Keeping Pigou on tracks: second-best externality pricing and infrastructure provision

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Environmental policy should encompass infrastructure

Emission-relevant private goods are often complemented by public spending

Environmental policy should encompass infrastructure

Price signals and infrastructure provision are often not (both) optimal

Optimal public spending has long been neglected in environmental economics

- With an environmental externality and public goods, implementing the optimum is theoretically simple:
  1. Correct the prices (Pigou: $\tau_P = -NU_E E_D / U_C$).
  2. Different types of public spending to match corrected demands (Samuelson: $NU_X = NU_Y = U_C$).

- *'Division of labor': public spending has no active role in first-best environmental policy (regardless of a potential effect on private choices). 'Predict & provide' is fine.*

- Thus, economists focused on second-best cases with other distortionary taxes (public econ.), R&D-related externalities (environmental econ.), congestion (transport econ.), etc.

An important second-best scenario has been neglected

Environmental taxes or 'clean' infrastructure are often constrained.

In these cases:

1. **Does the 'division of labor' break down?**
   (Is the constraint reflected in the second-best rule for the respectively other instrument?)
   Yes, if the tax is too low, infrastructure provision should be used as an environmental policy instrument.

2. **Should the other instrument be strengthened in turn?**
   (Second-best policy value $>$ first-best solution?)
   Not always, e.g. if reducing dirty consumption affects utility too much, given the constraint.

(I) General optimal policy conditions

First-best case

- Utility $U = U(C, D; X, Z, E)$, budget $C + (1+\tau)D = 1 - T$
- Maximization yields demand for clean and dirty private goods: $C = C(\tau, T, X, Z)$, and similarly for D
- The government chooses taxes and spending to solve

$$\begin{aligned} \text{max} \quad & NU = NU\left[C, D, X, Z, E(ND)\right] \\ \text{s.t.} \quad & X + Z = NT + N\tau D, \\ & X/Z \leq \bar{\Omega}, \\ & \tau \leq \bar{\tau}. \end{aligned}$$

- If policy constraints are *not* binding, first-best solution:
  Tax fully internalizes damages: $\tau^* = \tau_P := NU_E(-E_{ND})/U_C$.
  Public spending w/o environmental role: Ω^* solves $U_Z = U_X$.

(I) General optimal policy conditions

Second-best environmental taxation

- Utility $U = U(C, D; X, Z, E)$, budget $C + (1+\tau)D = 1 - T$
- Maximization yields demand for clean and dirty private goods: $C = C(\tau, T, X, Z)$, and similarly for D
- The government chooses taxes and spending to solve

$$\begin{aligned} \text{max} \quad & NU = NU\left[C, D, X, Z, E(ND)\right] \\ \text{s.t.} \quad & X + Z = NT + N\tau D, \\ & X/Z \leq \bar{\Omega} \quad \text{with} \quad \bar{\Omega} < \Omega^*, \\ & \tau \leq \bar{\tau}. \end{aligned}$$

- With a binding infrastructure constraint:

  Second-best environmental tax rule is the same: $\tau' = \tau_P$.

  The tax *level* will be different, since C and D change.

(I) General optimal policy conditions

Second-best public spending composition

- Utility $U = U(C, D; X, Z, E)$, budget $C + (1+\tau)D = 1 - T$
- Maximization yields demand for clean and dirty private goods: $C = C(\tau, T, X, Z)$, and similarly for D
- The government chooses taxes and spending to solve

$$\begin{aligned} \text{max} \quad & NU = NU\left[C, D, X, Z, E(ND)\right] \\ \text{s.t.} \quad & X + Z = NT + N\tau D, \\ & X/Z \leq \bar{\Omega}, \\ & \tau \leq \bar{\tau} \quad \text{with} \quad \bar{\tau} < \tau^*. \end{aligned}$$

- With a binding environmental tax constraint:

  Public spending composition as an environmental policy:

  Ω' solves $U_X - U_Z = \mu(\hat{\tau}_p - \bar{\tau})(D_X - D_Z)$.

(II) Second- vs. first-best policies

Compensate a constrained instrument by strengthening the other instrument?

Are τ' and Ω' smaller or larger than τ^* and Ω^*?

- General conditions can be derived for marginal deviations from the first-best.
- Otherwise, need to assume specific functional forms for utility and environmental quality.
- Evaluate and compare the previous optimal policy conditions.

(II) Second- vs. first-best policies

Second-best policies for marginal changes or a specific utility function

- **If dirty consumption is 'sufficiently important' in utility, second-best instruments may be below first-best levels ($\tau' < \tau^*$ and $\Omega' < \Omega^*$).**
- The stronger the constraint on one instrument, the smaller the second-best value of the other.
- This also hinges on endogenous E.

Intuition:

- Don't penalize car drivers too much if no alternative transport infrastructure can be provided to 'pull' them from their cars.
- Don't spend too much money on bicycle paths if you cannot raise fuel prices to 'push' people out of their cars.

(II) Second- vs. first-best policies

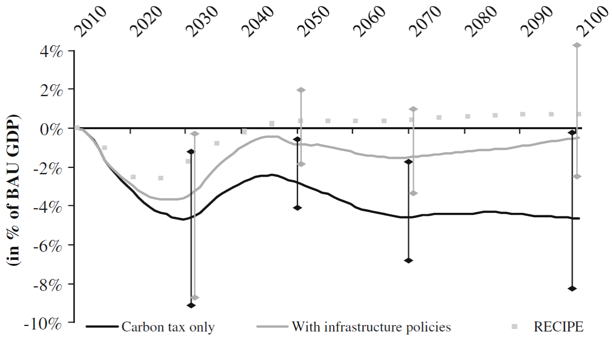
Second-best policies for marginal changes or a specific utility function

- **An additional binding environmental target prevents a trade-off between E and C, D: a constrained instrument is compensated by the other instrument.**
- If the environmental target exceeds the first-best outcome, second-best instruments are always above first-best levels ($\tau' > \tau^*$ and $\Omega' > \Omega^*$).
- The stronger the constraint on one instrument, the larger the second-best value of the other.

(II) Second- vs. first-best policies

Illustration for a fixed environmental target

- Waisman et al. (2012): *ad hoc* complementary transport infrastructure policies reduce costs and CO_2 price for 2°-target



For this numerical *evaluation* (not optimization) Waisman et al. (2012) use an IAM (Imaclim-R) and assume:

- Investment does not follow modal mobility demand, but is shifted from road to low-carbon infrastructure.
- Progressive building relocation to reduce commuting.
- Lower transport needs of industry (I-O-coefficient -1%).

Extensions and further implications

- Dynamic model: If a lack of infrastructure limits the optimal carbon price today, and building it takes time: prioritize infrastructure in climate policy.

- Only redirecting new investment may be insufficient: implementing Ω' may also require changes to existing infrastructure.
  (E.g. for a $2\,^{\circ}\mathrm{C}$ target, Guivarch & Hallegatte 2011).

Conclusion

- Simple and general model for policy portfolio optimization, integrating environmental and public finance issues.
- Methodologically, planning infrastructure for several demand scenarios with different (carbon) prices is not enough: need to model induced demand and apply environmental targets!
- Infrastructure provision should *correct* demand, rather than just *'matching'* it, when prices are non-optimal.
- Insufficient infrastructure may sometimes *reduce* the optimal environmental tax, and vice versa.
- As many externality are insufficiently priced today: start 'infrastructure turn-around' now!

Thank you for your attention!