Interjurisdictional Spillovers, Decentralized Policymaking, and the Elasticity of Capital Supply

Thomas Eichner, University Hagen
Marco Runkel, University of Technology Berlin

Workshop "Closing the Carbon Price Gap:
Public Finance and Climate Policy"

Mercator Research Institute on Global Commons and Climate Change

Berlin

May, 22-23, 2014

Research Question

Question addressed in this paper

Can decentralized policymaking in the presence of interjurisdictional spillovers be efficient?

Main motivation: climate policy

- GHG create interjurisdictional spillovers (externalities)
- climate summits all (more or less) failed to implement centralized (efficient) policy (no Super-Kyoto)
- is there hope that decentralized climate policy is efficient?

Intuitive answer: NO!

- spillovers are not internalized and
- policy instruments create policy/fiscal externalities

Research Question

Question addressed in this paper

Can decentralized policymaking in the presence of interjurisdictional spillovers be efficient?

Main motivation: climate policy

- GHG create interjurisdictional spillovers (externalities)
- climate summits all (more or less) failed to implement centralized (efficient) policy (no Super-Kyoto)
- is there hope that decentralized climate policy is efficient?

Intuitive answer: NO!

- spillovers are not internalized and
- policy instruments create policy/fiscal externalities

Research Question

Question addressed in this paper

Can decentralized policymaking in the presence of interjurisdictional spillovers be efficient?

Main motivation: climate policy

- GHG create interjurisdictional spillovers (externalities)
- climate summits all (more or less) failed to implement centralized (efficient) policy (no Super-Kyoto)
- is there hope that decentralized climate policy is efficient?

Intuitive answer: NO!

- spillovers are not internalized and
- policy instruments create policy/fiscal externalities

Research Question

Question addressed in this paper

Can decentralized policymaking in the presence of interjurisdictional spillovers be efficient?

Main motivation: climate policy

- GHG create interjurisdictional spillovers (externalities)
- climate summits all (more or less) failed to implement centralized (efficient) policy (no Super-Kyoto)
- is there hope that decentralized climate policy is efficient?

Intuitive answer: NO!

- spillovers are not internalized and
- policy instruments create policy/fiscal externalities

Research Question

Question addressed in this paper

Can decentralized policymaking in the presence of interjurisdictional spillovers be efficient?

Main motivation: climate policy

- GHG create interjurisdictional spillovers (externalities)
- climate summits all (more or less) failed to implement centralized (efficient) policy (no Super-Kyoto)
- is there hope that decentralized climate policy is efficient?

Intuitive answer: NO!

- spillovers are not internalized and
- policy instruments create policy/fiscal externalities

Research Question

Question addressed in this paper

Can decentralized policymaking in the presence of interjurisdictional spillovers be efficient?

Main motivation: climate policy

- GHG create interjurisdictional spillovers (externalities)
- climate summits all (more or less) failed to implement centralized (efficient) policy (no Super-Kyoto)
- is there hope that decentralized climate policy is efficient?

Intuitive answer: NO!

- spillovers are not internalized and
- policy instruments create policy/fiscal externalities

Contribution of this Paper

Answer in previous literature: YES!

- Oates/Schwab (1988, JPubE): decentralized choice of taxes on mobile capital with identical jurisd./local pollution efficient
- Ogawa/Wildasin (2009, AER): efficiency also with non-identical jurisdictions and global pollution (spillovers)

  note: fixed capital supply; emissions proportional to capital (*)

Two contributions of our paper

- in Ogawa/Wildasin: environmental externality due to spillovers + fiscal externality due to mobile capital

  $\rightarrow$ because of (*) both externalities just neutralize each other
- extension: elastic capital supply $\rightarrow$ total emissions endogenous

  $\rightarrow$ environmental ext. not enough to compensate fiscal ext.

  $\rightarrow$ decentrally chosen capital tax rates inefficiently low

Contribution of this Paper

Answer in previous literature: YES!

- Oates/Schwab (1988, JPubE): decentralized choice of taxes on mobile capital with identical jurisd./local pollution efficient
- Ogawa/Wildasin (2009, AER): efficiency also with non-identical jurisdictions and global pollution (spillovers)

note: fixed capital supply; emissions proportional to capital (*)

Two contributions of our paper

- in Ogawa/Wildasin: environmental externality due to spillovers + fiscal externality due to mobile capital

  $\rightarrow$ because of (*) both externalities just neutralize each other
- extension: elastic capital supply $\rightarrow$ total emissions endogenous

  $\rightarrow$ environmental ext. not enough to compensate fiscal ext.

  $\rightarrow$ decentrally chosen capital tax rates inefficiently low

Contribution of this Paper

Answer in previous literature: YES!

- Oates/Schwab (1988, JPubE): decentralized choice of taxes on mobile capital with identical jurisd./local pollution efficient
- Ogawa/Wildasin (2009, AER): efficiency also with non-identical jurisdictions and global pollution (spillovers)

  note: fixed capital supply; emissions proportional to capital (*)

Two contributions of our paper

- in Ogawa/Wildasin: environmental externality due to spillovers
  + fiscal externality due to mobile capital

  $\rightarrow$ because of (*) both externalities just neutralize each other
- extension: elastic capital supply $\rightarrow$ total emissions endogenous

  $\rightarrow$ environmental ext. not enough to compensate fiscal ext.

  $\rightarrow$ decentrally chosen capital tax rates inefficiently low

Contribution of this Paper

Answer in previous literature: YES!

- Oates/Schwab (1988, JPubE): decentralized choice of taxes on mobile capital with identical jurisd./local pollution efficient
- Ogawa/Wildasin (2009, AER): efficiency also with non-identical jurisdictions and global pollution (spillovers)

  note: fixed capital supply; emissions proportional to capital (*)

Two contributions of our paper

- in Ogawa/Wildasin: environmental externality due to spillovers
  + fiscal externality due to mobile capital

  → because of (*) both externalities just neutralize each other
- extension: elastic capital supply → total emissions endogenous

  → environmental ext. not enough to compensate fiscal ext.

  → decentrally chosen capital tax rates inefficiently low

Contribution of this Paper

Answer in previous literature: YES!

- Oates/Schwab (1988, JPubE): decentralized choice of taxes on mobile capital with identical jurisd./local pollution efficient
- Ogawa/Wildasin (2009, AER): efficiency also with non-identical jurisdictions and global pollution (spillovers)

  note: fixed capital supply; emissions proportional to capital (*)

Two contributions of our paper

- in Ogawa/Wildasin: environmental externality due to spillovers
  + fiscal externality due to mobile capital

  $\rightarrow$ because of (*) both externalities just neutralize each other
- extension: elastic capital supply $\rightarrow$ total emissions endogenous

  $\rightarrow$ environmental ext. not enough to compensate fiscal ext.

  $\rightarrow$ decentrally chosen capital tax rates inefficiently low

Contribution of this Paper

Answer in previous literature: YES!

- Oates/Schwab (1988, JPubE): decentralized choice of taxes on mobile capital with identical jurisd./local pollution efficient
- Ogawa/Wildasin (2009, AER): efficiency also with non-identical jurisdictions and global pollution (spillovers)

  note: fixed capital supply; emissions proportional to capital (*)

Two contributions of our paper

- in Ogawa/Wildasin: environmental externality due to spillovers
  + fiscal externality due to mobile capital

  $\rightarrow$ because of (*) both externalities just neutralize each other
- extension: elastic capital supply $\rightarrow$ total emissions endogenous

  $\rightarrow$ environmental ext. not enough to compensate fiscal ext.

  $\rightarrow$ decentrally chosen capital tax rates inefficiently low

Contribution of this Paper

Answer in previous literature: YES!

- Oates/Schwab (1988, JPubE): decentralized choice of taxes on mobile capital with identical jurisd./local pollution efficient
- Ogawa/Wildasin (2009, AER): efficiency also with non-identical jurisdictions and global pollution (spillovers)

  note: fixed capital supply; emissions proportional to capital (*)

Two contributions of our paper

- in Ogawa/Wildasin: environmental externality due to spillovers
  + fiscal externality due to mobile capital

  $\rightarrow$ because of (*) both externalities just neutralize each other
- extension: elastic capital supply $\rightarrow$ total emissions endogenous

  $\rightarrow$ environmental ext. not enough to compensate fiscal ext.

  $\rightarrow$ decentrally chosen capital tax rates inefficiently low

Contribution of this Paper

Answer in previous literature: YES!

- Oates/Schwab (1988, JPubE): decentralized choice of taxes on mobile capital with identical jurisd./local pollution efficient
- Ogawa/Wildasin (2009, AER): efficiency also with non-identical jurisdictions and global pollution (spillovers)

  note: fixed capital supply; emissions proportional to capital (*)

Two contributions of our paper

- in Ogawa/Wildasin: environmental externality due to spillovers
  + fiscal externality due to mobile capital

  $\rightarrow$ because of (*) both externalities just neutralize each other
- extension: elastic capital supply $\rightarrow$ total emissions endogenous

  $\rightarrow$ environmental ext. not enough to compensate fiscal ext.

  $\rightarrow$ decentrally chosen capital tax rates inefficiently low

Basic Structure, Firms and Households

Basic Structure

- $n \geq 2$ countries; country indices: i, j
- a representative firm + household in each country

Firm in country i

- after-tax profit: $\pi_i = F(k_i) - (\rho + t_i)k_i$ (1)

  with: k_i = capital, ρ = interest, t_i = tax in i, $F'' < 0 < F'$
- FOC: $F'(k_i) - t_i = \rho$ (2)

Household in country i

- utility: $u_i = U(\bar{k} - s_i) + (1 + \rho)s_i + \pi_i + t_i k_i + V(e_i)$ (3)

  with: $\bar{k}$ = capital endowment, s_i = savings, e_i = pollution

  and: $U'' < 0 < U'$, $V' < 0 < V''$
- FOC: $U'(\bar{k} - s_i) = 1 + \rho \Rightarrow s_i = S(\rho)$ (elastic capital supply)

Basic Structure, Firms and Households

Basic Structure

- $n \geq 2$ countries; country indices: i, j
- a representative firm + household in each country

Firm in country i

- after-tax profit: $\pi_i = F(k_i) - (\rho + t_i)k_i$ (1)

  with: k_i = capital, ρ = interest, t_i = tax in i, $F'' < 0 < F'$
- FOC: $F'(k_i) - t_i = \rho$ (2)

Household in country i

- utility: $u_i = U(\bar{k} - s_i) + (1 + \rho)s_i + \pi_i + t_i k_i + V(e_i)$ (3)

  with: $\bar{k}$ = capital endowment, s_i = savings, e_i = pollution

  and: $U'' < 0 < U'$, $V' < 0 < V''$
- FOC: $U'(\bar{k} - s_i) = 1 + \rho \Rightarrow s_i = S(\rho)$ (elastic capital supply)

Basic Structure, Firms and Households

Basic Structure

- $n \geq 2$ countries; country indices: i, j
- a representative firm + household in each country

Firm in country i

- after-tax profit: $\pi_i = F(k_i) - (\rho + t_i)k_i$ (1)

  with: k_i = capital, ρ = interest, t_i = tax in i, $F'' < 0 < F'$
- FOC: $F'(k_i) - t_i = \rho$ (2)

Household in country i

- utility: $u_i = U(\bar{k} - s_i) + (1 + \rho)s_i + \pi_i + t_i k_i + V(e_i)$ (3)

  with: $\bar{k}$ = capital endowment, s_i = savings, e_i = pollution

  and: $U'' < 0 < U'$, $V' < 0 < V''$
- FOC: $U'(\bar{k} - s_i) = 1 + \rho \Rightarrow s_i = S(\rho)$ (elastic capital supply)

Basic Structure, Firms and Households

Basic Structure

- $n \geq 2$ countries; country indices: i, j
- a representative firm + household in each country

Firm in country i

- after-tax profit: $\pi_i = F(k_i) - (\rho + t_i)k_i$ (1)

  with: k_i = capital, ρ = interest, t_i = tax in i, $F'' < 0 < F'$
- FOC: $F'(k_i) - t_i = \rho$ (2)

Household in country i

- utility: $u_i = U(\bar{k} - s_i) + (1 + \rho)s_i + \pi_i + t_i k_i + V(e_i)$ (3)

  with: $\bar{k}$ = capital endowment, s_i = savings, e_i = pollution

  and: $U'' < 0 < U'$, $V' < 0 < V''$
- FOC: $U'(\bar{k} - s_i) = 1 + \rho \Rightarrow s_i = S(\rho)$ (elastic capital supply)

Basic Structure, Firms and Households

Basic Structure

- $n \geq 2$ countries; country indices: i, j
- a representative firm + household in each country

Firm in country i

- after-tax profit: $\pi_i = F(k_i) - (\rho + t_i)k_i$ (1)

  with: k_i = capital, ρ = interest, t_i = tax in i, $F'' < 0 < F'$
- FOC: $F'(k_i) - t_i = \rho$ (2)

Household in country i

- utility: $u_i = U(\bar{k} - s_i) + (1 + \rho)s_i + \pi_i + t_i k_i + V(e_i)$ (3)

  with: $\bar{k}$ = capital endowment, s_i = savings, e_i = pollution

  and: $U'' < 0 < U'$, $V' < 0 < V''$
- FOC: $U'(\bar{k} - s_i) = 1 + \rho \Rightarrow s_i = S(\rho)$ (elastic capital supply)

Basic Structure, Firms and Households

Basic Structure

- $n \geq 2$ countries; country indices: i, j
- a representative firm + household in each country

Firm in country i

- after-tax profit: $\pi_i = F(k_i) - (\rho + t_i)k_i$ (1)

  with: k_i = capital, ρ = interest, t_i = tax in i, $F'' < 0 < F'$
- FOC: $F'(k_i) - t_i = \rho$ (2)

Household in country i

- utility: $u_i = U(\bar{k} - s_i) + (1 + \rho)s_i + \pi_i + t_i k_i + V(e_i)$ (3)

  with: $\bar{k}$ = capital endowment, s_i = savings, e_i = pollution

  and: $U'' < 0 < U'$, $V' < 0 < V''$
- FOC: $U'(\bar{k} - s_i) = 1 + \rho \Rightarrow s_i = S(\rho)$ (elastic capital supply)

Capital Market and Pollution

Capital market

- equilibrium $\sum_{i=1}^{n} k_i = nS(\rho)$ together with (2) yields:

$$\frac{\partial \rho}{\partial t_i} < 0, \quad \frac{\partial k_i}{\partial t_i} < 0, \quad \frac{\partial k_j}{\partial t_i} > 0, \quad \frac{\partial k_i}{\partial t_i} + (n-1)\frac{\partial k_j}{\partial t_i} = \frac{S'}{F''S' - 1}$$

- fixed supply ($S' = 0$): $t_i \uparrow \rightarrow$ relocation of capital
- elastic supply ($S' > 0$): $t_i \uparrow \rightarrow$ same + reduction of capital

Pollution

- pollution in i: $e_i = \alpha k_i + \beta \sum_{j \neq i} \alpha k_j \quad (\beta > 0$: spillovers)

$$\frac{\partial e_i}{\partial t_i} < 0, \quad \frac{\partial e_j}{\partial t_i} \gtreqless 0, \quad \frac{\partial e_i}{\partial t_i} + (n-1)\frac{\partial e_j}{\partial t_i} = \frac{\alpha[1 + \beta(n-1)]S'}{F''S' - 1}$$

- fixed supply ($S' = 0$): $t_i \uparrow \rightarrow$ total emissions unchanged
- elastic supply ($S' > 0$): $t_i \uparrow \rightarrow$ total emissions fall

Capital Market and Pollution

Capital market

- equilibrium $\sum_{i=1}^{n} k_i = nS(\rho)$ together with (2) yields:

$$\frac{\partial \rho}{\partial t_i} < 0, \quad \frac{\partial k_i}{\partial t_i} < 0, \quad \frac{\partial k_j}{\partial t_i} > 0, \quad \frac{\partial k_i}{\partial t_i} + (n-1)\frac{\partial k_j}{\partial t_i} = \frac{S'}{F''S' - 1}$$

- fixed supply ($S' = 0$): $t_i \uparrow \rightarrow$ relocation of capital
- elastic supply ($S' > 0$): $t_i \uparrow \rightarrow$ same + reduction of capital

Pollution

- pollution in i: $e_i = \alpha k_i + \beta \sum_{j \neq i} \alpha k_j \quad (\beta > 0$: spillovers)

$$\frac{\partial e_i}{\partial t_i} < 0, \quad \frac{\partial e_j}{\partial t_i} \gtreqless 0, \quad \frac{\partial e_i}{\partial t_i} + (n-1)\frac{\partial e_j}{\partial t_i} = \frac{\alpha[1 + \beta(n-1)]S'}{F''S' - 1}$$

- fixed supply ($S' = 0$): $t_i \uparrow \rightarrow$ total emissions unchanged
- elastic supply ($S' > 0$): $t_i \uparrow \rightarrow$ total emissions fall

Capital Market and Pollution

Capital market

- equilibrium $\sum_{i=1}^{n} k_i = nS(\rho)$ together with (2) yields:

$$\frac{\partial \rho}{\partial t_i} < 0, \quad \frac{\partial k_i}{\partial t_i} < 0, \quad \frac{\partial k_j}{\partial t_i} > 0, \quad \frac{\partial k_i}{\partial t_i} + (n-1)\frac{\partial k_j}{\partial t_i} = \frac{S'}{F''S' - 1}$$

- fixed supply ($S' = 0$): $t_i \uparrow \rightarrow$ relocation of capital
- elastic supply ($S' > 0$): $t_i \uparrow \rightarrow$ same + reduction of capital

Pollution

- pollution in i: $e_i = \alpha k_i + \beta \sum_{j \neq i} \alpha k_j \quad (\beta > 0$: spillovers)

$$\frac{\partial e_i}{\partial t_i} < 0, \quad \frac{\partial e_j}{\partial t_i} \gtreqless 0, \quad \frac{\partial e_i}{\partial t_i} + (n-1)\frac{\partial e_j}{\partial t_i} = \frac{\alpha[1 + \beta(n-1)]S'}{F''S' - 1}$$

- fixed supply ($S' = 0$): $t_i \uparrow \rightarrow$ total emissions unchanged
- elastic supply ($S' > 0$): $t_i \uparrow \rightarrow$ total emissions fall

Capital Market and Pollution

Capital market

- equilibrium $\sum_{i=1}^{n} k_i = nS(\rho)$ together with (2) yields:

$$\frac{\partial \rho}{\partial t_i} < 0, \quad \frac{\partial k_i}{\partial t_i} < 0, \quad \frac{\partial k_j}{\partial t_i} > 0, \quad \frac{\partial k_i}{\partial t_i} + (n-1)\frac{\partial k_j}{\partial t_i} = \frac{S'}{F''S' - 1}$$

- fixed supply ($S' = 0$): $t_i \uparrow \rightarrow$ relocation of capital
- elastic supply ($S' > 0$): $t_i \uparrow \rightarrow$ same + reduction of capital

Pollution

- pollution in i: $e_i = \alpha k_i + \beta \sum_{j \neq i} \alpha k_j$ ($\beta > 0$: spillovers)

$$\frac{\partial e_i}{\partial t_i} < 0, \quad \frac{\partial e_j}{\partial t_i} \gtreqless 0, \quad \frac{\partial e_i}{\partial t_i} + (n-1)\frac{\partial e_j}{\partial t_i} = \frac{\alpha[1 + \beta(n-1)]S'}{F''S' - 1}$$

- fixed supply ($S' = 0$): $t_i \uparrow \rightarrow$ total emissions unchanged
- elastic supply ($S' > 0$): $t_i \uparrow \rightarrow$ total emissions fall

Capital Market and Pollution

Capital market

- equilibrium $\sum_{i=1}^{n} k_i = nS(\rho)$ together with (2) yields:

$$\frac{\partial \rho}{\partial t_i} < 0, \quad \frac{\partial k_i}{\partial t_i} < 0, \quad \frac{\partial k_j}{\partial t_i} > 0, \quad \frac{\partial k_i}{\partial t_i} + (n-1)\frac{\partial k_j}{\partial t_i} = \frac{S'}{F''S' - 1}$$

- fixed supply ($S' = 0$): $t_i \uparrow \rightarrow$ relocation of capital
- elastic supply ($S' > 0$): $t_i \uparrow \rightarrow$ same + reduction of capital

Pollution

- pollution in i: $e_i = \alpha k_i + \beta \sum_{j \neq i} \alpha k_j$ ($\beta > 0$: spillovers)

$$\frac{\partial e_i}{\partial t_i} < 0, \quad \frac{\partial e_j}{\partial t_i} \gtreqless 0, \quad \frac{\partial e_i}{\partial t_i} + (n-1)\frac{\partial e_j}{\partial t_i} = \frac{\alpha[1 + \beta(n-1)]S'}{F''S' - 1}$$

- fixed supply ($S' = 0$): $t_i \uparrow \rightarrow$ total emissions unchanged
- elastic supply ($S' > 0$): $t_i \uparrow \rightarrow$ total emissions fall

Capital Market and Pollution

Capital market

- equilibrium $\sum_{i=1}^{n} k_i = nS(\rho)$ together with (2) yields:

$$\frac{\partial \rho}{\partial t_i} < 0, \quad \frac{\partial k_i}{\partial t_i} < 0, \quad \frac{\partial k_j}{\partial t_i} > 0, \quad \frac{\partial k_i}{\partial t_i} + (n-1)\frac{\partial k_j}{\partial t_i} = \frac{S'}{F''S' - 1}$$

- fixed supply ($S' = 0$): $t_i \uparrow \rightarrow$ relocation of capital
- elastic supply ($S' > 0$): $t_i \uparrow \rightarrow$ same + reduction of capital

Pollution

- pollution in i: $e_i = \alpha k_i + \beta \sum_{j \neq i} \alpha k_j$ ($\beta > 0$: spillovers)

$$\frac{\partial e_i}{\partial t_i} < 0, \quad \frac{\partial e_j}{\partial t_i} \gtreqless 0, \quad \frac{\partial e_i}{\partial t_i} + (n-1)\frac{\partial e_j}{\partial t_i} = \frac{\alpha[1 + \beta(n-1)]S'}{F''S' - 1}$$

- fixed supply ($S' = 0$): $t_i \uparrow \rightarrow$ total emissions unchanged
- elastic supply ($S' > 0$): $t_i \uparrow \rightarrow$ total emissions fall

Capital Market and Pollution

Capital market

- equilibrium $\sum_{i=1}^{n} k_i = nS(\rho)$ together with (2) yields:

$$\frac{\partial \rho}{\partial t_i} < 0, \quad \frac{\partial k_i}{\partial t_i} < 0, \quad \frac{\partial k_j}{\partial t_i} > 0, \quad \frac{\partial k_i}{\partial t_i} + (n-1)\frac{\partial k_j}{\partial t_i} = \frac{S'}{F''S' - 1}$$

- fixed supply ($S' = 0$): $t_i \uparrow \rightarrow$ relocation of capital
- elastic supply ($S' > 0$): $t_i \uparrow \rightarrow$ same + reduction of capital

Pollution

- pollution in i: $e_i = \alpha k_i + \beta \sum_{j \neq i} \alpha k_j$ ($\beta > 0$: spillovers)

$$\frac{\partial e_i}{\partial t_i} < 0, \quad \frac{\partial e_j}{\partial t_i} \gtreqless 0, \quad \frac{\partial e_i}{\partial t_i} + (n-1)\frac{\partial e_j}{\partial t_i} = \frac{\alpha[1 + \beta(n-1)]S'}{F''S' - 1}$$

- fixed supply ($S' = 0$): $t_i \uparrow \rightarrow$ total emissions unchanged
- elastic supply ($S' > 0$): $t_i \uparrow \rightarrow$ total emissions fall

Government and Externalities

Government in country i

- maximizes u_i from (3) wrt t_i s.t. (1), $s_i = S(\rho)$ and comparative statics of capital market and emissions
- takes as given $t_j \rightarrow$ Nash game between n countries
- equilibrium tax: $t^* = \dfrac{\alpha[(1-\beta)(n-1) - nF''S']V'}{nF''S' - (n-1)} > 0$

Externalities

- fiscal: $\text{FE} = \dfrac{\partial(t_j k_j)}{\partial t_i} = -\dfrac{t^*}{n(1-F''S')F''} > 0$
- environmental: $\text{EE} = V'\dfrac{\partial e_j}{\partial t_i} = \dfrac{\alpha(\beta - 1 - \beta n F''S')V'}{n(1-F''S')F''} \gtreqless 0$

Government and Externalities

Government in country i

- maximizes u_i from (3) wrt t_i s.t. (1), $s_i = S(\rho)$ and comparative statics of capital market and emissions
- takes as given $t_j \rightarrow$ Nash game between n countries
- equilibrium tax: $t^* = \dfrac{\alpha[(1-\beta)(n-1) - nF''S']V'}{nF''S' - (n-1)} > 0$

Externalities

- fiscal: $\text{FE} = \dfrac{\partial(t_j k_j)}{\partial t_i} = -\dfrac{t^*}{n(1-F''S')F''} > 0$
- environmental: $\text{EE} = V'\dfrac{\partial e_j}{\partial t_i} = \dfrac{\alpha(\beta - 1 - \beta n F''S')V'}{n(1-F''S')F''} \gtreqless 0$

Government and Externalities

Government in country i

- maximizes u_i from (3) wrt t_i s.t. (1), $s_i = S(\rho)$ and comparative statics of capital market and emissions
- takes as given $t_j \rightarrow$ Nash game between n countries
- equilibrium tax: $t^* = \dfrac{\alpha[(1-\beta)(n-1) - nF''S']V'}{nF''S' - (n-1)} > 0$

Externalities

- fiscal: $\text{FE} = \dfrac{\partial(t_j k_j)}{\partial t_i} = -\dfrac{t^*}{n(1-F''S')F''} > 0$
- environmental: $\text{EE} = V' \dfrac{\partial e_j}{\partial t_i} = \dfrac{\alpha(\beta - 1 - \beta n F''S')V'}{n(1-F''S')F''} \gtreqless 0$

Government and Externalities

Government in country i

- maximizes u_i from (3) wrt t_i s.t. (1), $s_i = S(\rho)$ and comparative statics of capital market and emissions
- takes as given $t_j \rightarrow$ Nash game between n countries
- equilibrium tax: $t^* = \dfrac{\alpha[(1-\beta)(n-1) - nF''S']V'}{nF''S' - (n-1)} > 0$

Externalities

- fiscal: $\text{FE} = \dfrac{\partial(t_j k_j)}{\partial t_i} = -\dfrac{t^*}{n(1-F''S')F''} > 0$
- environmental: $\text{EE} = V' \dfrac{\partial e_j}{\partial t_i} = \dfrac{\alpha(\beta - 1 - \beta n F''S')V'}{n(1-F''S')F''} \gtreqless 0$

Government and Externalities

Government in country i

- maximizes u_i from (3) wrt t_i s.t. (1), $s_i = S(\rho)$ and comparative statics of capital market and emissions
- takes as given $t_j \rightarrow$ Nash game between n countries
- equilibrium tax: $t^* = \dfrac{\alpha[(1-\beta)(n-1) - nF''S']V'}{nF''S' - (n-1)} > 0$

Externalities

- fiscal: $\text{FE} = \dfrac{\partial(t_j k_j)}{\partial t_i} = -\dfrac{t^*}{n(1-F''S')F''} > 0$
- environmental: $\text{EE} = V' \dfrac{\partial e_j}{\partial t_i} = \dfrac{\alpha(\beta - 1 - \beta n F''S')V'}{n(1-F''S')F''} \gtreqless 0$

Main Results (use t^*)

Sum of externalities

$$\text{EE} + \text{FE} = \frac{\alpha\beta n S' V'}{nF''S' - (n-1)}$$

Fixed capital supply ($S' = 0$)

- then: $\text{EE} + \text{FE} = 0 \rightarrow$ tax rates efficient
- reason: $\text{FE} > 0$, $\text{EE} < 0$ and $-\text{EE} = \text{FE}$
- put differently: total capital and total emissions are fixed!

Elastic capital supply ($S' > 0$)

- then: $\text{EE} + \text{FE} > 0 \rightarrow$ tax rates inefficiently low
- reason: $\text{FE} > 0$, EE smaller in absolute term; $-\text{EE} < \text{FE}$
- put different: total emissions and total capital fall; EE becomes absolutely smaller; not enough to compensate FE

Main Results (use t^*)

Sum of externalities

$$\text{EE} + \text{FE} = \frac{\alpha\beta n S' V'}{nF''S' - (n-1)}$$

Fixed capital supply ($S' = 0$)

- then: $\text{EE} + \text{FE} = 0 \rightarrow$ tax rates efficient
- reason: $\text{FE} > 0$, $\text{EE} < 0$ and $-\text{EE} = \text{FE}$
- put differently: total capital and total emissions are fixed!

Elastic capital supply ($S' > 0$)

- then: $\text{EE} + \text{FE} > 0 \rightarrow$ tax rates inefficiently low
- reason: $\text{FE} > 0$, EE smaller in absolute term; $-\text{EE} < \text{FE}$
- put different: total emissions and total capital fall; EE becomes absolutely smaller; not enough to compensate FE

Main Results (use t^*)

Sum of externalities

$$\text{EE} + \text{FE} = \frac{\alpha\beta n S' V'}{nF''S' - (n-1)}$$

Fixed capital supply ($S' = 0$)

- then: $\text{EE} + \text{FE} = 0 \rightarrow$ tax rates efficient
- reason: $\text{FE} > 0$, $\text{EE} < 0$ and $-\text{EE} = \text{FE}$
- put differently: total capital and total emissions are fixed!

Elastic capital supply ($S' > 0$)

- then: $\text{EE} + \text{FE} > 0 \rightarrow$ tax rates inefficiently low
- reason: $\text{FE} > 0$, EE smaller in absolute term; $-\text{EE} < \text{FE}$
- put different: total emissions and total capital fall; EE becomes absolutely smaller; not enough to compensate FE

Main Results (use t^*)

Sum of externalities

$$\text{EE} + \text{FE} = \frac{\alpha\beta n S' V'}{nF''S' - (n-1)}$$

Fixed capital supply ($S' = 0$)

- then: $\text{EE} + \text{FE} = 0 \rightarrow$ tax rates efficient
- reason: $\text{FE} > 0$, $\text{EE} < 0$ and $-\text{EE} = \text{FE}$
- put differently: total capital and total emissions are fixed!

Elastic capital supply ($S' > 0$)

- then: $\text{EE} + \text{FE} > 0 \rightarrow$ tax rates inefficiently low
- reason: $\text{FE} > 0$, EE smaller in absolute term; $-\text{EE} < \text{FE}$
- put different: total emissions and total capital fall; EE becomes absolutely smaller; not enough to compensate FE

Main Results (use t^*)

Sum of externalities

$$\text{EE} + \text{FE} = \frac{\alpha\beta n S' V'}{nF''S' - (n-1)}$$

Fixed capital supply ($S' = 0$)

- then: $\text{EE} + \text{FE} = 0 \rightarrow$ tax rates efficient
- reason: $\text{FE} > 0$, $\text{EE} < 0$ and $-\text{EE} = \text{FE}$
- put differently: total capital and total emissions are fixed!

Elastic capital supply ($S' > 0$)

- then: $\text{EE} + \text{FE} > 0 \rightarrow$ tax rates inefficiently low
- reason: $\text{FE} > 0$, EE smaller in absolute term; $-\text{EE} < \text{FE}$
- put different: total emissions and total capital fall; EE becomes absolutely smaller; not enough to compensate FE

Main Results (use t^*)

Sum of externalities

$$\text{EE} + \text{FE} = \frac{\alpha\beta n S' V'}{nF''S' - (n-1)}$$

Fixed capital supply ($S' = 0$)

- then: $\text{EE} + \text{FE} = 0 \rightarrow$ tax rates efficient
- reason: $\text{FE} > 0$, $\text{EE} < 0$ and $-\text{EE} = \text{FE}$
- put differently: total capital and total emissions are fixed!

Elastic capital supply ($S' > 0$)

- then: $\text{EE} + \text{FE} > 0 \rightarrow$ tax rates inefficiently low
- reason: $\text{FE} > 0$, EE smaller in absolute term; $-\text{EE} < \text{FE}$
- put different: total emissions and total capital fall; EE becomes absolutely smaller; not enough to compensate FE