The macroeconomic portfolio effect of climate policy

"Pigou and Piketty play on Feldstein's stage"

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Climate policy's effect on rents may improve efficiency

- Climate policy creates and shifts rents.
  (Fullerton and Metcalf 2001, Bauer et al. 2013)
- Traditionally: rent taxation neutral, rents a distributional issue.
  (Ricardo, George)
- But collecting rents (and redistributing them) *does* impact efficiency and may actually improve it...
  (Feldstein 1977, Edenhofer et al. 2013)
- ...and this also applies to carbon pricing!
  (Siegmeier et al. 2014)

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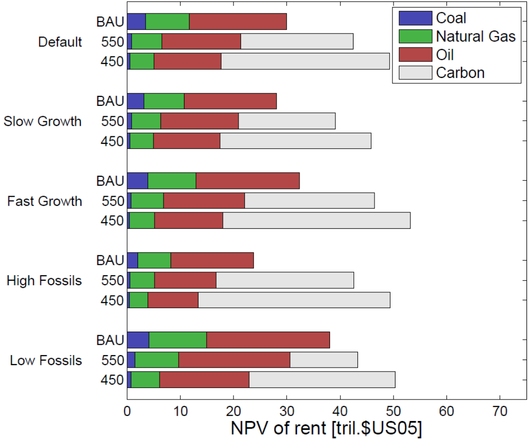
Climate policy shifts and creates significant rents



Net present value (2010-2100) of global fossil fuel rents and the global carbon permit rent. (Bauer et al. 2013)

These rents can be used to improve social welfare

- Redistribution:
  - Empirically, rising share of non-labor income, and rising inequality in wealth.
  - Addressing intergenerational inequality may improve efficiency.
- Support for resource efficiency improvements, since climate policy restricts resource supply.
- Public goods provision, e.g. low-carbon infrastructure.

Collecting rents may itself induce beneficial distortions

"Macroeconomic portfolio effect":

- Two revenue-generating assets as alternative investments.
- Taxing returns from asset A shifts investment towards asset B.
- Dynamic effect is *unambiguously beneficial* if asset A is fixed and asset B is undersupplied.
- Efficiency argument for taxation *in addition* to distributional or Pigouvian motives!

Examples:

- Land and capital, land rent tax. (Feldstein 1977, Edenhofer et al. 2013)
- Here: Fossil resource and capital, carbon pricing. (Siegmeier et al. 2014)

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Analyzing the effect of rent collection via climate policy

Modified Yaari-Blanchard continuous OLG:

- Individuals invest in capital K or fossil resource stocks S (at price p).
- Uncertain lifetimes (birth & death rate ϕ), no bequests
  $\rightarrow$ wealthy agents die and are replaced by fundless newborns
  $\rightarrow$ capital underaccumulation.

Production (CRS) from capital, labor and extracted resources E:
$Y = F(K, L, AE)$.

Government: Carbon pricing and technological progress

Climate policy:

- Simplest case: Upstream emission trading scheme, short permit lifetimes.
- Resource owners may extract an *exogenously fixed fraction* of their stock, $\bar{E} = \sigma S$ (sold at price b).
- No analysis of the optimal choice of the extraction rate σ and the total resource stock $S(t = 0)$.
- Crucial policy parameter: Auctioning rate of permits T.

Public investment in R&D:

- Investment I_A in resource efficiency improvements (exogenously require $I_A = I_A^*$ so that $A\bar{E} =$ const.).
- Two cases: Financing by auction revenues, or lump-sum tax.

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Aggregate dynamics

$$\dot{S} = -\bar{E}$$

$$\dot{A} = I_A A$$

$$\dot{K} = F(K, L, A\bar{E}) - \delta K - I_A - C$$

$$\frac{\dot{p}}{p} = r + \frac{p - (1 - T)b}{p}\sigma$$

$$\frac{\dot{C}}{C} = r - \rho - (\rho + \phi)\frac{\phi(K + pS)}{C}$$

Assumptions leading to $A\bar{E} =$ const. establish balanced path:

$$\{K^*(T), C^*(T), p_0(T)e^{\sigma t}, S_0 e^{-\sigma t}, A_0 e^{\sigma t}\}$$

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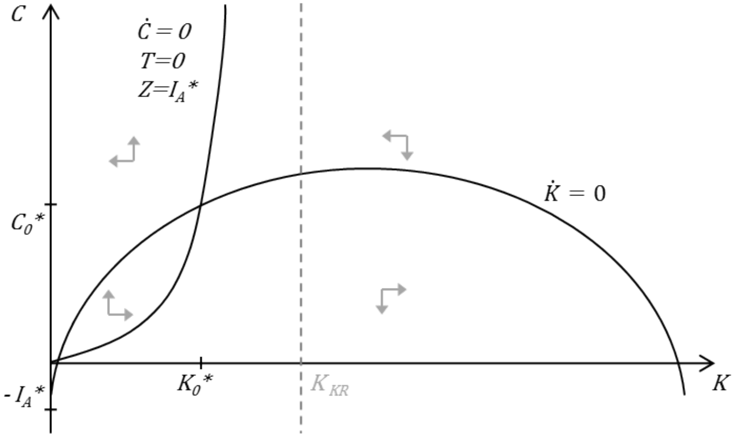
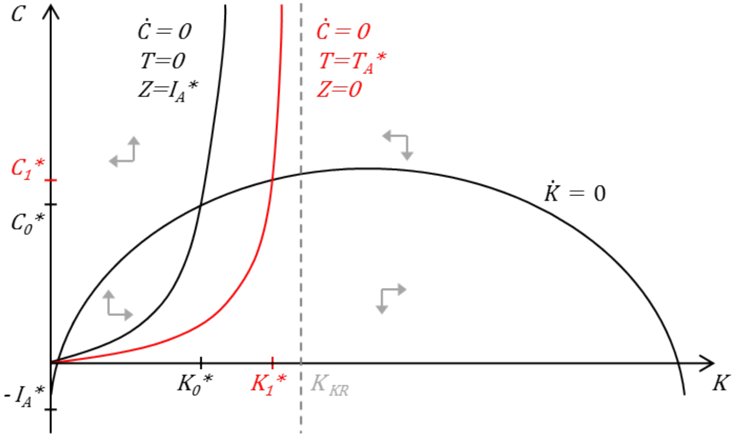
Result: Macroeconomic Portfolio Effect of Climate Policy

Lump-sum funding of resource efficiency improvements...



Result: Macroeconomic Portfolio Effect of Climate Policy

...vs. funding R&D by rent collection (permit auctioning)



Auctioning short-term emission permits leads to higher aggregate consumption than lump-sum taxation.

What to do with additional funds? Reaching the Social Optimum

Edenhofer et al. (2013)

Suppose appropriating the climate rent generates higher revenues than needed for financing technological progress: $Tb_0E_0 > I_A^*$.

The social optimum

- In a continuous OLG (Calvo and Obstfeld 1988): equivalent to Keynes-Ramsey levels.
- Sufficient condition: Only newborns obtain remaining funds (distribution effect), and enough revenues to fully compensate newborns' missing capital.

Other policy instruments

Other paths for mitigation and R&D:

- Analysis unaffected as long as $AE =$ const.

Long permit lifetimes or carbon tax:

- Endogenous extraction path, but intuition is the same
- Long-term permits: $S(0)$ determines mitigation, $T(t)$ free
- Carbon tax: $\dot{T}(t)$ sets mitigation path, 1 policy parameter less

'Stock instrument':

- Right to annually receive emission permits as tradable asset.
- Closed economy, homogenous agents: same formal results,
- ...but improves real-world robustness of portfolio effect.

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Summary

- Climate policy provides a non-environmental benefit if it induces a portfolio effect and capital is underaccumulated.
- This has been shown for an emission trading scheme.
- This implies an *efficiency* reason for resource rent taxation, additional to environmental and distributional motives.
- Social optimality requires intergenerational redistribution towards the young.

Thank you for your attention!

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BACKUP

Households (1/2): Individual setup

- ϕ: Birth rate = death rate; age-independent exponential distribution of remaining lifetime; population normalized to 1.
- $s(\nu, t)$: fossil resource stock owned by agent born at time ν, at time $t > \nu$. Aggregation:

$$\int_{-\infty}^{t} s(\nu, t)\phi e^{-\phi(t-\nu)} \mathrm{d}\nu \equiv S(t)$$

- Utility of agent born at time ν, at time $t > \nu$:

$$u(\nu, t) = \int_{t}^{\infty} \ln c(\nu, \tau) e^{-(\phi+\rho)(\tau-t)} \mathrm{d}\tau$$

- Instantaneous budget with taxes and insurance:

$$\dot{k} + p\dot{s} + c = w + rk + (1 - T)be - pe - z + \phi(k + ps)$$

...where $c(\nu, t)$: consumption, ρ: pure rate of time preference, $k(\nu, t)$: capital, $p(t)$: resource stock price, $r(\tau)$: interest rate, $w(\tau)$: wage rate, $e(\nu, t)$: resource extraction, $b(t)$: resource price, T: extraction tax, $z(\nu, t)$: lump-sum tax.

Firms: Setup and optimization

A representative firm employs capital, labor and fossil resources to maximize profit, taking resource productivity and prices as given:

$$\max_{K,L,E} F(K, L, AE) - (r + \delta)K - wL - bE$$

$\rightarrow$ first-order conditions:

$$r + \delta = F_K(\cdot)$$
$$w = F_L(\cdot)$$
$$b = F_E(\cdot)$$

...where $K(t)$: aggregate capital, $L(t)$: aggregate labor, $A(t)$: resource productivity, $E(t)$: aggregate fossil resource use, δ: depreciation rate.

Government (1/2): Climate policy and revenues

- Upstream policy: Continuously restricts aggregate resource extraction by issuing a decreasing amount of short-term emission permits:

$$E(t) \leq \bar{E}(t) = E_0 e^{-\sigma t}$$
$$\Rightarrow \dot{S}(t) = -\bar{E}(t) \quad \text{(if binding)}$$
$$\Rightarrow \bar{E}(t) = \sigma S(t) \quad \text{(if } S(\infty) = 0\text{)}$$

- Individuals obtain permits and extract in proportion to their share in the total stock (*no separate choice of s and e, rent redistribution via climate policy not modelled!*):

$$\bar{e}(\nu, t) = \bar{E}(t) s(\nu, t) / S(t) = \sigma s$$

- "Tax T on resource extraction": Auction of share T of permits, or free allocation of all permits followed by tax on extraction.

...where σ: maximum permissible extraction rate, $\bar{e}$, $\bar{E}$: maximum individual/aggregate extraction.

Government (2/2): Spending on technological progress

- Tax revenues are instantaneously invested in R&D:

$$Tb(t)\bar{E}(t) + Z(t) = I_A(t)$$

- Technological progress assumed as a linear function of existing technology level and public R&D investment:

$$\dot{A}(t) = \gamma I_A(t) A(t)$$

- Required R&D investment to keep the "effective supply" of the fossil resource stable:

$$I_A^* = \sigma/\gamma \;\Rightarrow A(t) = A_0 e^{\sigma t} \;\Rightarrow A(t)\bar{E}(t) = const.$$

...where γ: R&D investment efficiency

Households (2/2): Individual optimization

First-order conditions:

- No arbitrage between capital and fossils:

$$\frac{\dot{p}}{p} = r + \frac{p - (1 - T)b}{p}\sigma$$

- ...and Euler-Keynes-Ramsey rule:

$$\frac{\dot{c}}{c} = r - \rho$$

Aggregate dynamics

- Aggregate capital growth: Resource stock trades and insurance each sum to zero, tax revenues equal R&D investment:

$$\dot{K} = w + rK + b\bar{E} - I_A - C$$

- Consumption growth: Lower since newborns inherit nothing:

$$\frac{\dot{C}}{C} = r - \rho - \phi(\rho + \phi)\frac{K + pS}{C}$$

- Aggregate dynamics are completed by

$$\dot{S} = -\bar{E}, \quad \dot{A} = \gamma I_A A, \quad \frac{\dot{p}}{p} = r + \frac{p - (1 - T)b}{p}\sigma$$

Result: Balanced paths

- Assuming $\bar{E}(t)$ and constant factor shares with tax revenues sufficient for financing I_A^* yields balanced path

$$\{K^*, C^*, p_0^* e^{\sigma t}, S_0 e^{-\sigma t}, A_0 e^{\sigma t}\}$$

- ...where S_0, A_0 are given and K^*, C^*, p_0^* satisfy:

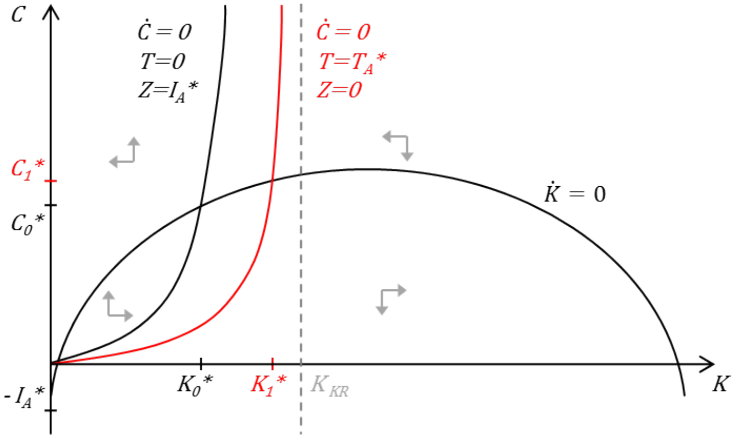
$$\dot{K} = 0 \rightarrow \quad C_P(K) = F(K) - \delta K - I_A^*$$

$$\dot{C} = 0 \rightarrow \quad C_H(K) = \phi(\rho + \phi)\frac{K + p_0(K)S_0}{r(K) - \rho}$$

$$\text{(no-arb.)} \rightarrow \quad p_0(K) = (1 - T)\sigma b_0(K)/r(K)$$

- Compare Ramsey: No $C_H(K)$, vertical line $r(K^{kr}) = \rho$.
- Underaccumulation persists for any combination of T and Z to finance I_A^* - but the higher T, the higher K^* and C^*!

Result: "Climategeorgism"



Auctioning short-term emission (or fossil extraction) permits leads to higher aggregate consumption than lump-sum taxation.

Result: “Climategeorgism”

Intuition:

- Tax on resources makes investment in resource stocks less attractive, relative to investment in capital.
- The social optimum cannot be reached, as price effect counteracts only the newborns’ missing land...
- ...unless $Tb_0E_0 > I_A^*$ and revenues are sufficient to fully compensate newborns’ missing capital (see “Hypergeorgism”).

Equivalence of conventional "flow" instrument to a "stock instrument"

- **Assume households own shares s_a of the atmosphere, linked to annual emission rights that "shrink" at rate σ.**
- The atmosphere is rented out at a rate l to firms, households' revenues are taxed. Modified individual budget:

$$\dot{k} + ps_a + c = w + rk + [(1-T)l - p\sigma]s_a - z + \phi(k + ps_a)$$

- **The two models are equivalent:** Perpetually renting the stock of the atmosphere S_a at rate l, or buying a flow of extracted resources from a larger stock $\bar{E} = \sigma S$ at price b, must have the same value to firms, so $l = b\sigma$. Thus, the original and modified budget equations are the same.
- **The short-term permit scheme already contains the core of the stock instrument:** It treats e as proportional to s and thus prevents endogenous extraction dynamics.

Political economy differences between "flow and stock instruments"?

Equivalent in closed, competitive economy, where everyone owns resources/permits. In more realistic settings, differences may arise:

- Fossil stocks not fully traded/not in capitalists' portfolio (several classes/countries)?
  → Stock instrument creates assets that may be traded more, in particular if initial allocation includes non-resource owners.
- Non-competitive market structures for fossils (oligopoly, natural monopoly)?
  → ...but not for atmosphere stock permits?
- The two instruments seem to imply different distributions ("only resource owners" vs. "everyone gets permits").
  → But initial/perpetual stock reallocation is possible for *both*!