Regulation vs. Taxation: Efficiency of Zoning and Tax Instruments as Anti-Congestion Policies

Feb. 23, 2015
Innsbruck, Austria

Hyok-Joo Rhee, Seoultech
Georg Hirte, TU Dresden

Motivations and Objectives

- Zoning and taxes = Two different, but important instruments to control congestion/externalities
  - Zoning: FAR regulation, land-use type regulation
  - Taxes: Road tolls, property taxes
- However,
  - Tend to be analyzed separately
  - Confusing views on zoning: Efficiency, Prescriptions
  - Theoretical issues of the Anas-type LUT models with heterogeneous households

The model

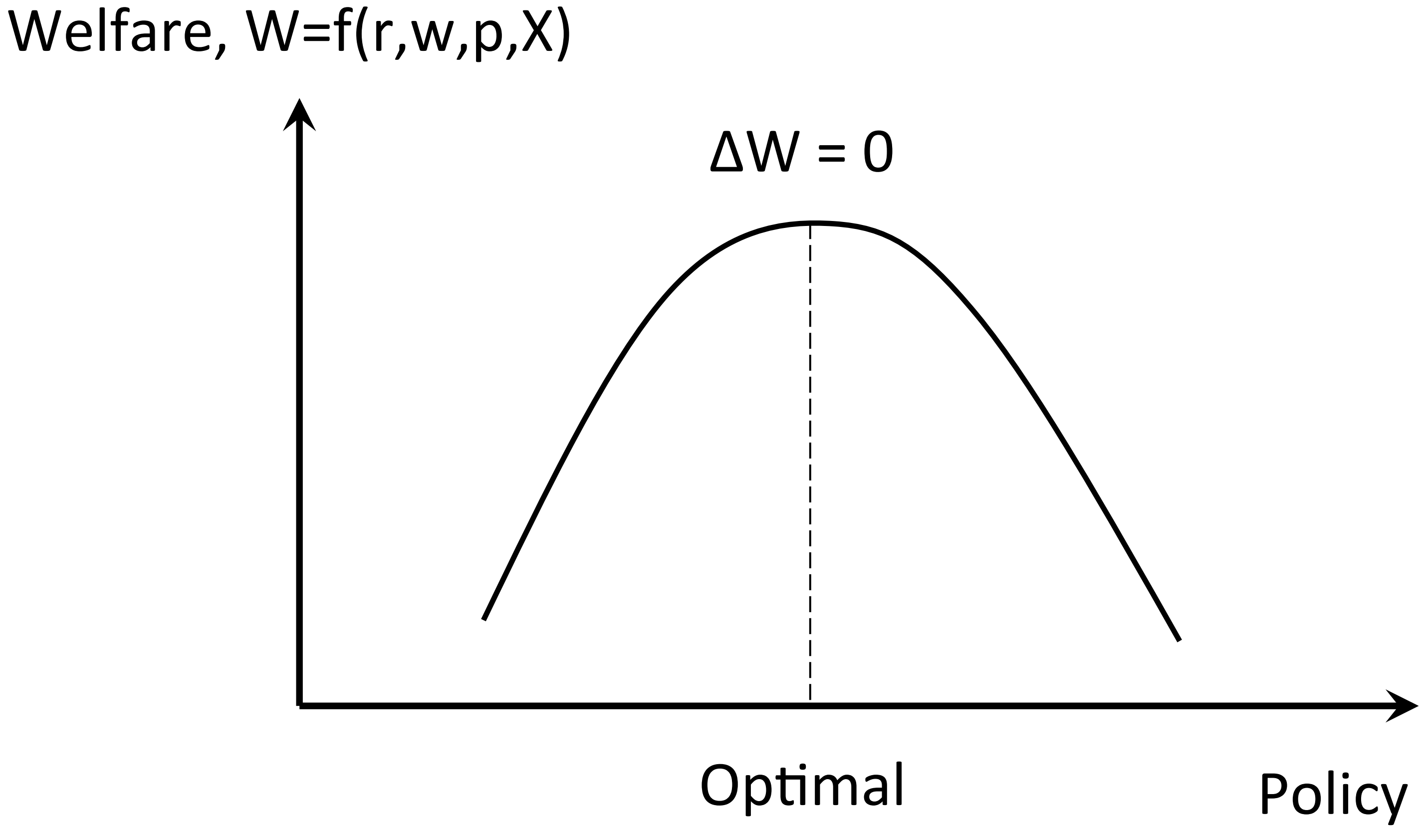
- We construct a model as general as possible to clarify the confusing views.
  - Road and non-road infra. externalities
  - General equilibrium (production, labor/land markets) and mixed land use
  - Housing & office buildings
  - But, we do not consider such issues as incompatible uses of land & benefits of sun light, etc.

The model

- Infra: Roads, Non-roads (water, sewage, electricity, telecommunications)
- Service quality of non-roads affects the productivity of firms.
  - Serv. quality = f(Floor areas of Bldg & Housing, Capacity)
  - Congestible
  - Serv. quality is the same for the proportionate change in Floor Area and Capacity.
- Households:

  u=u(goods,housing,leisure; Infra) + idiosyn. taste term
- Metro area composed of *n* zones/local govts

Optimal policy



(Potential) First-best regime

- Policies available
  - Congestion tolls for travel [$/km] and office buildings & housing [$/fl. area]
  - Infra capacities
  - Inter-HH income transfers √

ΔW = (Non-road's MEC – Non-road toll)*Δ(Floor area)
+ (Road's MEC – Road toll)*Δ(Traffic volume)
+Spatial resorting of HHs
+ Cov of MUIs & Price-induced change in consumer surplus

=0

Here come the complications.

- When Cov = 0, the standard theory follows.
  - Tolls and Cap. Chosen appropriately maximize W; HGT holds when pop is chosen properly.
- When Cov ≠ 0 → All the troubles follow.
  - Standard prescriptions are not necessarily first-best; the HGT does not hold.
  - Any policy mix could be first-best optimal.

Implications on Anas-type models

- Anas-type LUT models: random utility, eqlm model, firm microecon. foundation
- By deriving the precise math. structure of the welfare change, we can answer
  - Why Anas and Rhee (2006) have obtained the absolute harmfulness proposition of greenbelts,
  - Why congestion tolls = MEC is not first-best,
  - Whey zoning is 99% as efficient as the FB in Rhee, Yu and Hirte (2014),
  - Why the std prescriptions fail to maximize welfare and why HGT fails to hold in Anas (2012).

Second-Best Optimal LURs

- The following holds when LURs are optimally set:

ΔW = (Non-road's MEC – ~~Non-road toll~~)*Δ(fl. area)

+ (Road's MEC – ~~Road toll~~)*Δ(Traffic volume)

+ Cov + Distortionary cost = 0 To Jun

  – The distortionary cost turns out to be pretty high such that doing nothing could be better.

- Optimal adjustment of land uses:

The planner should adjust LURs by assigning more weight to the externalities with higher cost shares and higher elasticities wrt the LUR concerned.

Lower or higher FAR in the CBD?

- Pop externalities (noise, privacy, congestions)
  → Lower FAR in CBD, Higher FAR in suburbs
- Metro-wide traffic congestion
  → Higher FAR in CBD, Lower FAR in suburbs

$$\Delta W = (\text{Infra's MEC} - \text{Non-road toll}) * \Delta(\text{floor area})$$
$$+ (\text{Road's MEC} - \text{Road toll}) * \Delta(\text{Traffic volume})$$
$$+ \underline{\text{Distortionary cost}} = 0$$

Implication on Spatial Input-Output Models

- To run regional IO models, you need detailed inter-regional, inter-industry linkages. → The single most serious barrier to their extensive application
- However, depending on the question, the formulas we derived greatly simplify our task.
- Ex 1: Regulatory cost of the restricted supply of industrial land in Korea (Jun, 2012, Urban Studies)
- Ex 2: Comparison of different metro. Development patterns in England (Echenique et al., 2012, JAPA)

Implication on theoretic urban models

- Behrens and Murata. 2009. City size and the Henry George Theorem under monopolistic competition. *JUE* 65, 228-235.
- Firms' and HHs' consumption of land = 1
- Monocentric city with point CBD
- Utility function is specialized.
- Production cost=c*q+f
- Agglomeration present, but congestion absent

←Our methodology is equally applicable to possibly improve their approach.

Implication on theoretic urban models

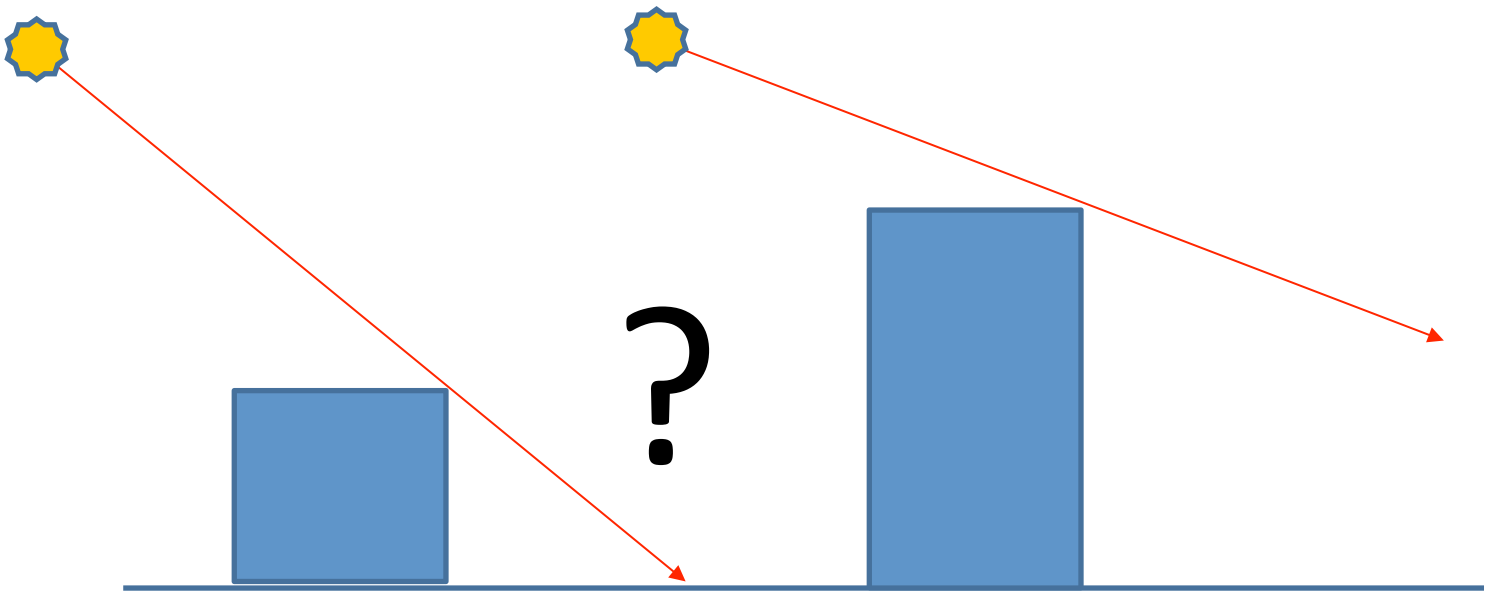
- Behrens, Kanemoto, and Murata. 2015. The Henry George Theorem in a second-best world. *JUE* 85, 34-51.
- Extremely general setup
- However, Non-spatial model
  - Internal spatial structure of a city is absent.
  - Land area of each city is fixed (footnote 41).

←Our methodology is equally applicable to possibly improve on their approach.

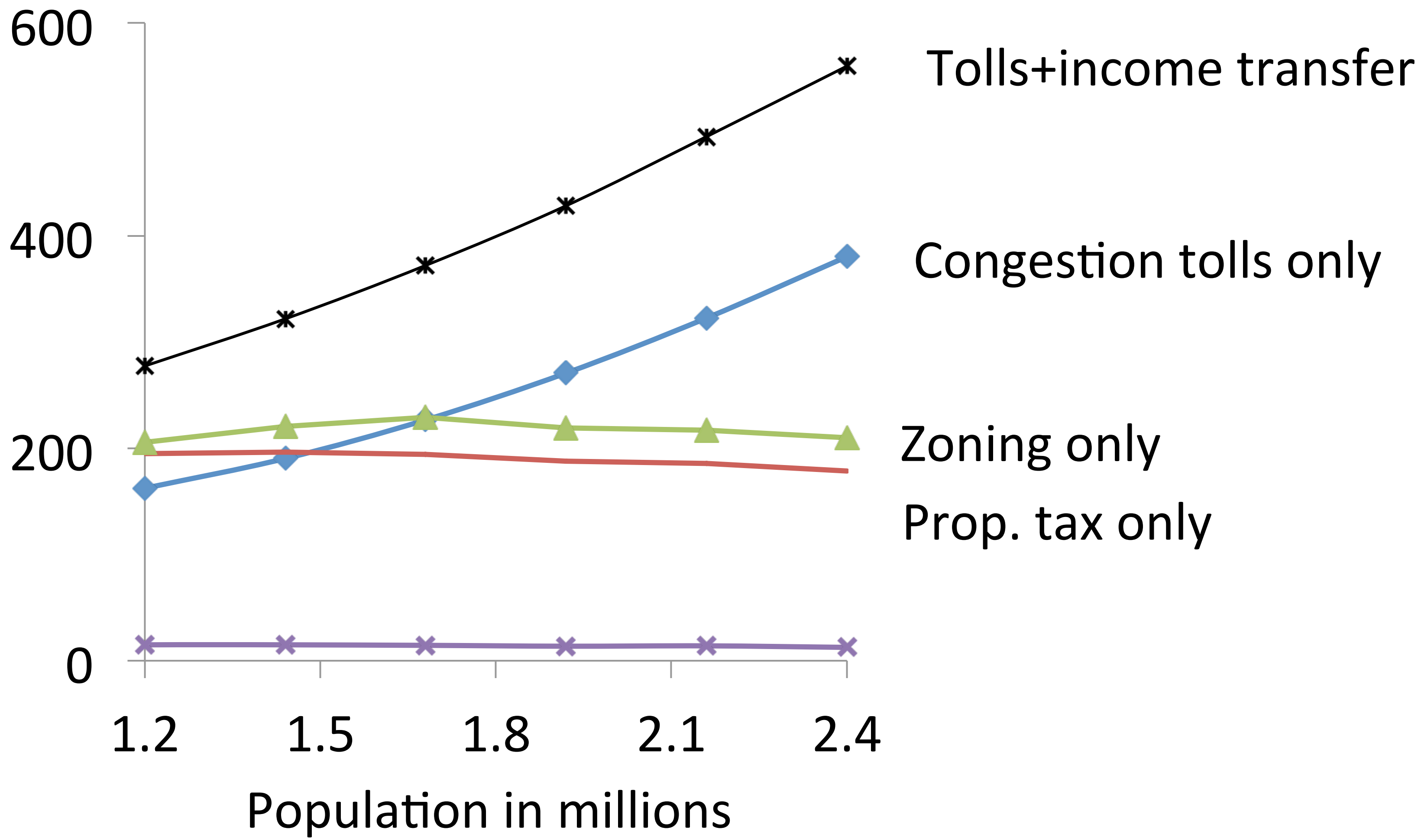
Finally, we compare efficiencies of
Zoning
and
Pricing instruments.

Overall plan

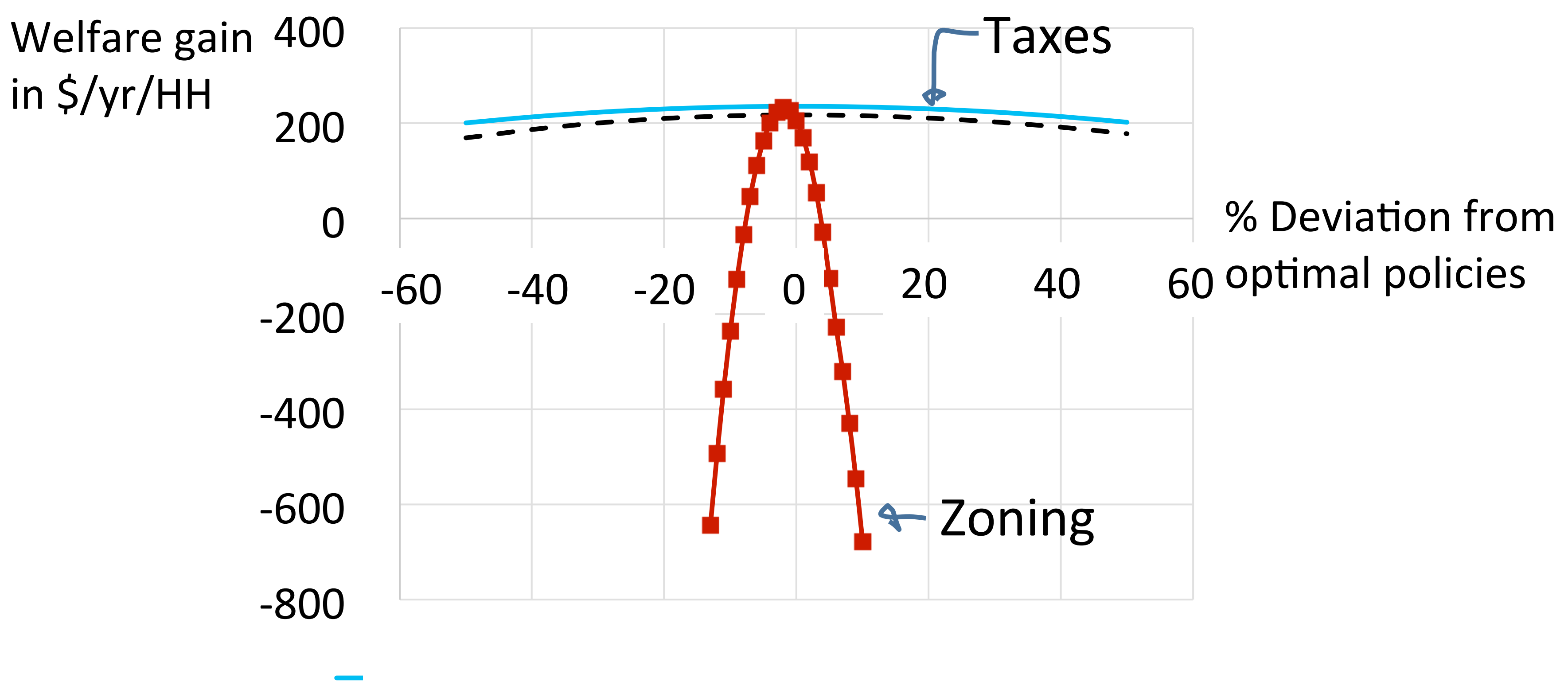
- Experiment 1 : When optimal policies are known
- Experiment 2 : When optimal policies are not known



Experiment 1: Optimal known

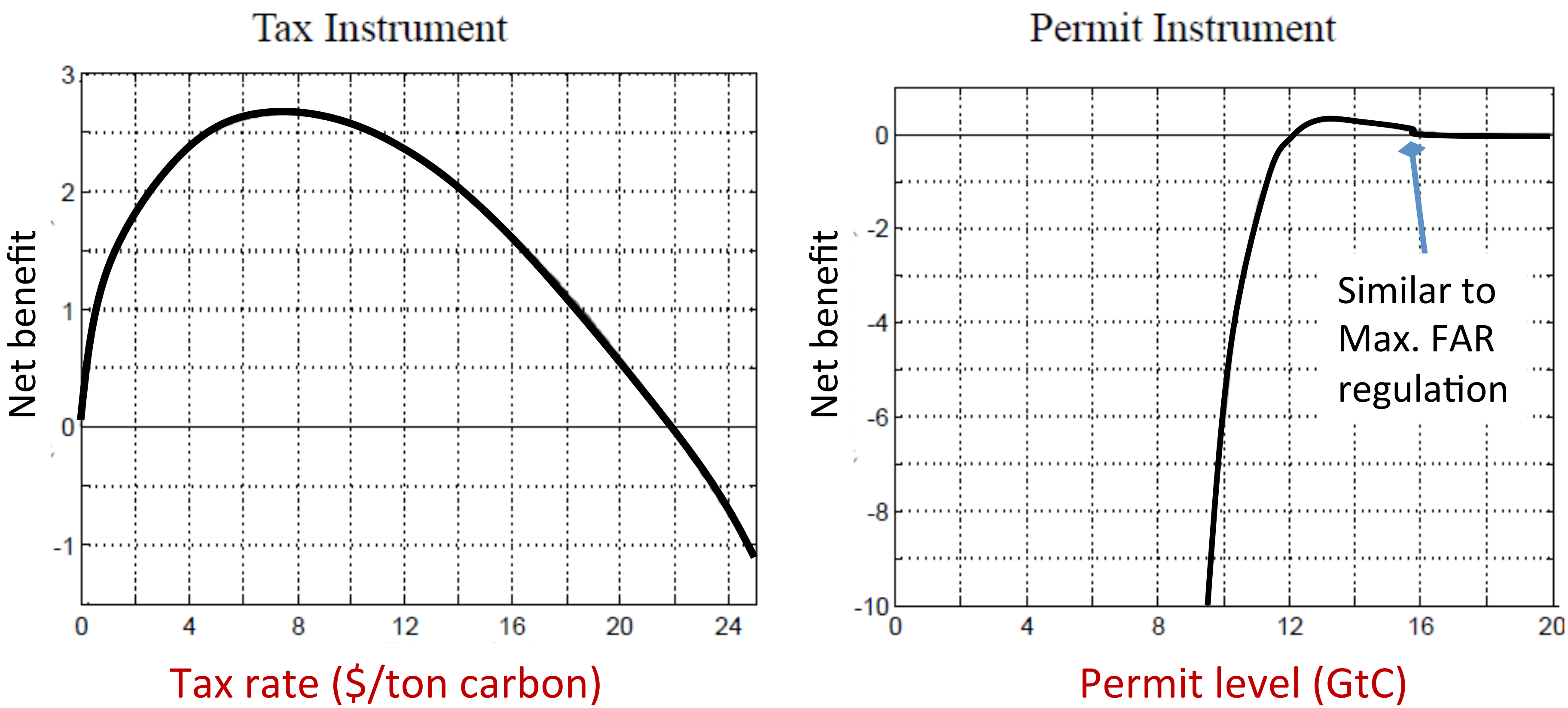


Experiment 2: Optimal unknown



The Same Pattern Found in the Pollution Control Literature

Figure 7: Welfare Consequences of Pure Tax and Permit Instruments in 2010



From Pizer (1997)

Is this a coincidence?

Maybe Not

- Maybe, the result is natural, because …
- Pricing

ΔW= (Non-road's MEC – non-road toll)*Δ(fl. area)

+ (Road's MEC – Road toll)*Δ(Traffic volume)

= 0

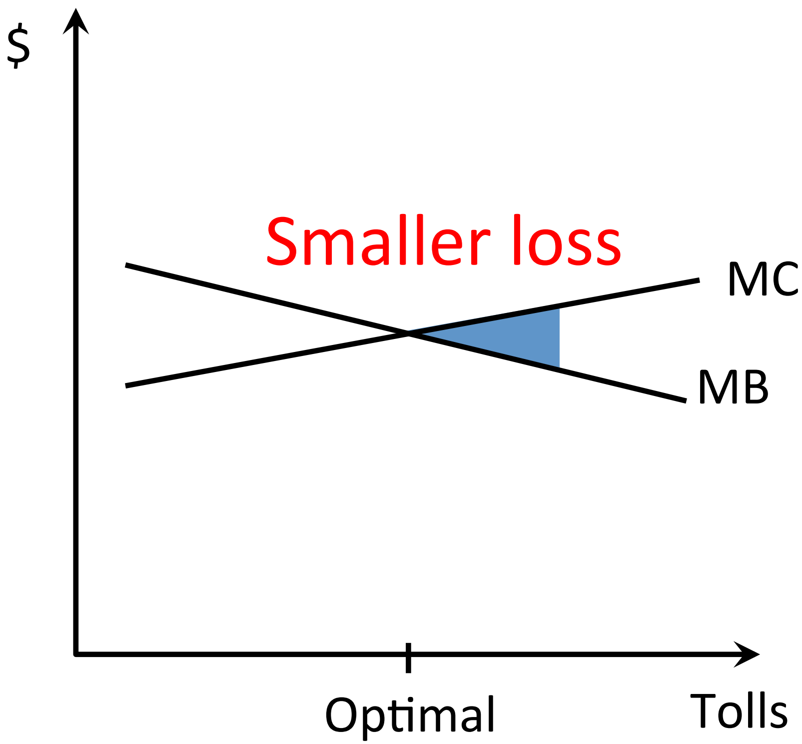
- Zoning

ΔW = (Non-road's MEC – ~~Non-road toll~~)*Δ(fl. area)

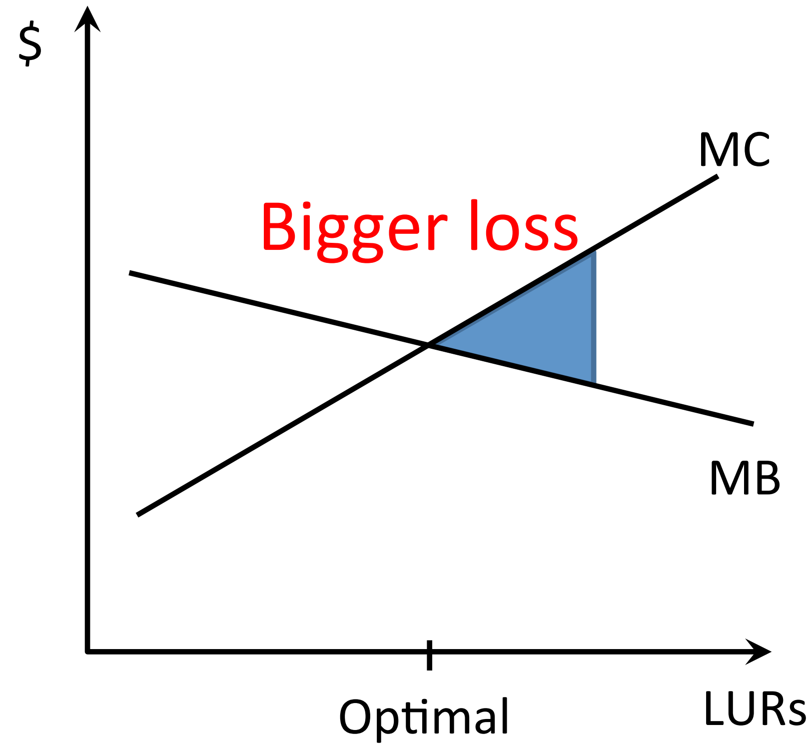
+ (Road's MEC – ~~Road toll~~)*Δ(Traffic volume)

+ Distortionary cost = 0

The point is clear in the graphical rendering below.



(a) “Prices”



(b) “Quantities”

So, the result itself is significant.

- The theory, simulations, and empirical studies are compatible with each other in both planning and pollution control, showing why prices perform better than physical regulations.
- In fact, the theory extends local analysis of Weitzman (1974) and Kaplow and Shavell (2012) of the instrument choice literature to the model with multiple externalities for deviations from the optimal policies for any conceivable deviations.

Thanks