Environ. Tax Reform and Endogenous Growth
The Swiss Case

4^{th} SimLab Educational Workshop

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The Environmental Tax Reform Hypothesis

Definition

An environmental tax reform (ETR) aims at increased taxation of environmentally damaging activities while reducing other taxes and/or redistributing tax revenue to households or firms.

Dividends

1. Environmental quality improvement
2. Improvement of economic performance (higher consumption)
3. Stimulation of innovation $\rightarrow$ Hicks (1932), Porter (1991)

Scope

1. Explore theoretically and numerically the existence of a growth dividend from an ETR

2. Measure the impact of an ETR in Switzerland using dynamic CGE model of endogenous growth

   - Federal Council agreed upon implementing an ETR from 2021
   - No existing measure of the effects on growth

Literature

Empirical relevance - energy price increases stimulate innovation

- *Newell et al. (1999)*: efficient A/C following 70s oil prices
- *Popp (2002)*: systematic evidence using pattent data
- *Lanoie et al. (2011)*: policy induced env. innovation in OECD

Where do R&D resources come from? Crowding-out?

- *Gerlagh (2008), Popp & Newell (2012), Dechezlepretre & Popp (2015)*: Energy–saving R&D comes mainly at the expense of dirty R&D

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Static vs. Dynamic models

- *Bovenberg and De Mooij (1994), Goulder (1995)*: environmental taxes exacerbate pre-existing tax distortions
- *Bretschger (1998), Bretschger and Smulders (2012)*: sectoral input reallocation towards R&D can stimulate growth
- *Kruse-Andersen (2016)*: "static models and models of exogenous growth [...] leave out an important welfare effect of environmental policy."

ETR in Switzerland using static models

- *Ecoplan (2012, 2013, 2015), Imhof (2012)*: negative 2^{nd} dividend; no measure of 3^{rd}

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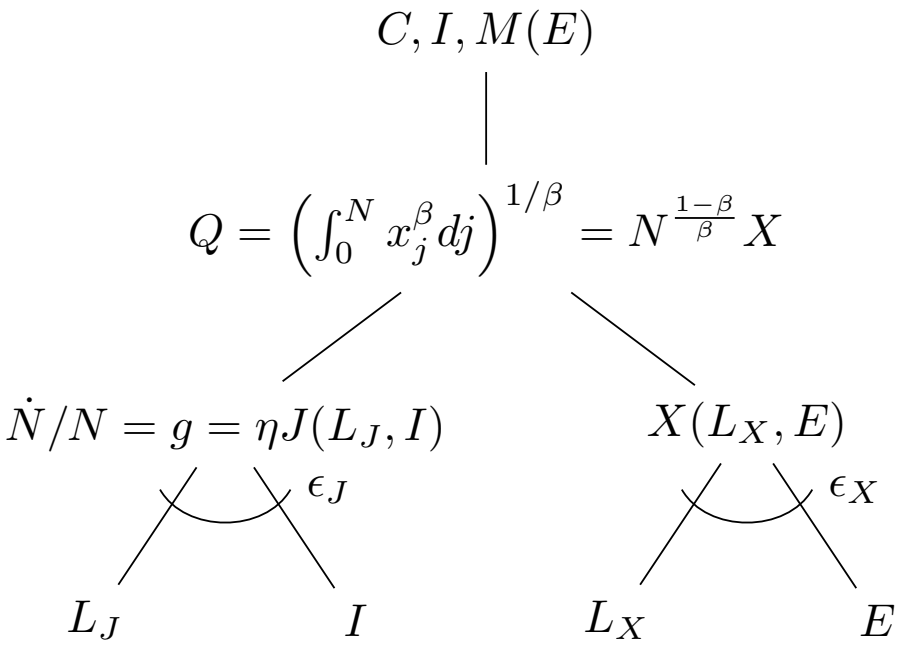
Theoretical model

Graphical representation



- Preferences $U(C) = log(C)$
- Households own assets and face labor income tax, t_L; firms face energy tax t_E
- Government: $t_L w + t_E p_E E = T$

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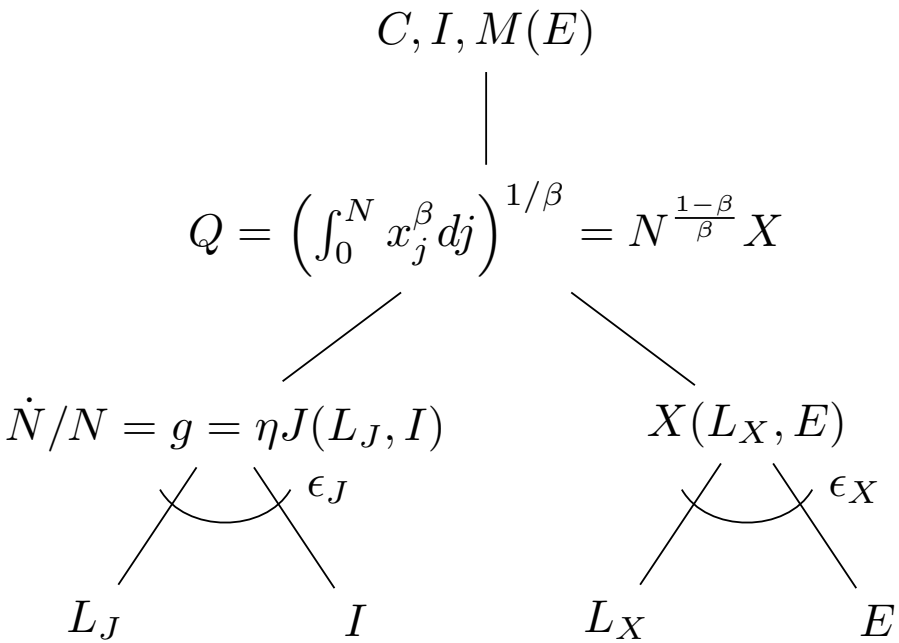

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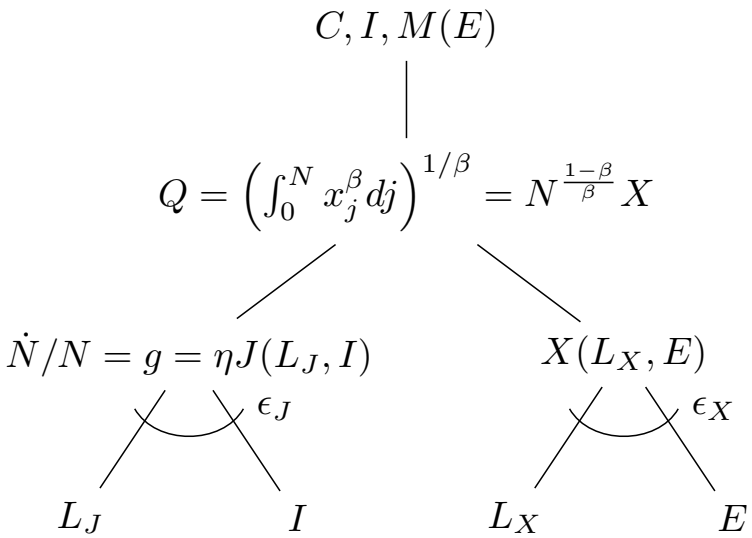
Technical conditions for BGP



- Manufacturing: $X = \left[\alpha_X L_X^{\frac{\epsilon_X - 1}{\epsilon_X}} + (1-\alpha_X) E^{\frac{\epsilon_X - 1}{\epsilon_X}}\right]^{\frac{\epsilon_X}{\epsilon_X - 1}}$
- R&D: $J = \left[\alpha_J L_J^{\frac{\epsilon_J - 1}{\epsilon_J}} + (1-\alpha_J)(zI)^{\frac{\epsilon_J - 1}{\epsilon_J}}\right]^{\frac{\epsilon_J}{\epsilon_J - 1}}$

Methodology

- Define: $\gamma_X = \frac{\partial X}{\partial L_X}\frac{L_X}{X}$, $\gamma_J = \frac{\partial J}{\partial L_J}\frac{L_J}{J}$, $s_X = \frac{wL_X}{p_Q Q}$, $s_J = \frac{wL_J}{p_Q Q}$
- Comparative statics - relative change from the BGP "~"
- We need to study $\tilde{g}(\tilde{t}_e)$
- Government: $\tilde{T} = 0 \rightarrow$ reduce distorting labor taxation
- Small-open economy: $\tilde{p}_e = 0$

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Results: the growth dividend and its effect on welfare

Tax induced innovation

$$\tilde{g}(\tilde{t}_e) = \frac{-(1-\gamma_X)[s_J(1-\gamma_J)\epsilon_J + s_X(\epsilon_X-\gamma_J)]}{\Delta}\tilde{t}_e - \frac{\gamma_X(1-\gamma_J)+\gamma_J}{\Delta} s_U \tilde{l}_U(\tilde{t}_e)$$

Proposition

If no leisure is considered

$\tilde{g}(\tilde{t}_e) > 0$, *if* $J = J(L_J)$ *and* $\epsilon_X \in (0,1)$ *(pos. growth effect)*
$\tilde{g}(\tilde{t}_e) < 0$, *if* $J = J(I)$ *(neg. level effect)*

ambiguous if $J = J(L_J, I)$, *and/or leisure is an option*

Positive welfare effects of the third dividend

$$\tilde{W} = \tilde{C} + \theta \tilde{L}_U + \frac{1-\beta}{\beta}\frac{g}{\rho}\tilde{g}$$

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Computational model

Our method

Dynamic CGE model of endogenous growth - CITE

- Top-down multisectoral model
- Detailed bottom-up representation of energy related sectors
- Mobile inputs within, and between, manufacturing and R&D
- Elastic labor supply (labor-leisure option)
- Detailed representation of the Swiss fiscal system
- Different household types

Previous version used in

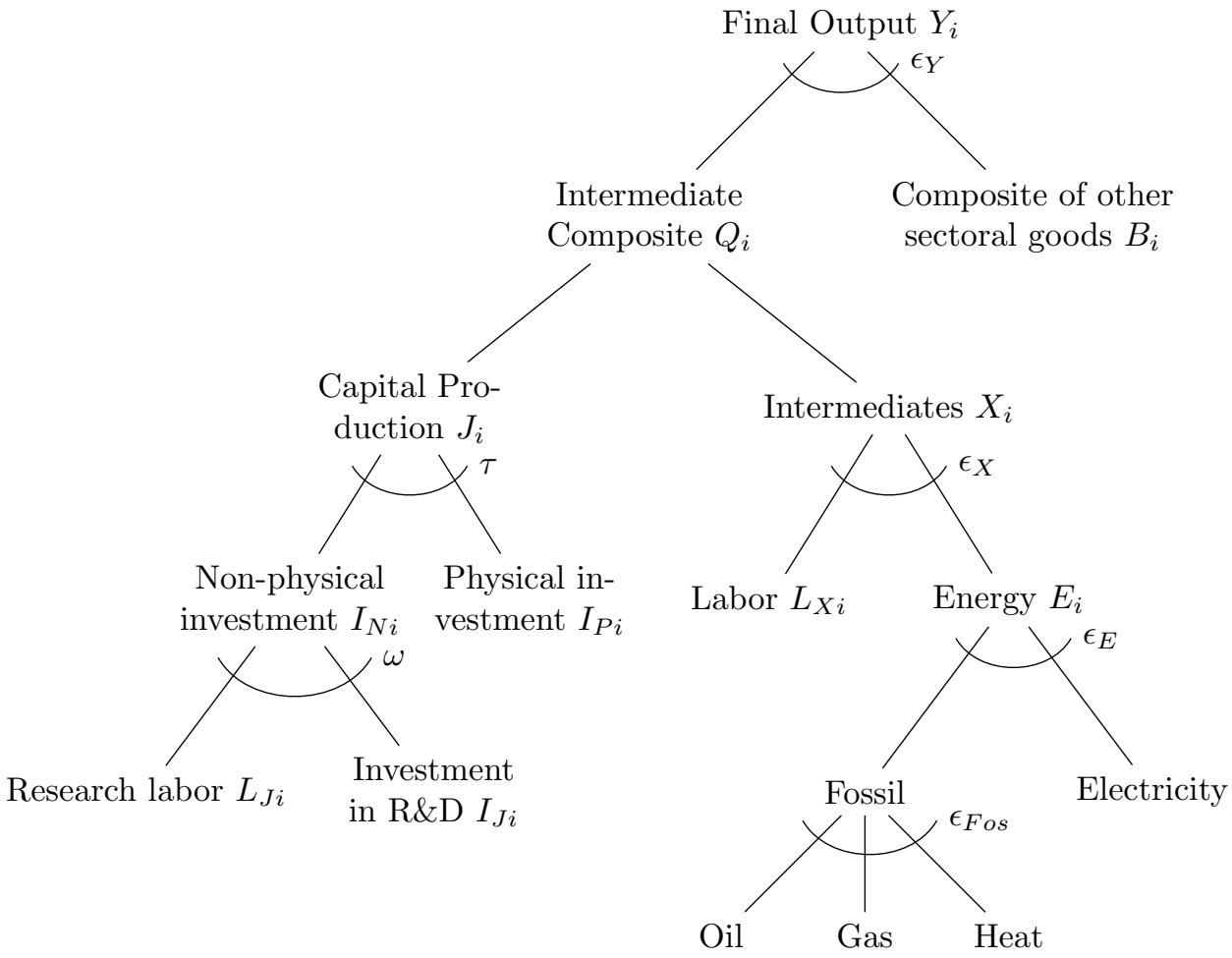
- Bretschger et al. (2011) - growth effects of climate policy
- Bretschger et al. (2017) - costs of a nuclear phase-out

Data sources...

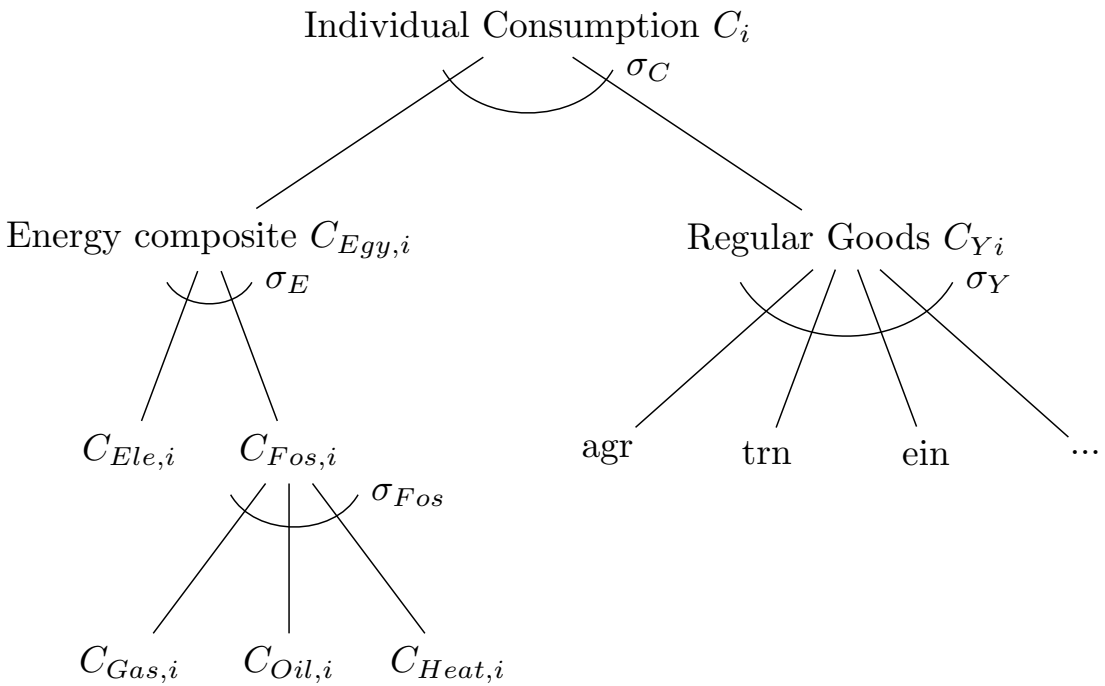
...to match National Accounting Matrix 2008

- Manufacturing - Energy IOT-2008
- Households - Energy IOT-2008 (consumption totals and taxes) and HABE
- Taxes, Contributions - Swiss National Accounts

Production structure



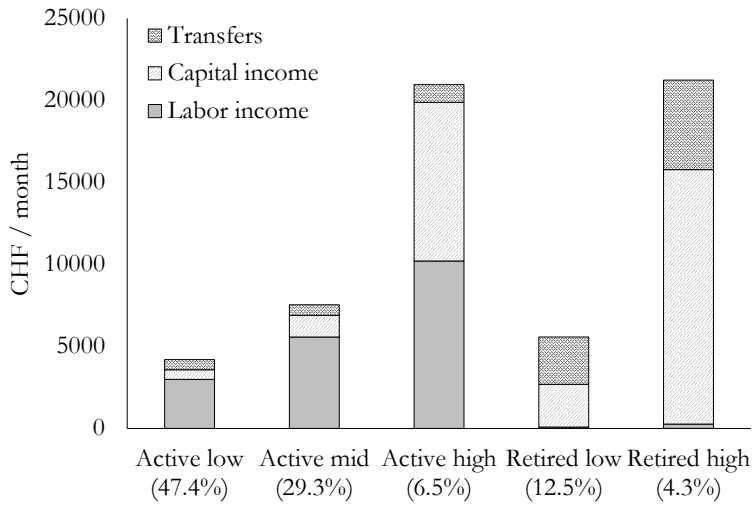
Household structure



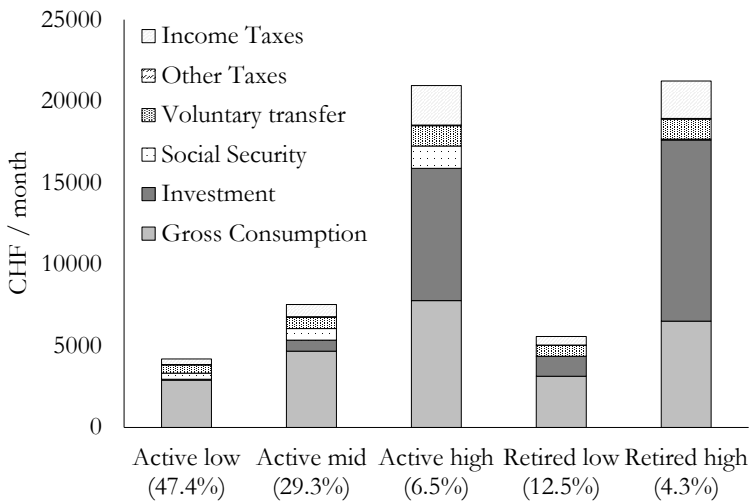
Household structure

Table: CO2-intensive energy expenditure share of total disposable income

Active low	Active mid	Active high	Retired low	Retired High
3.9%	3.7%	2.3%	2.3 %	1.2%



(a) Income



(b) Expenditure

Scenarios

- BAU includes all the existing energy related taxes
- 60% CO2 emissions reduction in 2050 compared to 2010
- Government keeps public good provision constant
- Different tax revenue redistribution options
  - Lump-Sum per capita
  - Reduction in labor income taxes
  - Reduction in capital income taxes

Simulation results

Simulation Results

Results on output growth

- Economic growth almost unaffected by an ETR (<-0.05%)
- Lowering capital tax is beneficial for production and growth
- EoS $\sigma_E/\epsilon_E > 1$ allows for input reallocation towards R&D (benchmark with $\sigma_E/\epsilon_E = 0.7$; sensitivity analysis for 1.5)

Results on output levels

- Aggregate output level minimally impaired by a GTR

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Results on output levels

- Aggregate output level minimally impaired by a GTR

Primary sector (1% of GDP)	-58%
Secondary sector (27% of GDP)	-1%
Tertiary sector (72% of GDP)	+1%

The Carbon Tax

Table: Carbon tax in CHF/tonCO2 for 60% emissions reduction in 2050

$\sigma_E/\epsilon_E = 0.7$

Year	Capital tax	Fed. Income tax	Lump-sum	Revenue (% GDP)
2020	107	107	106	1.5
2030	314	311	310	3.5
2040	722	717	716	6.1
2050	1'717	1'705	1'706	9.9

$\sigma_E/\epsilon_E = 1.5$

Year	Capital tax	Fed. Income tax	Lump-sum	Revenue (% GDP)
2020	88	87	86	1.2
2030	247	244	243	2.7
2040	539	534	534	4.6
2050	1'209	1'200	1'200	7.0

Growth considerations

Table: Output growth in 2050 (% p.a.)

$\sigma_E/\epsilon_E = 0.7$

Target in 2050	BAU	Capital tax	Fed. Income tax	Lump-sum
20%	1.33	1.35	1.31	1.31
60%	1.33	1.31	1.28	1.28

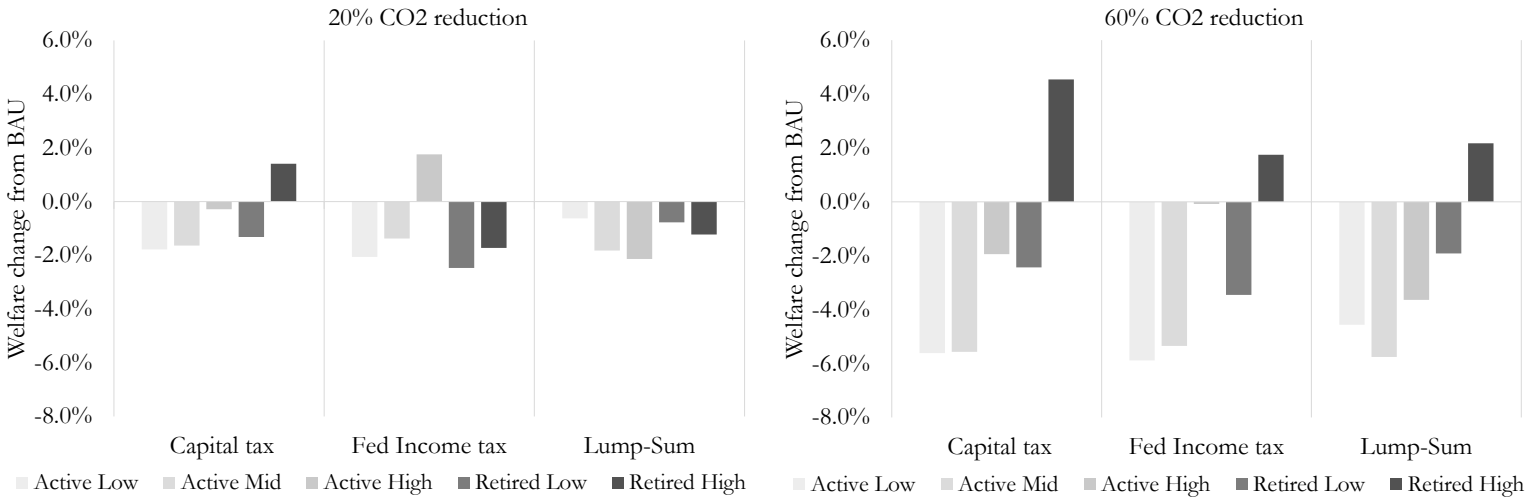
$\sigma_E/\epsilon_E = 1.5$

Target in 2050	BAU	Capital tax	Fed. Income tax	Lump-sum
20%	1.33	1.34	1.32	1.32
60%	1.33	1.36	1.33	1.33

Effects of policy on households

Table: Welfare change (in % from BAU) for 60% CO2 emissions reduction

Elasticities	Capital tax	Fed. Income tax	Lump-sum
$\sigma_E/\epsilon_E = 0.7$	-3.79%	-3.83%	-4.00%
$\sigma_E/\epsilon_E = 1.5$	-2.65%	-3.12%	-3.19%



Conclusion

1. Mobile scarce factor allows for positive growth dividend from ETR; results ambiguous when including direct R&D investment or another option for leisure (crowding-out)

2. For high CO2 emission targets, when $\sigma_E/\epsilon_E \in (0,1)$ negative level effects of reduced investments outweigh positive growth effects of more resources in R&D; the opposite for $\sigma_E/\epsilon_E > 1$

3. ETR not detrimental for growth; capital tax redistribution preferable; also best option for efficiency

4. Progressive character of lump-sum redistribution fails for higher emission reduction targets

Thank you!