Short-Term Tax Cuts, Long-Term Stimulus

James Cloyne, Joseba Martinez, Haroon Mumtaz and Paolo Surico

UC Davis, London Business School, Queen Mary University London, NBER & CEPR

SI 2022 Impulse and Propagation Mechanisms

Motivation

- Do tax cuts have long-run effects on economic performance?

Motivation

- Do tax cuts have long-run effects on economic performance?
- Studies find large short-run effects; limited evidence on long-run.

Motivation

- Do tax cuts have long-run effects on economic performance?
- Studies find large short-run effects; limited evidence on long-run.
- Tax shocks identified in literature are transitory
- Does the type of tax (corporate or personal) matter for the long run?

The dynamic effects of temporary tax changes on GDP

	Corporate Income Tax Changes	Personal Income Tax Changes
Shorter-term effects (within 2 years)	smaller	large

The dynamic effects of temporary tax changes on GDP

	Corporate Income Tax Changes	Personal Income Tax Changes
Shorter-term effects (within 2 years)	smaller	large
Longer-term effects (up to 10 years)	**large** (this paper)	*insignificant* (this paper)

The dynamic effects of temporary tax changes on GDP

	Corporate Income Tax Changes	Personal Income Tax Changes
Shorter-term effects (within 2 years)	smaller	large
Longer-term effects (up to 10 years)	**large** (this paper)	*insignificant* (this paper)

- Impact on GDP (largely) through **productivity** not hours

Interpreting the evidence: Strategy & Outcomes

Strategy:

- NK model with endogenous growth and variable factor utilization
- Estimate model by jointly matching empirical IRFs to both tax shocks
- Counterfactual simulations switching off one channel at the time

Findings:

1. Pro-cyclical response of productivity is key to match all empirical results
2. Endogenous growth channel accounts for response to corporate income taxes
3. Variable labour utilization accounts for response to personal taxes

Related literature

1. *Short-run effects of tax policies*:
   Romer and Romer (2010), Barro and Redlick (2011), Mertens and Ravn (2013), Cloyne (2013), Caldara and Kamps (2012), and many other recent examples

2. *Long-run effects of other policies*:
   Akcigit et al. (2022), Baley et al. (2022), Jordà et al. (2020), Antolin and Surico (2022)

3. *Long-run effects of transitory shocks*: Comin and Gertler (2006), Benigno and Fornaro (2017), Anzoategui et al. (2019), Beaudry et al. (2020).

Outline

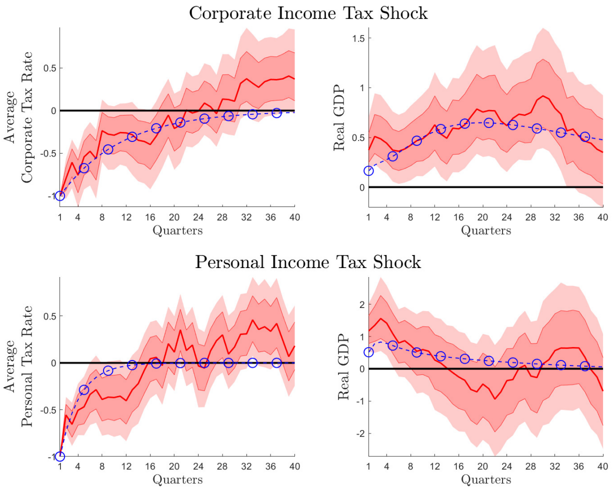
1. Empirical framework
2. Model and structural estimation
3. Inspecting the mechanism
4. The mechanism under the microscope

Identification and Estimation of IRFs

- Narrative identification (Romer and Romer (2010))
- Personal and corporate income taxes (Mertens and Ravn (2013))
- Local projections to estimate long-run effects (Jordà (2005))

Empirical Estimates

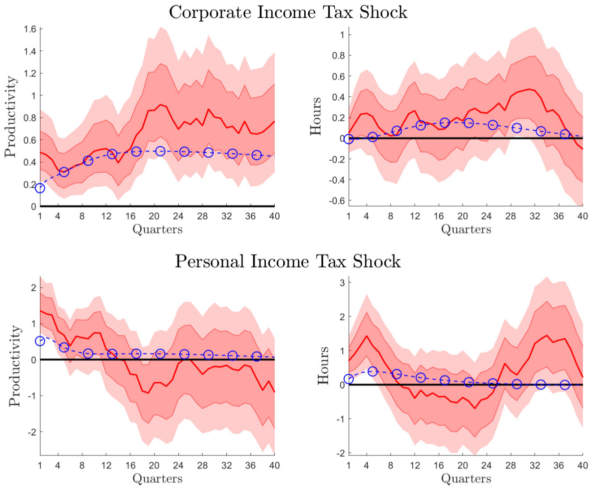
Do Temporary Tax Rate Cuts lead to a Persistent GDP increase?



Plots of posterior median, 68% and 90% credible intervals and estimated model IRF

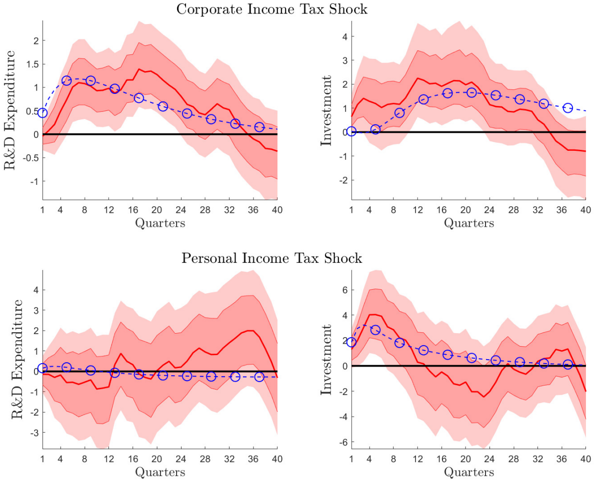
Cumulative Response

Productivity and Hours



Plots of posterior median, 68% and 90% credible intervals and estimated model IRF

R&D and Investment



Plots of posterior median, 68% and 90% credible intervals and estimated model IRF

W TFP C

Structural Model

A New-Keynesian model with endogenous growth

Standard features:

- Habit formation in consumption
- Calvo price rigidity
- Taylor rule for monetary policy
- Flow investment adjustment costs
- Variable capital and labor utilization

Non-standard feature:

- Endogenous productivity via R&D and adoption (Comin and Gertler (2006))

Production Sector and Endogenous TFP

- Final good output

$$Y_t = \left(\int_0^{A_t} \left(Y_{i,t} \right)^{\frac{1}{\theta}} \mathrm{d}i \right)^{\theta}$$

- $A_t =$ stock of adopted technologies (Romer (1990)), $\theta > 1$
- Aggregation (symmetric equilibrium)

$$Y_t = \underbrace{A_t^{\theta-1}}_{\substack{\text{Endog.} \\ \text{TFP}}} \; (\underbrace{U_{K,t}}_{\substack{\text{Capital} \\ \text{Util.}}} \; K_t)^{\alpha} \; (\underbrace{U_{N,t}}_{\substack{\text{Labor} \\ \text{Util.}}} \; N_t)^{1-\alpha}$$

Taxes and Labor Productivity

$$\frac{Y_t}{N_t} = A_t^{\theta-1} \left(U_{K,t}\right)^{\alpha} \left(\frac{K_t}{N_t}\right)^{\alpha} \left(U_{N,t}\right)^{1-\alpha}$$

Taxes and Labor Productivity

$$\frac{Y_t}{N_t} = A_t^{\theta-1} \left(U_{K,t}\right)^{\alpha} \left(\frac{K_t}{N_t}\right)^{\alpha} \left(U_{N,t}\right)^{1-\alpha}$$

- Corporate income tax $\downarrow$
    1. $\uparrow$ after-tax return on capital

Taxes and Labor Productivity

$$\frac{Y_t}{N_t} = A_t^{\theta-1} \left(U_{K,t}\right)^{\alpha} \left(\frac{K_t}{N_t}\right)^{\alpha} \left(U_{N,t}\right)^{1-\alpha}$$

- Corporate income tax $\downarrow$
  1. $\uparrow$ after-tax return on capital
     $\uparrow$ capital utilization ($U_{K,t}$)
     $\uparrow$ capital accumulation $\left(\frac{K_t}{N_t}\right)$

Taxes and Labor Productivity

$$\frac{Y_t}{N_t} = A_t^{\theta-1} \left(U_{K,t}\right)^{\alpha} \left(\frac{K_t}{N_t}\right)^{\alpha} \left(U_{N,t}\right)^{1-\alpha}$$

- Corporate income tax $\downarrow$
  1. $\uparrow$ after-tax return on capital
     - $\uparrow$ capital utilization ($U_{K,t}$)
     - $\uparrow$ capital accumulation $\left(\frac{K_t}{N_t}\right)$
  2. $\uparrow$ after-tax monopolistic profits

Taxes and Labor Productivity

$$\frac{Y_t}{N_t} = A_t^{\theta-1} \left(U_{K,t}\right)^{\alpha} \left(\frac{K_t}{N_t}\right)^{\alpha} \left(U_{N,t}\right)^{1-\alpha}$$

- Corporate income tax $\downarrow$
  1. $\uparrow$ after-tax return on capital
     - $\uparrow$ capital utilization ($U_{K,t}$)
     - $\uparrow$ capital accumulation $\left(\frac{K_t}{N_t}\right)$
  2. $\uparrow$ after-tax monopolistic profits
     - $\uparrow$ tech. adoption and R&D (A_t)

Taxes and Labor Productivity

$$\frac{Y_t}{N_t} = A_t^{\theta-1} \left(U_{K,t}\right)^{\alpha} \left(\frac{K_t}{N_t}\right)^{\alpha} \left(U_{N,t}\right)^{1-\alpha}$$

- Corporate income tax $\downarrow$
  1. $\uparrow$ after-tax return on capital
     - $\uparrow$ capital utilization ($U_{K,t}$)
     - $\uparrow$ capital accumulation $\left(\frac{K_t}{N_t}\right)$
  2. $\uparrow$ after-tax monopolistic profits
     - $\uparrow$ tech. adoption and R&D (A_t)

- Personal income tax $\downarrow$
  1. $\uparrow$ after-tax wage

Taxes and Labor Productivity

$$\frac{Y_t}{N_t} = A_t^{\theta-1} \left(U_{K,t}\right)^{\alpha} \left(\frac{K_t}{N_t}\right)^{\alpha} \left(U_{N,t}\right)^{1-\alpha}$$

- Corporate income tax $\downarrow$
  1. $\uparrow$ after-tax return on capital
     - $\uparrow$ capital utilization ($U_{K,t}$)
     - $\uparrow$ capital accumulation $\left(\frac{K_t}{N_t}\right)$
  2. $\uparrow$ after-tax monopolistic profits
     - $\uparrow$ tech. adoption and R&D (A_t)

- Personal income tax $\downarrow$
  1. $\uparrow$ after-tax wage
     - $\uparrow$ labor utilization ($U_{N,t}$)

Structural Estimation

- Estimate subset of parameters using Bayesian limited-information approach (Christiano et al. (2010))
- Standard priors for structural parameters: imply acyclical productivity response and no long-run effect

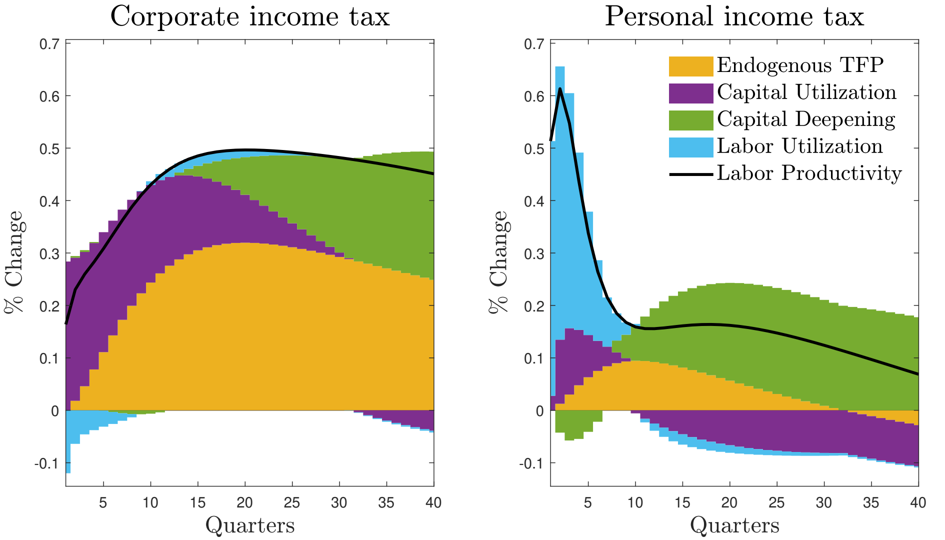
Calibrated Estimated QL

Inspecting the mechanism

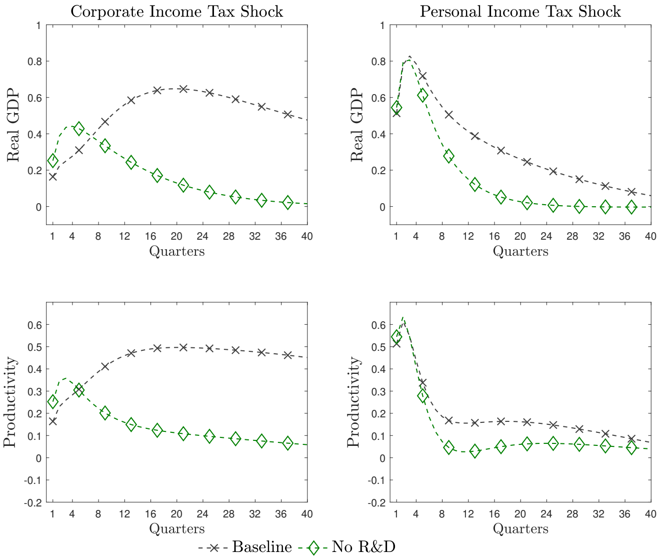
1. Model-based decomposition of corporate and personal tax effects

2. Counterfactual simulations
   a) No endogenous productivity
   b) No endogenous productivity or variable utilization

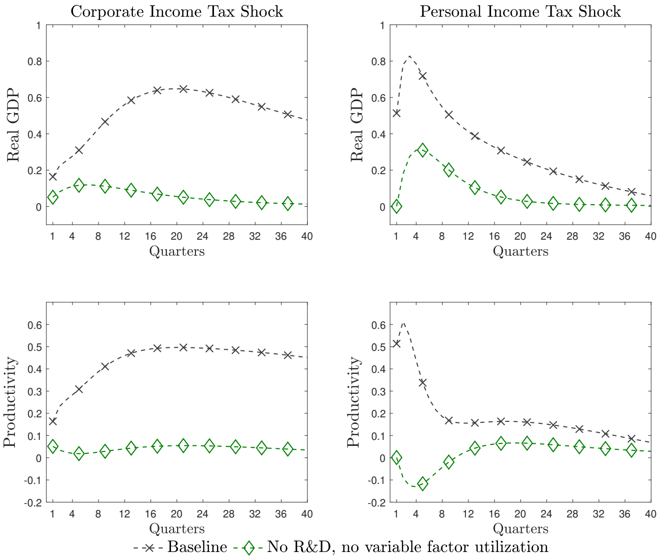
1. Model-based Decomposition: Productivity



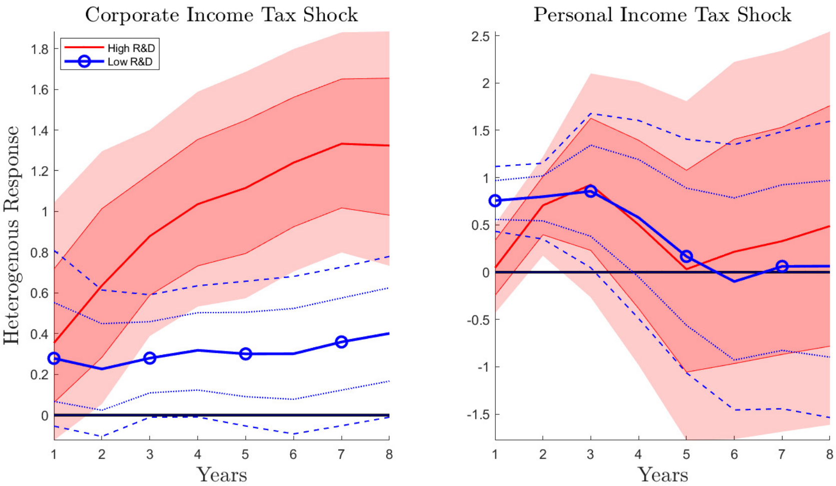
2a. Counterfactual: no endogenous productivity



2b. Counterfactual: no endogenous productivity or variable utilization



The mechanism under the microscope



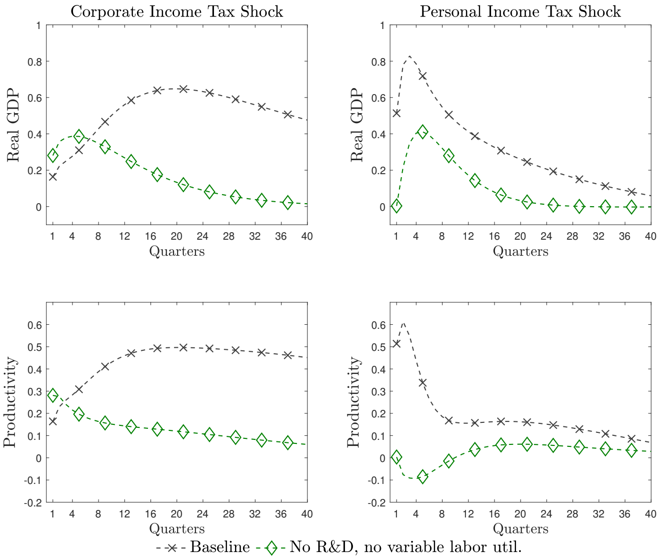
Note: IRF of aggregate sector gross output (source: BEA industry accounts)

Conclusions

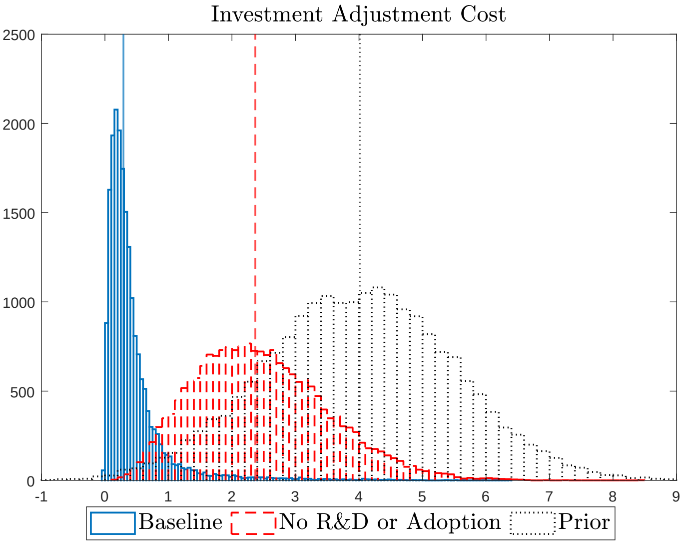
1. Transitory changes in corporate income tax, long-run effect on GDP
2. Persistent response of labor productivity explains GDP response
3. Through lens of the model, labor productivity driven by:
    - R&D and adoption for corporate tax changes
    - Labor utilization for personal tax changes

APPENDIX

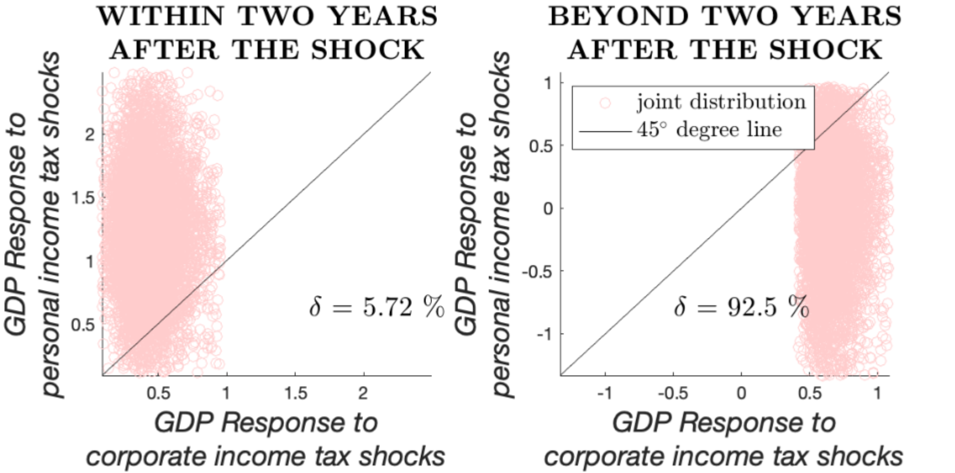
2c. Counterfactual: No endogenous productivity or capital utilization



Investment Adjustment Cost



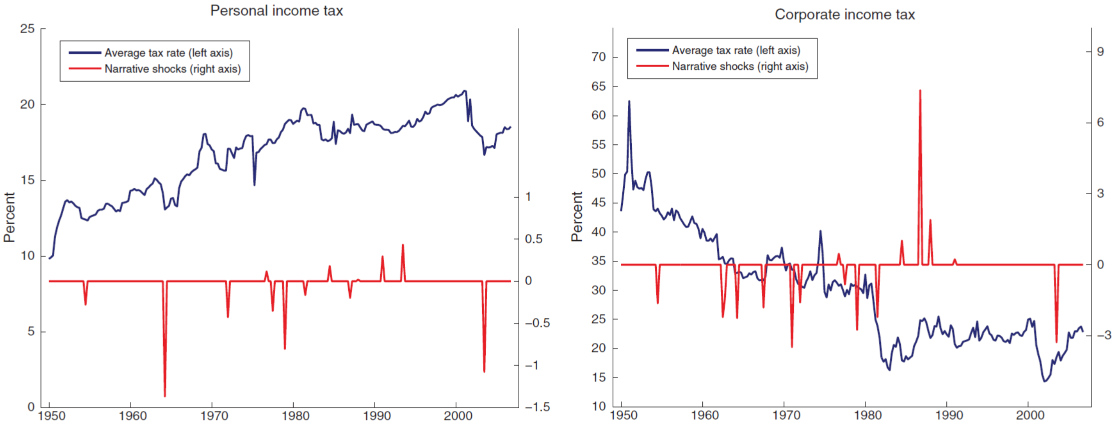
Joint Posterior Distributions



Joint Posterior Distribution of Shorter-term versus Longer-term Effects on GDP

Back

Mertens and Ravn (2013) Shocks



From Mertens and Ravn (2013)

Back

Narrative Identification

Romer and Romer (2010)

- "*The [narrative] analysis allows us to separate legislated changes into those taken for reasons related to prospective economic conditions and those taken for more exogenous reasons.* [...] *[T]ax changes motivated by factors unrelated to the current or prospective state of the economy form our new series of fiscal shocks.*"

From Mertens and Ravn (2013):

- federal tax liability changes are classified into personal and corporate income tax changes

Back

Local Projections (LP)

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

- Z: variable of interest and controls (average PIT and CIT rates and bases, government spending, GDP, federal debt, interest rate, macro/finance principal component)
- Reduced-form errors u_t linked to structural shocks by

$$u_t = A_0 \varepsilon_t$$

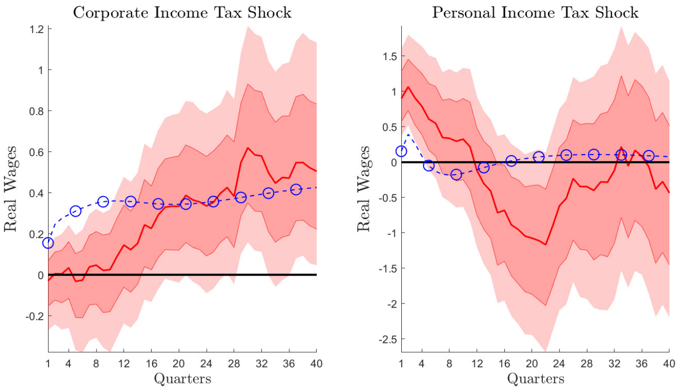
- Impulse response at forecast horizon h can be computed as

$$B_1^{(h)} A_0$$

- Jordà et al. (2020); Li et al. (2021) show that LP estimates of $B_1^{(h)}$ are unbiased $\forall h$

Back

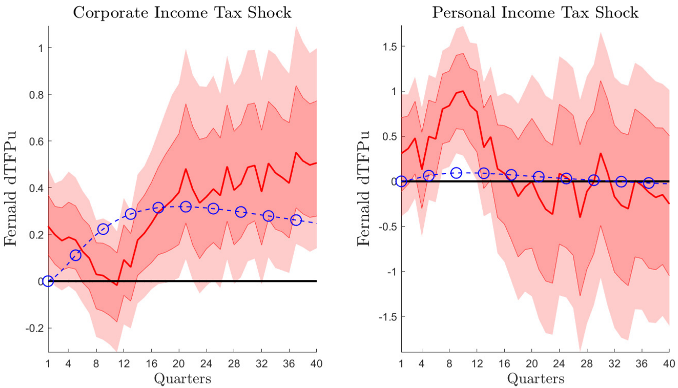
Real Wages



Plots of posterior median, 68% and 90% credible intervals and estimated model IRF

Back

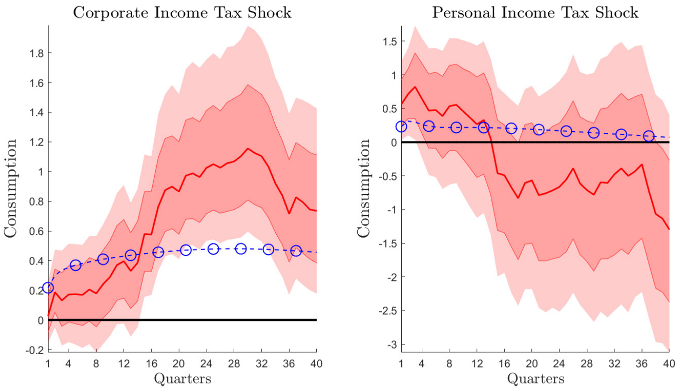
Fernald dTFPu



Plots of posterior median, 68% and 90% credible intervals and estimated model IRF

Back

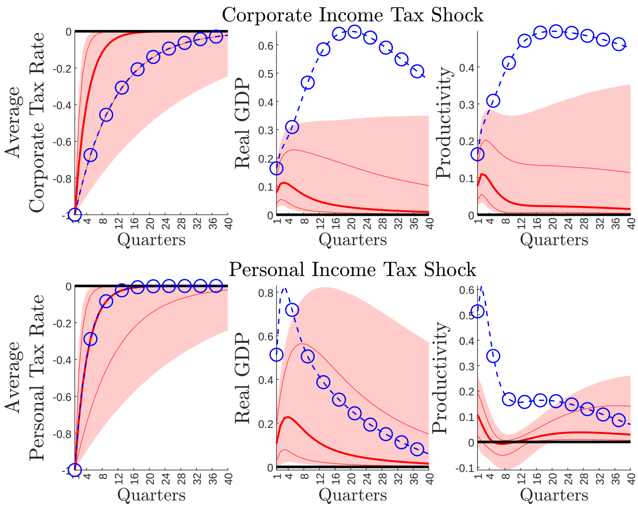
Consumption



Plots of posterior median, 68% and 90% credible intervals and estimated model IRF

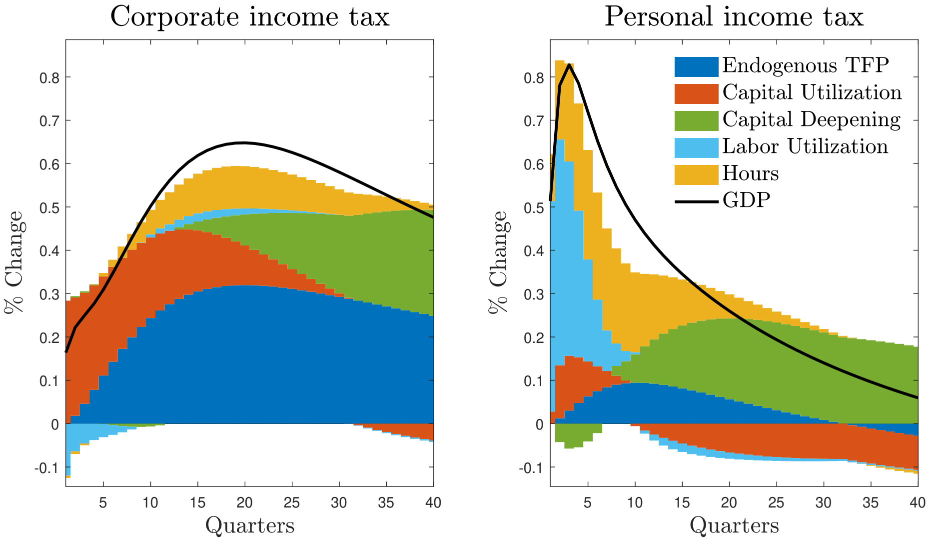
Back

Prior Predictive Analysis



Back

Model: GDP Decomposition



Back

The Structural Estimation Approach

- Estimate subset of parameters Υ using Bayesian limited-information approach (Christiano et al. (2010))
- IRFs matched: average tax rates, GDP, consumption, investment, R&D expenditure, hours worked, labor productivity
- $\hat{\Phi}$: median of empirical LP IRF posteriors to 2 tax shocks; $\Phi(\Upsilon)$: model IRFs
- Quasi-likelihood:

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

- With priors $p\left(\Upsilon\right)$, quasi-posterior is

$$F\left(\Upsilon|\hat{\Phi}\right) \propto F(\hat{\Phi}|\Upsilon)p\left(\Upsilon\right)$$

Back

Calibrated Parameters (all)

Parameter	Description	Value	Source
Preference & Households			
g_y	100*SS GDP growth rate	0.45	
β	Discount factor	0.99	
ψ_N	Employment adjustment	0.25	Wen (2004)
Technology			
GY	Government spending/GDP	0.16	
α	Capital share	0.35	
δ	Capital depreciation.	0.02	
ς	Markup	1.09	Profits/GDP=8%
$\bar{\lambda}$	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			
ρ_r	Smoothing	0.83	Anzoategui et al. (2019)
ϕ_y	Output	0.39	Anzoategui et al. (2019)
ϕ_π	Inflation	1.64	Anzoategui et al. (2019)

Back

Estimated Parameters

Parameter	Description	Prior			Posterior	
		Distr	Mean	Std. Dev.	Median	90% int.
Preference & HHs						
h	Consumption habit	beta	0.5	0.2	0.43	[0.15, 0.75]
γ	Inverse effort elasticity	gamma	1	0.5	0.28	[0.11, 0.67]
Frictions & Production						
f_a''	Adoption adjustment	normal	4	1.5	4.36	[1.86, 6.81]
f_z''	R&D adjustment	normal	4	1.5	6.67	[4.75, 8.71]
f_I''	Investment adjustment	normal	4	1.5	0.29	[0.05, 1.31]
ν''	Capital utilization adjustment	beta	0.6	0.15	0.49	[0.33, 0.69]
ξ_p	Calvo prices	beta	0.5	0.2	0.21	[0.07, 0.37]
Endogenous Technology						
θ-1	Dixit-Stiglitz parameter	gamma	0.15	0.1	0.42	[0.32, 0.53]
ρ_λ	Adoption elasticity	beta	0.5	0.2	0.59	[0.54, 0.64]
ρ_Z	R&D elasticity	beta	0.5	0.2	0.15	[0.09, 0.23]
$1-\phi$	Knowledge depreciation	beta	0.05	0.05	0.11	[0.06, 0.19]
Shocks						
$\rho_{\tau,CI}$	Corporate taxes AR	beta	0.7	0.2	0.91	[0.89, 0.92]
$\rho_{\tau,PI}$	Labour taxes AR	beta	0.7	0.2	0.73	[0.68, 0.78]

Back

Labor productivity and taxes

- From production function, labor productivity is

$$\frac{Y_t}{N_t} = \underbrace{A_t^{\theta-1}}_{\substack{\text{Endog.}\\ \text{TFP}}} \underbrace{\left(U_{K,t}\right)^{\alpha}}_{\substack{\text{Capital}\\ \text{Util.}}} \left(\frac{K_t}{N_t}\right)^{\alpha} \underbrace{\left(U_{N,t}\right.}_{\substack{\text{Labor}\\ \text{Util.}}} \left.\right)^{1-\alpha}$$

Labor productivity and taxes

- From production function, labor productivity is

$$\frac{Y_t}{N_t} = \underbrace{A_t^{\theta-1}}_{\substack{\text{Endog.}\\ \text{TFP}}} \underbrace{\left(U_{K,t}\right)^{\alpha}}_{\substack{\text{Capital}\\ \text{Util.}}} \left(\frac{K_t}{N_t}\right)^{\alpha} \underbrace{\left(U_{N,t}\right.}_{\substack{\text{Labor}\\ \text{Util.}}} \left.\right)^{1-\alpha}$$

- Capital utilization and labor effort

$$\nu'\left(U_{K,t}\right) = \left(1 - \tau_t^{CI}\right) r_t^k$$

$$U_{N,t}^{\gamma} = u_{c,t}\left(\left(1 - \tau_t^{PI}\right) w_t / \gamma_0\right)$$

- Euler equation for capital

$$P_{I,t} = \mathbb{E}_t \left\{ \beta \Lambda_{t,t+1} \left[r_{t+1}^k U_{K,t+1} - \tau_{t+1}^{CI} \left(r_{t+1}^k U_{K,t+1} - \delta \right) + (1-\delta) P_{I,t+1} - a\left(U_{K,t+1}\right) \right] \right\}$$

Labor productivity and taxes

- Labor productivity

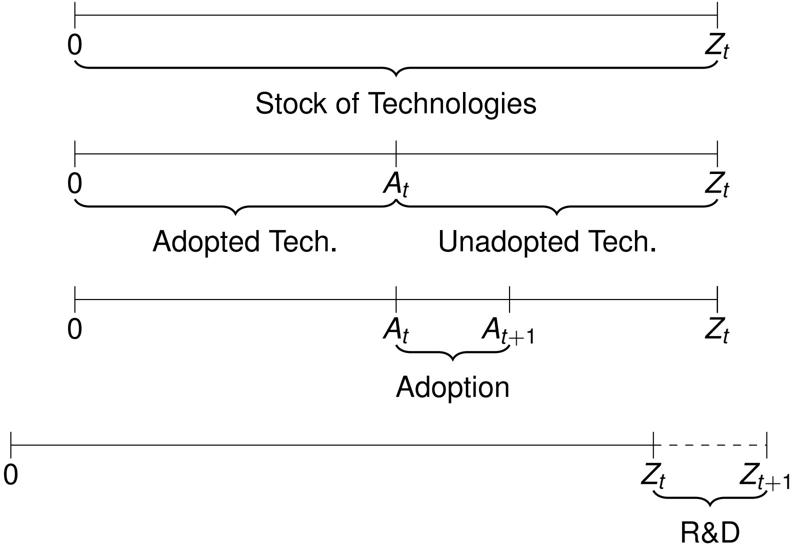
$$\frac{Y_t}{N_t} = \underbrace{A_t^{\theta-1}}_{\substack{\text{Endog.}\\ \text{TFP}}} \underbrace{(U_{K,t})^{\alpha}}_{\substack{\text{Capital}\\ \text{Util.}}} \left(\frac{K_t}{N_t}\right)^{\alpha} \underbrace{(U_{N,t}}_{\substack{\text{Labor}\\ \text{Util.}}})^{1-\alpha}$$

- Adoption decision

$$V_t = \left(1 - \tau_t^{CI}\right) \Pi_{i,t} + \phi E_t \left\{\beta \Lambda_{t,t+1} V_{t+1}\right\}$$

$$\underbrace{\frac{\partial \lambda_t}{\partial X_{k,a,t}} \cdot \phi E_t \left\{\Lambda_{t,t+1} \left[V_{t+1} - J_{t+1}\right]\right\}}_{\text{Marginal benefit of adoption}} = \underbrace{P_{a,t}}_{\text{Marginal cost}}$$

Technological progress



The Adoption Process

- Adoption is the process that transforms ideas, $Z_t - A_t$, into technologies, A_{t+1}
- The probability that adopter k successfully adopts a new technology is:

$$\lambda_t = \lambda\left(\frac{Z_t X_{k,a,t}}{\Psi_t}\right)$$

- with $\lambda' > 0$, $\lambda'' < 0$; Ψ_t: scaling factor
- The value of the technology adopted by the intermediate good producer is:

$$V_t = \left(1 - \tau_t^{CI}\right)\Pi_{i,t} + \phi E_t\left\{\beta\Lambda_{t,t+1}V_{t+1}\right\}$$

- where $\Pi_{i,t}$ are the profits from adopted intermediate good

The Adoption Process cont'ed

- The value of unadopted technology, J_t, depends on the probability of successfully adopting, λ_t, and the quantity of adoption goods, $X_{k,a,t}$, chosen by the intermediate good producer:

$$J_t = \max_{X_{k,a,t}} E_t \left\{ -P_{a,t} X_{k,a,t} + \phi \beta \Lambda_{t,t+1} \left[\lambda_t V_{t+1} + (1 - \lambda_t) J_{t+1} \right] \right\}$$

- FOC

$$\underbrace{\frac{\partial \lambda_t}{\partial X_{k,a,t}} \cdot \phi E_t \left\{ \Lambda_{t,t+1} \left[V_{t+1} - J_{t+1} \right] \right\}}_{\text{Expected Marginal Benefit}} = \underbrace{P_{a,t}}_{\text{Marginal Cost}}$$

- LOM for adopted technology in the aggregate

$$A_{t+1} = \lambda_t \phi \left[Z_t - A_t \right] + \phi A_t$$

Adoption

- Value of an adopted technology

$$V_t = \underbrace{\left(1 - \tau_t^{CI}\right)\Pi_{i,t}}_{\text{After-tax monopolistic profit}} + \phi E_t \left\{\beta \Lambda_{t,t+1} V_{t+1}\right\}$$

- Adoption decision (value of *un*adopted technology)

$$J_t = \max_{X_{a,t}} E_t \left\{-P_{a,t} X_{a,t} + \phi \beta \Lambda_{t,t+1} \left[\lambda(X_{a,t}) V_{t+1} + (1 - \lambda(X_{a,t})) J_{t+1}\right]\right\}$$

- Adoption probability $\lambda(X_{a,t})$, $\lambda' > 0$, $\lambda'' < 0$

$$A_{t+1} = \lambda_t \phi \left[Z_t - A_t\right] + \phi A_t$$

R&D and Adoption

- Z_t: Total stock of knowledge (i.e. adopted technology, A_t, + ideas, $Z_t - A_t$)
- J_t: Value of unadopted technology (sold by the innovator to the adopter)
- $X_{z,t}$: R&D-specific goods
- $P_{z,t}$: Price of R&D goods
- φ_t: New (unadopted) technologies created per unit of R&D goods $X_{s,t}$:

$$\varphi_t = Z_t^{\zeta+1} X_{z,t}^{\rho_z - 1}$$

- Innovator j's decision problem:

$$\max_{X_{j,z,t}} E_t \left\{ \beta \Lambda_{t,t+1} J_{t+1} \varphi_t X_{j,z,t} \right\} - P_{z,t} X_{j,z,t}$$

R&D optimization and the LOM of the stock of knowledge

- R&D decision FOC:

$$E_t \left\{ \beta \Lambda_{t,t+1} J_{t+1} \varphi_t \right\} - P_{z,t} = 0$$

- In aggregate:

$$E_t \left\{ \beta \Lambda_{t,t+1} J_{t+1} Z_t^{1+\zeta} X_{z,t}^{\rho_z - 1} \right\} = P_{z,t}$$

- The Law of Motion (LOM) of the stock of knowledge Z_t:

$$\begin{aligned} Z_{t+1} &= \varphi_t X_{z,t} + \phi Z_t \\ &= Z_t^{1+\zeta} X_{z,t}^{\rho_z} + \phi Z_t \end{aligned}$$

Households

- Household problem standard except for labor supply
- The household's maximization problem and budget constraint are

$$\max_{C_t, N_{t+1}, U_{N,t}, U_{K,t}, I_t} E_t \sum_{\tau=0}^{\infty} \beta^{\tau} \left\{ \log\left(C_{t+\tau} - bC_{t+\tau-1}\right) - \gamma_0 \frac{1 + U_{N,t}^{1+\gamma}}{1+\gamma} N_t \right\}$$

s.t.

$$C_t = \left(1 - \tau_t^{PI}\right) w_t L_t + D_t - \frac{\psi_n}{2} \left(\frac{N_{t+1}}{N_t} - 1\right)^2 \Psi_t + T_t,$$

- Effective labor supply (hours $\times$ effort):

$$L_t = U_{N,t} N_t$$

- Dividend:

$$D_t = \left(1 - \tau_t^{CI}\right) \left(Y_t - w_t L_t - P_{z,t} X_{z,t} - P_{a,t} X_{a,t} - \delta K_t\right) - P_{I,t} I_t - \left(\nu\left(U_{K,t}\right) - \delta\right) K_t$$

Households

1. Employment

$$\beta\mathbb{E}_t\{\gamma_0\frac{1+(U_{N,t+1})^{1+\gamma}}{1+\gamma}+u_{c,t+1}[(1-\tau^{PI}_{t+1})w_{t+1}U_{N,t+1}$$
$$+\phi_n\Psi_{t+1}(\frac{N_{t+2}}{N^2_{t+1}})(\frac{N_{t+2}}{N_{t+1}}-1)]\}-\psi_n u_{c,t}\Psi_t\frac{1}{N_t}\left(\frac{N_{t+1}}{N_t}-1\right)=0$$

2. Effort

$$-\gamma_0\left(U_{N,t}\right)^{\gamma}+u_{c,t}\left(\left(1-\tau^{PI}_t\right)w_t\right)=0$$

3. Euler Equation

$$P_{I,t}=\mathbb{E}_t\left\{\beta\Lambda_{t,t+1}\left[\left(1-\tau^{CI}_{t+1}\right)r^k_{t+1}U_{K,t+1}+(1-\delta)P_{I,t+1}-\nu\left(U_{K,t+1}\right)\right]\right\},$$

4. Capital Utilization

$$\left(1-\tau^{CI}_t\right)r^k_t=\nu'\left(U_{K,t}\right)$$

END