productivity of firms $z_t = A_t \left(K_t^G\right)^{\vartheta}$
- Collects taxes and pays benefits

Calibration

- Calibrated to US, monthly frequency
- Match transition probabilities between unemployment and employment estimated from CPS microdata (1994–2020) ▸ Details
- Output elasticity of public capital $\vartheta = 0.1$ (Bom and Ligthart 2014; Cubas 2020)
- Wage stickiness to get business cycle volatility of unemployment

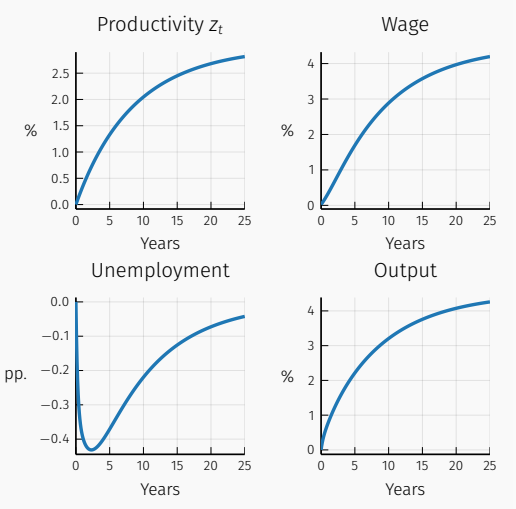
Table 1: Business cycle moments

	U	Y	Inv	Wages	Lab. prod.	z
Data	0.101	0.015	0.065	0.010	0.012	0.012
Model	0.081	0.017	0.090	0.008	0.011	0.012

Quantitative Results

Long-run Effect of Investment Program

- Start from steady state
- Permanent increase in public investment by 1% of GDP
- Financed by lump-sum taxes on firm owners
- Productivity increases by 3% in the long-run
- Unemployment drops initially and converges back



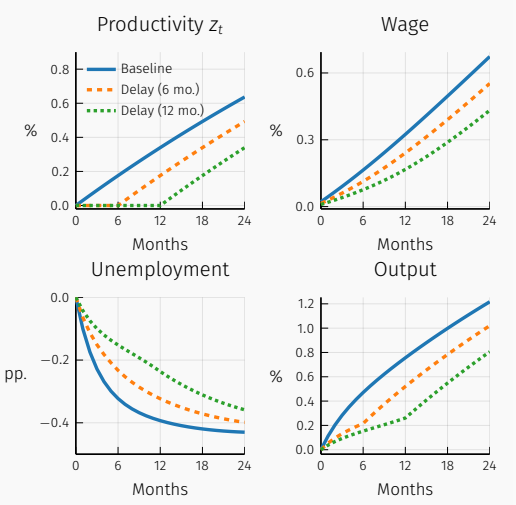
Short-run Effect of Investment Program

- Consider short run now
- After 12 months:
  - unemp. 0.4 pp. lower
  - output 0.8% higher
  - wages 0.3% higher

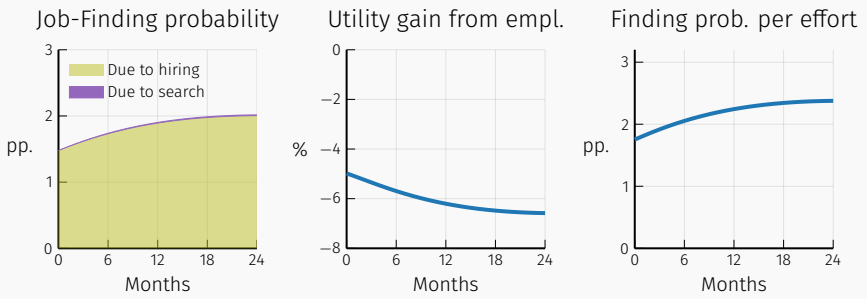
Implementation Delays

- Delay until investment takes place
- Six months delay:
  - Unemployment 0.36 pp. lower after one year
- One year delay:
  - Unemployment 0.25 pp. lower after one year
- Indicates importance of anticipation effect

▸ Transitory expansion



The Role of Search Effort

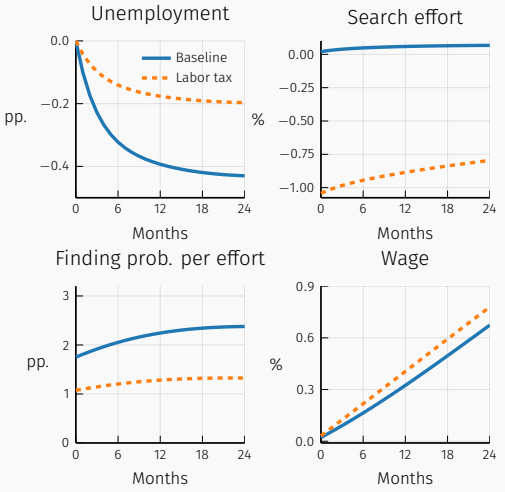


- Effort has little effect on change in the job finding probability
- Finding job expected to get even easier in future: effort ↓
- Firms create more vacancies ⇝ finding prob. per effort increases: effort ↑

▸ Delays

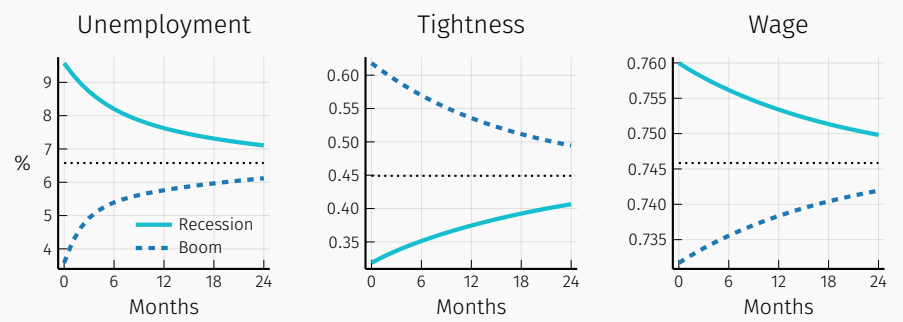
Financing with Distortionary Labor Taxes

- Consider financing with contemporaneous distortionary labor taxes
- Discourages search effort
- Firms share tax burden through bargaining
- Dampened effect on job creation



State Dependence: Recession vs. Boom I/II

- Recession: unemp. 3 pp. higher than in steady state, wage 2% higher; boom: 3 pp. and 2% lower
- Unemployment in recession: 9.5% (as in 2009), in boom 3.5% (as in 2020)
- Tightness in recession: 0.32 (as in 2007), in boom 0.65 (as in 2003)



State Dependence: Recession vs. Boom II/II

- Unemployment after one year is reduced 40% more in recession than boom
- High unemployment $\rightsquigarrow$ congestion externality of additional vacancies is smaller
- High wage $\rightsquigarrow$ wage increases less, larger effect on labor demand

Fiscal Output Multipliers

- Cumulative output multiplier of public investment $\frac{\sum_{t=0}^{T-1} \Delta Y_t}{\sum_{t=0}^{T-1} \Delta I_t^G}$
- Peak output multiplier of public investment $\frac{\max_{t=0,\ldots,T-1} \Delta Y_t}{\Delta I_t^G}$

Table 2: Fiscal output multipliers

	1 year	2 years	3 years	Long run
Peak	0.71	1.18	1.57	4.52
Cumulative	0.41	0.69	0.93	4.52

$\rightsquigarrow$ The fiscal multiplier for productive public investment is larger than for unproductive government spending

Conclusion

Conclusion

- Short-run employment multiplier of public investment is large because of anticipation effect on labor demand
- Unemployment reduced by 0.4 pp. one year after permanent expansion in public investment by 1% of GDP
- Effect 40% larger in recession than in boom
- Announcing investment program can stimulate employment in the short-run even if implementation takes time

Thank you!

References

- Barro, Robert J., and Robert G. King. 1984. “Time-Separable Preferences and Intertemporal-Substitution Models of Business Cycles.” *The Quarterly Journal of Economics* 99 (4): 817–839.
- Baxter, Marianne, and Robert G King. 1993. “Fiscal Policy in General Equilibrium.” *American Economic Review* 83 (3): 315–334.
- Boehm, Christoph E. 2020. “Government Consumption and Investment: Does the Composition of Purchases Affect the Multiplier?” *Journal of Monetary Economics* 115:80–93.

- Bom, Pedro R.D., and Jenny E. Ligthart. 2014. “What Have We Learned from Three Decades of Research on the Productivity of Public Capital?” *Journal of Economic Surveys* 28 (5): 889–916.
- Brinca, Pedro, Hans A. Holter, Per Krusell, and Laurence Malafry. 2016. “Fiscal multipliers in the 21st century.” *Journal of Monetary Economics* 77:53–69.
- Chetty, Raj. 2008. “Moral Hazard versus Liquidity and Optimal Unemployment Insurance.” *Journal of Political Economy* 116 (2): 173–234.
- Christiano, Lawrence, Martin Eichenbaum, and Sergio Rebelo. 2011. “When Is the Government Spending Multiplier Large?” *Journal of Political Economy* 119 (1): 78–121.

Cubas, German. 2020. “Public Capital and Economic Development.” *The Economic Journal* 130 (632): 2354–2381.

Ferriere, Axelle, and Gaston Navarro. 2018. “The Heterogeneous Effects of Government Purchases: It’s All About Taxes.”

Hagedorn, Marcus, Iourii Manovskii, and Kurt Mitman. 2019. *The Fiscal Multiplier.* Technical report.

Leeper, Eric M., Todd B. Walker, and Shu-Chun S. Yang. 2010. “Government Investment and Fiscal Stimulus.” *Journal of Monetary Economics* 57 (8): 1000–1012.

Michaillat, Pascal. 2014. “A Theory of Countercyclical Government Multiplier.” *American Economic Journal: Macroeconomics* 6 (1): 190–217.

Michaillat, Pascal, and Emmanuel Saez. 2018. “Optimal Public Expenditure with Inefficient Unemployment.” *The Review of Economic Studies* 86 (3): 1301–1331.

Ramey, Valerie A. 2020. *The Macroeconomic Consequences of Infrastructure Investment.* National Bureau of Economic Research Working Paper 27625.

Rendahl, Pontus. 2016. “Fiscal Policy in an Unemployment Crisis.” *The Review of Economic Studies* 83 (3): 1189–1224.

Shimer, Robert. 2010. *Labor Markets and Business Cycles.* Princeton, NJ: Princeton University Press.

———. 2012. “Reassessing the Ins and Outs of Unemployment.” *Review of Economic Dynamics* 15 (2): 127–148.

Sims, Eric, and Jonathan Wolff. 2018. “The Output and Welfare Effects of Government Spending Over the Business Cycle.” *International Economic Review* 59 (3): 1403–1435.

Appendix

Investment Plans

EU:

- Recovery Fund 2021–2023
- 383 billion Euros to public investments
- ca. 0.9% of 2019 GDP p.a.

UK:

- National Infrastructure Strategy
- Increase: 2.2% of GDP in 2019/20 to 3.0% in 2024/25

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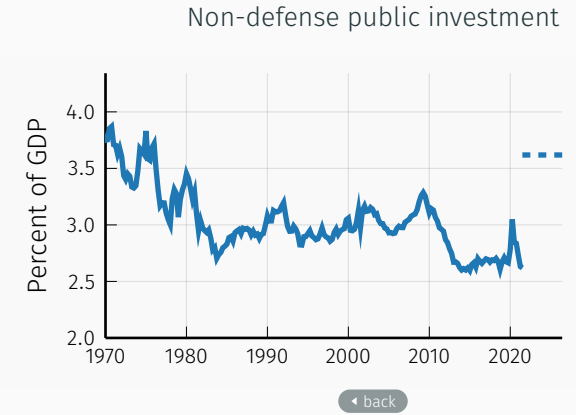
Public Investment



Workers

- Mass of measure one
- Labor market state $s_t \in \{e, u\}$
- Wage income w_t, benefits b_t
- Search effort decision $\ell_t(s_t)$
- All workers are hand-to-mouth
  $\rightsquigarrow$ can be equilibrium of extension with saving

$$\max_{\{\ell_t(s_t), c_t(s_t)\}} \sum_{t=0}^{\infty} \sum_{s^t \in S^t} \beta^t \left(\log(c_t(s_t)) - d(\ell_t(s_t), s_t)\right) \pi(s^t | s_0, \{\ell_t(s_t), \theta_t\})$$

$$\text{s.t.} \quad c_t(s_t) = (1 - \tau_t) w_t \mathbb{1}\{s_t = e\} + b_t \mathbb{1}\{s_t = u\},$$

$$\ell_t(s^t) \geq 0 \text{ and given } s_0.$$

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Firm Owners

- Mass μ^F
- Risk-neutral
- Own capital k_t^F and equity
- Receive firm profits Π_t^F
- Lump-sum taxes T_t^F
- Capital adjustment costs

$$\max_{\{c_t^F, i_t^F, k_{t+1}^F\}} \sum_{t=0}^{\infty} \beta^t c_t^F$$

$$\text{s.t.} \quad i_t^F + c_t^F = r_t^k k_t^F + \Pi_t^F - T_t^F - \frac{\phi}{2}\left(\frac{i_t^F}{k_t^F} - \delta_k\right)^2 k_t^F$$

$$k_{t+1}^F = (1-\delta_k) k_t^F + i_t^F.$$

back

Firms and Labor Market

- Firm posts vacancy at cost $\kappa \cdot y_t$, when filled, firm rents capital k_t and produces
$$y_t = A_t (K_t^G)^{\vartheta} k_t^{\alpha}$$
- Total number of new matches $M(v_t, L_t^u) = \zeta {v_t}^{1-\eta} (L_t^u)^{\eta}$
  - v_t aggregate number of vacancies
  - $L_t^u = \sum_{s^t | s_t = u} \ell(s^t) \pi_t(s^t)$ aggregate search effort
- Job-finding probability of individual worker $\pi(e|u) = \frac{M(L^u, v)}{L^u} \ell_t$
- Existing matches separate exogenously with probability ρ
- Aggregate output is $Y_t = A_t (K_t^G)^{\vartheta} K_t^{\alpha} N_t^{1-\alpha}$ $\rightsquigarrow$ Baxter and King (1993)

back

Wage Determination

- Wage is sticky

$$w_t = \gamma w_{t-1} + (1-\gamma) w_t^*$$

- I consider two alternatives for the target wage w_t^*:

  a) Fixed output share: $w_t^* = \omega A_t (K_t^G)^{\vartheta} k_t^{\alpha} \rightsquigarrow$ for theoretical results

  b) Nash bargaining $\rightsquigarrow$ for quantitative analysis

back

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back

Government

- Collects taxes, pays unemployment benefits, invests I_t^G

$$\mu^F T_t^F + \tau_t w_t N_t = b_t(1 - N_t) + I_t^G$$

- Law of motion for public capital

$$K_{t+1}^G = (1 - \delta_G)K_t^G + I_t^G$$

- More public investment financed by higher taxes T_t^F or τ_t

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Equilibrium Definition

Equilibrium

- Unemployed workers: optimal effort
- Firm owners: optimal savings
- Firms: optimal capital $r_t^k = \alpha z_t k_t^{\alpha-1}$
- Tightness solves job creation equation (free-entry)
- Capital market clears $K_t = \frac{k_t^F}{\mu^F} = k_t N_t$
- Wage rule satisfied
- Government budget is balanced

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Related Literature

	No matching frictions	Matching frictions
Unproductive spending	Barro and King (1984), Brinca et al. (2016), Ferriere and Navarro (2018), and Hagedorn, Manovskii, and Mitman (2019)	Michaillat (2014), Michaillat and Saez (2018), and Rendahl (2016)
Productive spending	Baxter and King (1993), Boehm (2020), Leeper, Walker, and Yang (2010), Ramey (2020), and Sims and Wolff (2018)	This paper

- Literature: short-run multiplier smaller for more productive spending b/c of wealth effect on labor supply: future productivity ↑, wealth ↑, labor supply ↓
- Difference to literature: employment multiplier is larger if spending is more productive

General Parameters

Calibrated parameters

Param.	Interpretation	Value	Target / Source
θ_G	ela. priv. prod. w.r.t. K_G	0.1	Bom and Ligthart (2014)
δ_G	pub. cap. depreciation	0.00874	10% ann. deprec. rate
I_G/Y	public investment rate	2.9%	US avg.
α	output ela. priv. capital	0.33	standard
β	disc. factor	0.992	interest rate p.a. 1%
δ_k	priv. cap. depreciation	0.00874	10% ann. deprec. rate

back

Search Effort and Transition Probabilities

- Disutility from search effort

$$d(\ell, s) = d_{0,s} + \frac{\ell^{1+\chi}}{1+\chi} \tag{1}$$

- Normalize $d_{0,u} = 0$, no difference in steady state: $d_{0,e} = \frac{\ell^{1+\chi}}{1+\chi}$
- $\chi = 4.70 \Rightarrow$ micro elasticity of job finding prob. w.r.t. b of −0.5 (Chetty 2008)
- Posting costs proportional to labor productivity $\kappa_t = \kappa z_t k_t^{\alpha}$
- Match steady state transition probabilities from CPS microdata (1994–2020)

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Estimation of Transition Probabilities

Estimate job finding probability from gross flows as in Shimer (2012):

- Match individuals across monthly CPS waves to obtain panel
- For every month: compute the number of workers who transition between employed, unemployed, inactive
  - Seasonally adjust using X13-ARIMA-SEATS
- From flows obtain Markov matrix for the monthly transition
- Adjust for time aggregation using method in Shimer (2012)

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Estimated Transition Probabilities

Monthly transition probabilities

	1976–2020	1994–2020
Find. Prob. U-3	29.8	29.4
Find. Prob. U-5	-	26.9
Sep. Rate	1.9	1.9

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Labor Market Parameters

Calibrated parameters

Param.	Interpretation	Value	Target / Source
ρ	sep. rate	0.019	monthly EU prob. 1.9%
ζ	match. effcy.	0.53	monthly UE prob. 26.9%
κ	posting costs	0.89	monthly. vac. fill. prob. 71%
b	benefits	0.37	replacement rate 70%
η	match. elast.	0.30	standard range
ψ	worker barg. weight	0.38	lab. share 63%
γ	wage stickiness	0.993	Shimer (2010), sd. unemp.

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Business Cycle Properties

- We assume that exogenous productivity is

$$\log A_t = \rho_A \log A_{t-1} + \epsilon_t, \quad \text{with } \epsilon_t \sim N(0, \sigma_\epsilon^2) \tag{2}$$

- With $\rho_A = 0.9957$ and $\sigma_\epsilon = 0.0056$ we match volatility of autocorrelation of TFP

Table 3: Business cycle moments

		U-5	U-3	Y	Inv	Wages	Lab. prod.	z
Data	Std. dev.	0.101	0.128	0.015	0.065	0.010	0.012	0.012
	Autocorr.	0.943	0.886	0.845	0.821	0.744	0.761	0.797
Model	Std. dev.	0.081	–	0.017	0.090	0.008	0.011	0.012
	Autocorr.	0.848	–	0.846	0.248	0.947	0.789	0.791

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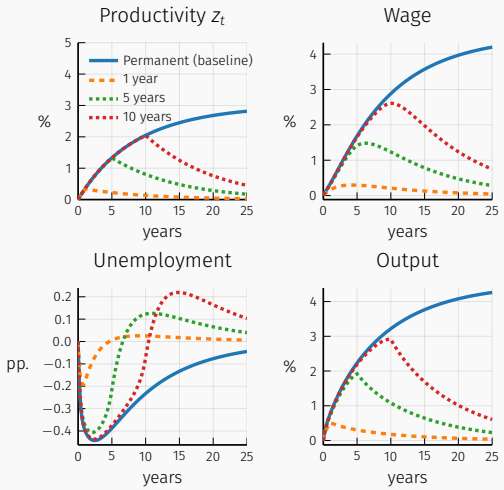
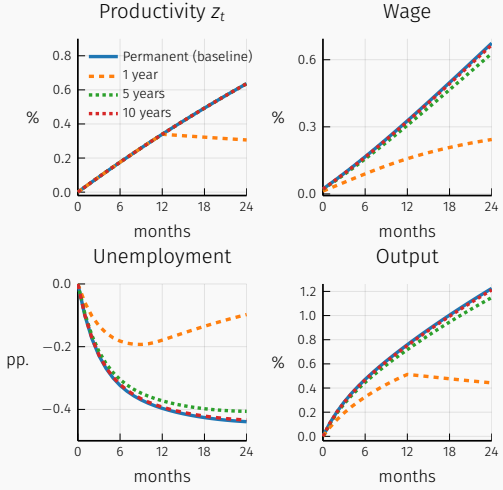
Temporary Expansion of Public Investment

Long-run



Short-run



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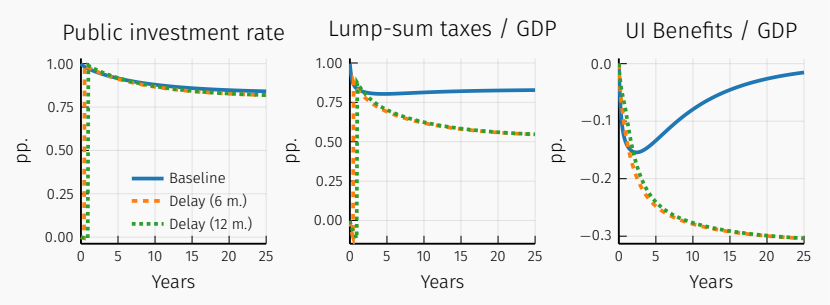
Robustness: Steady State Investment Rate

- With distortionary tax financing the fiscal cost of the investment program matters through its effect on search effort
- The size of the fiscal costs depends on the steady state investment rate
- For given replacement rate of UI, steady state employment and capital are unaffected by public investment
- The optimal investment rate is then

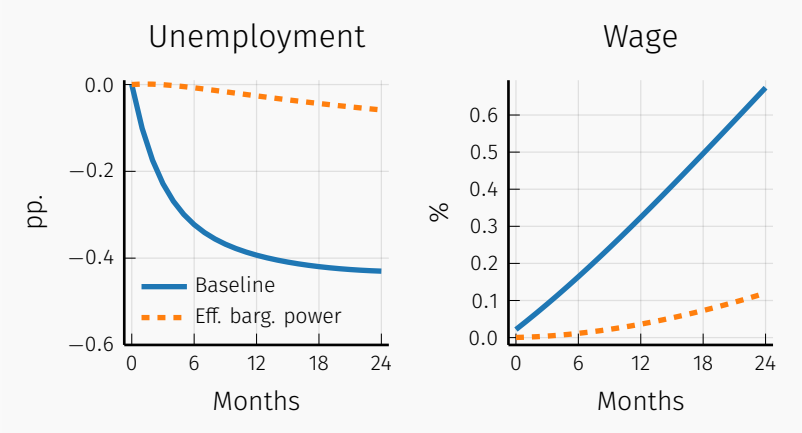
$$\frac{I_G}{Y} = \frac{\theta_G \delta_G}{\frac{1}{\beta} - 1 + \delta_G} \tag{3}$$

- Can analyze employment effect in this case
- Smaller because tax burden will be larger
- See also Ramey (2020, section 2.6)

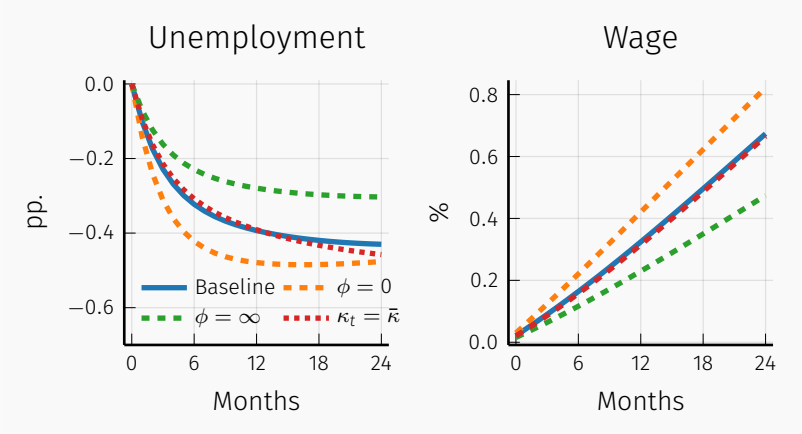
Response of Fiscal Variables



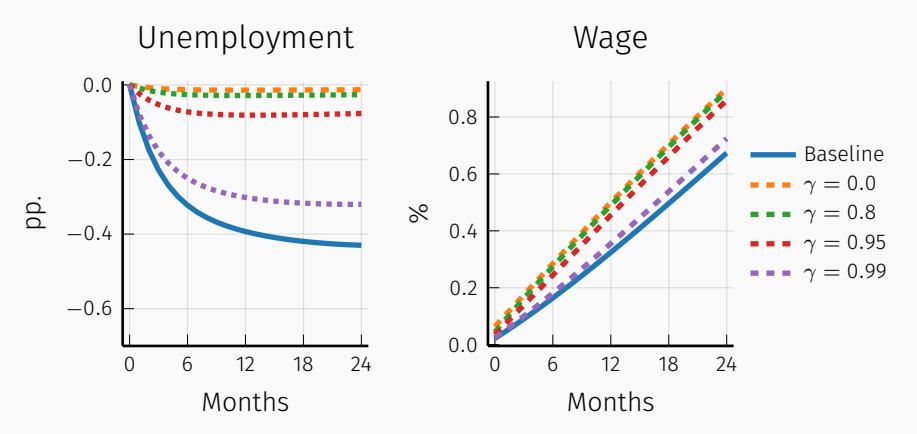
Responses with Efficient Steady State Bargaining Power



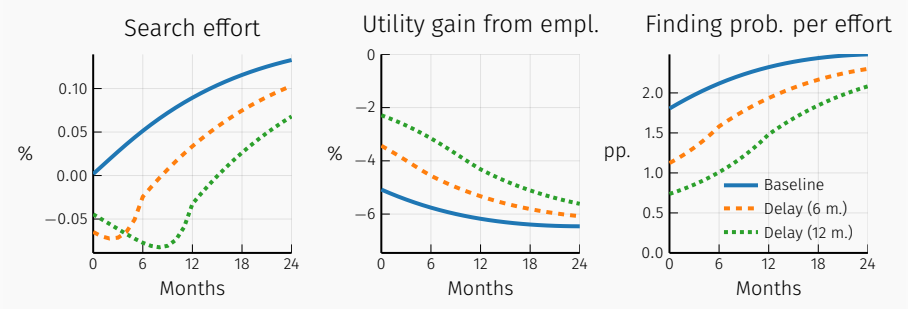
Capital Adjustment Costs and Proportional Posting Costs



Varying Wage Stickiness



Response of Search Effort



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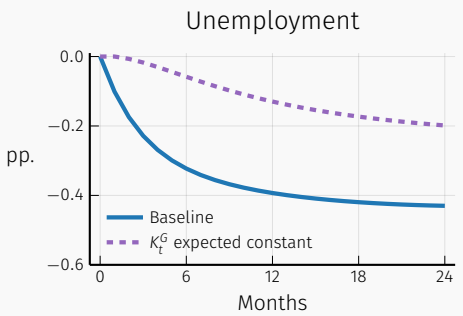
Size of Anticipation Effect

- Want to quantify contribution of anticipation effect
- Unemployment change $=$ $\underbrace{\text{Current productivity effect}}_{\text{Change with } K_t^G \text{ expected const.}}$ $+$ Anticipation effect



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Size of Anticipation Effect

- How large is the contribution of the anticipation effect?
- Suppose in every period, public capital stock was expected to stay constant
- Unemployment change $=$ $\underbrace{\text{Current productivity effect}}_{\text{Change with } K_t^G \text{ expected const.}}$ $+$ Anticipation effect