Fiscal Policy and the Distribution of Consumption Risk

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- Endogenous growth
  - Fiscal policy affects long-term growth prospects
- Recursive Epstein-Zin (EZ) preferences
  - Agents care about long-run uncertainty
- Asset market data suggest a high price of long-run uncertainty

Step 1: Model

- Accumulation of product varieties
- EZ preferences

Government

- We assume exogenous government expenditures

$$\frac{G_t}{Y_t} = \frac{1}{1 + e^{-gy_t}} \in (0, 1),$$

where

$$gy_t = (1 - \rho)\overline{gy} + \rho_g gy_{t-1} + \epsilon_{G,t}, \quad \epsilon_{G,t} \sim N(0, \sigma_{gy}).$$

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- A government policy finances expenditures G_t using a mix of
  - labor income tax

$$T_t = \tau_t W_t L_t$$

  - public debt

$$\int_{h_{t+1}} Q_t^B(h_{t+1}) B_{t+1}(h_{t+1}) = B_t + G_t - T_t$$

Consumers

- Agent has Epstein-Zin preferences defined over consumption and leisure:

$$U_t = \left[(1-\beta)u_t^{1-\frac{1}{\psi}} + \beta(\mathbb{E}_t U_{t+1}^{1-\gamma})^{\frac{1-\frac{1}{\psi}}{1-\gamma}}\right]^{\frac{1}{1-1/\psi}}$$

$$u_t = \left[\kappa C_t^{1-1/\nu} + (1-\kappa)[A_t(1-L_t)]^{1-1/\nu}\right]^{\frac{1}{1-1/\nu}}$$

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\end{aligned}
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- Stochastic Discount Factor:

$$
M_{t+1} = \beta\left(\frac{U_{t+1}^{1-\gamma}}{\mathbb{E}_t[U_{t+1}^{1-\gamma}]}\right)^{\frac{1/\psi-\gamma}{1-\gamma}} \left(\frac{u_{t+1}}{u_t}\right)^{2-\frac{1}{\psi}-\frac{1}{\nu}} \left(\frac{C_{t+1}}{C_t}\right)^{-\frac{1}{\nu}}
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$$

- The intratemporal optimality condition on labor

$$
MRS_t^{c,L} = \underbrace{(1-\tau_t)}_{\text{Tax Distortion}} W_t
$$

Competitive Final Goods Sector

- Firm uses labor and a bundle of intermediate goods as inputs:

$$Y_t = \Omega_t L_t^{1-\alpha} \left[\int_0^{A_t} X_{it}^{\alpha} \, di \right]$$

- Growth comes from increasing measure of intermediate goods A_t.
- Ω_t is the stationary productivity process in this economy:

$$\log(\Omega_t) = \rho \log(\Omega_{t-1}) + \epsilon_t, \quad \epsilon_t \sim N(0, \sigma^2)$$

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- Intermediate goods are purchased at price P_{it}. Optimality implies:

$$X_{it} = L_t \left(\frac{A_t \alpha}{P_{it}} \right)^{\frac{1}{1-\alpha}}$$

$$W_t = (1-\alpha) \frac{Y_t}{L_t}$$

Intermediate Goods Sector

- The monopolist producing patent $i \in [0, A_t]$ sets prices in order to maximize profits:

$$\begin{aligned} \Pi_{it} &\equiv \max_{P_{it}} \underbrace{P_{it}X_{it}}_{\text{Revenues}} - \underbrace{X_{it}}_{\text{Costs}} \\ &= \underbrace{(\frac{1}{\alpha} - 1)}_{\text{Markup}}(\Omega_t \alpha^2)^{\frac{1}{1-\alpha}} L_t \equiv \Theta_t L_t \end{aligned}$$

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- Assume in each period intermediate goods become obsolete at rate δ.
- The value of a new patent is the PV of future profits

$$V_t = E_t\left[\sum_{j=0}^{\infty}(1-\delta)^j M_{t+j}\Theta_{t+j}L_{t+j}\right]$$

R&D Sector

- Recall S_t denotes R&D investments, the measure of input variety A_t evolves as:

$$A_{t+1} = \vartheta_t S_t + (1 - \delta) A_t$$

  - ϑ_t measures R&D productivity: $\vartheta_t = \chi(\frac{S_t}{A_t})^{\eta - 1}$

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- Free-entry condition:

$$\underbrace{\frac{1}{\vartheta_t}}_{\text{Cost}} = \underbrace{E_t\Big[M_{t+1}V_{t+1}\Big]}_{\text{Benefit}}$$

Equilibrium Growth

- The equilibrium growth rate is given by

$$\frac{A_{t+1}}{A_t} = 1 - \delta + \chi^{\frac{1}{1-\eta}} E_t \left[M_{t+1} V_{t+1} \right]^{\frac{\eta}{1-\eta}}$$

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- Discount rate channel: Growth rate is negatively related to discount rate and hence risk
  - With recursive preferences, long-run uncertainty affects growth rate

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$$= 1-\delta+\chi^{\frac{1}{1-\eta}} E_t\left[\sum_{j=1}^{\infty} M_{t+j|t}(1-\delta)^{j-1}\underbrace{\Theta_{t+j}L_{t+j}}_{\text{Profits}}\right]^{\frac{\eta}{1-\eta}}.$$

- Labor channel: Long-term movements in taxes affect future labor supply, and hence profits and growth
  - Short-run tax stabilization may come at the cost of slowdown in growth

Step 2: Ramsey's Problem

- Write Ramsey FOCs determining optimal policy
- Goal: *qualitative* analysis of relevance of the intertemporal distribution of tax distortions with EZ

Ramsey Problem

Choose Ψ in order to

$$\max_{\{C_t, L_t, S_t, A_{t+1}\}_{t=0,h^t}^{\infty}} U_0 = W(u_0, U_1)$$

subject to

$$Y_t = C_t + A_t X_t + S_t + G_t \quad (1)$$

$$\Upsilon_0 = \sum_{t=0}^{\infty} \sum_{h^t} \left(\prod_{j=1}^{t} W_2(u_{j-1}, U_j) \right) W_1(u_t, U_{t+1}) [u_{C_t} C_t + u_{L_t} L_t] \quad (2)$$

where

- $\Upsilon_0 = W_1(u_0, U_1) u_{C_0} (Q_0 + \mathcal{D}_0)$

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and subject to

$$\begin{aligned} A_{t+1} &= \vartheta_t S_t + (1 - \delta) A_t && (3) \\ \frac{1}{\vartheta_t} &= E_t \left[M_{t+1} V_{t+1} \right] && (4) \\ U_t &= W(u_t, U_{t+1}) && (5) \end{aligned}$$

Optimal Tax policy (I): FOC C_t

- Let:
  - $u_{C,t}^{Ram,EZ}$ and $u_{C,t}^{Ram,SL}$ be the multiplier attached to the resource constraint in benchmark model, and Lucas and Stokey (1983)
  - ξ and O_t be multipliers on the implementability & free-entry constraints
  - $\Xi_{C,t} = \frac{\partial M_{t+1}/\partial C_t}{M_{t+1}}$

$$u_{C_t}^{Ram,EZ} = W_{1_t} u_{C_t}^{Ram,SL} - \underbrace{O_t \Xi_{C,t} V_t}_{\text{Incentives}} + \underbrace{\xi W_{1_t} u_{C_t} FD_t}_{\text{Distortions}}$$

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- **Endogenous growth:** incentives for growth depend on asset prices, V_t
- **EZ:** Ramsey cares about future distortions, i.e., U_{t+1} smoothing

$$FD_t = (u_{C_t} C_t + u_{L_t} L_t)\left(\frac{W_{11_t}}{W_{1_t}} + \frac{W_{1_t} W_{22_{t-1}}}{W_{2_{t-1}}}\right)$$

Optimal Tax policy (II): FOC L_t

- Let $\Xi_{L,t} = \frac{\partial M_{t+1}/\partial L_t}{M_{t+1}}$.
- Let MPL denote the marginal product of labor:

$$MPL_t = MRS^{Ram,EZ}_{C_t,L_t} = \frac{u^{Ram,SL}_{L_t} + \xi u_{L_t} FD_t - O_{C,t}\Xi_{C,t}V_t}{u^{Ram,SL}_{C_t} + \xi u_{C_t} FD_t - O_{L,t}\Xi_{L,t}V_t}$$

Step 3: Exogenous Fiscal Policy

- Goal: *quantitatively* characterize the trade-off between current vs future taxation distortions
- Financing policy $\rightarrow$ consumption risk reallocated toward long-run
- Preference for early resolution of uncertainty $\rightarrow$ short-run countercyclical fiscal policies lead to long-run distortions and sizeable welfare losses

Exogenous Policy Rule

- Government implements (uncontingent) debt policies of the form

$$\frac{B_t}{Y_t} = \rho_B \frac{B_{t-1}}{Y_{t-1}} + \epsilon_{B,t} \tag{6}$$
$$\epsilon_{B,t} = \phi_1^G \cdot (\log L_{ss} - \log L_t)$$

  - L_{ss} steady state level of labor
  - $\phi_1^G = 0$: Zero deficit policy
    - $B_t = 0$ and
    - $G_t = T_t$
  - $\phi_1^G > 0$: Countercyclical policy (tax smoothing)

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    - $G_t = T_t$
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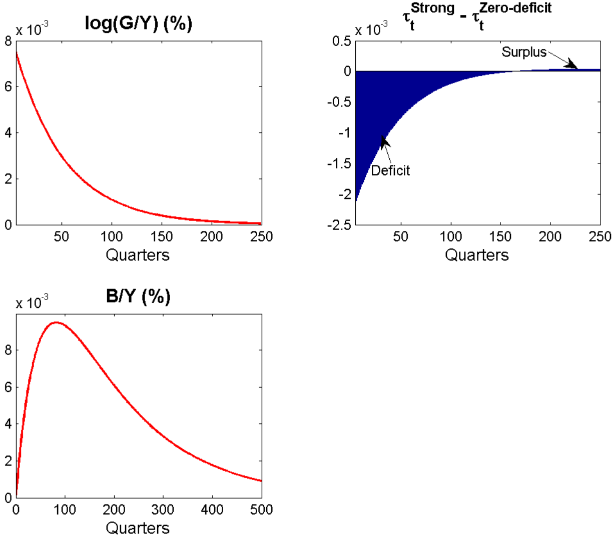
- Combine (6) with $B_t = (1 + r_{f,t-1})B_{t-1} + G_t - T_t$ to recover the implied tax-rate policy.

Fiscal variables after a government expenditure shock

- Tax smoothing through initial deficit



Welfare costs (WCs)

- Benchmark: the zero-deficit consumption process

$$E\left[\frac{U}{C}(\{C_{zd}\})\right]$$

- The welfare costs (benefits) of an alternative consumption process C^* is:

$$\log E\left[\frac{U}{C}(\{C^*\})\right] - \log E\left[\frac{U}{C}(\{C_{zd}\})\right]$$

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- Welfare reflects the present value of consumption, P_C/C:

$$\frac{U_t}{C_t} \quad = \quad \left[(1-\delta)\cdot(\frac{P_{c,t}}{C_t}+1)\right]^{\frac{1}{1-1/\Psi}}$$

Welfare costs (WCs) and consumption distribution

- P_c/C in the BY(2004) log-linear case:

$$\begin{aligned} \Delta c_{t+1} &= \mu + x_t + \sigma_c \epsilon_{c,t+1} \\ x_t &= \rho_x x_{t-1} + \sigma_x \epsilon_{x,t} \end{aligned}$$

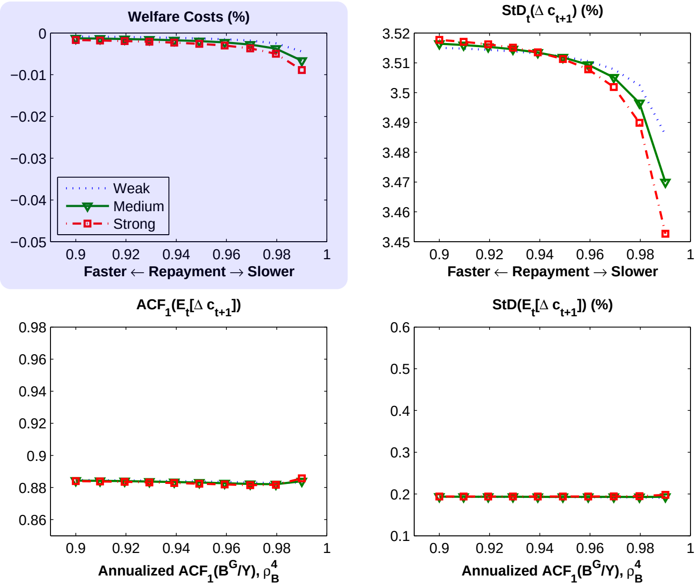
- For explanation purposes, we map:

$$\begin{aligned} \mu &\rightarrow E[\Delta c_t] \\ \sigma_c &\rightarrow StD_t[\Delta c_{t+1}] \\ StD[x_t] = \tfrac{\sigma_x}{\sqrt{1-\rho_x^2}} &\rightarrow StD[E_t[\Delta c_t]] \\ \rho_x &\rightarrow ACF_1[E_t[\Delta c_t]] \end{aligned}$$

- Debt policy: a device altering the distribution of consumption risk.

WCs when RRA=1/IES=10 (CRRA)

- Small welfare benefits of tax smoothing



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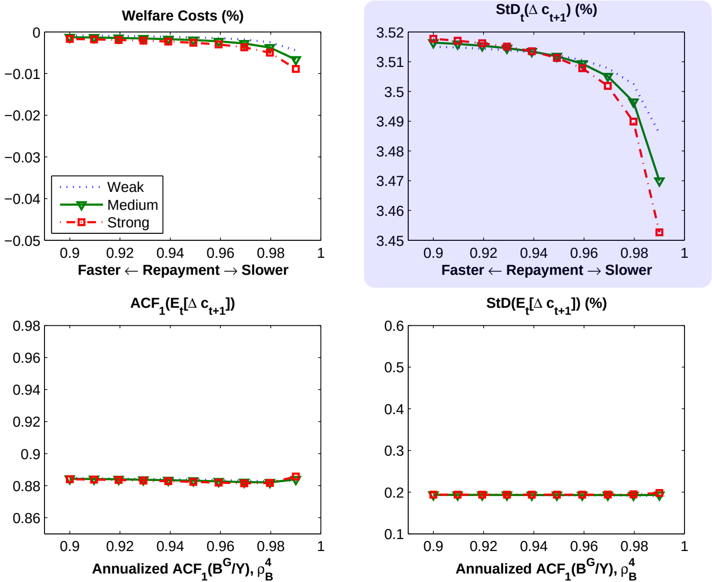

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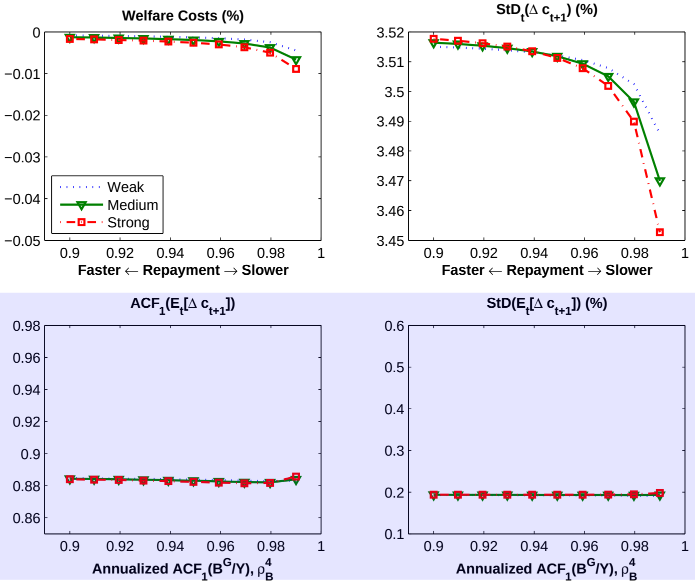

WCs when IES=1.7 & RRA=10

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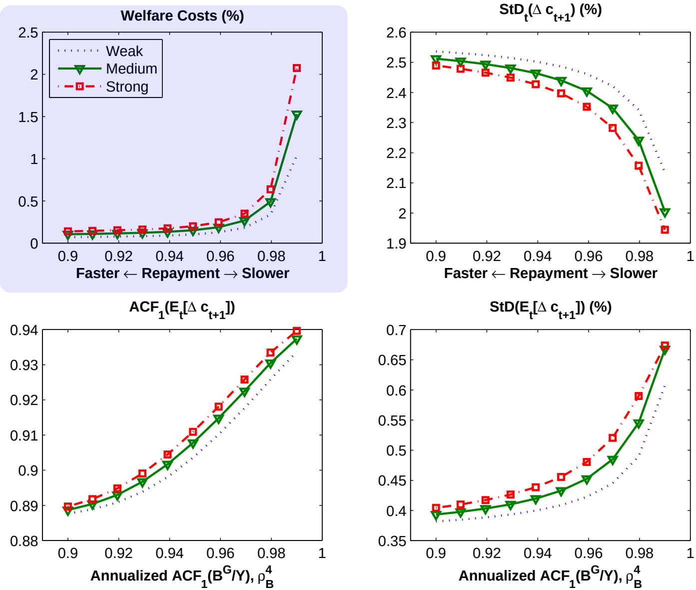

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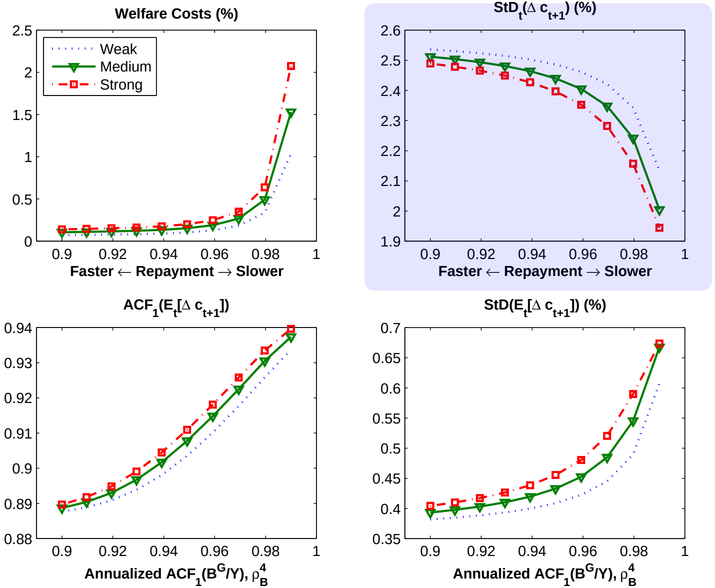

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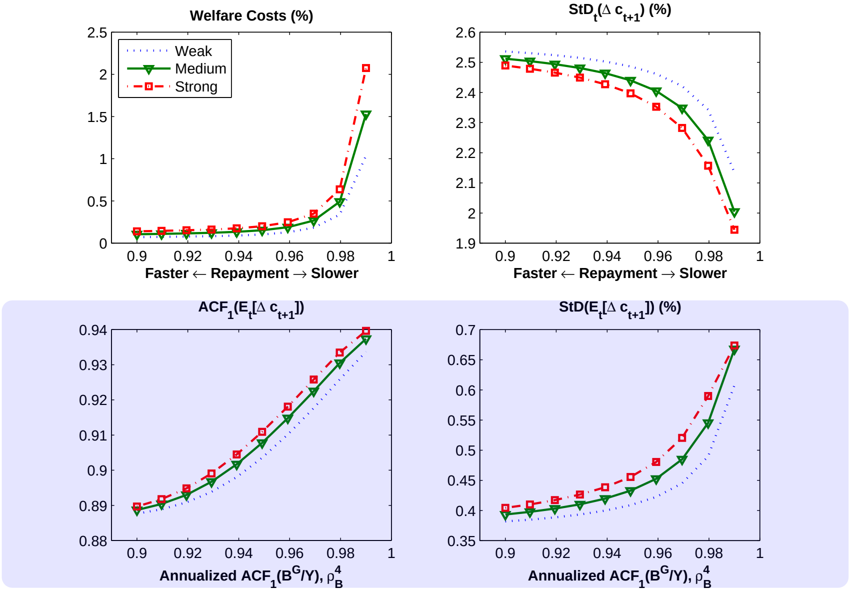
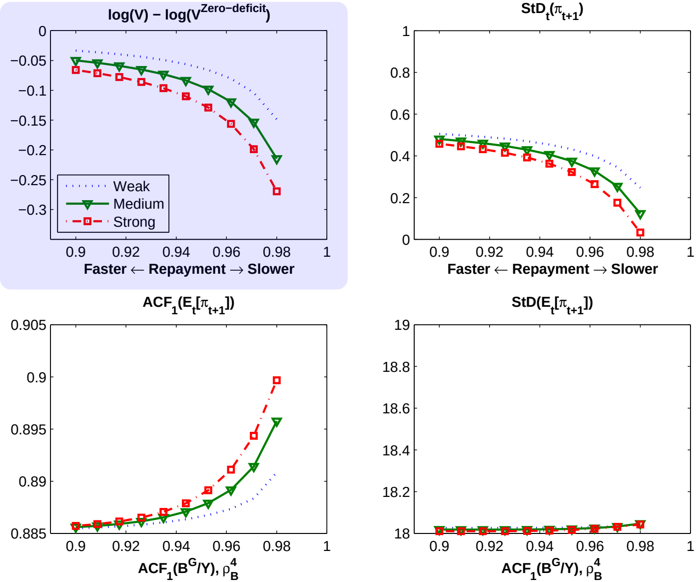


Patent value (V), profits (π) distribution, and growth

$$E\left[A_{t+1}/A_t\right] = 1 - \delta + \chi^{\frac{1}{1-\eta}} E_t\left[M_{t+1}V_{t+1}\right]^{\frac{\eta}{1-\eta}}$$



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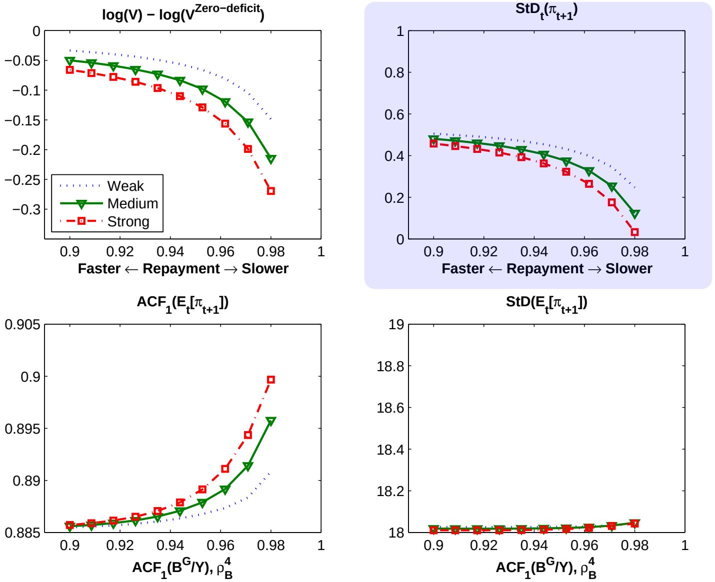

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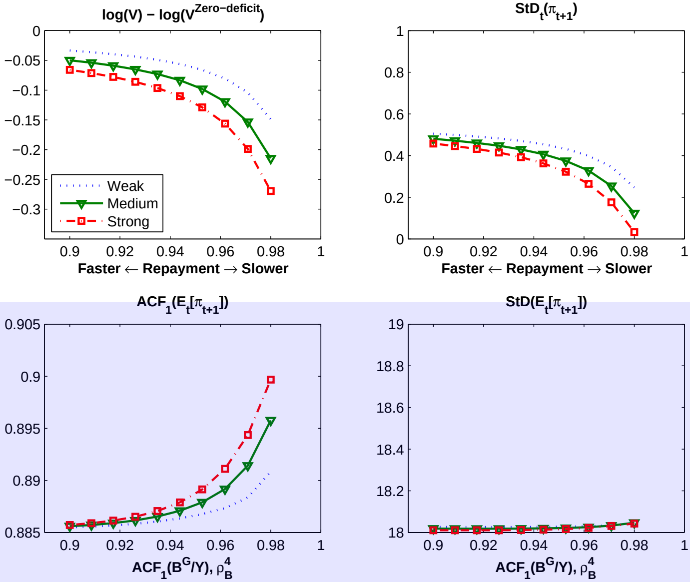

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- Asset Pricing Perspective:
  - Fiscal policy alters long-run growth risk and wealth
- Fiscal Policy Perspective:
  - Financial markets dynamics are essential to design optimal fiscal policy
- Broader Point:
  - Conveying the need of introducing risk considerations in the current fiscal debate

Impulse responses: $G \uparrow$

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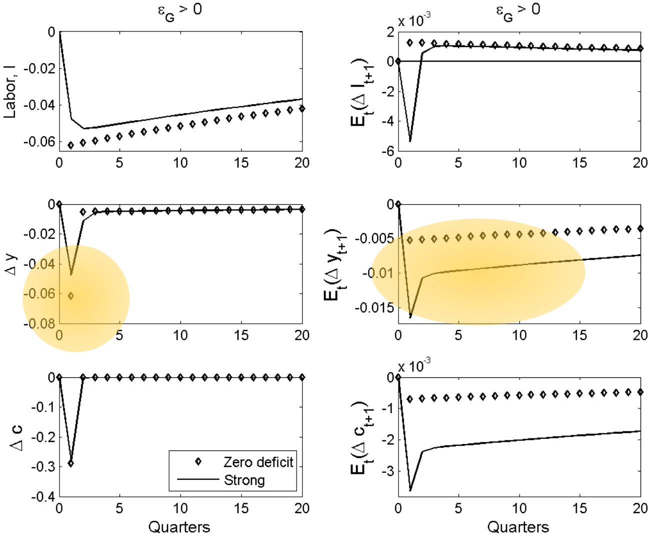

Impulse responses: $G \uparrow$ and IES $= 0.1$ (CRRA)

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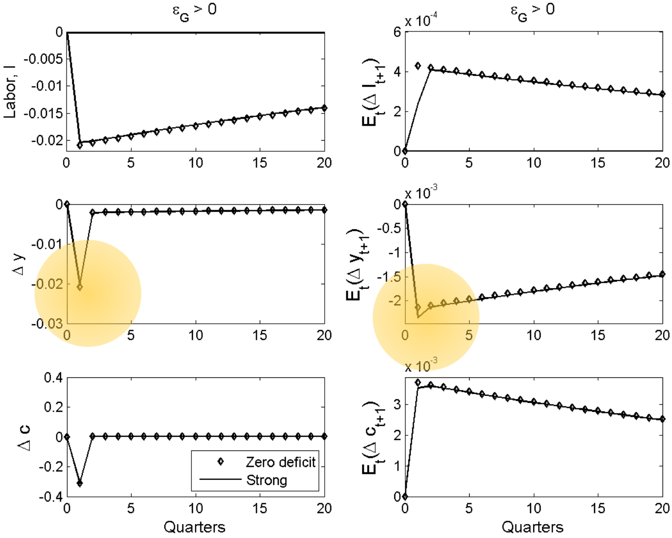
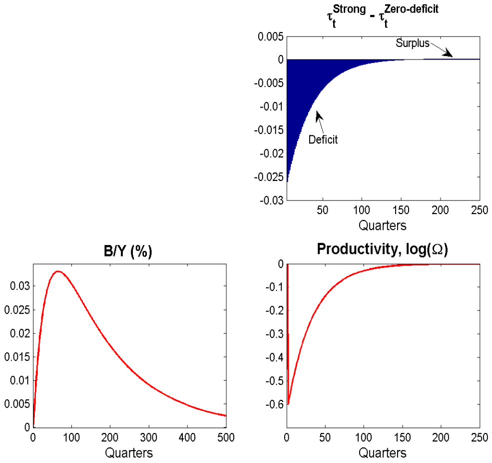
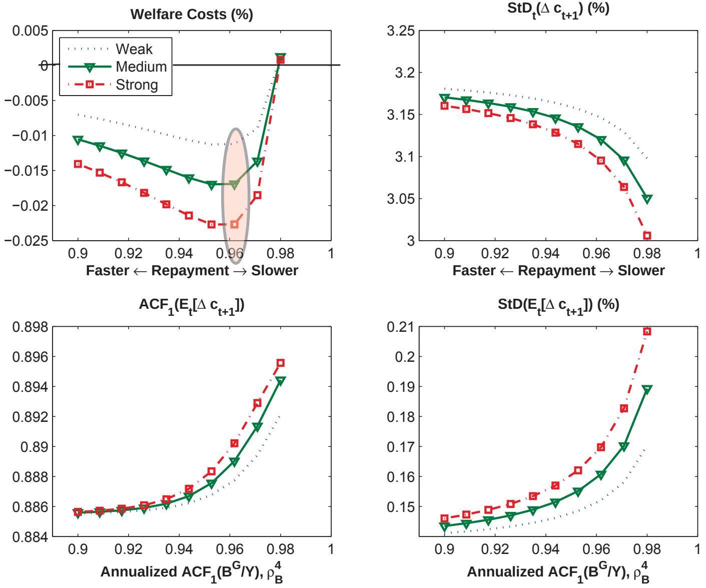


Fiscal variables after a negative productivity shock



WCs when IES=.8 and RRA=10

- Smooth taxes, but not too much...



Ramsey: utility smoothing

- Assume IES=1 and take logs:

$$U_t = (1-\delta)\log C_t + \frac{\delta}{1-\gamma}\log E_t \exp\left\{\frac{U_{t+1}}{\theta}\right\}$$

Ramsey: utility smoothing

- Assume IES=1 and take logs:

$$U_t = (1-\delta)\log C_t + \frac{\delta}{1-\gamma}\log E_t \exp\left\{\frac{U_{t+1}}{\theta}\right\}$$

- When utilities are long-normal:

$$U_t = (1-\delta)\log C_t + \delta E_t[U_{i,t+1}] + \frac{\delta}{2(1-\gamma)} V_t[U_{i,t+1}].$$

Agenda

Where we are coming from:

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What's next?

- Ai, Croce, Schmid (2013a): "Global Growth and Fiscal Imbalances", fiscal policy and **endogenous technology diffusion**;
- Croce, Donadelli, Schmid (2013b): "Global Entropy", **robust endogenous technology diffusion**.

Income effects?

- Crowding out

$$
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MRS &= (1-\tau)W \\
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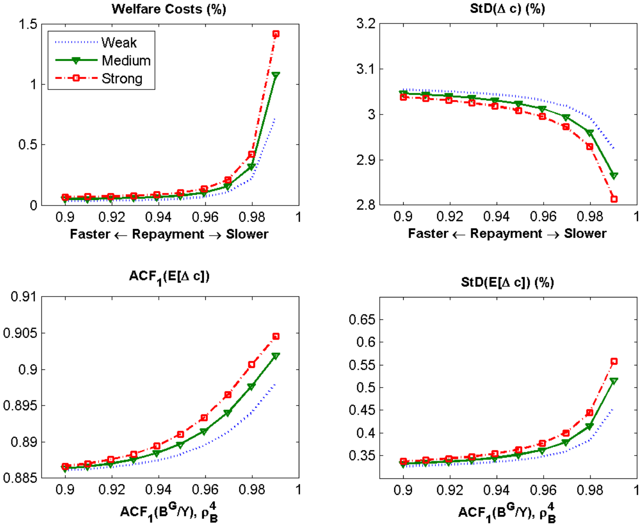
- A possible way to isolate the distortionary effect

$$\begin{aligned} MRS &= (1-\tau)W \\ C &= Y - S - AX \end{aligned}$$

  - Tax is transfered back to household in lump-sum.

WCs and consumption distribution with transfer

- Substantial welfare costs even with lump-sum transfer



Calibration

Description	Symbol	Value
Preference Parameters		
Consumption-Labor Elasticity	ν	0.8
Utility Share of Consumption	κ	0.17
Discount Factor	β	0.997
Intertemporal Elasticity of Substitution	ψ	1.7
Risk Aversion	γ	10
Technology Parameters		
Elasticity of Substitution Between Intermediate Goods	α	0.7
Autocorrelation of Productivity	ρ	0.97
Scale Parameter	χ	0.44
Survival rate of intermediate goods	ϕ	0.97
Elasticity of New Intermediate Goods wrt R&D	η	0.8
Standard of Deviation of Technology Shock	σ	0.006
Government Expenditure Parameters		
Level of Expenditure-Output Ratio (G/Y)	$\overline{gy}$	-2.2
Autocorrelation of G/Y	ρ_g	0.98
Standard deviation of G/Y shocks	σ_g	0.008

Main Statistics

- Quarterly calibration; time aggregated annual statistics.

	Data	Zero deficit $\phi_1^G = 0$
$E(\Delta c)$	2.83	2.13
$\sigma(\Delta c)$	2.34	2.57
$ACF_1(\Delta c)$	0.44	0.30
$E(L)$	33.0	35.59
$E(\tau)$ (%)	33.5	33.50
$\sigma(\tau)$ (%)		2.01
$\sigma(m)$ (%)		53.20
$E(r_f)$	0.93	1.28
$E(r^C - r_f)$		1.51

- We use asset prices to discipline the calibration

Price of Long-Run Uncertainty

Asset market data suggest a high price of long-run uncertainty

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We examine fiscal policy design in the presence of high costs of long-run uncertainty