Lecture Notes: Systems Competition Chapter II.2: Capital Tax Competition and Public Infrastructure*

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2.2 Capital Tax Competition and Public Infrastructure

There is plenty of evidence showing that capital is nowadays more mobile now than before and that countries cut taxes in response to tax competition.

Labor may be the victim of systems competition because these markets are less integrated than capital markets.

Here we will study:

- how systems competition affects taxes and the provision of public goods and

- which factor ultimately pays the provision of the infrastructure goods.

2.2.1 Short Repetition: The Standard Tax Competition Argument (Chapter I.2)

Assumptions:

- Labor supply is fixed and internationally immobile.
- Capital is available at the exogenous interest rate r and is internationally mobile (small open economy).
- A source based tax, τ, is levied on capital (the tax receipts are not spent on goods which enter the production function).

Results:

$\Longrightarrow$ The increase in the user cost of capital ($r > r + t$) drives capital out of the country.

$\Longrightarrow$ The shrinking capital stock hurts workers since production declines (while the return on capital r stays constant).

$\Longrightarrow$ The *race to the bottom* view is a pessimistic view of capital taxation.

Further Assumptions:

- Not only taxes are important for investors' allocation decisions but public infrastructure, legal systems or the protection of property rights matter, too.
- Investors will accept taxes if they are seen as the price that must be paid for the publicly provided infrastructure (benefit taxation).
- Assume that all of the tax revenues goes to financing infrastructure, which is necessary for production and that capital becomes sufficiently more productive as to generate the required higher rate of return.

Results:

$\Longrightarrow$ Capital may not react to higher capital taxes.

$\Longrightarrow$ The immobile factor may accept to bear the tax which is necessary to finance the public infrastructure, as the immobile factor benefits from the tax, too (area DEG).

2.2.2 Fiscal Competition and Public Goods

Model Setup (Sinn 2003, Chapter 2)

- There is a private cost of using infrastructure: $c(K, W)$. This user cost function, $c(K, W)$, is homogeneous of degree λ.

- The size of this cost depends on the number of usage acts, K, and the capacity of the infrastructure provided by the government, W.

- We have that
  - $c_K(K, W) > 0$ (users get in each others' way; crowding externality) and
  - $c_W(K, W) < 0$ (larger amount of infrastructure reduces individual user costs).
  - In the case of a pure public good, $c_K(K, W) = 0$, as there is no rivalry in use.

- The total cost of using the public good is: $c(K, W)K$.

- The variable K represents the amount of capital employed in the country while $\overline{K}$ determines stock of capital owned by the country's citizen.

- The government levies a source based tax τ on capital and a head tax τ^L on labor.

- The unit cost of providing public infrastructure are ρ. The total cost of infrastructure are ρW.

- The production function, $f(K, L)$, features constant returns to scale and as usual:

$$f_K(K, L) > 0 \quad \textit{and} \quad f_{KK}(K, L) < 0,$$
$$f_L(K, L) > 0 \quad \textit{and} \quad f_{LL}(K, L) < 0.$$

- Capital is perfectly mobile while labor is completely immobile.

- The return on capital, r, is constant from the point of view of the (small) country.

Firm Behavior

Firms maximize their profit π by selecting the optimal amount of capital for production. They solve the following problem

$$\max_{k} \pi = f(K, L) - rK - c(K, W)K - \tau K - wL.$$

The first-order condition is

$$f_K(K, L) - r - c(K, W) - \tau = 0. \qquad (1)$$

Note, that the social marginal usage cost is

$$c(K, W) + c_K(K, W)K.$$

However, since the firm does not take the marginal congestion externality

$$c_K(K, W)K$$

into account, this term does not show up in the first-order condition.

Equilibrium Policy

As for the government, the budget balancing condition is

$$\tau^L L + \tau K = \rho W, \tag{2}$$

where τ^L is residually determined to balance the budget.

If, for example, the tax on capital generates more revenue than needed for the provision of the public infrastructure, there will be a subsidy to labor.

The government maximizes net-of-tax income of the domestic residents given by

$$R = f(K, L) - f_K(K, L)K + r\overline{K} - \tau^L L$$

subject to the firms' first-order condition (1) and the budget constraint (2).

Hence, substituting equations (1) and (2) into the government's problem gives

$$R = f(K, L) + r(\overline{K} - K) - c(K, W)K - \rho W$$

The government's problem is to

$$\max_{K,W} f(K,L) + r(\overline{K} - K) - c(K,W)K - \rho W.$$

Note, the federal government does not optimize over τ. The capital tax rate τ can be inferred from the first-order condition (1). For a given level of K and W the condition gives the tax rate τ which supports the choices of K and W as an equilibrium.

The first-order conditions are

$$f_K(K,L) - r - c(K,W) - c_K(K,W)K = 0 \quad (3)$$

and

$$-c_W(K,W)K - \rho = 0. \quad (3')$$

Now, remember the firms' first-order condition (1):

$$f_K(K,L) - r - c(K,W) - t = 0.$$

We note that, in contrast to the firms, the government takes the congestion externality $c_K(K,W)K$ into account.

Results:

$\Longrightarrow$ To make firms behavior congruent with the government's preferences, the capital tax rate is set to $\tau = c_K(K, W)K$.

$\Longrightarrow$ Only with a tax rate of $\tau = c_K(K, W)K$ the normative analysis (maximization of social welfare) coincide the *positive* analysis (individual profit maximization of firms = market outcome).

$\Longrightarrow$ W is such that the sum of all users' marginal willingness to pay is equal to the marginal cost of providing infrastructure (= Samuelson Rule) as derived by equation (3').

Social Optimum in Systems Competition

How does the competitive equilibrium compare with the international social optimum?

Suppose there is a supranational benevolent planner ruling over n countries.

The planner selects the international capital allocation and the respective national provisions of public goods such that the sum of all rents is maximized.

- Therefore, the planer solves

$$\max_{K_i, W_i} \sum_{i=1}^{n} \left[f(K_i, L_i) - c(K_i, W_i) K_i - \rho W_i \right].$$

$$s.t. \ \sum_{i=1}^{n} K_i = \sum_{i=1}^{n} \bar{K}_i$$

- The first order condition with respect to K yields:

$$f_{K_i}(K_i, W_i) - c(K_i, W_i) - c_{K_i}(K_i, W_i)K_i$$

$$= f_{K_j}(K_j, W_j) - c(K_j, W_j) - c_{K_j}(K_j, W_j)K_j. \tag{4}$$

$\Longrightarrow$ Accordingly, the marginal product of capital net of the marginal social cost of using the infrastructure is equal in all countries.

- The first order condition with respect to W gives:

$$-c_W K_i = \rho. \tag{5}$$

$\Longrightarrow$ The social marginal willingness to pay for infrastructure is equal to its price.

Results:

$\Longrightarrow$ *Proposition* 2.1: The equilibrium in systems competition is efficient. Both the international allocation of capital (*production efficiency*) and the pattern of infrastructure (*allocative efficiency*) are chosen so as to maximize the sum of all rents accruing in all countries.

- Production efficiency holds as $\tau = c_K(K, W)K$ and the firms' first-order condition (1) gives (4).

- Allocative efficiency holds as public infrastructure provision satisfies (5) which resembles the Samuelson rule.

$\Longrightarrow$ To summarize, the equilibrium in systems competition is efficient.

$\Longrightarrow$ Positive view of systems competition.

2.2.3 Who Pays for the Infrastructure?

The question analyzed next is a distributional one:

- Is the "congestion driven" tax revenue collected from capital taxation sufficient to finance the optimal amount of infrastructure?

- Or, does the government have to accept a deficit which would have to be covered by the fixed factor labor?

When infrastructure is a pure public good $c_K(K, W) = 0$, it is clear that the tax-rate is equal to zero because there is no congestion externality.

Therefore, there will be no capital tax revenues to finance the public expenditures.

But back to the more realistic case that congestion cost do exist

$$c_K(K, W) > 0.$$

The Euler theorem implies that

$$c_K(K,W)K + c_W(K,W)W = \lambda c(K,W). \qquad (6)$$

where λ is the degree of homogeneity of the usage cost function $c(K,W)$.

We now derive expressions for c_k and c_W in terms of ρ, t and K.

The Samuelson condition (5) gives

$$-c_W(K,W)K = \rho \qquad \Rightarrow \qquad c_W(K,W) = -\frac{\rho}{K}.$$

The equilibrium tax rate satisfies

$$\tau = c_K(K,W)K \qquad \Rightarrow \qquad c_K(K,W) = \frac{t}{K}.$$

Now, substitute for c_W and c_K in Eq. (6) to get

$$\tfrac{\tau}{K}K - \tfrac{\rho}{K}W = \lambda c(K,W)$$

$$\Rightarrow \quad \tau K - \rho W = \lambda c(K,W)K.$$

- If we double inputs and the cost goes down ($\lambda < 0$), we have $\tau^L > 0$.

- If the cost goes up when we double inputs ($\lambda > 0$), then $\tau^L < 0$.

- If the cost remains constant when we double inputs ($\lambda = 0$), then $\tau^L = 0$.

⇒ The point is that, in general, marginal cost pricing generates enough capital tax revenues to cover the total cost of production only when there are constant or decreasing returns to scale ($\lambda \geq 0$).

⇒ Otherwise, labor has to be taxed in order to fulfill the government's budget constraint.

What is the plausible sign of λ?

- Constant returns to scale is often assumed in production theory, $\lambda = 0$.

- Only in case $\lambda < 0$, when private competition is ruinous, public intervention is needed according to the selection principle.

2.2.4 Theory of the Clubs

There are $i = 1...n$ identical private clubs, which supply the infrastructure at the entrance fees: $\varphi_i ... \varphi_m$.

K_i is the number of usage acts sold by club i and W_i is the capacity of club i.

The quality of the services supplied by each club is inversely related to the usage costs since $c_{W_i}(K_i, W_i) < 0$.

Production cost per unit is again ρ.

P is the overall usage price which incorporates both the pecuniary entrance fee, φ_i, and the non-pecuniary individual usage cost, $c(K_i, W_i)$.

In a competitive equilibrium, members must be indifferent between all clubs

$$
\begin{aligned}
P &= \varphi_i + c(K_i, W_i) \\
&= \varphi_j + c(K_j, W_j), \\
& \qquad \forall\ i, j = 1 ... m.
\end{aligned}
$$

Each individual club i takes P as given and chooses K_i and W_i in order to maximize its profits

$$
\max_{K_i, W_i} \left[P - c(K_i, W_i)\right] K_i - \rho W_i
$$

The first-order condition with respect to K_i is

$$P - c(K_i, W_i) - c_{K_i}(K_i, W_i)K_i = 0$$

As the price P consists of the entrance fees φ_i and the individual usage cost, $c(K_i, W_i)$, we get

$$c_{K_i}(K_i, W_i)K_i = \varphi_i. \tag{7}$$

$\Longrightarrow$ Production efficiency is also met, if the public infrastructure is provided by profit maximizing clubs. Each club sets its entrance fee equal to the occurring congestion costs.

The first-order condition with respect to W_i yields

$$c_{W_i}(K_i, W_i)K_i = \rho. \tag{8}$$

$\Longrightarrow$ The provision of the public infrastructure by profit maximizing clubs is allocative efficient since it replicates the Samuelson condition.

The question arises, whether the entrance fee collected by each clubs is sufficient to finance the expenditures for infrastructure.

To give an answer we have to get back to the Euler equation, derived in (6), and substitute in the above first order conditions (7) and (8)

$$\varphi_i K_i - \rho W_i = \lambda c(K_i, W_i) K_i$$

Again our answer hinges on the sign of λ :

- If $\lambda \geq 0$, each club generates sufficient revenues from the entrance fee to cover the expenditures on infrastructure.

- In case $\lambda < 0$ competition would be ruinous. Each club would incur losses and thus decide not to provide any infrastructure.

The positive analysis showed that a market failure occurs in case $\lambda < 0$. Accordingly, it is time for the government to intervene if we follow the selection principle .

$\Longrightarrow$ *Proposition* 2.2: In case $\lambda \geq 0$ the optimal congestion charge is sufficient to finance the cost of providing infrastructure.

$\Longrightarrow$ *Proposition* 2.3: The Selection Principle implies that the government limits itself to the provision of those public goods for which $\lambda < 0$, e.g. where the efficient congestion charge is not sufficient to finance the cost of providing infrastructure.

In the sequel we discuss what policy makers could do to overcome the ruinous effects of systems competition. In particular, we consider two policy proposal, namely:

- tax harmonization and
- a self-financing constraint.