Short-Term Tax Cuts, Long-Term Stimulus

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Motivation

- Do transitory tax changes have long-run effects on GDP?
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- Does the type of tax (personal or corporate income) matter?
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- Do transitory tax changes have long-run effects on GDP?
- Does the type of tax (personal or corporate income) matter?
- SVAR studies have found large short run-effects from tax cuts
- This paper: evidence of large long-run effects, use theory to understand transmission channels
Summary of empirical results

- Narrative identification to study transmission of tax shocks into real activity at short and long horizons
- Distinguish between personal income taxes (PIT) and corporate income taxes (CIT)
Summary of empirical results

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- Distinguish between personal income taxes (PIT) and corporate income taxes (CIT)
- Effect on GDP of PIT and CIT shocks:

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- Unifying mechanism: pro-cyclical labor productivity
Inspecting the mechanism

- Takeaways from empirics:
  - Effects of CIT persistent vs PIT transitory
  - Labor productivity pro-cyclical at different frequencies
Inspecting the mechanism

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- N-K model with 2 twists: endogenous productivity (R&D and adoption) and labor hoarding with effort margin
Inspecting the mechanism

- Takeaways from empirics:
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  - Labor productivity pro-cyclical at different frequencies
- N-K model with 2 twists: endogenous productivity (R&D and adoption) and labor hoarding with effort margin
- Through lens of model, productivity dynamics driven by:
  - PIT: transitory increase in labor effort
  - CIT: persistent increase in R&D and technology adoption
Literature

- Akcigit et al. (2022), Jordà et al. (2020), Antolin-Diaz and Surico (2022)
Outline

1. Empirical framework
2. Model
3. Structural estimation
4. Inspecting the mechanism
Empirical Framework
Two challenges:

1. Exogenous variation in personal and corporate income tax rates
   - Narrative identification + proxy SVAR (Mertens and Ravn (2013), Romer and Romer (2010))

2. Identify long-run effects
   - Local projections (Jordà (2005), Miranda-Agrippino and Ricco (2021))
Empirical Specification

- Local projections

\[ Z_{t+h} = c^{(h)} + B_1^{(h)} Z_{t-1} + \sum_{j=1}^{P} b_j^{(h)} Z_{t-1-j} + u_{t+h}, \quad u_{t+h} \sim N(0, \Omega_h) \]

- \( Z \): controls + variable of interest
- Controls: Average PIT and CIT rates and bases, government spending, GDP, federal debt, interest rate, macro/finance principal component
- Estimate reduced form propagation mechanism \( B_1^{(h)} \) using Bayesian methods
- \( u_t \) are not structural shocks: \( u_t = A_0 \varepsilon_t \)
- Impulse response at horizon \( h \): \( B_1^{(h)} A_0 \)
Narrative Identification

- Romer and Romer (2010): legislated changes to tax policy exogenous wrt prospective economic conditions
- Mertens and Ravn (2013) exclude changes with implementation lag longer than 1 quarter
- Use narrative changes as proxies to identify structural tax shocks
Narrative Identification

- Romer and Romer (2010): legislated changes to tax policy exogenous wrt prospective economic conditions
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- Use narrative changes as proxies to identify structural tax shocks
- Identification: narrative measures correlate with latent tax shocks, but are orthogonal to other structural shocks
LR IRFs

- VARs with finite lags may not provide consistent estimates of medium LR responses (Jordà et al. (2020))
LR IRFs

- VAR and LP with 4 lags
Empirical estimates
Empirical IRFs: average CIT and PIT rates, and GDP

Plots of posterior median, 68% and 90% credible intervals
Empirical IRFs: Comparison with VAR estimates

Plots of posterior median, 68% and 90% credible intervals

Corporate Tax shock

Average Corporate Tax Rate

quarters

0 10 20 30

-1

0

0.5

Real GDP

quarters

0 10 20 30

-1

0

0.5

1

1.5

0 10 20 30

-2

-1

0

1

2

Personal Tax shock

Average Personal Tax Rate

quarters

0 10 20 30

-1

0

0.5

Real GDP

quarters

0 10 20 30

-2

-1

0

1

2
Within/Beyond 2 Years Cumulative Response of GDP

Plot of joint posterior distribution of cumulative GDP responses
Within/Beyond 2 Years Cumulative Response of GDP using a BVAR(4)

**WITHIN TWO YEARS AFTER THE SHOCK**

GDP Response to personal income tax shocks

**BEYOND TWO YEARS AFTER THE SHOCK**

GDP Response to personal income tax shocks

\[ \delta = 5.48\% \]

\[ \delta = 56.0\% \]

GDP Response to corporate income tax shocks

GDP Response to corporate income tax shocks

joint distribution

45° degree line
Empirical IRFs: Productivity and Hours

Corporate Income Tax Shock

Plots of posterior median, 68% and 90% credible intervals

Personal Income Tax Shock
Empirical IRFs: R&D, Investment, Consumption

Plots of posterior median, 68% and 90% credible intervals
Model
Overview

- **Non-standard features**
  - Endogenous productivity via R&D and adoption (Comin and Gertler (2006), Anzoategui et al. (2019))
  - Labor hoarding + effort (Oi (1962), Wen (2004), Galí and van Rens (2020))

- **Standard features**
  - Habit formation in consumption
  - Calvo price rigidity
  - Taylor rule for monetary policy
  - Flow investment adjustment costs
  - Variable capital utilization
Production Sector and Endogenous TFP

- $Z_t$: Total technology stock
- $A_t$: Adopted tech
- $Z_t - A_T$: unadopted tech
- distinguish between innovation and adoption to allow for technology adoption lags
- Law of motion for technology stock $Z_{t+1} = \varphi_t X_{s,t} + \phi Z_t$ where $X_{s,t}$ is R&D
R&D and Adoption

- Adoption: adopters convert unadopted tech to adopted tech
- Adopter buys new tech. from innovator at price $J_t$
- Spends adoption goods $X_{a,t}$ to convert technology into use.
- Probability that adopter $k$ successfully converts tech:
  \[
  \lambda_t = \lambda \left( \frac{Z_t X_{k,a,t}}{\psi_t} \right)
  \]
  - with $\lambda' > 0$, $\lambda'' < 0$; $\psi_t$: scaling factor
- once in usable form, adopter sells rights to intermediate good producer
- Value of adopted technology:
  \[
  V_t = \left( 1 - \tau^C_t \right) \Pi_{i,t} + \phi E_t \{ \beta \Lambda_{t,t+1} V_{t+1} \}
  \]
  - $\Pi_{i,t}$: profits from adopted intermediate good
Households

- Household problem standard except for labor supply
- Choose employment $N_t$ 1 period in advance and face an adjustment cost of changing employment
- in period $t$ household chooses effort and effective labor supply (hours $\times$ effort)

$$L_t = e_t N_t$$

- taxes on labour income and on after-tax firm-profits.
Calvo prices

Monetary policy follows Taylor rule

\[ \tilde{G} (1 + g_y)^t - T_t = \tau_t^{PI} w_t L_t + \tau_t^{CI} \left( r_t^K U_t K_t + \Pi_t \right) \]

Fiscal policy

\[ \bar{G} (1 + g_y)^t - T_t = \tau_t^{PI} w_t L_t + \tau_t^{CI} \left( r_t^K U_t K_t + \Pi_t \right) \]

Tax rates \( \tau_t^{CI} \) and \( \tau_t^{PI} \) follow AR(1) processes (in logs):

\[ \log (\tau_t^x) = (1 - \rho_{\tau x}) \bar{\tau}_t^x + \rho_{\tau x} \log (\tau_{t-1}^x) + \varepsilon_t^x, \]

for \( x \in \{ CI, PI \} \), with \( \rho_{\tau x} \in (0, 1) \), and \( \varepsilon_t^x \sim N(0, 1) \) is i.i.d.
Estimation
Overview

- Limited-information Bayesian approach to estimate structural parameter vector $\hat{\gamma}$ (Christiano et al. (2010))
- 'Data': median of empirical LP IRF posteriors to both tax shocks, $\hat{\Phi}$
- Model IRFs: $\Phi(\gamma)$
- Quasi-likelihood:

$$ F(\hat{\Phi}|\gamma) = \left(\frac{1}{2\pi}\right)^{\frac{N}{2}} |V|^{-\frac{1}{2}} \exp \left(-\frac{1}{2} (\hat{\Phi} - \Phi(\gamma))' V^{-1} (\hat{\Phi} - \Phi(\gamma)) \right) $$

- $V$: posterior variance of $\hat{\Phi}$ on main diagonal
- Quasi-posterior:

$$ F(\gamma|\hat{\Phi}) \propto F(\hat{\Phi}|\gamma)p(\gamma) $$

- $p(\gamma)$ are prior distributions
Overview

- Approximate posterior using random walk M-H algorithm
- 'Data': IRFs of average tax rates, GDP, consumption, investment, R&D, hours, labor productivity
- Jointly estimate responses of corporate and personal income taxes
## Calibrated Parameters (selected)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
<th>Source</th>
</tr>
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<tbody>
<tr>
<td>$\zeta$</td>
<td>Markup</td>
<td>1.09</td>
<td>Profits/GDP=8%</td>
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<tr>
<td>$\bar{\lambda}$</td>
<td>SS technology adoption rate</td>
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<td>Anzoategui et al. (2019)</td>
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<td>$\bar{\tau}^{PI}$</td>
<td>SS personal income tax</td>
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<td><strong>Preference &amp; HHs</strong></td>
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<td>$\gamma$</td>
<td>Inverse effort elasticity</td>
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<td><strong>Frictions &amp; Production</strong></td>
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<tr>
<td>$f_a''$</td>
<td>Adoption adjustment</td>
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<tr>
<td>$f_z''$</td>
<td>R&amp;D adjustment</td>
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<td>$f_I''$</td>
<td>Investment adjustment</td>
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<td>$\xi_p$</td>
<td>Calvo prices</td>
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<td><strong>Endogenous Technology</strong></td>
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<tr>
<td>$\theta-1$</td>
<td>Dixit-Stiglitz parameter</td>
<td>gamma</td>
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<tr>
<td>$\rho_\lambda$</td>
<td>Adoption elasticity</td>
<td>beta</td>
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<td>$\rho_Z$</td>
<td>R&amp;D elasticity</td>
<td>beta</td>
<td>0.5</td>
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<td>$1 - \phi$</td>
<td>Knowledge depreciation</td>
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<td>0.05</td>
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<td><strong>Shocks</strong></td>
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<tr>
<td>$\rho_{\tau,CI}$</td>
<td>Corporate taxes AR</td>
<td>beta</td>
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<tr>
<td>$\rho_{\tau,PI}$</td>
<td>Labour taxes AR</td>
<td>beta</td>
<td>0.7</td>
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Model Fit 1/2

Corporate Income Tax Shock

- Average Corporate Tax Rate
- Real GDP
- Productivity
- Hours

Quarters

-1 -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8

-1 -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6

-2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2

-2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2

Personal Income Tax Shock

- Average Personal Tax Rate
- Real GDP
- Productivity
- Hours

Quarters

-1 -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8

-1 -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6

-2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2

-2.5 -2 -1.5 -1 -0.5 0 0.5 1 1.5 2
Model Fit 2/2

Corporate Income Tax Shock

Personal Income Tax Shock

More 26 / 31
Model: Within/Beyond 2 Years Cumulative Response

WITHIN 2 Years After the Shock: Structural Model Estimates

- **prior $\delta = 0.30$**
- **posterior $\delta = 0.00$**

BEYOND 2 Years After the Shock: Structural Model Estimates

- **prior $\delta = 0.40$**
- **posterior $\delta = 1.00$**

WITHIN 2 Years After the Shock: Structural Model Estimates

- **prior $\delta = 0.83$**
- **posterior $\delta = 0.04$**

BEYOND 2 Years After the Shock: Structural Model Estimates

- **prior $\delta = 0.51$**
- **posterior $\delta = 1.00$**
Model: Labor Productivity Decomposition

Corporate income tax

Personal income tax

GDP Decomposition

- Endogenous TFP
- Capital Utilization
- Capital Deepening
- Labor Utilization
- Labor Productivity
Counterfactual 1: no R&D or effort

![Graphs showing the impact of Corporate Income and Personal Income Tax Shocks on Real GDP and Productivity with different tax policies: Baseline, No R&D, Inelastic Labor Effort.](image-url)
Mechanism

- Corporate income tax shock:
  - Raises after-tax profit and increases value of adopted and unadopted technology
  - R & D spending increases and productivity rises
  - Increase in investment, capital utilisation, employment are transitory

- Personal income tax shock:
  - Households supply more labour. Hours increase gradually but effort rises
  - Short-run increase in productivity but no effect on innovation
Conclusions

- Personal income tax shock: short-term effects
- Corporate income tax shock: longer-term effects
- Unifying theme: transmission through pro-cyclical labor productivity
- Through lens of model:
  - Labor effort accounts for almost all of short-run response to personal tax cuts
  - Corporate tax cut stimulates R&D and adoption, accounting for persistent increase in labor productivity
- We are examining distributional effects in ongoing research
Appendix
Calibrated Parameters (all)

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<td>$g_y$</td>
<td>100*SS GDP growth rate</td>
<td>0.45</td>
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<tr>
<td>$\beta$</td>
<td>Discount factor</td>
<td>0.99</td>
<td></td>
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<tr>
<td>$\psi_N$</td>
<td>Employment adjustment</td>
<td>0.25</td>
<td>Wen (2004)</td>
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| Technology                   | GY                                 | 0.16  |                |
| $\alpha$                    | Capital share                      | 0.35  |                |
| $\delta$                    | Capital depreciation.              | 0.02  |                |
| $\zeta$                     | Markup                             | 1.09  | Profits/GDP=8% |
| $\lambda$                   | SS technology adoption rate        | 0.05  | Anzoategui et al. (2019) |

| Taxes                        | $\bar{\tau}^{CI}$ SS Corp. Tax    | 0.19  | Sample average |
| $\bar{\tau}^{PI}$ SS Lab. Tax | 0.3                              | Sample average |

| Monetary Policy              | $\rho_r$                           | 0.83  | Anzoategui et al. (2019) |
| $\phi_y$                    | Output                             | 0.39  | Anzoategui et al. (2019) |
| $\phi_\pi$                  | Inflation                          | 1.64  | Anzoategui et al. (2019) |
Balanced Growth Path

- Model is non-stationary
- $Z_t$ and $A_t$ grow at rate $1 + g_a$ where
  
  $$1 + g_a = Z_t^\zeta X_s^{\rho_z} + \phi = \bar{\lambda} \left( \frac{Z_t}{A_t} - 1 \right) + \phi$$

- Balanced growth requires
  
  $$\zeta = -\rho_z \frac{\theta - 1}{1 - \alpha}$$

- $Y_t$ grows at rate $1 + g_y$ where
  
  $$1 + g_y = (1 + g_a)^{\frac{\theta - 1}{1 - \alpha}}$$
Mertens and Ravn (2013) Shocks
Sector-level Evidence

Note: IRF of aggregate sector gross output (source: BEA industry accounts)
Wages IRF

Corporate Income Tax Shock

Average Wage

5 10 15 20 25 30 35 40
quarters

Personal Income Tax Shock

Average Wage

5 10 15 20 25 30 35 40
quarters
Note: Estimated IRF of Fernald utilization-adjusted TFP and model TFP
Prior Predictive Analysis
Adjustment Parameter Distribution

Investment Adjustment Cost

Utilization Adjustment Cost

Baseline
No R&D or Adoption
Prior
Model: GDP Decomposition

The graphs illustrate the percentage change in GDP over time, decomposed into various factors:

- **Endogenous TFP**
- **Capital Utilization**
- **Capital Deepening**
- **Labor Utilization**
- **Hours**

Each factor is represented by a different color or shade, allowing for a visual comparison of their impacts on GDP over the quarters depicted.
Literature


