Potsdam Institute for Climate Impact Research

Tax Competition, Globalization, and the Green Paradox

or

Why finance ministers may favor a carbon tax even if they do not believe in climate change

Max Franks, Ottmar Edenhofer, Kai Lessmann

10.06.2014

Capital mobility leading to tax competition and tighter budgets

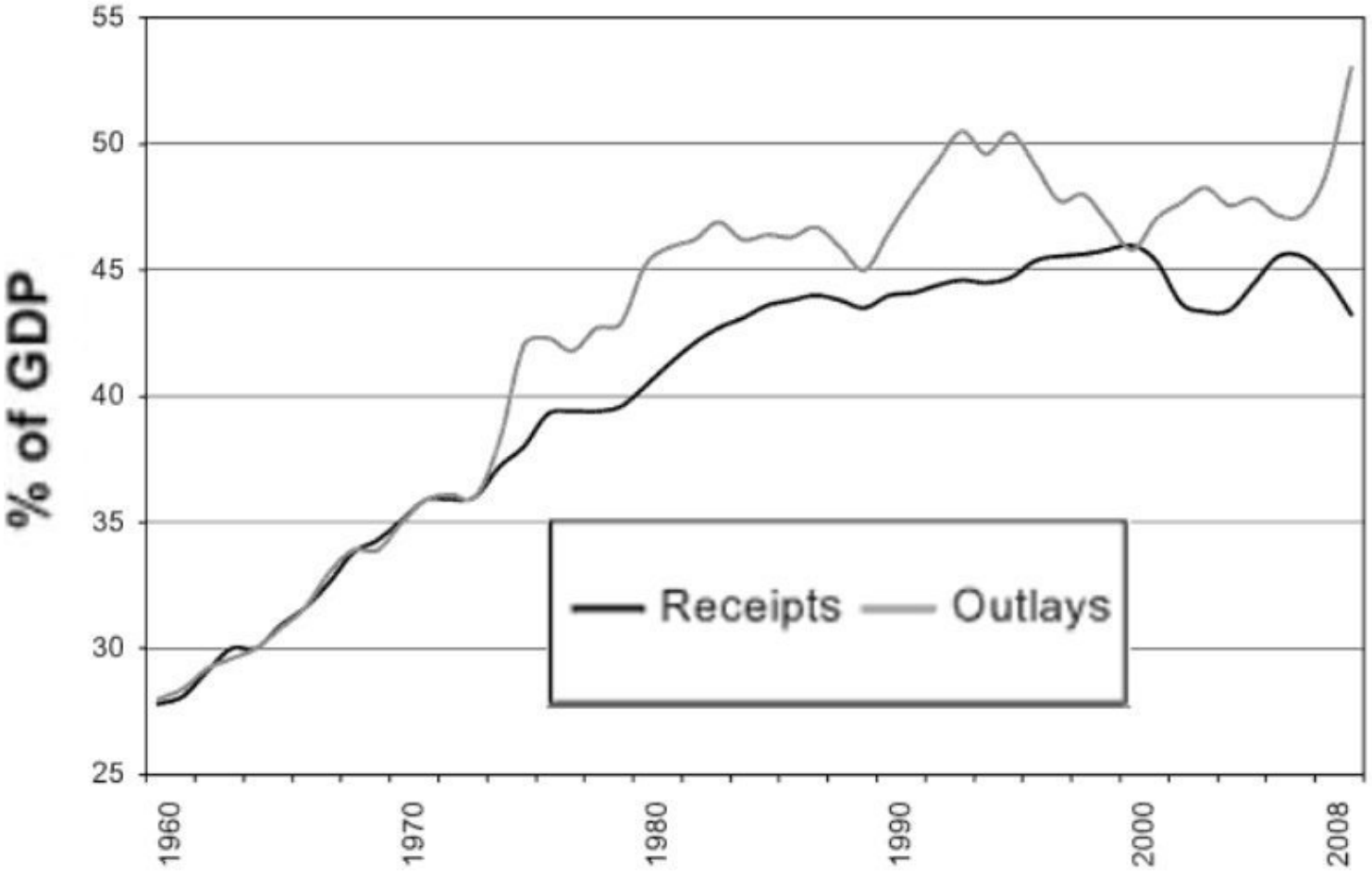

Figure 3.8 Public expenditure and receipts in the OECD countries.

Source: Benassy-Quere et. al. (2010)

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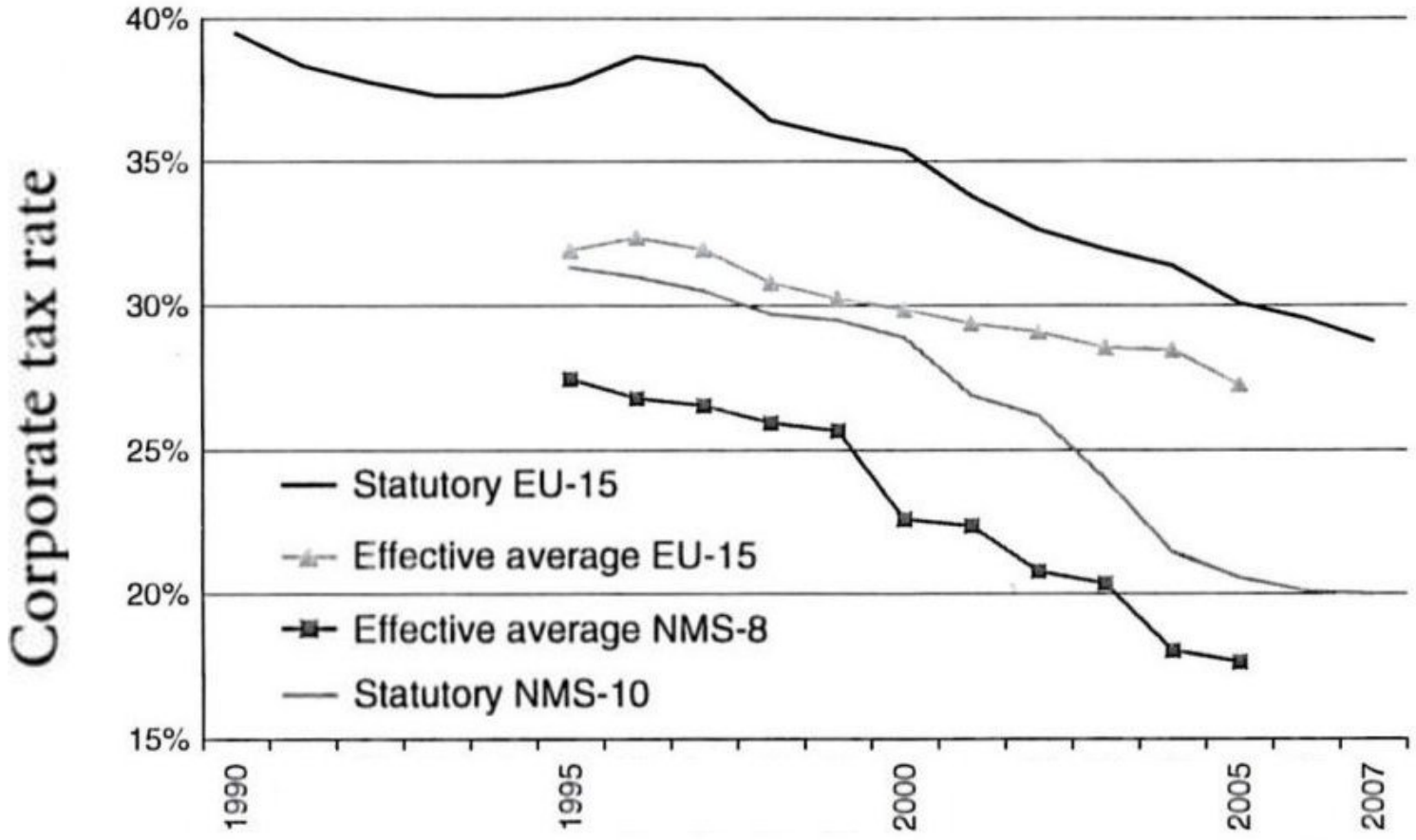

Figure 7.17 Taxing mobile and immobile tax bases in the EU.

Source: Benassy-Quere et. al. (2010)

Demand for public expenditures, e.g. infrastructure

The Economist | World politics | Business & finance | Economics | Science & technology | Culture | Blogs | Debate | Multimedia | Print edition

Infrastructure

Highways to hell

A harsh winter and tight budgets mean lots of potholes

Apr 19th 2014 | CHICAGO | From the print edition

ONLY the drunk, they say, drive in a straight line in Chicago. The sober

Süddeutsche.de

Home > Auto > Autobahnen, Brücken, Bahngleise - Deutschland kaputt

28. Juli 2013 13:12 Autobahnen, Brücken, Bahngleise

Deutschland kaputt

Motivation and research questions

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- Could the fiscal motive for carbon taxation facilitate negotiations within the UNFCCC?

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4. Only when importers cooperate, the entire rent is captured.

Some related research

- Tax competition with intertemporal dynamics:
  - Eichner and Runkel (2012): Decentralized policy making inefficient
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Our contribution

First model to combine:

- decentralized market solution, general equilibrium

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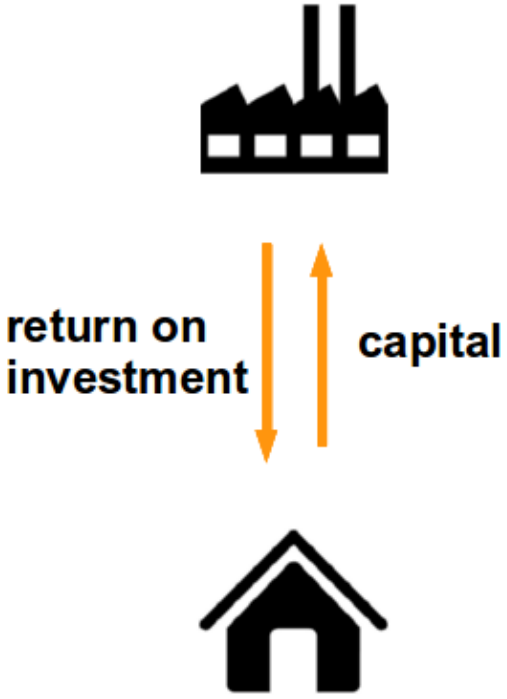
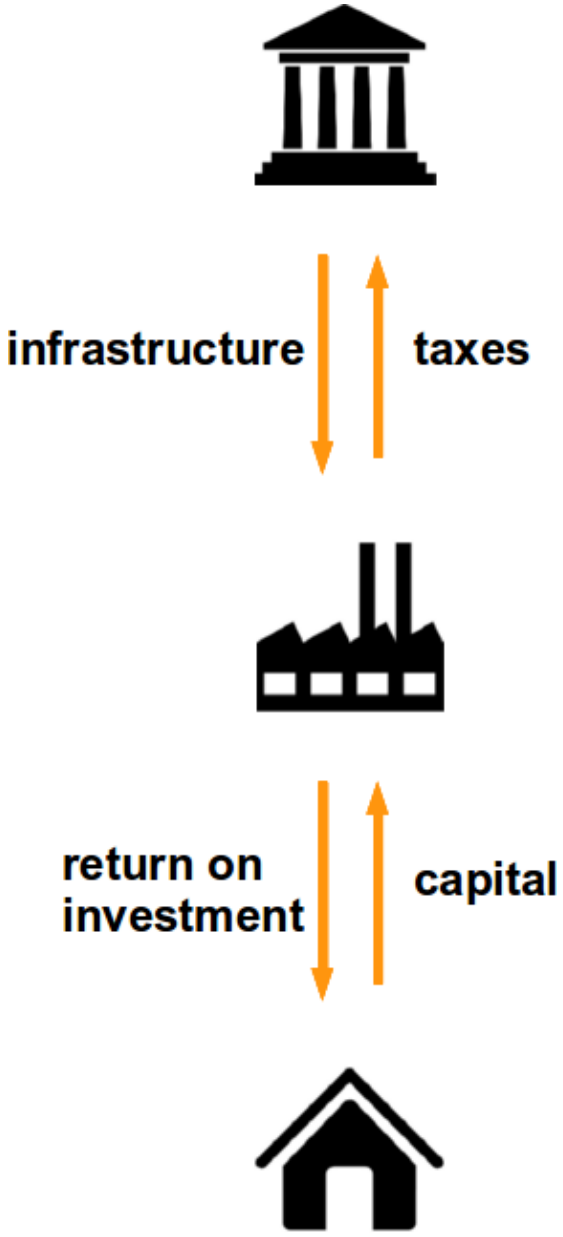
- productivity enhancing infrastructure

MODEL SETUP


return on
investment
capital


infrastructure
taxes
return on investment
capital

Household:

$$\max_{C_t} W = \sum_{t=0}^{T} \frac{U(C_t)}{(1+\rho)^t},$$

$$C_t = r_t K_t - I_t + \Pi_t^F + Tax_t^{transfer} \text{ (lump-sum)}$$

Firm:

$$\max_{K_t, R_t} \Pi_t^F = F(K_t, G_t, R_t) - r_t(1 + \tau_{K,t})K_t - (p_t + \tau_{R,t})R_t$$

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$$\Longrightarrow F_{K,t} = r_t(1+\tau_{K,t})$$

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Government:

$$\max_{\tau_{K,t},\tau_{R,t}} W = \sum_{t=0}^{T} \frac{U(C_t)}{(1+\rho)^t}$$

$$I_t^G + Tax_t^{transfer\ \text{(lump-sum)}} = r_t \tau_{K,t} K_t + \tau_{R,t} R_t$$

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$$\max_{K_t,R_t} \Pi_t^F = F(K_t, G_t, R_t) - r_t(1+\tau_{K,t})K_t - (p_t + \tau_{R,t})R_t$$

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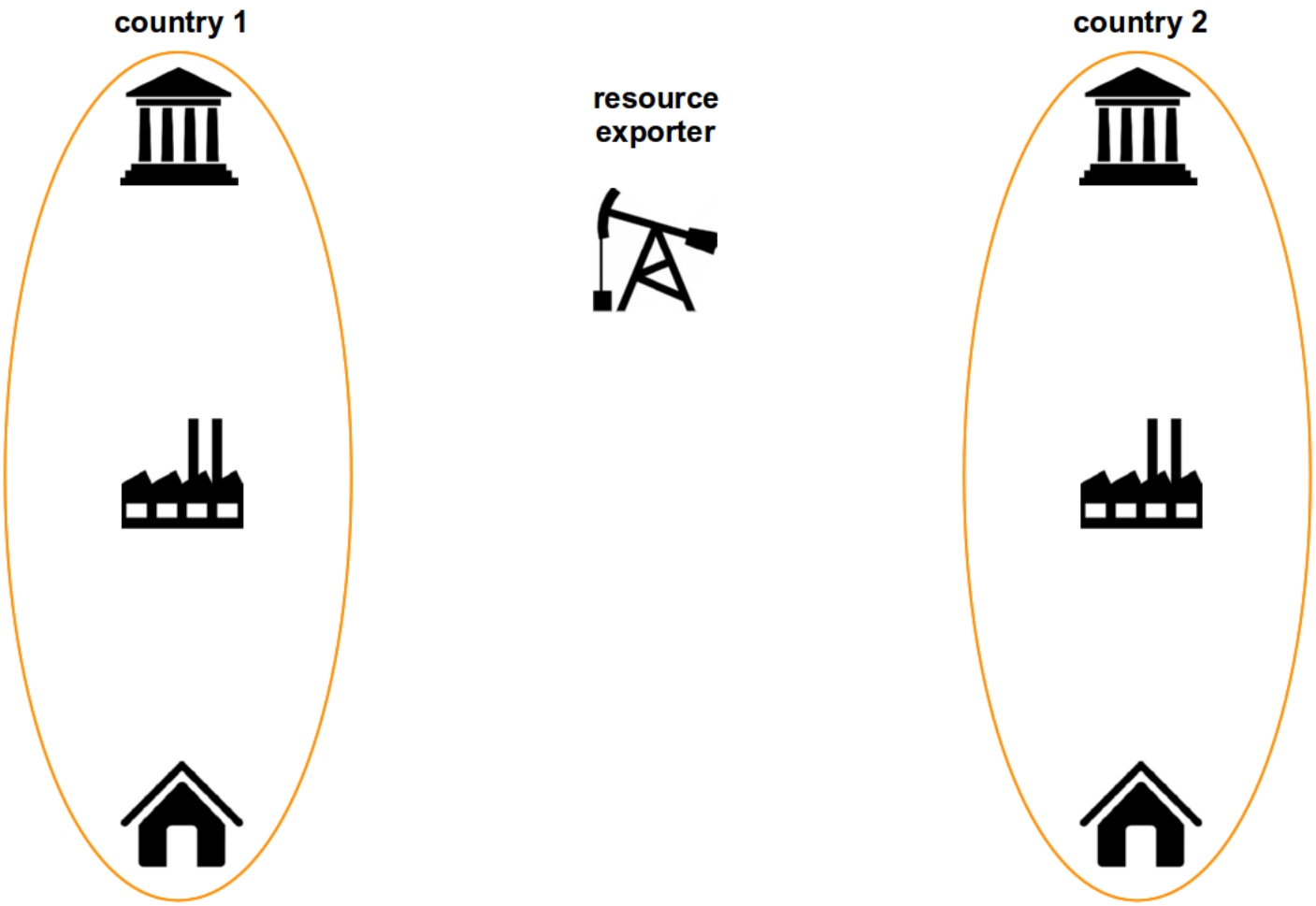
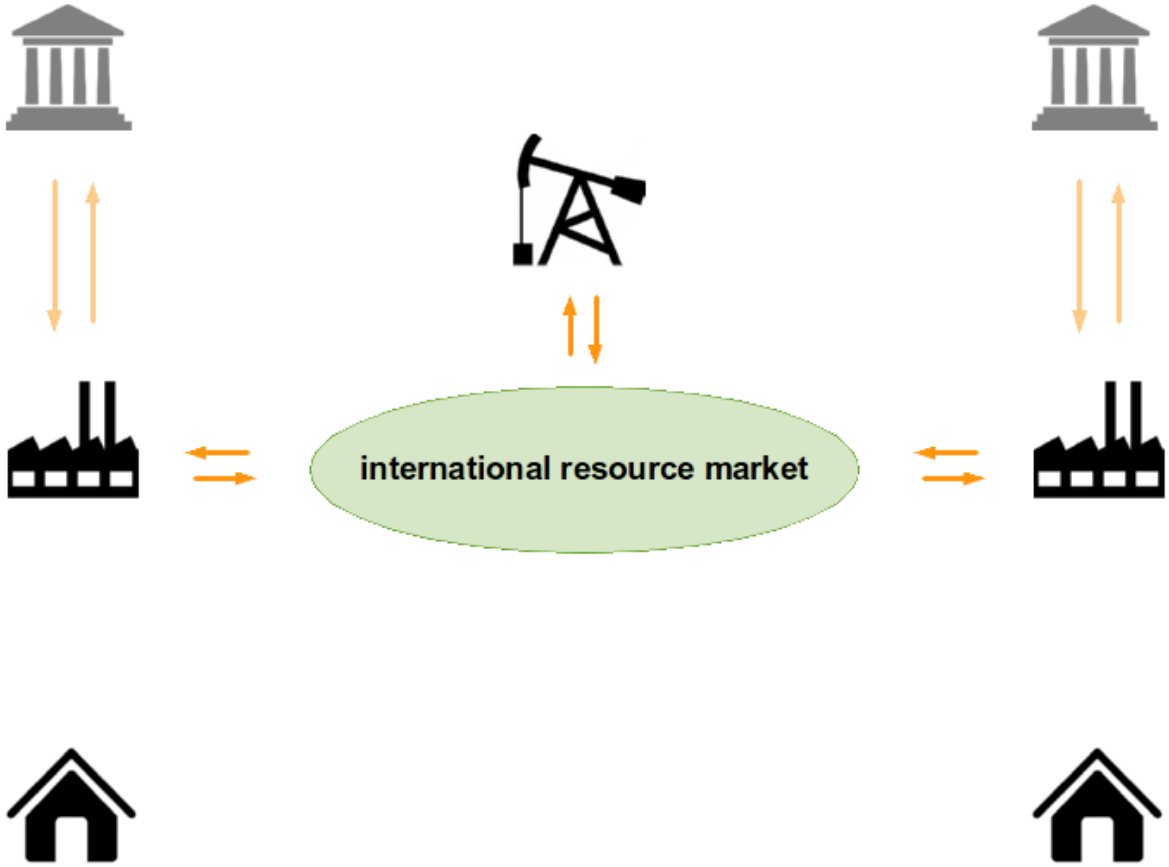
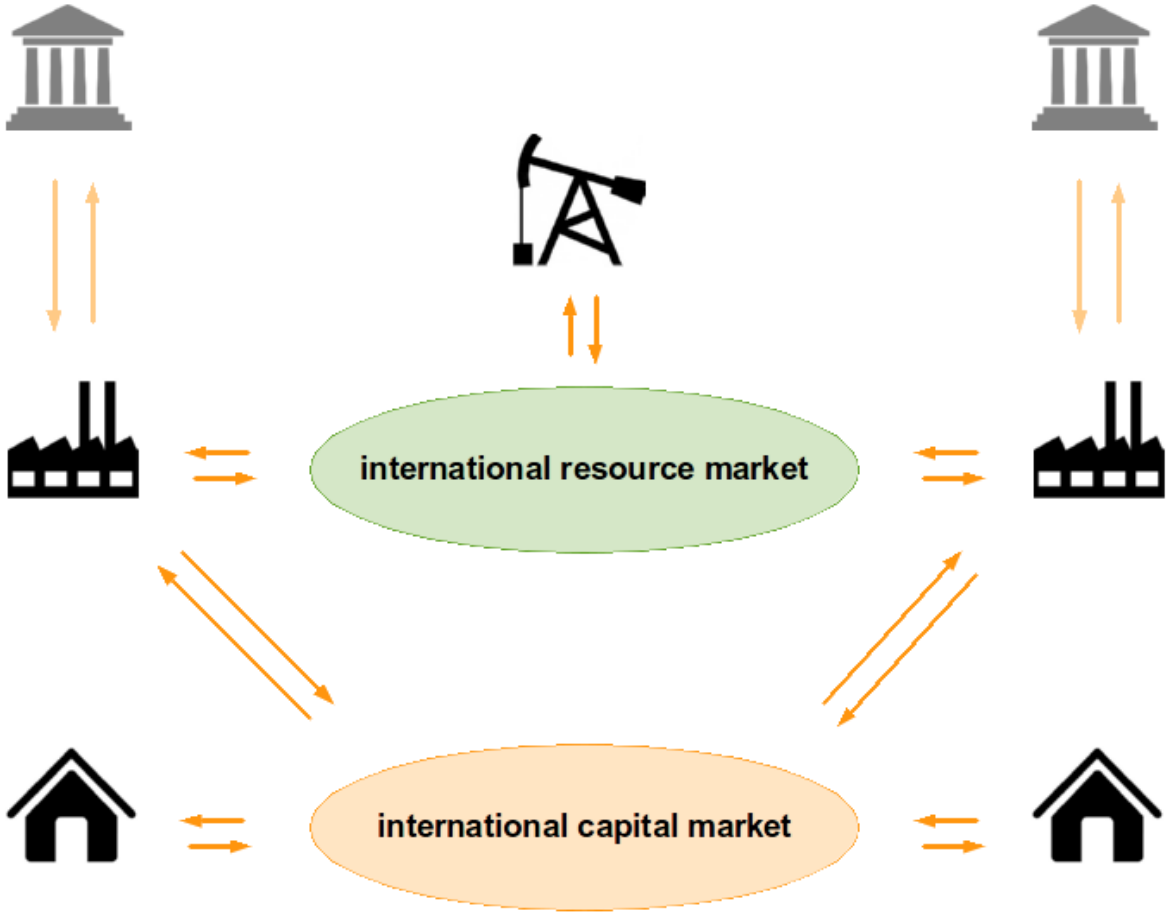

country 1
resource exporter
country 2


international resource market


international resource market
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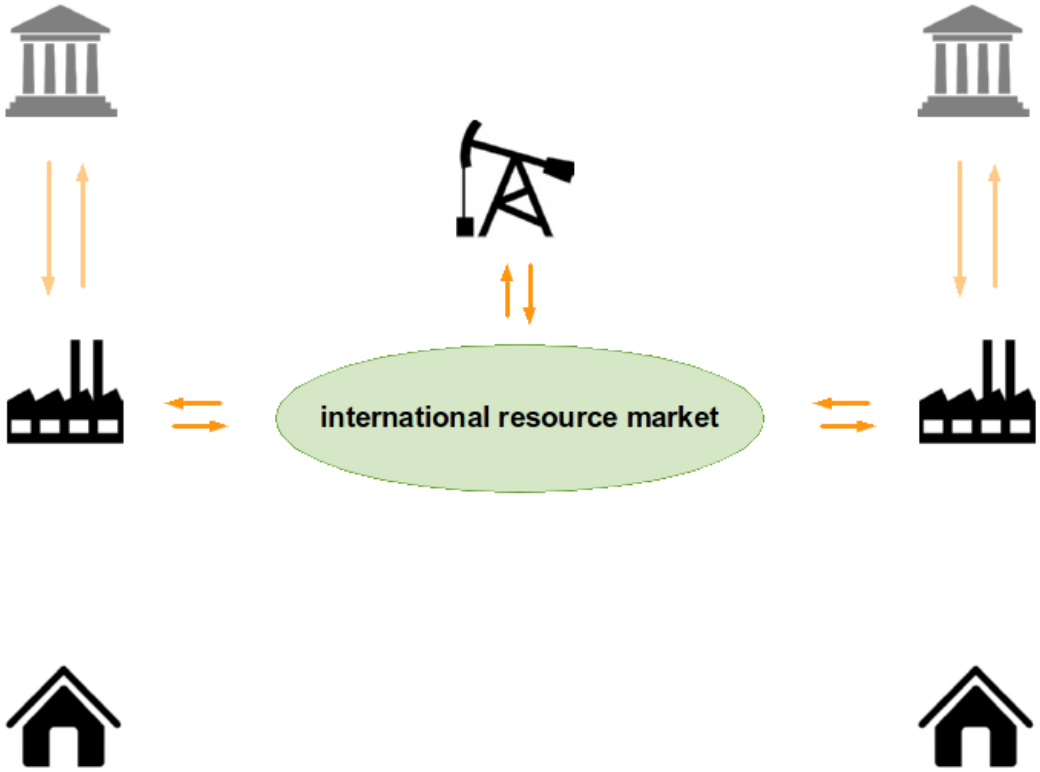


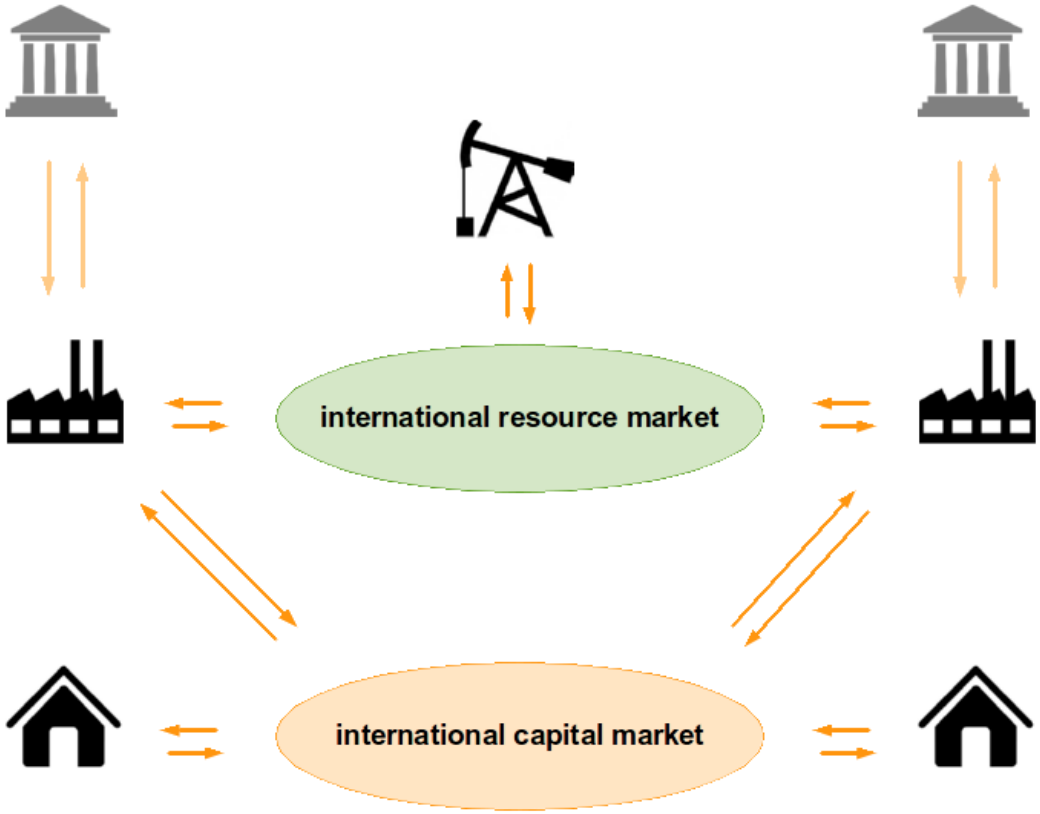
Resource exporter:

$$\max_{R_t} \sum_{t=0}^{T} \frac{p_t R_t}{\prod_{s=0}^{t}(1+r_s)}$$

Resource market:

$$R^{supply} = \sum_j R_j^{demand}$$

$$p = p_j \ \forall j$$



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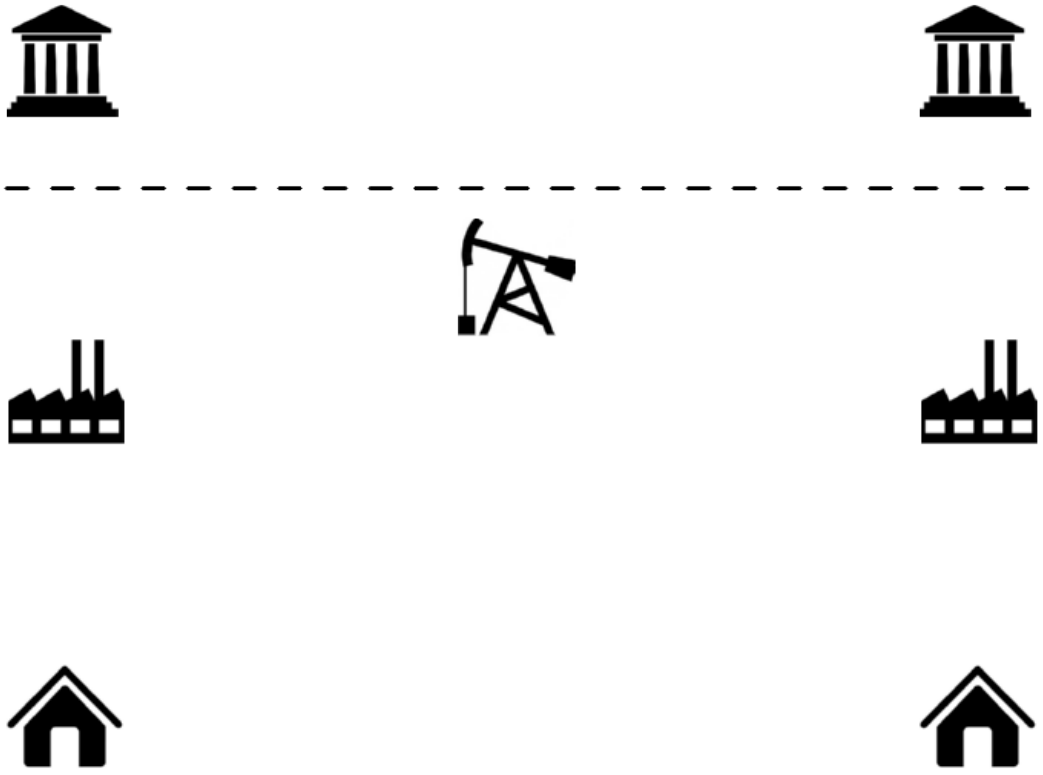
Capital market:

$$\sum_j K_j^{supply} = \sum_j K_j^{demand}$$

$$r = r_j \ \forall j$$

Nash equilibrium, two sub-games,



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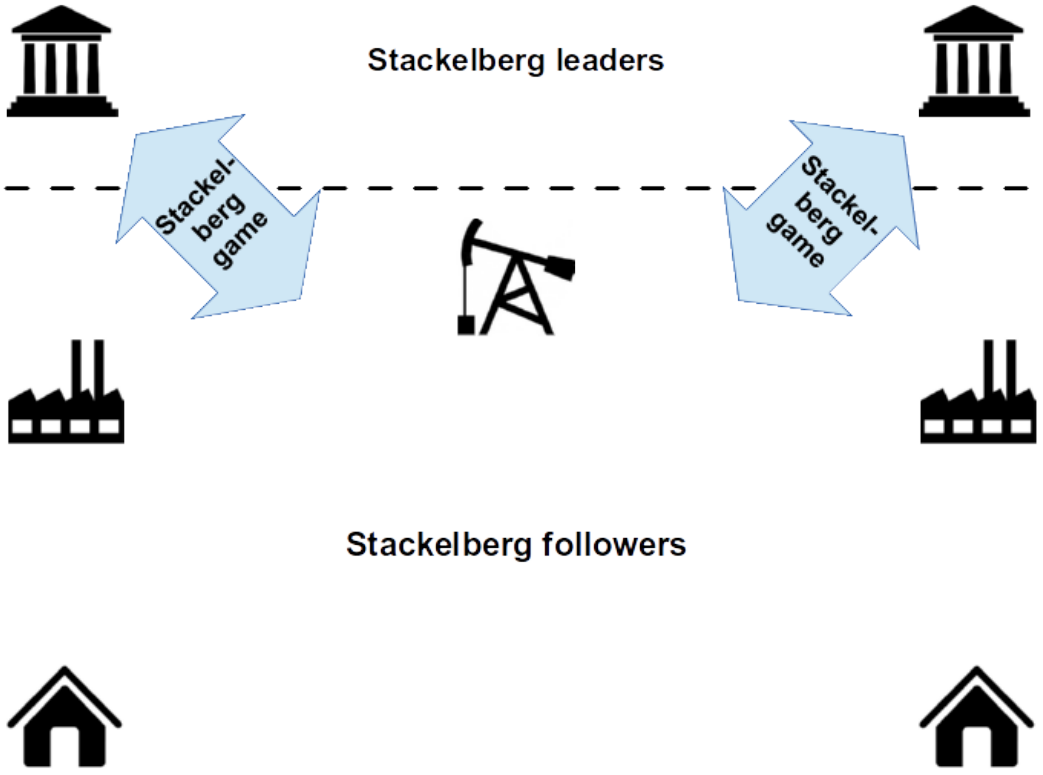

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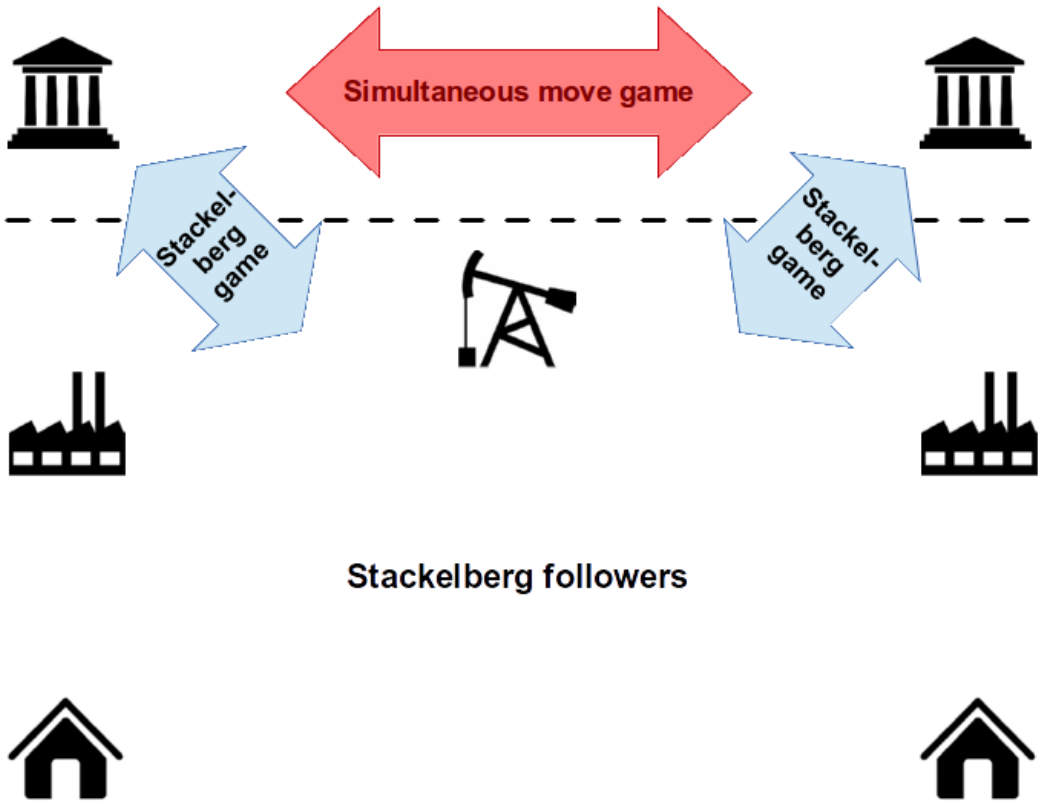

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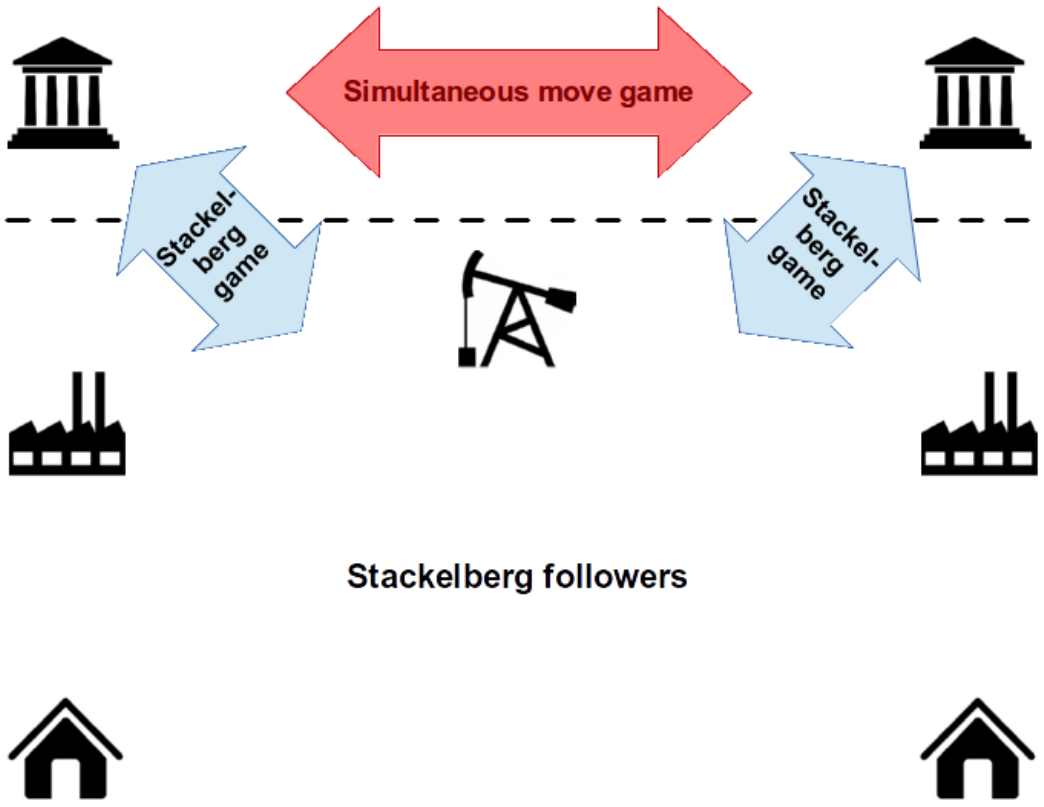
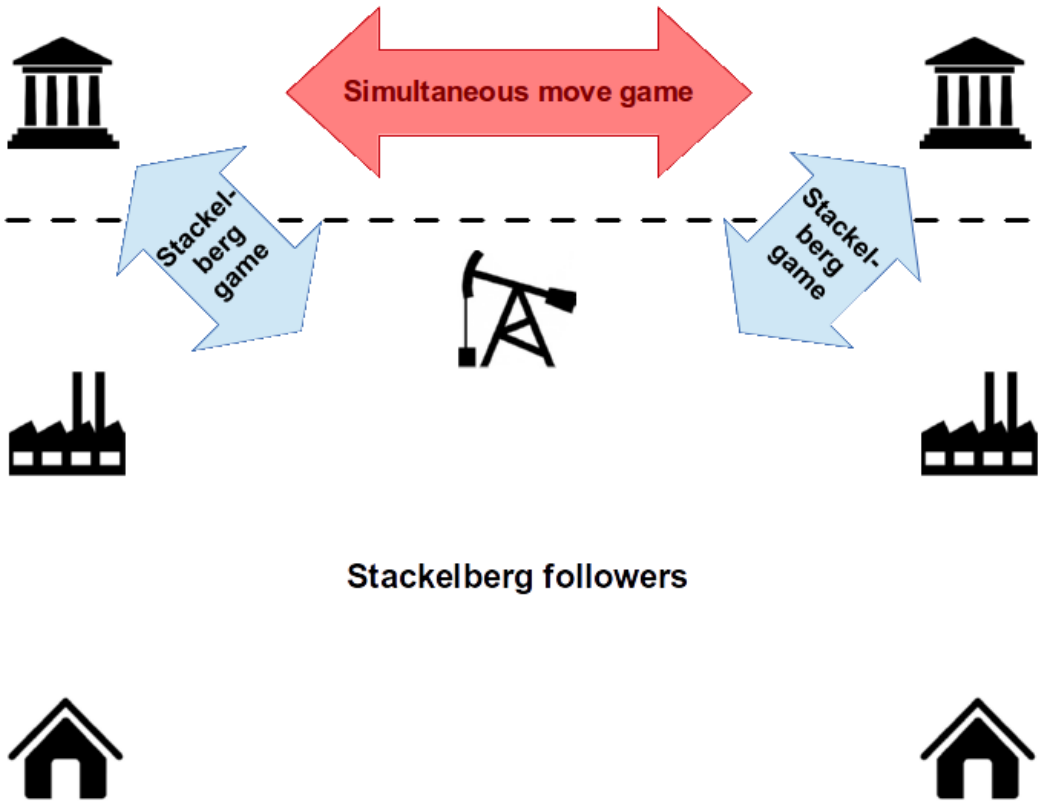


Nash equilibrium, two sub-games, solved for

non-cooperative behavior **or**

$$\max_{\tau_K^i, \tau_R^i} W_i, \text{ given } \tau_K^j, \tau_R^j, \quad i \neq j$$



Nash equilibrium, two sub-games, solved for

non-cooperative behavior **or** **cooperative behavior of governments**

$$\max_{\tau_K^i, \tau_R^i} W_i, \text{ given } \tau_K^j, \tau_R^j, \quad i \neq j$$

$$\max_{\{\tau_K^i, \tau_R^i\}_{i=1,2}} W_1 + W_2$$

Numerical Model: Details

CES production function

$$F(K, G, R) = (\alpha_1 R^{s_1} + (1 - \alpha_1) Z^{s_1})^{\frac{1}{s_1}}$$

$$Z(K, G) = (\alpha_2 K^{s_2} + (1 - \alpha_2) G^{s_2})^{\frac{1}{s_2}}$$

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CiES social welfare function

$$W = \sum_t \frac{C_t^{1-\eta}}{1-\eta} \frac{1}{(1+\rho)^t}$$

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Parameter values

σ_1	α_1	σ_2	α_2	η	ρ
0.5	0.1	1.1	0.7	1.1	0.03

, where $s_i = \frac{\sigma_i - 1}{\sigma_i}$

Source: Empirical literature, details in appendix

Intertemporal optimization: Household

$$\max_{C_t} W = \sum_{t=0}^{T} \frac{U(C_t)}{(1+\rho)^t},$$

$$\text{subject to} \quad C_t + I_t = r_t K_t^s + \Pi_t^F + Tax_t^{transfer}$$

$$I_t = K_{t+1}^s - (1-\delta) K_t^s$$

taking Π_t^F and $Tax_t^{transfer}$ as given.

Lagrangian:

$$\mathcal{L}_t^{HH} = \sum_{t=0}^{T} \left[\frac{U(C_t)}{(1+\rho)^t} + \lambda_t \left(K_{t+1}^s - K_t - (I_t - \delta K_t) \right) \right]$$

FOCs and TC:

$$U'(C_t) = \frac{1}{C_t^\eta} = \lambda_t,$$

$$\lambda_{t-1}(1+\rho) = \lambda_t \left(1 + r_t - \delta\right),$$

$$(I_T - \delta K_T^s)\lambda_T = 0.$$

Intertemporal optimization: Resource exporter

$$\max_{R_t} \sum_{t=0}^{T} \frac{p_t R_t}{\prod_{s=0}^{t}(1+r_s)}$$

subject to

$$\sum_t R_t \leq S_0$$

where $R_t = S_t - S_{t+1}$, and S_0 is given.

Lagrangian:

$$\mathcal{L}_t^{RO} = \sum_{t=0}^{T} \left[\frac{p_t R_t}{\prod_{s=0}^{t}(1+r_s)} + \lambda_t^R \left(-S_{t+1} + S_t - R_t\right) \right]$$

FOCs and TC:

$$\lambda_t^R = p_t,$$
$$\lambda_t^R = \lambda_{t-1}^R (1 + r_t - \delta),$$
$$\lambda_{T-1}^R S_T = 0.$$

Intertemporal optimization: Government

$$\max_{\tau_{R,t},\tau_{K,t}} W = \sum_{t=0}^{T} \frac{U(C_t)}{(1+\rho)^t}$$

subject to

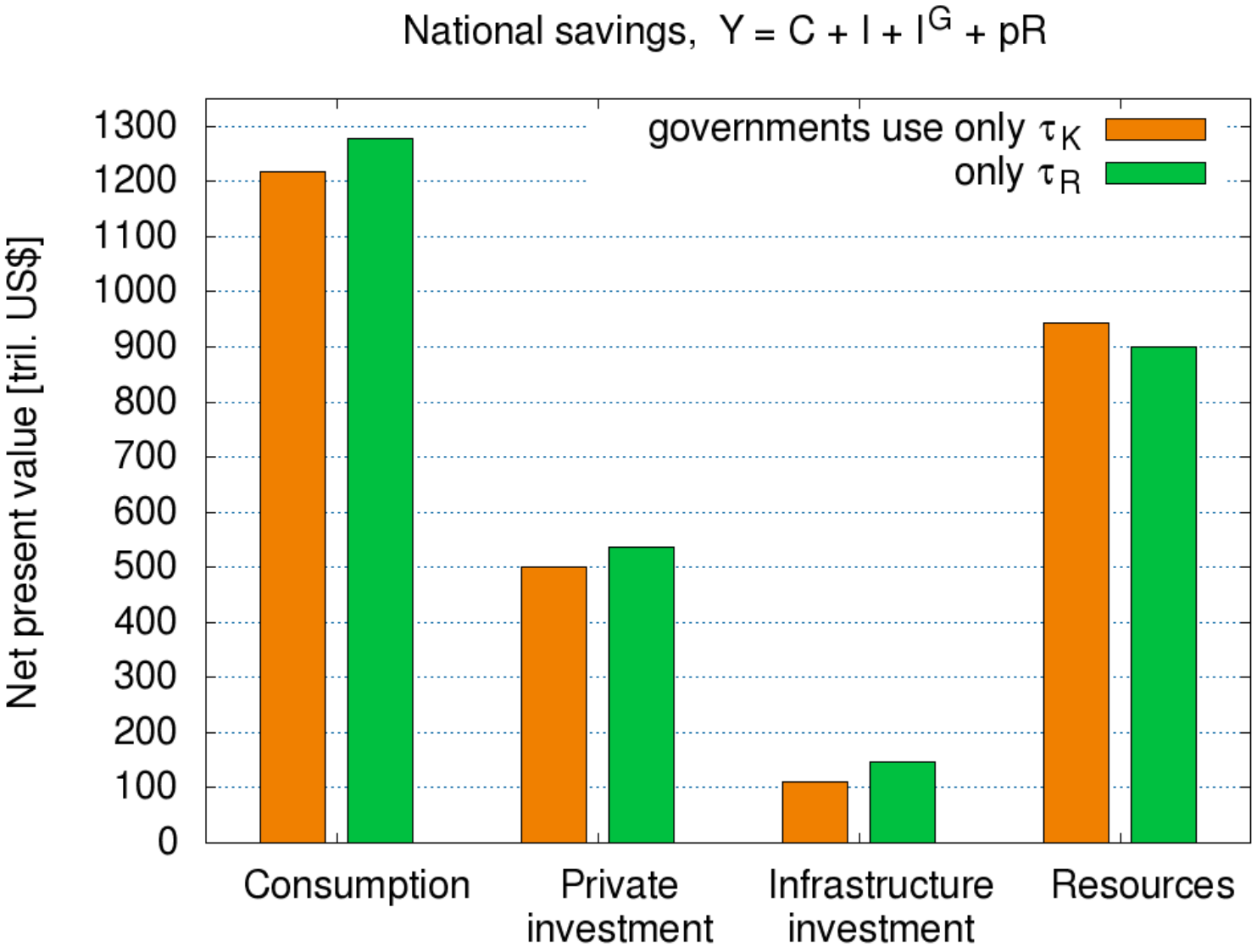
$$I_t^G + Tax_t^{transfer} = r_t \tau_{K,t} K_t^d + \tau_{R,t} R_t^d,$$
$$G_{t+1} = G_t + I_t^G - \delta G_t$$

and

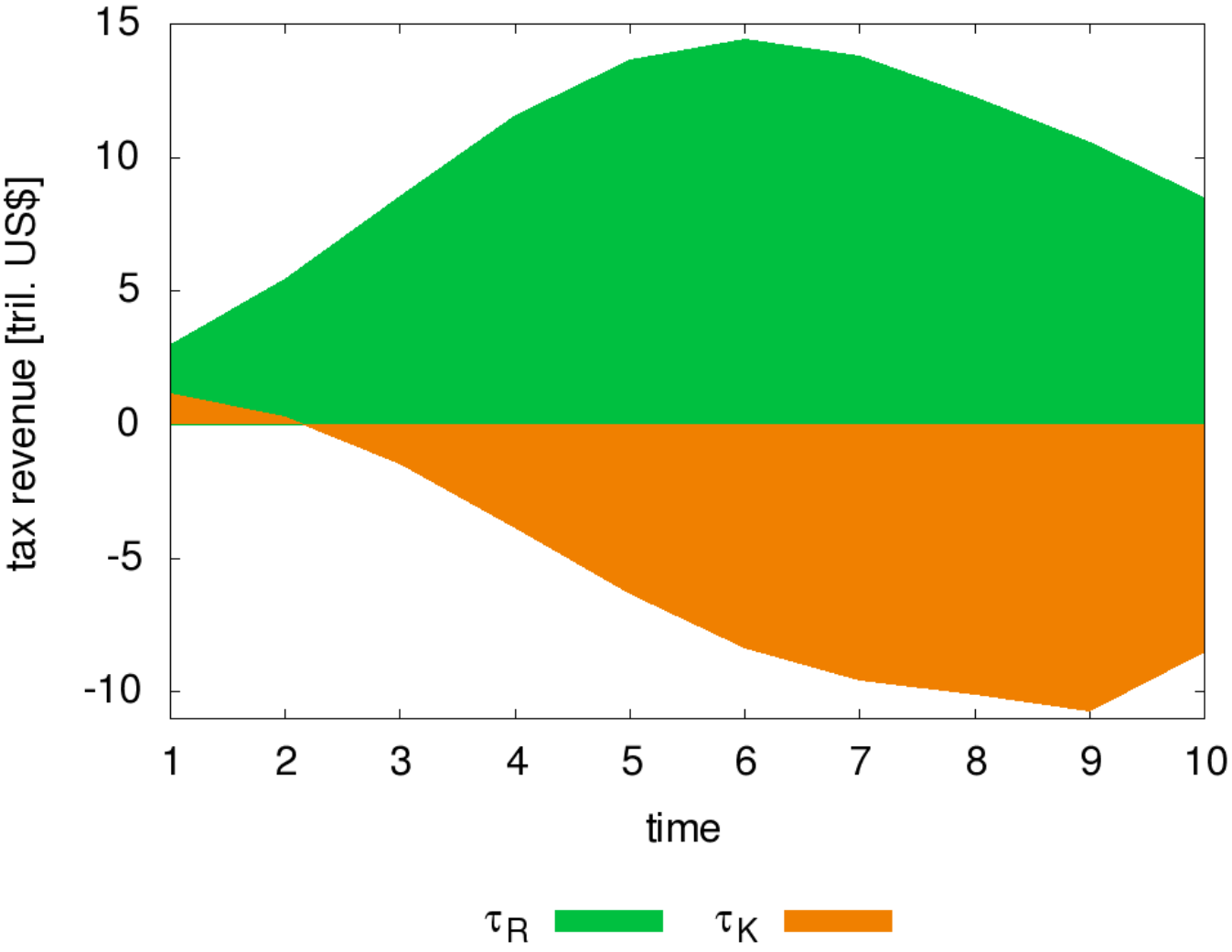
- the international market clearing conditions,
- the maximization problems of households, firms, and the resource exporter,
- their respective FOCs and TCs

RESULTS

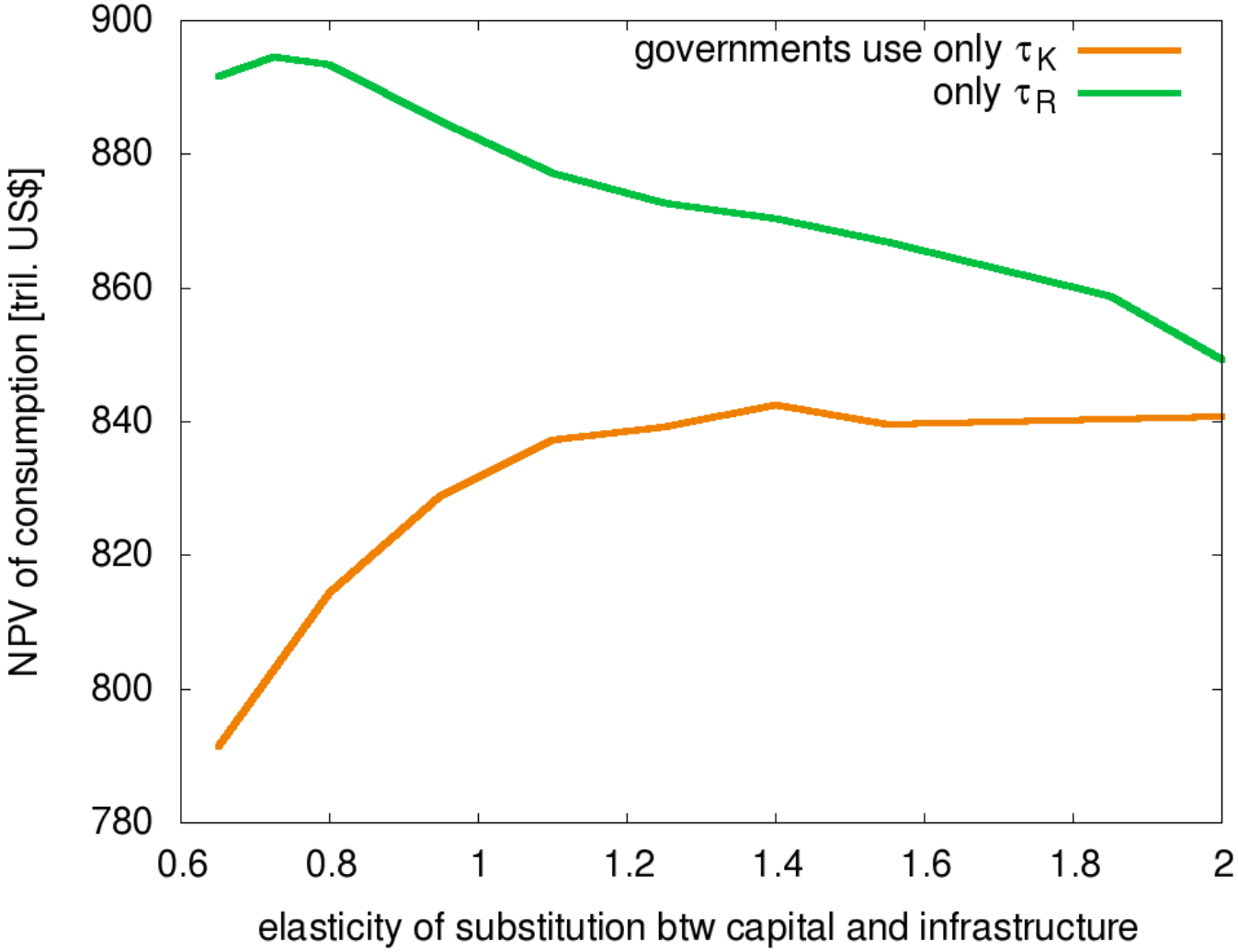
Macroeconomic data – non-cooperation



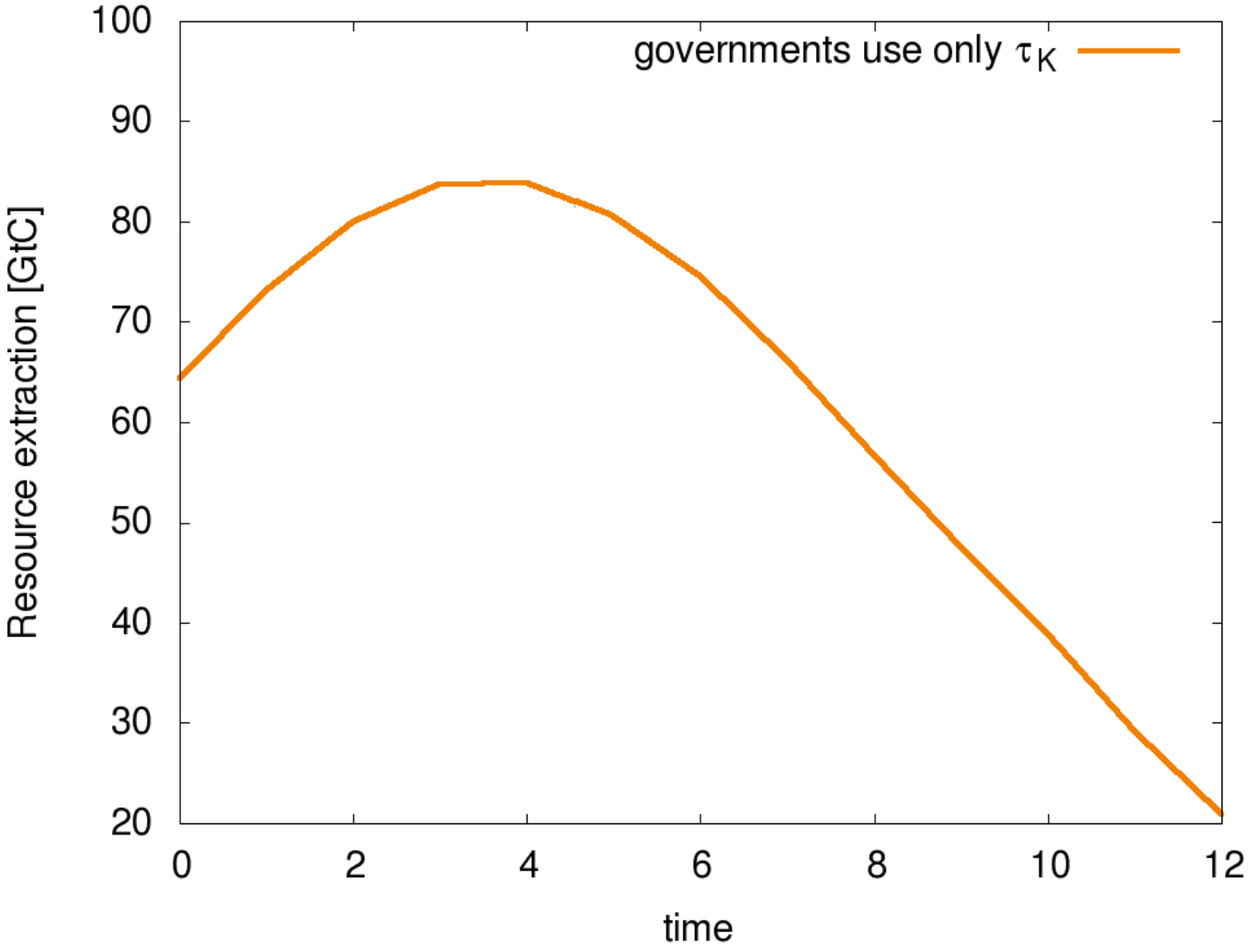
Mixed portfolio of τ_K and τ_R – non-cooperation



Elasticity of substitution – non-cooperation



Without cooperation:
No green paradox, but viable green policy



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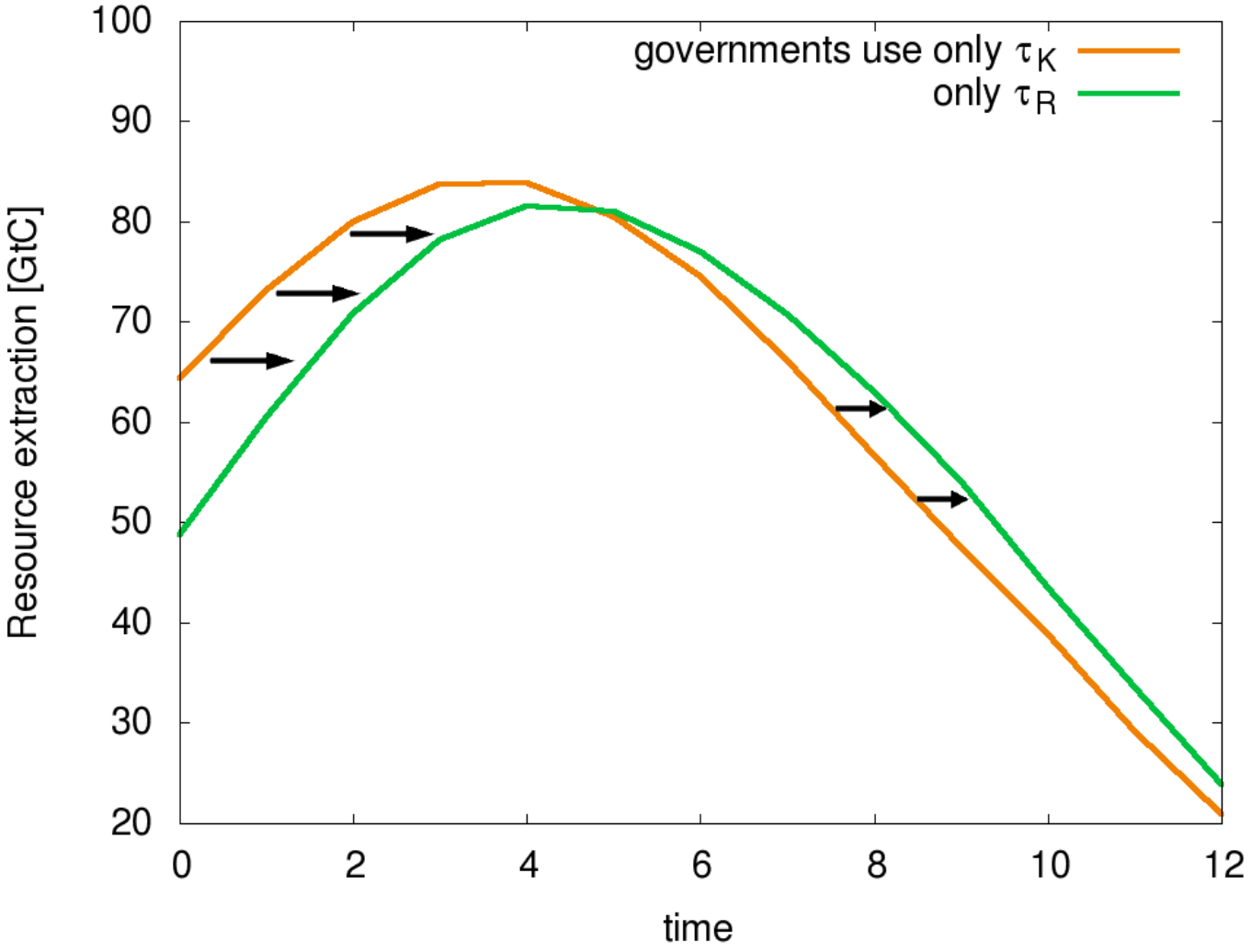

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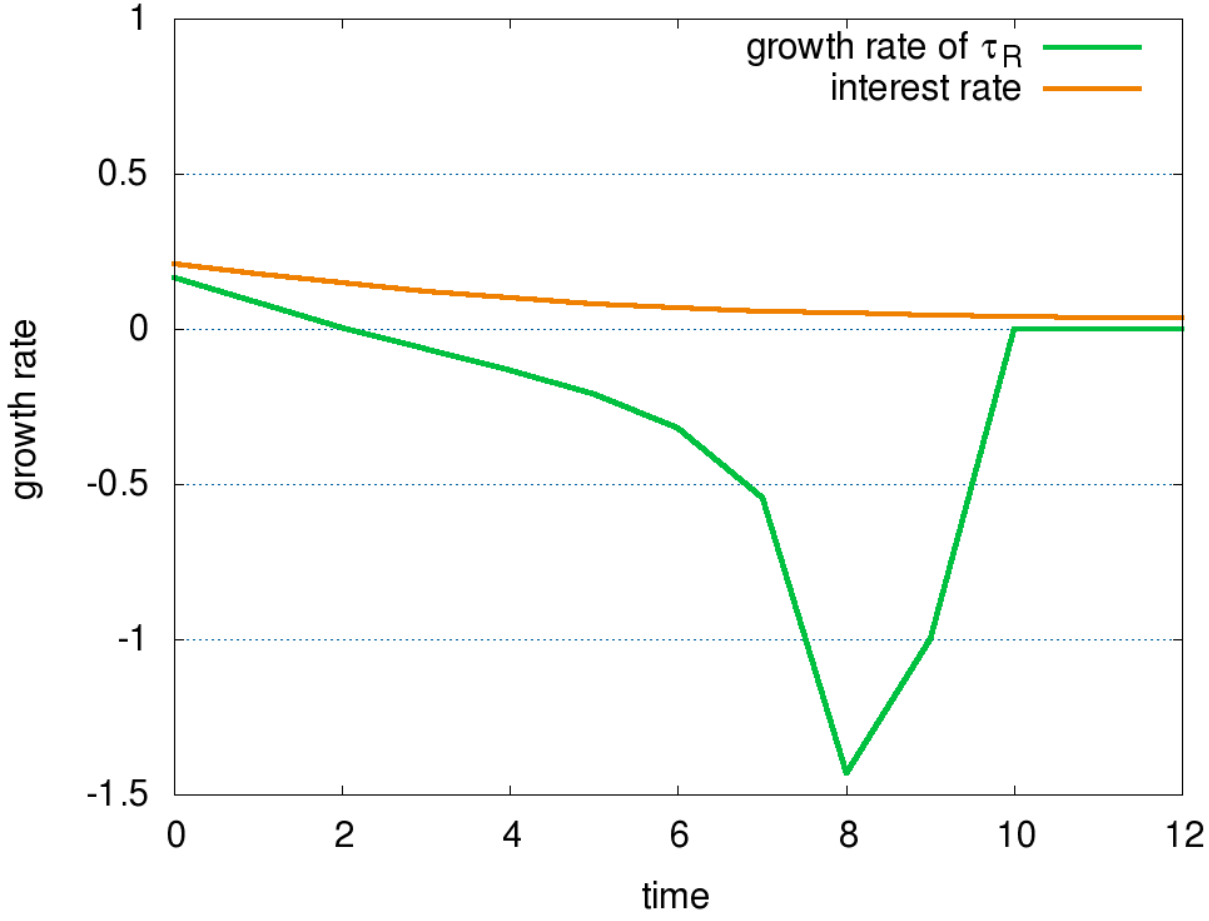
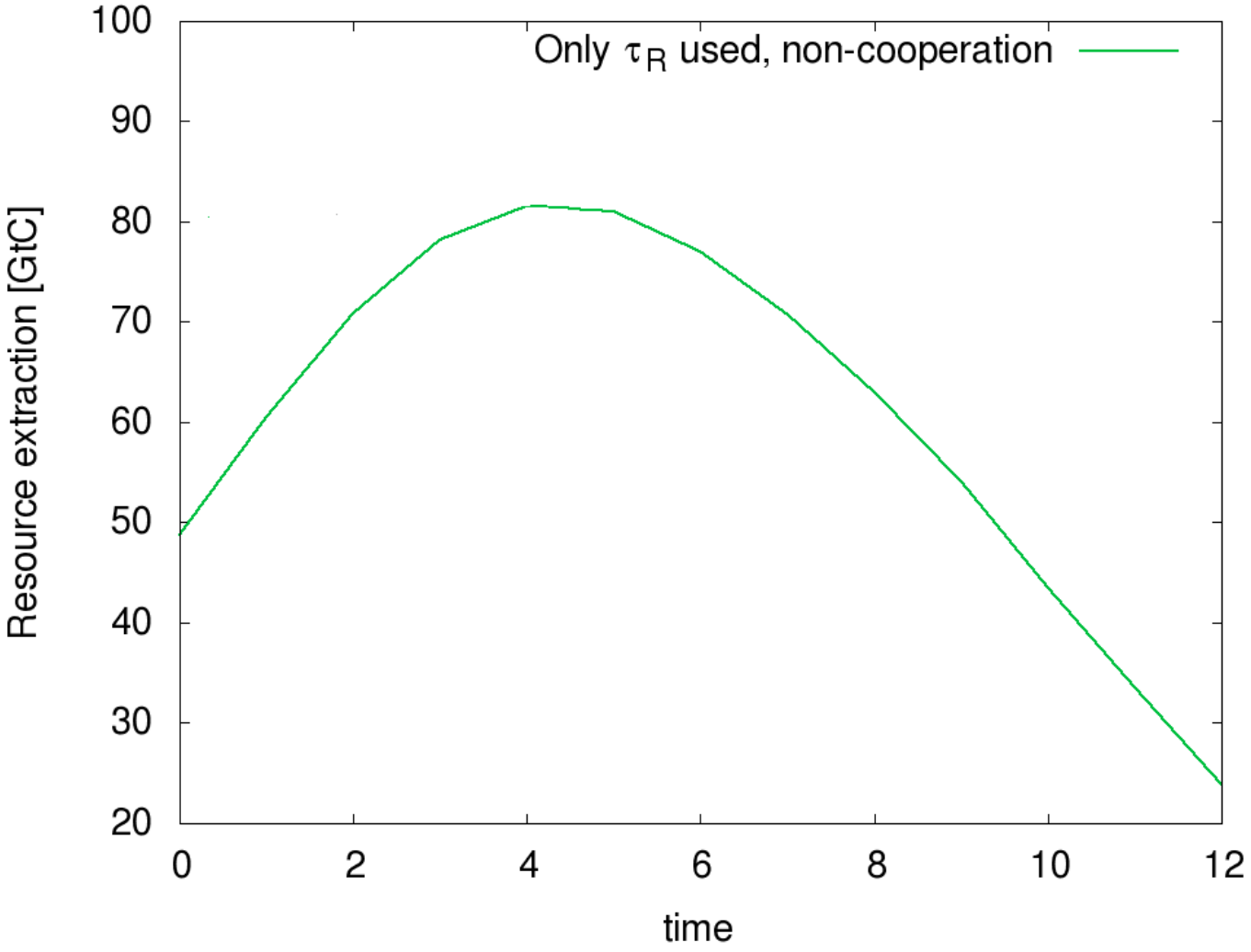


Carbon tax postpones extraction, because

$$r_t > \frac{\dot{\tau}_{R,t}}{\tau_{R,t}} \quad \forall t$$

See also Edenhofer and Kalkuhl (2011)

With cooperation:
Carbon tax speeds up extraction



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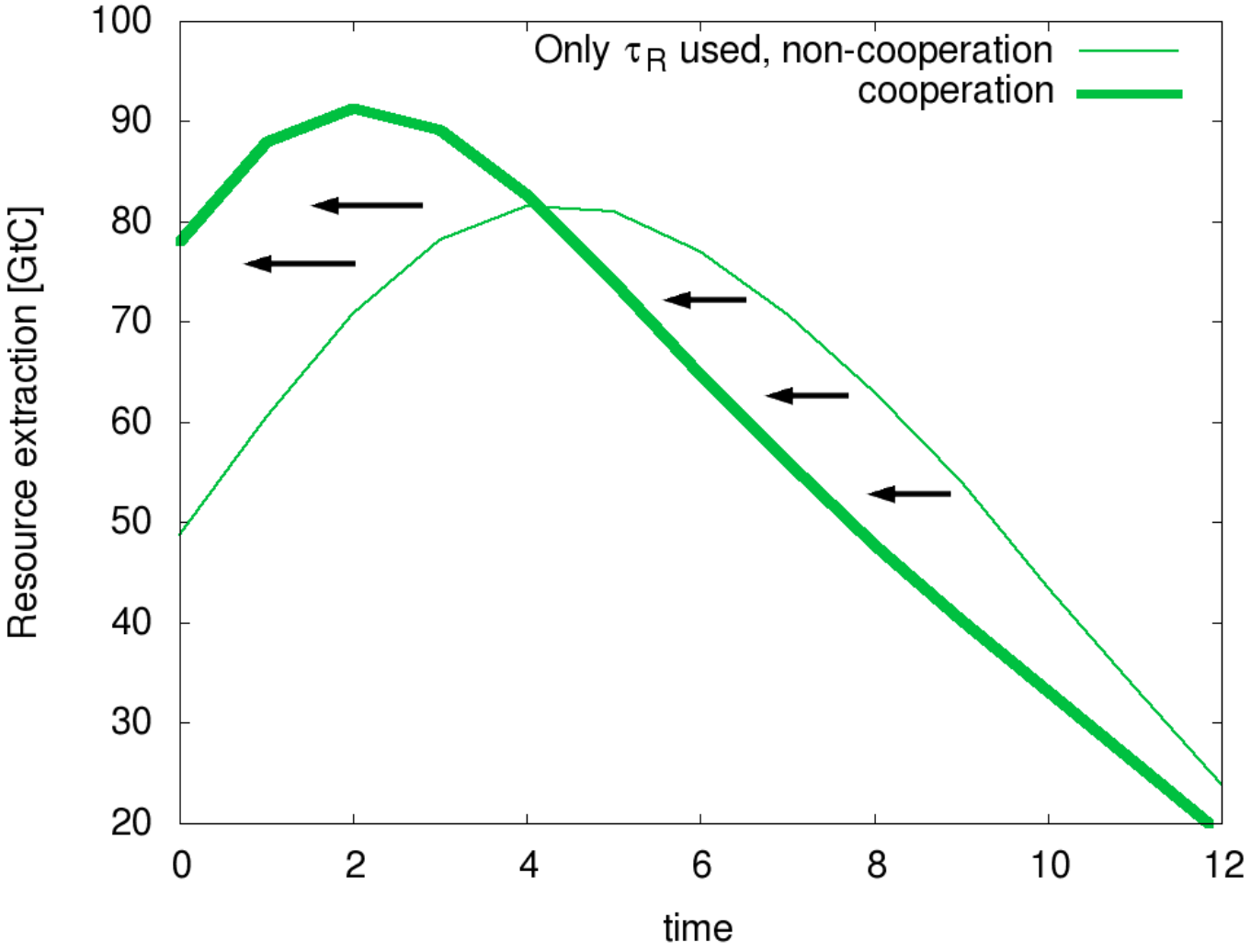
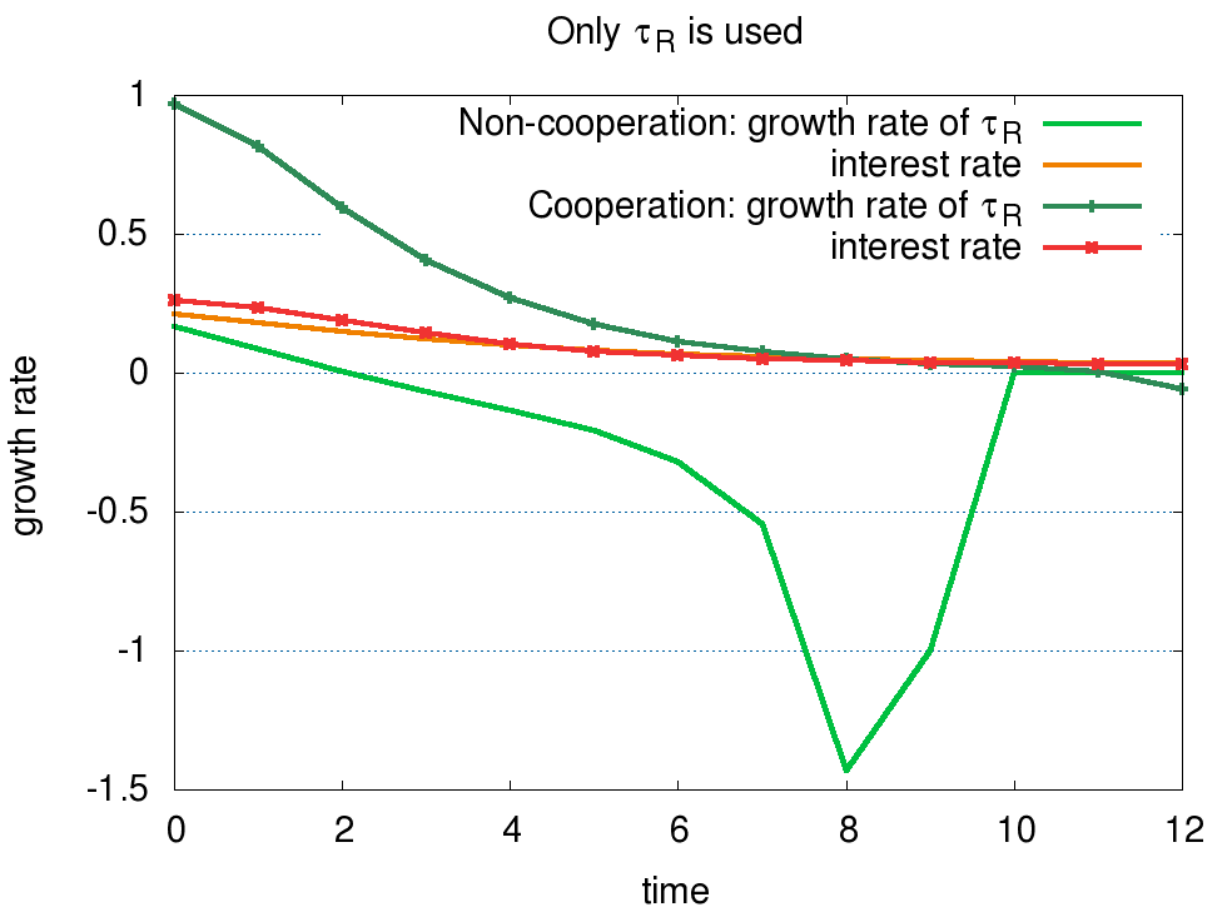


With cooperation: Carbon tax speeds up extraction



Non-cooperation: carbon tax postpones extraction, because

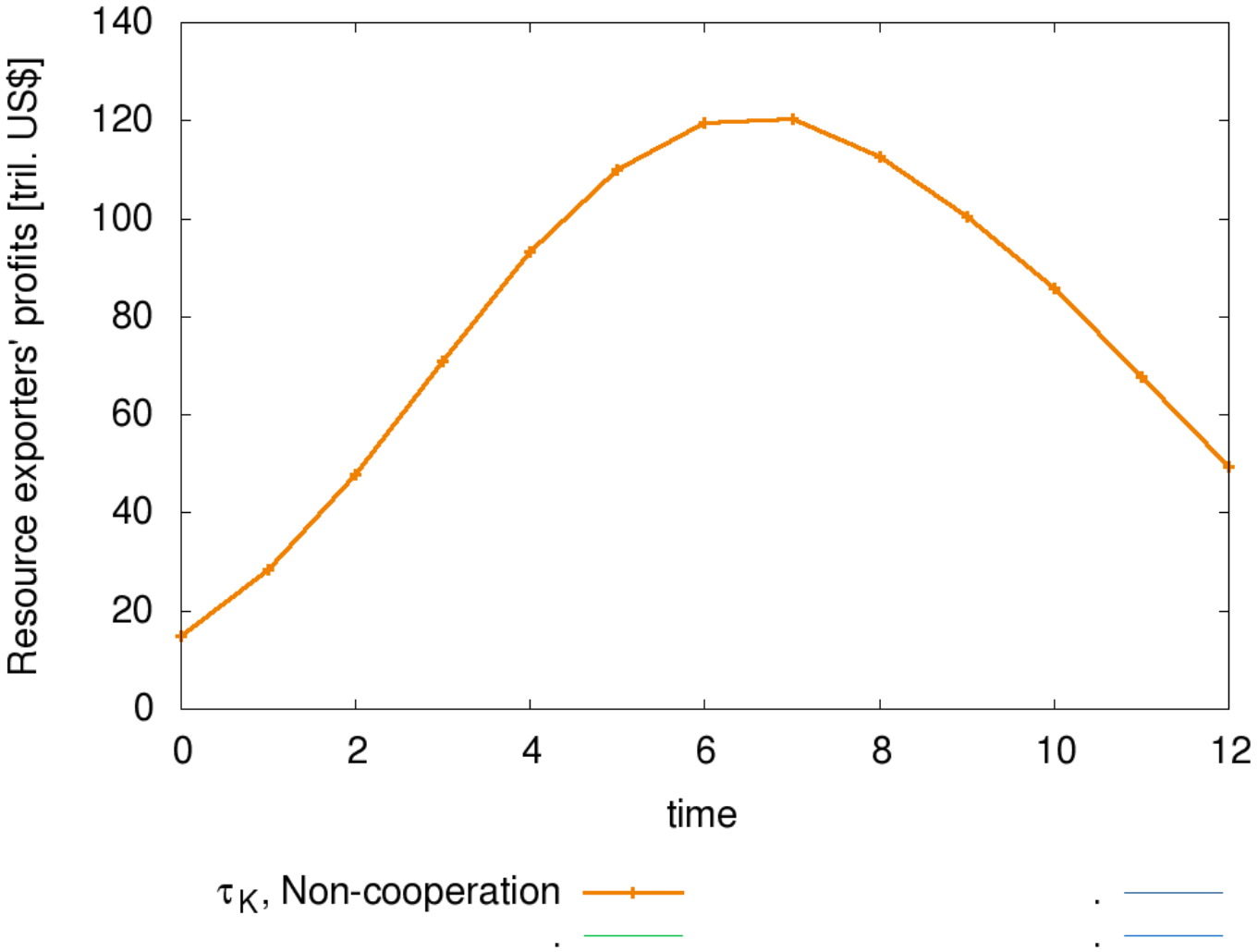
$$r_t > \frac{\dot{\tau_{R,t}}}{\tau_{R,t}} \quad \forall t$$

Cooperation: carbon tax speeds up extraction, because

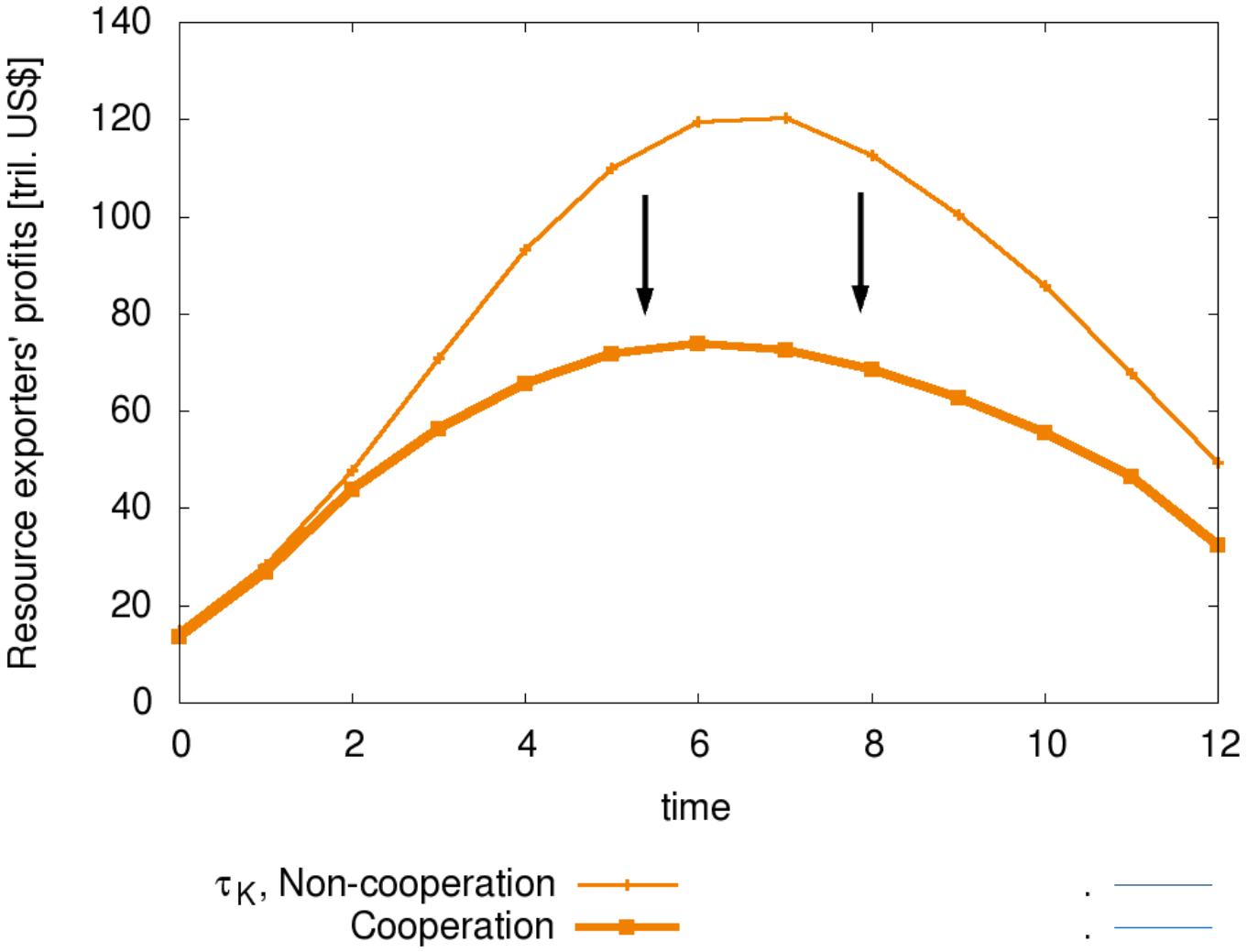
$$r_t < \frac{\dot{\tau_{R,t}}}{\tau_{R,t}} \quad \forall t < 10$$

See also Edenhofer and Kalkuhl (2011)

Rent capturing, with and without cooperation



Rent capturing, with and without cooperation



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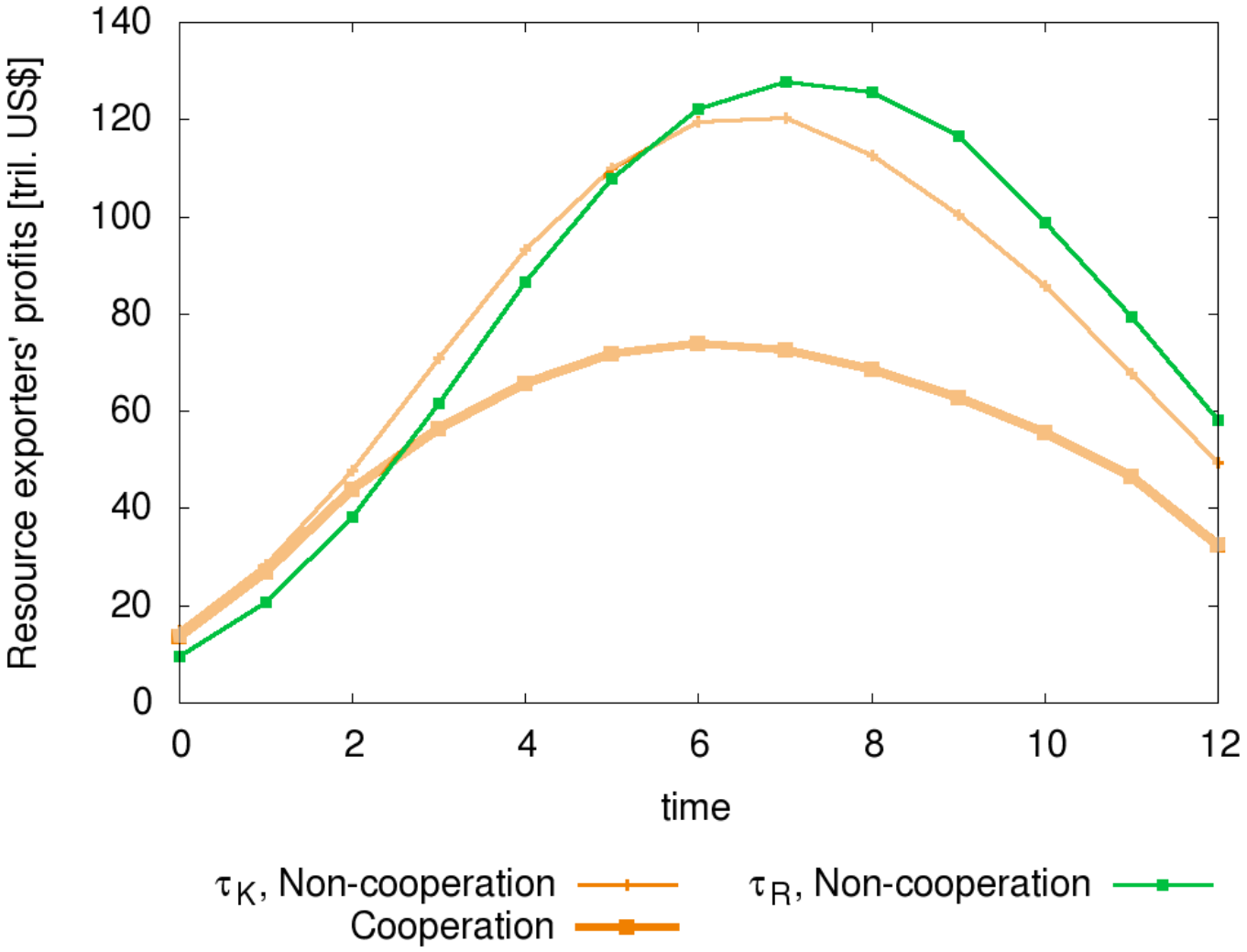
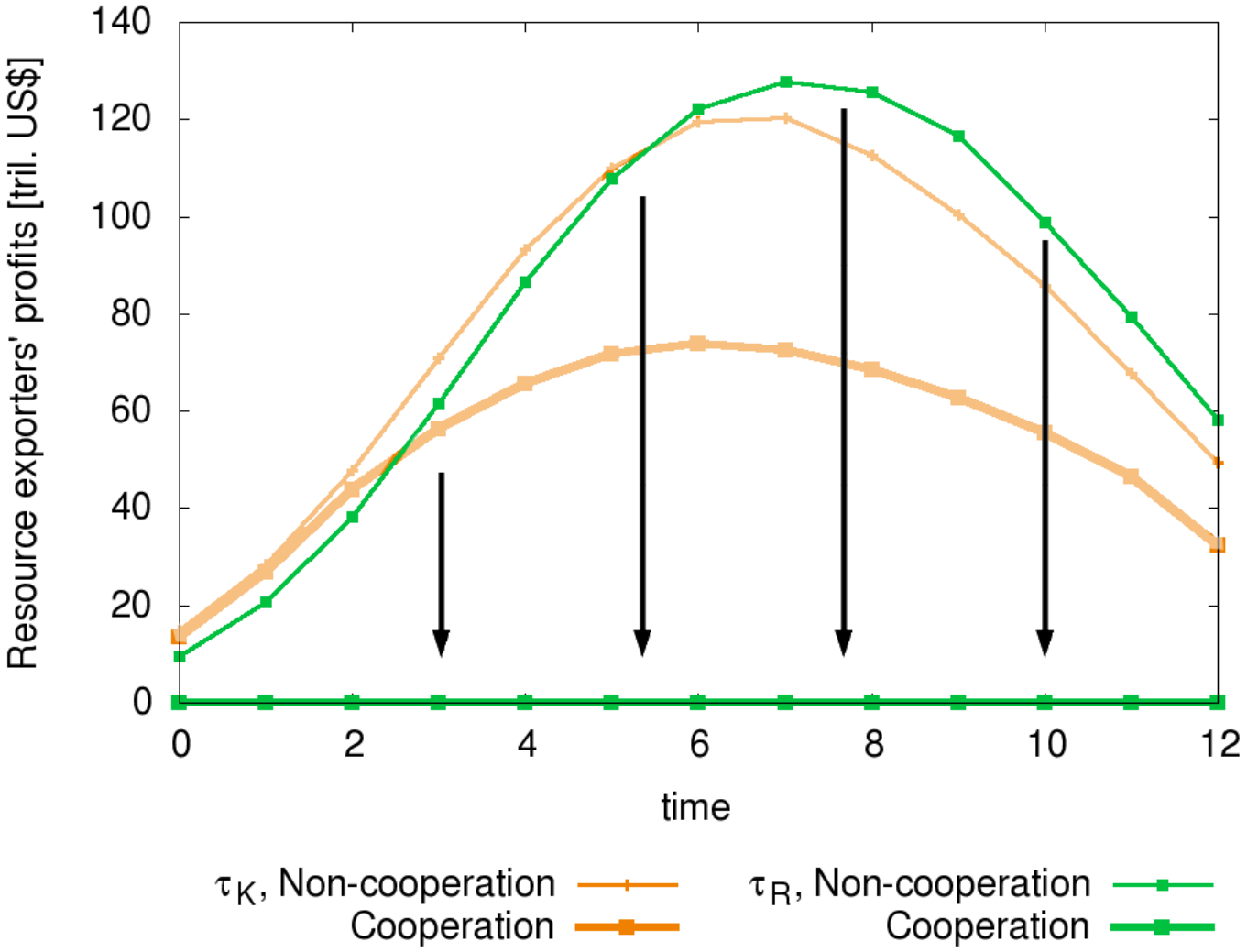


Rent capturing, with and without cooperation



Trade-off between fiscal and environmental benefits

Non-cooperation	Cooperation
Carbon tax delays extraction	Carbon tax speeds up extraction, relative to non-cooperation
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impact of extraction costs / climate externality

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   - could be a game changer and facilitate global agreement on climate policy.

Appendix

Future research

- Endogenous carbon budget as policy instrument (rent creation via artificial scarcity)
- Dynamics of fiscal and environmental taxation motive (include damage function)
- Intertemporal borrowing and lending

Model setup - solution algorithm

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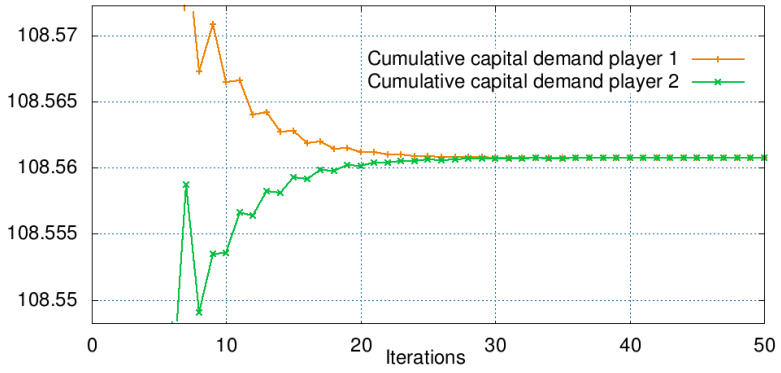
- ...until policy instruments converge.



Parameter values

Description	symbol	value	range	sources
Intertemporal elasticity of substitution	η	1.1		
Pure rate of time preference	ρ	0.03		
Annual depreciation rate of capital	δ	0.03		
Share parameter of fossil resource	α_1	0.11		Edenhofer et. al. (2005)
Elasticity of substitution btw. Z and R	σ_1	0.5	0.25 – 0.92	Hogan and Manne (1979) Kemfert and Welsch (2000) Burniaux et. al. (1992) Markandya et. al. (2007)
Share parameter of private capital	α_2	0.7		
Elasticity of substitution btw. K and G	σ_2	1.1	0.5 – 4	Baier and Glomm (2001) Coenen et. al. (2012) Otto and Voss (1998)
Total factor productivity	A	0.8		
Initial world capital [tril. US$]	K_0	165		
Initial world infrastructure [tril. US$]	G_0	50		
Initial world resource stock [GtC]	S_0	4000		
Time horizon [years]	T	75		

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