The Unequal Costs of Pollution: Carbon Tax, Inequality, and Redistribution

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Background and Motivation

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- Without careful design, regressive impacts could exacerbate inequality and erode political support.
- The costs and benefits of reducing emissions (**efficiency**) vs redistribution (**equity**) materialize at different horizons.
- ⇒ **Cyclicality** of the social cost of carbon (SCC).

Shadow price of carbon for the social planner

Research Question and Contribution

- How does household heterogeneity shape the **level** and **dynamics** of the social cost of carbon and the associated optimal carbon tax?
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- **Key ingredients**:

  1. **Limited asset market participation**: a carbon tax on firms *directly* affects firm owners' income. (Känzig, 2023)

  2. **Heterogeneous impact of climate externality**: poorer households bear a higher marginal disutility of pollution. (European Environment Agency, 2018; Colmer et al., 2024).

     ⇒ both the **costs** and the **benefits** of carbon taxation differ across households.

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  - Heterogeneity ↑ SCC → ↑ $\tau^{\star}$ & Emissions generate tax revenues → ↓ $\tau^{\star}$
- This wedge is **dynamic** and so is the tax!
  - Inequality affects also the cyclical properties of both the SCC and the optimal carbon tax.
  - Countercyclical inequality → dampens (amplifies) SCC (tax) fluctuations.
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    - Countercyclical inequality → dampens (amplifies) SCC (tax) fluctuations.
    - Expansions emerge as favorable times for stricter abatement policies.
- Optimal design crucially depends on **horizon**.
    - A high tax rate curbing emissions but exacerbating inequality preferable only in the very long run.

Related Literature

- Macro literature on LAMP, inequality fluctuations, and business cycles (Bilbiie, 2024; Känzig, 2023). **Inequality between savers and HtM households introduces time-varying wedge in the SCC.**

- Climate issues through business-cycle model (Heutel, 2012; Golosov et al., 2014; Annicchiarico and Di Dio, 2015; Benmir et al., 2020; Gibson and Heutel, 2023; Känzig, 2023; Sahuc et al., 2024). **SCC not necessarily procyclical (Heutel, 2012; Benmir et al., 2020) if inequality sufficiently countercyclical.**

- Carbon taxation in heterogeneous agent settings (Fullerton and Monti, 2013; Jacobs and van der Ploeg, 2019; Goulder et al., 2019; Känzig, 2023; Fried et al., 2024; Ascari et al., 2025; Belfiori et al., 2024). **Inequality and redistribution impact level and *dynamics* of the optimal carbon tax. The level turns out to be higher than in a RA economy.**

Setup

- A RBC model with an environmental externality due to an accumulated pollution stock in the **utility function** (Benmir et al., 2020; Acemoglu et al., 2012; Stokey, 1998).
- Two types of households: HtM, who consume all their income, and savers, who save and invest.
- Firms produce and generate greenhouse gas (GHG) emissions. Details
- The government runs a balanced budget. Details

Stock of GHGs and Emissions - Heutel (2012)

- The accumulation of greenhouse gases (GHGs) depends on human activity according to:

  $$X_{t+1} = \eta X_t + E_t, \tag{1}$$

  where X_t is the concentration of GHGs in the atmosphere, $E_t \geq 0$ the flow of emissions, and $\eta \in (0, 1)$ is the linear rate of continuation of CO2-equivalent emissions on a quarterly basis.

- Emissions result from human activity as follows:

  $$E_t = (1 - \mu_t)\phi_1 Y_t^{1-\phi_2}, \tag{2}$$

  where $\mu_t \in [0, 1]$ is the fraction of emissions abated by firms, Y_t denotes aggregate output, and $\phi_1, \phi_2 \geq 0$ are carbon intensity parameters governing the relationship between the production process and emissions.

Firms

- Dividends are defined as:

$$D_t = Y_t - W_t N_t - I_t - f(\mu_t) Y_t - \tau_t E_t. \tag{3}$$

- The abatement cost function is defined as:

$$f(\mu_t) = \theta_1 \mu_t^{\theta_2}, \tag{4}$$

  where μ_t is level of abatement. A lower θ_1 implies a more efficient abatement technology.

- τ_t denotes the carbon tax potentially levied by the fiscal authority on firms' emissions.

Households

- Savers (fraction $1-\gamma$) and HtM (fraction γ) households.
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  - HtM excluded from financial markets. Savers hold bonds and stocks (productive sector).
  - For now, both groups do not value leisure.
- External habit preferences in the spirit of Campbell and Cochrane (1999):

$$u_t^i = \frac{(c_t^i - \chi X_t)^{1-\sigma}}{1-\sigma}, \quad i \in \{H, S\}, \tag{5}$$

where $\chi \in [0, 1]$ denotes the sensitivity of utility to the GHGs stock, or equivalently the strength of the environmental externality.

Heterogeneous Disutility of GHGs

- Environmental externality enters the utility function **non-additively**. This has two key implications:

  1. Consumption and the stock of emissions are complements (the so called *compensation effect* in Michel and Rotillon, 1995);

  2. Poorer households suffer relatively more from environmental hazards (European Environment Agency, 2018; Hausman and Stolper, 2021; Cain et al., 2024; Colmer et al., 2024).

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- Marginal disutility of an increase in the stock of GHGs is given by:

$$u^i_{X,t} = -\chi(C^i_t - \chi X_t)^{-\sigma}. \tag{6}$$

Thus, $C^H_t < C^S_t \Rightarrow |u^H_{X,t}| > |u^S_{X,t}|$.

Decentralized Economy

- Firm does not consider X_t to be a control variable and neglects its negative impact on household utility when making production decisions.

- The private marginal cost of emissions for firms (V_t^E) is simply given by the carbon tax (τ_t).

- Firms do not abate emissions in the decentralized economy (BAU scenario) where $\tau_t = 0$.

- Dec. Economy

Unconstrained Transfer Policy (PU)

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- Then: Details

$$\begin{aligned} C_t^H &= C_t^S, \\ V_t^{E,PU} &= V_t^{X,PU}, \\ V_t^{X,PU} &= \mathbb{E}_t \mathbb{M}_{t,t+1}^{PU} [\eta V_{t+1}^{X,PU} + \chi]. \end{aligned}$$

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- In the decentralized economy, $V_t^E = \tau_t$. Then, first-best allocation in the competitive equilibrium by imposing the tax rate:

$$\tau_t^* = V_t^{X,PU}, \tag{7}$$

i.e., by re-aligning the firms' private cost of emission to the SCC.

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- Specifically, the planner can only transfer (lump-sum) the tax revenue to HtM households and/or savers based on a policy of the form (see, e.g., Känzig, 2023):

$$T_t^S = \frac{1-\xi}{1-\gamma}\tau_t E_t, \tag{8}$$

$$T_t^H = \frac{\xi}{\gamma}\tau_t E_t. \tag{9}$$

- Parameter $\xi \in [0, 1]$ controls the share of revenues accruing to HtM households.
    - For example, $\xi = 0$ ($\xi = 1$) implies that taxes are fully transferred to savers (HtM households). If $\xi = \gamma$, tax revenues are redistributed uniformly.

Constrained Transfer Policy (PC): The SCC

- The FOCs that differ compared to the unconstrained case are: Details

$$\lambda_t^{PC} = (C_t^S - \chi X_t)^{-\sigma}, \tag{10}$$

$$\lambda_t^{H,PC} = \gamma \frac{\left[(C_t^H - \chi X_t)^{-\sigma} - \lambda_t^{PC}\right]}{\lambda_t^{PC}}, \tag{11}$$

$$V_t^{X,PC} = \mathbb{E}_t \mathbb{M}_{t,t+1}^{PC} \left\{\eta V_{t+1}^{X,PC} + \chi\left[1 + \lambda_{t+1}^{H,PC}\right]\right\}, \tag{12}$$

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- **Novel results**:
    1. The SCC features a **time-varying wedge** capturing the marginal utility gap;
    2. The private cost of emissions equals the SCC **net of redistribution benefits**.

Constrained Transfer Policy (PC): Optimal Tax

- By imposing $V_t^{E,PC} = \tau_t^*$ in equation (13), we can solve for the constrained optimal tax rate:

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  1. Emissions induce a more negative effect on social welfare relative to the unconstrained case. $V_t^{X,PC} > V_t^{X,PU} \Rightarrow \tau_t^* \uparrow$;
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- An **equity-efficiency trade-off** emerges in the presence of inequality and heterogeneous marginal disutility of pollution.

Uniform Redistibution Case

Constrained Transfer Policy (PC): Optimal Tax *Dynamics*

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- If $\xi > 0$, the dynamics of $\lambda_t^{H,PC}$ affects not only the SCC but also the planner's marginal benefit of redistribution.

- Thus, while dampening the dynamics of the SCC, countercyclical inequality could actually *amplify* fluctuations in the optimal tax relative to the unconstrained case.

Means

Calibration Full Table

Variable	BAU	PU	PC		
			$\xi = 0$	$\xi = \gamma$	$\xi = 1$
C_t^S	0.827	0.785	0.820	0.820	0.816
C_t^H	0.641	0.785	0.623	0.643	0.675
V_t^X	0.034	0.020	0.032	0.031	0.028
τ_t^*	0.000	0.020	0.032	0.020	0.010
X_t	476.84	321.79	276.13	321.42	371.54
μ_t	0.000	0.322	0.417	0.322	0.218
$\mathcal{W}_t$	−108.65	−69.895	−74.368	−77.856	−81.622
U_t^S	−77.078	−69.895	−54.302	−59.020	−66.184
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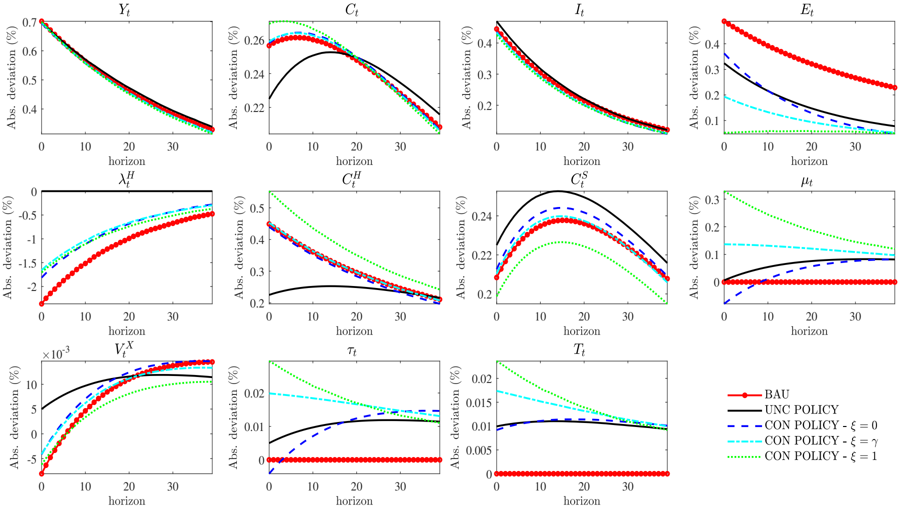
Responses to TFP Shocks

St. Deviations



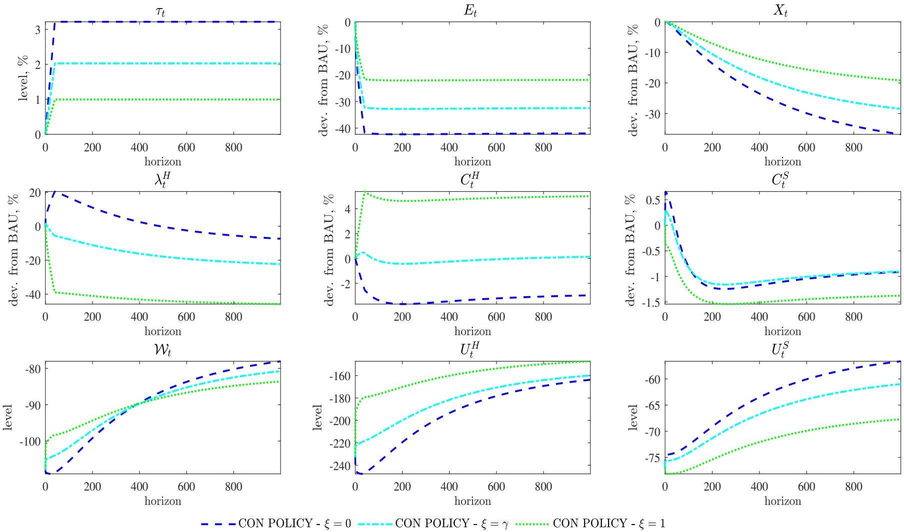
Transitions from BAU

- Transitions from BAU to each of the alternative constrained policy schemes.
- How long does it take for each policy to be beneficial?
- When do costs and benefits start to materialize?
- We assume that the tax rate increases linearly from zero to its optimal level for 10 years (similar to Ascari et al., 2025).
- Conversely, the government fully implements the relevant redistribution scheme starting from period 1.
- Perfect foresight solution.

Transitions from BAU

Zoom in

Y, C, I



Sensitivity Analysis

Rob. Means Rob. Stds Rob. IRFs Rob. Transition

1. Low HtM share (Kaplan et al., 2014).
   - ∗ Affects weight of poorer households in welfare function.
2. Low abatement efficiency (high θ_1).
   - ∗ Affects efficiency/equity trade-off on average, but not dynamics.
3. Low externality weight.
   - ∗ Affects disutility from GHGs.
4. Capital adjustment costs (high ϵ).
   - ∗ Affects inequality dynamics, but not levels.

Conclusion

- This paper explores the implications of household heterogeneity for the design and cyclical behavior of optimal carbon taxes in a real economy.
    - Heterogeneity in income, consumption, and **disutility of GHGs accumulation**.

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- If the redistribution policy is constrained, an efficiency-equity trade-off arises, which affects both the level and the cyclical properties of the optimal carbon tax.

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- This paper explores the implications of household heterogeneity for the design and cyclical behavior of optimal carbon taxes in a real economy.
  - Heterogeneity in income, consumption, and **disutility of GHGs accumulation**.
- Inequality introduces a **time-varying wedge** in the SCC relative to a RA economy.
- If the planner's redistribution policy is unconstrained, inequality is eliminated and the optimal carbon tax is the same as in a RA economy.
- If the redistribution policy is constrained, an efficiency-equity trade-off arises, which affects both the level and the cyclical properties of the optimal carbon tax.
- Second best policy crucial depends on the horizon considered by the social planner.

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The Unequal Costs of Pollution: Carbon Tax, Inequality, and Redistribution

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PSE Macro Days

Paris

September 26th, 2025

Appendix

Firms

- Firms maximize profits in a competitive market and produce according to a Cobb-Douglas production function:

$$\begin{aligned} Y_t &= \varepsilon_t^A A K_t^{\alpha} N_t^{1-\alpha}, && (15) \\ \log(\varepsilon_t^A) &= \rho_A \log(\varepsilon_{t-1}^A) + \eta_t^A. && (16) \end{aligned}$$

- The capital stock follows the law of motion:

$$K_{t+1} = (1-\delta)K_t + \Phi\left(\frac{I_t}{K_t}\right)K_t, \qquad (17)$$

with $\Phi\left(\frac{I_t}{K_t}\right)$ being the capital adjustment cost function defined as in Jermann (1998):

$$\Phi\left(\frac{I_t}{K_t}\right) = \left[\frac{b_1}{1-\epsilon}\left(\frac{I_t}{K_t}\right)^{1-\epsilon} + b_2\right]. \qquad (18)$$

Back

Government and Market Clearing

- The government runs a balanced budget:

$$\begin{aligned} T_t &= \tau_t E_t, & (19)\\ T_t &= \gamma T_t^H + (1-\gamma) T_t^S. & (20) \end{aligned}$$

- Aggregation:

$$\begin{aligned} C_t &= \gamma C_t^H + (1-\gamma) C_t^S, & (21)\\ N_t &= \gamma N_t^H + (1-\gamma) N_t^S, & (22)\\ 1 &= (1-\gamma) S_t, & (23)\\ 0 &= (1-\gamma) B_t. & (24) \end{aligned}$$

- Finally, market clearing in the goods market requires:

$$Y_t = C_t + I_t + f(\mu_t) Y_t, \tag{25}$$

i.e., total output is either consumed, invested, or used to abate emissions.

Back

Unconstrained Transfer Policy (PU): Social Planner's Problem

- Consider first the case where the planner can freely transfer income between the two groups of households.
- The associated Lagrangian is:

$$
\begin{aligned}
\mathcal{L}^{PU} \quad = \quad & \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left\{ \gamma \frac{(C_t^H - \chi X_t)^{1-\sigma}}{(1-\sigma)} + (1-\gamma) \frac{(C_t^S - \chi X_t)^{1-\sigma}}{(1-\sigma)} \right. \\
& + \lambda_t^{PU} [Y_t - \gamma C_t^H - (1-\gamma) C_t^S - I_t - f(\mu_t) Y_t] \\
& + \lambda_t^{PU} Q_t^{PU} \left[(1-\delta) K_t + \Phi \left(\frac{I_t}{K_t} \right) K_t - K_{t+1} \right] \\
& + \lambda_t^{PU} \varrho_t^{PU} [\varepsilon_t^A A K_t^{\alpha} N_t^{1-\alpha} - Y_t] \\
& + \lambda_t^{PU} V_t^{X,PU} [X_{t+1} - \eta X_t - E_t] \\
& \left. + \lambda_t^{PU} V_t^{E,PU} \left[E_t - (1-\mu_t) \phi_1 Y_t^{1-\phi_2} \right] \right\}.
\end{aligned}
$$

Back

Unconstrained Transfer Policy (PU): The RA Benchmark

- The FOCs w.r.t. the two agents' consumption levels are:

$$C_t^H \quad : \quad \lambda_t^{PU} = (C_t^H - \chi X_t)^{-\sigma}, \tag{26}$$

$$C_t^S \quad : \quad \lambda_t^{PU} = (C_t^S - \chi X_t)^{-\sigma}, \tag{27}$$

  which implies $C_t^H = C_t^S$.

- It can be easily shown that equalized consumption entails:

$$T_t^H = \tau_t^{*,PU} E_t + D_t, \tag{28}$$

$$T_t^S = \tau_t^{*,PU} E_t - \frac{\gamma}{(1-\gamma)} D_t, \tag{29}$$

  that is, the planner redistributes the revenues from the optimal tax uniformly, while transferring financial income from the savers to the HtM.

Back

Unconstrained Transfer Policy (PU): Optimal Tax

- Consider the FOCs wrt emissions and the stock of GHGs in the atmosphere:

$$\begin{aligned} E_t &: \quad V_t^{E,PU} = V_t^{X,PU}, \qquad (30) \\ X_{t+1} &: \quad V_t^{X,PU} = \mathbb{E}_t \mathbb{M}_{t,t+1}^{PU} [\eta V_{t+1}^{X,PU} + \chi]. \qquad (31) \end{aligned}$$

- Condition (7) equalizes the private cost of emissions to the ***social* cost of carbon (SCC)**.

Back

Unconstrained Transfer Policy (PU): Output, Investment, and Capital

- Finally, the social planner also chooses output, investment, and capital stock:

$$Y_t : \varrho_t^{PU} = 1 - f(\mu_t) - V_t^{E,PU}(1-\phi_2)E_t/Y_t, \tag{32}$$

$$I_t : Q_t^{PU} b_1 \left(\frac{I_t}{K_t}\right)^{-\epsilon} = 1, \tag{33}$$

$$K_{t+1} : Q_t^{PU} = \mathbb{E}_t \mathbb{M}_{t,t+1}^{PU} \left\{ \varrho_{t+1}^{PU} \alpha Y_{t+1}/K_{t+1} + Q_{t+1}^{PU} \left[(1-\delta) + \Phi\left(\frac{I_{t+1}}{K_{t+1}}\right) - b_1 \left(\frac{I_{t+1}}{K_{t+1}}\right)^{1-\epsilon} \right] \right\}. \tag{34}$$

These optimality conditions are common to the RBC literature and are equivalent to the decentralized economy, with the only exception that the SDF depends on the planner's, rather than savers', marginal utility.

Back

Summary

- We start by analyzing the decentralized economy.
- Firms maximize profits and households maximize utility, separately.
- In this context, the private marginal cost of emissions for firms is simply the carbon tax.
- As a consequence, in a business-as-usual (BAU) scenario (where the tax rate is zero) firms do not abate emissions.
    - Hence, firms do not internalize the negative utility effect of pollution when making production decisions.

Back

Firms' Problem

- The representative firm chooses output, labor, investment, capital stock, abatement, and emissions to maximize its value, using the savers (firm owners) marginal utility to discount payoffs.
- The associated Lagrangian is:

$$
\begin{aligned}
\mathcal{L}^F \quad = \quad & \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \lambda_t^S \Big\{ Y_t - W_t N_t - I_t - f(\mu_t) Y_t - \tau_t E_t \\
& + \varrho_t [\varepsilon_t^A A K_t^{\alpha} N_t^{1-\alpha} - Y_t] \\
& + Q_t \left[(1-\delta) K_t + \Phi\left(\frac{I_t}{K_t} \right) K_t - K_{t+1} \right] \\
& + V_t^E [E_t - (1-\mu_t)\, \phi_1 Y_t^{1-\phi_2}] \Big\}.
\end{aligned}
$$

Back

Firms' FOCs

- The resulting FOCs are:

$$Y_t : \varrho_t = 1 - f(\mu_t) - V_t^E (1 - \phi_2) E_t / Y_t, \tag{35}$$

$$\mu_t : V_t^E \frac{E_t}{1 - \mu_t} = f'(\mu_t) Y_t, \tag{36}$$

$$E_t : V_t^E = \tau_t, \tag{37}$$

$$N_t : W_t = (1 - \alpha) \varrho_t Y_t / N_t, \tag{38}$$

$$I_t : Q_t b_1 \left(\frac{I_t}{K_t} \right)^{-\epsilon} = 1, \tag{39}$$

$$K_{t+1} : Q_t = \mathbb{E}_t \mathbb{M}^S_{t,t+1} \left\{ \varrho_{t+1} \alpha Y_{t+1} / K_{t+1} + Q_{t+1} \left[(1 - \delta) + \Phi \left(\frac{I_{t+1}}{K_{t+1}} \right) - b_1 \left(\frac{I_{t+1}}{K_{t+1}} \right)^{1-\epsilon} \right] \right\}. \tag{40}$$

Back

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Back

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&\qquad \left. \left. b_1 \left(\frac{I_{t+1}}{K_{t+1}} \right)^{1-\epsilon} \right] \right\}. && (40)
\end{aligned}
$$

Back

Households' Problem

- Being excluded from financial markets and given inelastic labor supply, HtM households consume labor income every period.
- Conversely, the Lagrangian of the saver reads:

$$\begin{aligned}\mathcal{L}^S &= \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left\{ \frac{(C_t^S - \chi X_t)^{1-\sigma}}{(1-\sigma)} \right. \\ &\left. + \lambda_t^S [W_t N_t^S + B_t + S_t(D_t + P_t^s) + T_t^S - C_t^S - P_t^b B_{t+1} - P_t^s S_{t+1}] \right\}.\end{aligned}$$

Back

Savers' FOCs

- The resulting FOCs are:

$$
\begin{aligned}
C_t^S &: \quad \lambda_t^S = (C_t^S - \chi X_t)^{-\sigma}, && (41)\\
B_{t+1} &: \quad P_t^b = \mathbb{E}_t \mathbb{M}_{t,t+1}^S, && (42)\\
S_{t+1} &: \quad P_t^s = \mathbb{E}_t \mathbb{M}_{t,t+1}^S (D_{t+1} + P_{t+1}^s). && (43)
\end{aligned}
$$

- Equation (41) denotes savers' marginal utility of consumption with $\mathbb{M}_{t,t+1}^S \equiv \beta(\lambda_{t+1}^S / \lambda_t^S)$ being the associated stochastic discount factor (SDF).
- Conditions (42)-(43) are the standard asset pricing equations for bonds and stocks.

Back

Constrained Transfer Policy (PC): Social Planner's Problem

- The Lagrangian is:

$$
\begin{aligned}
\mathcal{L}^{PC} \quad = \quad & \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \Bigg\{ \gamma \frac{(C_t^H - \chi X_t)^{1-\sigma}}{(1-\sigma)} + (1-\gamma) \frac{(C_t^S - \chi X_t)^{1-\sigma}}{(1-\sigma)} \\
& + \lambda_t^{PC} [Y_t - \gamma C_t^H - (1-\gamma) C_t^S - I_t - f(\mu_t) Y_t] \\
& + \lambda_t^{PC} \lambda_t^{H,PC} [W_t N_t^H + \frac{\xi}{\gamma} \tau_t E_t - C_t^H] \\
& + \lambda_t^{PC} Q_t^{PC} \left[(1-\delta) K_t + \Phi \left(\frac{I_t}{K_t} \right) K_t - K_{t+1} \right] \\
& + \lambda_t^{PC} \varrho_t^{PC} [\varepsilon_t^A A K_t^{\alpha} N_t^{1-\alpha} - Y_t] \\
& + \lambda_t^{PC} V_t^{X,PC} [X_{t+1} - \eta X_t - E_t] \\
& + \lambda_t^{PC} V_t^{E,PC} \left[E_t - (1-\mu_t) \phi_1 Y_t^{1-\phi_2} \right] \Bigg\}.
\end{aligned}
$$

Constrained Transfer Policy (PC): Uniform Redistribution

- If tax revenues are redistributed uniformly ($\xi = \gamma$), then the steady-state optimal tax is:

$$\tau^* = \frac{V^{X,PC}}{1+\lambda^{H,PC}}. \tag{44}$$

- It is easy to notice that:

$$\tau^* = \frac{\beta}{1-\beta\eta}\chi. \tag{45}$$

  Thus, the steady-state constrained optimal tax rate under uniform redistribution coincides with the unconstrained one, evaluated in the steady state.

Back

Calibration

Back

Description	Parameter	Value	Source/Target
Fraction of HtM	γ	0.20	Bottom income quintile
Discount rate	β	0.98267	Heutel (2012)
Local utility curvature	σ	4.199	Benmir et al. (2020)
Externality weight	χ	4×10^{-4}	"
Labor supply	N	1	Inelastic labor supply
Steady-state TFP	A	$(N_{BAU}^{1-\alpha} K_{BAU}^{\alpha})^{-1}$	$Y_{BAU} = 1$ in steady state
Capital share of income	α	0.36	Heutel (2012)
Depreciation rate	δ	0.025	"
Capital adjustment cost	ϵ	0.000	"
TFP persistence	ρ^A	0.95	"
TFP shock volatility	σ_{η^A}	0.007	"
Pollution decay	η	0.9979	"
Abatement efficiency	θ_1	0.05607	"
Abatement cost curvature	θ_2	2.8	"
Steady-state E_{BAU}/Y_{BAU}	ϕ_1	1	"
Elasticity of E_t to Y_t	$1-\phi_2$	0.696	"
Redistribution of tax revenues	ξ	$0/\gamma/1$	To S/Uniform/To H

Means: Additional Variables

Back

Variable	BAU	PU	PC		
			$\xi = 0$	$\xi = \gamma$	$\xi = 1$
Y_t	1.002	0.996	0.992	0.995	0.998
I_t	0.212	0.208	0.206	0.208	0.210
$f(\mu_t)Y_t$	0.000	0.002	0.005	0.002	0.001
C_t	0.790	0.785	0.781	0.785	0.787
C_t^S	0.827	0.785	0.820	0.820	0.816
C_t^H	0.641	0.785	0.623	0.643	0.675
V_t^X	0.034	0.020	0.032	0.031	0.028
τ_t^*	0.000	0.020	0.032	0.020	0.010
E_t	1.001	0.676	0.580	0.675	0.780
$\tau_t^* E_t$	0.000	0.014	0.019	0.014	0.008
X_t	476.84	321.79	276.13	321.42	371.54
μ_t	0.000	0.322	0.417	0.322	0.218
$\mathcal{W}_t$	-108.65	-69.895	-74.368	-77.856	-81.622
U_t^S	-77.078	-69.895	-54.302	-59.020	-66.184
U_t^H	-224.95	-69.895	-154.62	-153.20	-143.27

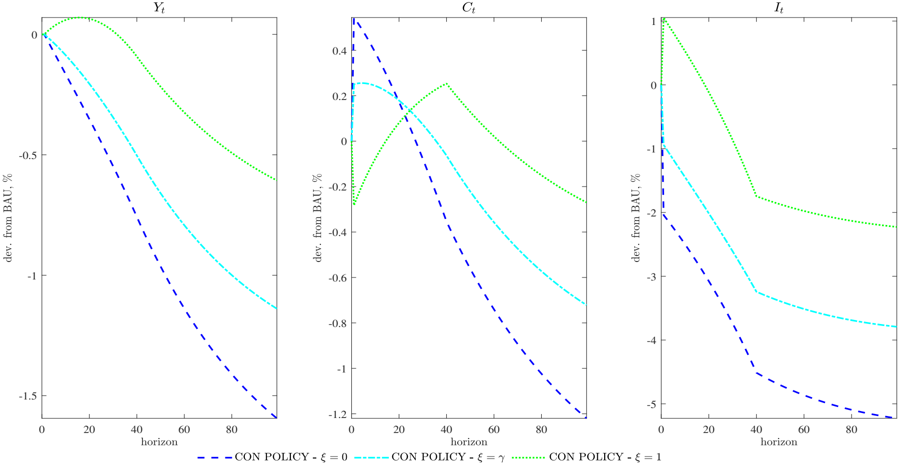
Standard Deviations

Back

Variable	BAU	PU	PC		
			$\xi = 0$	$\xi = \gamma$	$\xi = 1$
$\log(Y_t)$	3.62	3.68	3.55	3.54	3.51
$\log(I_t)$	8.12	8.53	7.89	7.84	7.66
$\log(C_t)$	2.54	2.55	2.52	2.51	2.50
$\log(C_t^S)$	2.35	2.55	2.35	2.32	2.22
$\log(C_t^H)$	3.62	2.55	3.52	3.57	4.03
$\log(\lambda_t^H)$	12.86	0.00	10.33	11.53	17.85
$\log(\tau_t^*)$	0.00	4.86	3.76	6.37	13.06
$\log(E_t)$	2.52	1.77	1.99	1.12	0.66
$\log(V_t^X)$	3.73	4.86	3.76	3.65	3.22

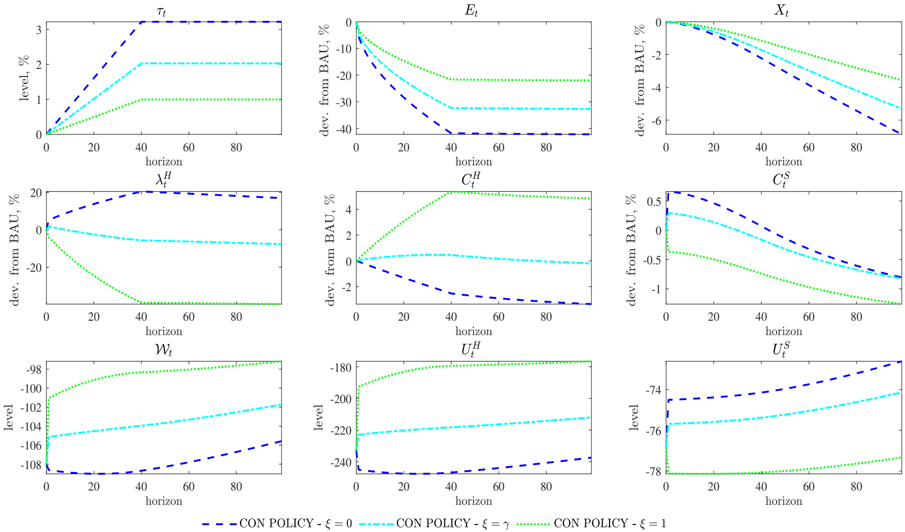
Transitions: Additional Variables

Back



Transitions: Zoom in on first 100 quarters

Back



Means: Sensitivity Analysis

Back

Variable	BAU	PU	PC		
			$\xi = 0$	$\xi = \gamma$	$\xi = 1$
Panel A: Lower HtM Share					
V_t^X	0.027	0.020	0.026	0.025	0.022
τ_t^*	0.000	0.020	0.026	0.020	0.014
$\mathcal{W}_t$	-101.37	-69.895	-72.427	-74.006	-74.369
Panel B: Low Abatement Efficiency					
V_t^X	0.034	0.020	0.035	0.031	0.027
τ_t^*	0.000	0.020	0.035	0.020	0.01
$\mathcal{W}_t$	-108.65	-81.078	-91.7	-91.245	-90.418
Panel C: Low Externality Weight					
V_t^X	0.015	0.01	0.015	0.015	0.014
τ_t^*	0.000	0.01	0.015	0.01	0.005
$\mathcal{W}_t$	-64.718	-53.447	-58.426	-58.685	-59.11
Panel D: Capital Adjustment Costs					
V_t^X	0.03	0.020	0.032	0.031	0.028
τ_t^*	0.000	0.020	0.032	0.020	0.01
$\mathcal{W}_t$	-108.67	-70.003	-74.413	-77.901	-81.678

Standard Deviations: Sensitivity Analysis

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Variable	BAU	PU	PC		
			$\xi = 0$	$\xi = \gamma$	$\xi = 1$
Panel A: Lower HtM Share					
$\log(\lambda_t^H)$	13.03	0.00	10.67	11.69	44.57
$\log(V_t^X)$	4.30	4.86	4.18	4.15	3.42
$\log(\tau_t^*)$	0.00	4.86	4.18	5.69	19.20
Panel B: Low Abatement Efficiency					
$\log(\lambda_t^H)$	12.86	0.00	11.04	12.57	21.18
$\log(V_t^X)$	3.73	5.08	3.87	3.66	3.05
$\log(\tau_t^*)$	0.00	5.08	3.87	6.85	14.77
Panel C: Low Externality Weight					
$\log(\lambda_t^H)$	10.42	0.00	9.63	10.24	12.71
$\log(V_t^X)$	3.72	4.57	3.73	3.66	3.48
$\log(\tau_t^*)$	0.00	4.57	3.73	5.80	10.31
Panel D: Capital Adjustment Costs					
$\log(\lambda_t^H)$	7.19	0.00	4.79	6.07	11.29
$\log(V_t^X)$	5.22	6.36	5.14	5.14	4.73
$\log(\tau_t^*)$	0.00	6.36	5.14	7.09	11.82

Responses to TFP Shocks: Sensitivity Analysis

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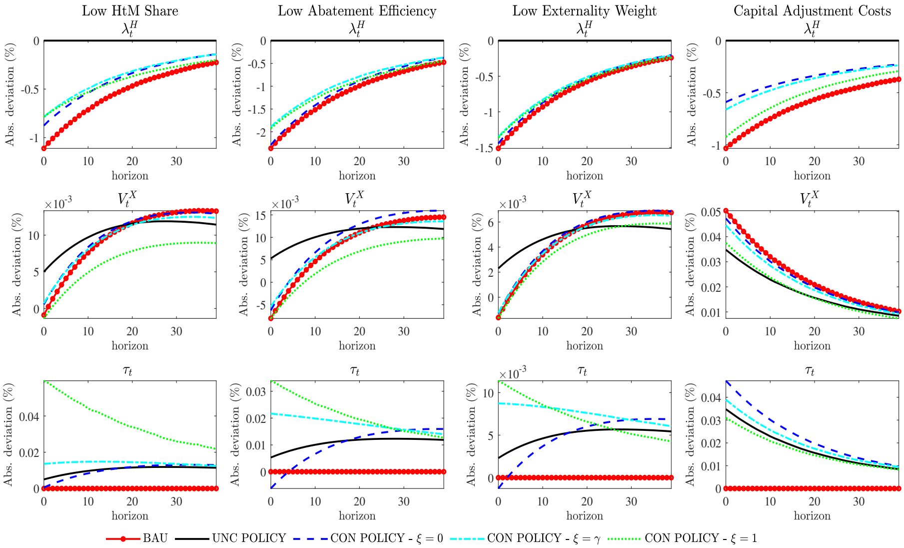

Transitions: Sensitivity Analysis

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