Why Do Most Countries Set High Tax Rates on Capital?

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1. Introduction

▷ **Important Results of the Tax Competition Literature**

- Tax competition leads to tax rates that are inefficiently low.
  - Intuition: The taxation of a mobile tax base imposes a positive fiscal externality.
  - Wilson (1986) or Zodrow and Mieszkowski (1986).

- Smaller countries – in terms of population – set lower tax rates.
  - Intuition: Smaller countries face a more elastic tax base.
  - Thus: Countries with N low → Lower rates → Capital importers → K/N large.
  - Bucovetsky (1991), Kanbur and Keen (1993), and Wilson (1991).

▷ **Real World – Problems with the Theory I – Table 1**

- Effective average tax rates on capital are not low – except for very few countries.
  - In 1991, Ireland imposes a low tax rate, but the rest of the EU countries impose significantly higher tax rates. (Same for 1981, except that Ireland and Spain both have low tax rates.)

- Intensification of tax competition (more integration) has not lead to lower capital taxes.
  - Hines (2005) presents evidence that corporate tax collections did not decline as a percentage of GDP between 1982 and 1999.
  - Haufler (2001) reports a modest reduction in the average effective tax rate on capital in OECD countries (at the expense of labour) between 1981 and 1991.

▷ **Real World – Problems with the Theory II – Table 1**

- The correlation between population size and tax rates is debatable.
  Theory: $\partial t / \partial \text{pop} > 0$ Fact: the reverse
  - Large countries like France and Germany impose below average tax rates.
  - In 1991, Ireland has at the lowest rate, but in 1981, Spain also has a low rate.
  - This small set of data reveals that the 1991 capital taxes and population have a negative correlation (-0.108).
  - Hines (2005) reports that since 1999, there is no correlation between country size (population) and tax rates.

▷ **Real World – Other Facts I – Table 1**

- There is some positive relation between capital stocks and tax rates.
  Theory: $\partial t/\partial(K/N) < 0$ Fact: the reverse
  - Some high capital/labour ratio countries – e.g. Belgium and Denmark – set high tax rates.
  - The very low tax rates are found in countries with low capital/labour ratio – e.g. Ireland and Spain.
  - The correlation between the 1991 tax rates and the capital/labor ratio is small but positive (0.169).

▷ **Real World – Other Facts II – Table 1**

- There is a stronger positive relation between capital productivity and tax rates.
  Fact: $\partial t/\partial(\mathrm{MP}_K) > 0$
  - The two countries — Ireland and Spain — with the lowest capital productivity in 1983 are also the ones with the lowest tax rate in 1981.
  - The correlation between the 1981 tax rates and the 1983 capital productivity is strongly positive (0.848).
  - Spain had a relatively low TFP at the beginning of the eighties. As Spain TFP rose during the eighties, so did its tax rate. Aiyar and Dalgaard (2001)

▷ **Framework**

- Multi-country strategic tax competition for physical capital.

- Two types of capital:
  - Mobile: Locates where the after tax return is the highest.
  - Immobile: Cannot escape taxation by the country in which it is located.

- Countries may be heterogeneous:
  - In the size of their immobile capital.
  - In their productivity.

- We analyze:
  - Simultaneous tax setting games.
  - Sequential tax setting games.

2. The Model

▷ **Countries**

- There are J countries (we sometime focus on $J = 2$), with N_i immobile local capital owners.
- Identical production function $F(K_i) = \gamma K_i$, where K_i is total capital.
- The government in each country i maximizes tax revenue by choice of a per unit tax t_i on capital (uniform).

▷ **Capital Owners: Location**

- N_i immobile owners in i, $i = 1, \ldots, J$, and M mobile owners who must locate.
- All capital owners are identical, and each chooses investment I.
- If N_i local capital owners and M mobile capital owners invest I units of capital in i, then output in i is $F(N_i I + MI) = \gamma(N_i + M)I$.

▷ **Capital Owners: Investment**

- The per unit after tax return on investment is $\gamma - t_i$.
- The cost of investing is given by $c(I)$, with $c', c'' > 0$.

▷ **Timing**

1. Countries choose tax rates.
    - Simultaneously.
    - Sequentially (order of play is exogenous).

2. Mobile capital owners choose the country in which to locate.

3. All capital owners make investment decision.

▷ 3. Investment Decision

- Capital owner chooses I to: $\max\ (\gamma - t_i)I - c(I) \quad \rightarrow I(t_i)$, with $I' < 0$.

▷ 2. Mobile Capital Locational Choice

- Mobile capital locates in g if $\min\{t_j\}_{j=1}^{J} = t_g$, i.e. if g has the lowest tax rate.
- If S countries have chosen the same lowest tax rate, then all capital owners invest in a country belonging to this set with probability $1/S$.

▷ Countries' Welfare - I

- Government of i maximizes tax revenue by choice of per unit tax t_i on capital.
- Given tax t_i, tax revenue in i is written as:

$$[N_i + Mm_i]t_i I(t_i)$$

where

$m_i = 1$ if mobile capital locates in i.

$m_i = 0$ if mobile capital does not locate in i.

▷ Countries' Welfare - II

- Denote by $W^i(t, m_i)$ the welfare (tax revenue) of country i when tax t is imposed and when the indicator variable takes a value of m_i:

$$W^i(t,1) = [N_i + M]tI(t)$$
$$W^i(t,0) = N_i tI(t)$$

- Denote by $\hat{t}$ the tax rate maximizing $W^i(t,0)$ and $W^i(t,1)$.

- Let $\tilde{t}_i < \hat{t}$ solve $W^i(\tilde{t}_i, 1) = W^i(\hat{t}, 0)$, i.e. $[N_i + M]\tilde{t}_i I(\tilde{t}_i) = N_i \hat{t} I(\hat{t})$.
  Note that $\partial \tilde{t}_i / \partial N_i > 0$.

- The Payoffs are represented in Figure 1.

3. Efficient allocation

The efficient allocation is as follows:

- Efficient tax rates are $t_1 = t_2 = ... = t_J = \hat{t}$.

- Mobile capital locates in any of the countries (all of them are equally productive).

- Total tax revenue is given by $M\hat{t}I(\hat{t}) + \sum_{i=1}^{J} W^i(\hat{t}, 0)$

4. Equilibrium of the Simultaneous Move Game

Lemma 1: *Country i never chooses a strategy $t_i > \hat{t}$.*

Lemma 2: *Country i never chooses a strategy $t_i < \tilde{t}_i$.*

Lemma 3: *When the countries play simultaneously, the game has no pure strategy Nash equilibrium.*

▷ Gathering Intuition: The Case With Two Identical Countries

With only two countries having the same number of local capital owners ($N_i = N_j$), the game has a symmetric mixed strategy Nash equilibrium in which the two countries:

- Play $t \in [\tilde{t}, \hat{t}]$ according to the continuous cumulative function $H(t)$ given by:

$$H(t) = \frac{W(t,1) - W(\hat{t},0)}{W(t,1) - W(t,0)}.$$

In equilibrium, the expected payoff of the two countries is $W(\hat{t}, 0)$.

Intuition: No point masses in equilibrium, and indifference between all pure strategies.

Outcome:

- All the rent from the taxation of mobile capital is dissipated.
- Inefficient tax rates in both countries.
- Heterogeneity in tax rates with homogenous countries. Dynamic inconsistency.
- Mobile capital locates in the country with the lowest tax rate.

▷ More Intuition: Two Heterogeneous Countries

⋆ Note that in such a case, because $N_i > N_j$, we have $0 < \tilde{t}_j < \tilde{t}_i < \hat{t}$.

When country i is large and j is small ($N_i > N_j$), the game has a mixed strategy Nash Equilibrium, in which:

- Large country i. With probability q_i, plays $\hat{t}$; With probability $(1 - q_i)$, plays the interval $[\tilde{t}_i, \hat{t}[$ with a continuous probability distribution $H_i(t)$.

- Small country j plays the interval $[\tilde{t}_i, \hat{t}[$ with a probability distribution $H_j(t)$.

Outcome:

- The expected payoff of large country i is $W^i(\tilde{t}_i, 1) = W^i(\hat{t}, 0)$.
- The expected payoff of small country j is $W^j(\tilde{t}_i, 1) > W^j(\tilde{t}_j, 1) = W^j(\hat{t}, 0)$.
- This equilibrium is still inefficient, but large country i plays the efficient tax rate with probability $q_i > 0$.
- Closer to the idea that low capital endowment countries discipline those with a large capital endowment.

Proposition 1 (J Heterogeneous Countries): In a world with J countries differing in their number of local capital owners (say $N_1 > N_2 > ... > N_J$), the game has an asymmetric mixed strategy Nash equilibrium in which the equilibrium strategies are as follows.

$\diamond$ Countries $j = 1, ..., J-2$: Play $\hat{t}$ with probability $q_j = 1$.

$\diamond$ Country $J-1$: With positive probability $q_{J-1} \in]0,1[$, plays $\hat{t}$; with positive probability $(1 - q_{J-1})$, plays the interval $[\tilde{t}_{J-1}, \hat{t}[$ with continuous probability distribution $H_{J-1}(t)$, with:

$$q_{J-1} = 1 - \left[\frac{W^J(\hat{t},1) - W^J(\tilde{t}_{J-1},1)}{W^J(\hat{t},1) - W^J(\hat{t},0)} \right]$$

$$H_{J-1}(t) = \frac{[W^J(t,1) - W^J(\tilde{t}_{J-1},1)]\ [W^J(\hat{t},1) - W^J(\hat{t},0)]}{[W^J(t,1) - W^J(t,0)]\ [W^J(\hat{t},1) - W^J(\tilde{t}_{J-1},1)]}$$

$\diamond$ Country J: Plays the interval $[\tilde{t}_{J-1}, \hat{t}[$ with continuous probability distribution $H_J(t)$, with:

$$H_J(t) = \frac{W^{J-1}(t,1) - W^{J-1}(\hat{t},0)}{W^{J-1}(t,1) - W^{J-1}(t,0)}$$

▷ **Equilibrium Outcome (Proposition 1):**

- All but the two smallest countries are out of the race for mobile capital; all set $\hat{t}$.
- Mobile capital locates in country $J-1$ or J.
- All countries, except the smallest one, obtain $W^j(\tilde{t}_j, 1) = W^j(\hat{t}, 0)$.
- The smallest one obtains an expected payoff of $W^J(\tilde{t}_{J-1}, 1) > W^J(\tilde{t}_J, 1) = W^J(\hat{t}, 0)$.

▷ **How bad is the Inefficiency?**

⋆ At first glance, the equilibrium appears to be almost efficient.

- $J-2$ countries choose $\hat{t}$.
- One country chooses $\hat{t}$ with positive probability.
- At most two countries choose $t < \hat{t}$.

⋆ However, all the mobile capital ends up in the country with the lowest tax rate.

▷ **A Measure of the Inefficiency of Tax Competition:**

⋆ Let Φ be expected foregone tax revenues as a proportion of efficient tax revenues. Calculating Φ in the equilibrium characterized in Proposition 1 yields:

$$\Phi = \frac{[W^J(\hat{t},1) - W^J(\tilde{t}_{J-1},1)]}{M\hat{t}I(\hat{t}) + \sum_{i=1}^{J} W^i(\hat{t},0)}$$

- Inefficiency Φ grows larger when M increases relative to the N_js.
- If the size of the economy was doubled (e.g. M and all the N_js are doubled):
  - the absolute value of foregone tax revenues would double,
  - but Φ would remain unchanged.

5. Equilibrium of the Sequential Move Game

$\star$ New breaking rule: If several countries with the same lowest t, then mobile capital locates in the country that could undercut the other ones.

$\triangleright$ **Gathering Intuition: The Leader is a Small Country ($J = 2$).**

If country 2 acts as the leader and is smaller than country 1 ($N_2 < N_1$), the game has a pure perfect Nash equilibrium in which:

- Country 2 sets $t_2 = \tilde{t}_1$ (and obtains the mobile capital for sure – breaking rule);
- Country 1 sets $t_1 = \hat{t}$.

In equilibrium, the payoffs are given by:

- Country 2: $W^2 = \tilde{t}_1[N_2 + M]I(\tilde{t}_1) > \hat{t}N_2I(\hat{t})$;
- Country 1: $W^1 = \hat{t}N_1I(\hat{t})$.

Intuition: Country 2 has a lower $\tilde{t}$ ($\tilde{t}_2 < \tilde{t}_1$) so it sets its tax rate at a level low enough to attract the mobile capital. Country 1 then sets its tax rate optimally.

▷ **More intuition: The Leader Is a Large Country ($J = 2$).**

If country 1 acts as the leader and is larger than country 2 ($N_1 > N_2$), the game has a pure perfect Nash equilibrium in which:

- Country 1 sets $t_1 = \hat{t}$;
- Country 2 sets $\hat{t}$ and obtains the mobile capital (breaking rule).

In equilibrium, the payoffs are given by:

- Country 1: $W^1 = \hat{t} N_1 I(\hat{t})$;
- Country 2: $W^2 = \hat{t}[N_2 + M]I(\hat{t})$.

Intuition: Country 1 has a higher $\tilde{t}$ ($\tilde{t}_1 > \tilde{t}_2$) and it knows it will lose anyway, so it prefers to set $\hat{t}$. Then, country 2 just undercuts 1 (by setting $\hat{t}$ – breaking rule).

Outcome: Allocation is efficient.

▷ Case With J Countries

⋆ Suppose $N_1 \geq N_2 \geq \ldots \geq N_{J-1} > N_J$, then $\tilde{t}_1 \geq \tilde{t}_2 \geq \ldots \geq \tilde{t}_{J-1} > \tilde{t}_J$.

Consider any order of play. Let a_i be an indicator function:

$a_i = 1$ if country i chooses its tax rate after jurisdiction J;

$a_i = 0$ if country i chooses it before.

$\mathcal{A} \subset \mathcal{J}$ is the set of countries who choose their tax rate after J: $\mathcal{A} = \{i \in \mathcal{J} | a_i = 1\}$.

Proposition 3 (Case With J Countries): If $\tilde{t}_J = \min\{\tilde{t}_j, j \in \mathcal{J}\}$, then the subgame perfect equilibrium of the tax competition game is a strategy profile $(t_1^\star, \ldots, t_J^\star)$ in which all countries play the efficient tax rate ($t_j^\star = \hat{t}$, $\forall\ j \neq J$) except for country J which plays $t_J^\star = \min\{\tilde{t}_k | k \in \mathcal{A}\}$

Intuition:

- Country J (the one with the smallest $\tilde{t}$) will win for any order.
- All other countries play $\hat{t}$.
- When J plays, it sets its tax rate at the level of the lowest $\tilde{t}$ of the countries who still have to play (recall the breaking rule).

▷ **Welfare**

⋆ If the smallest country plays late, its t is more likely to be close to the efficient level.

⋆ The other countries set their tax rate efficiently.

Equilibrium Outcome (Proposition 3):

- Results are similar to Table 1.
- Welfare depends on the order of play.
- All countries obtain $W^j(\hat{t}, 0)$ in all orders of moves, except for J which, in the worse case scenario, obtains a welfare of $W^J(\tilde{t}_{J-1}, 1)$.
- Using our inefficiency measure Φ, we note two points:
  - Inefficiency, in the worse case scenario of the sequential game, is equal to that in the simultaneous game;
  - In any other scenario of the sequential game, inefficiency is less than that in the simultaneous game.

Since the worse case scenario occurs with a probability less than one in the sequential game, it follows that there is less inefficiency in the sequential game than in the simultaneous game.

6. Varying Productivities

- Suppose $F(K) = \gamma_i K$, so mobile capital locates in i if $\gamma_i - t_i > \gamma_j - t_j$.
- For capital owners investing in i, the optimal size of their investment is:

$$I(\gamma_i - t_i) = \arg\max_I \; (\gamma_i - t_i)I - c(I).$$

- Welfare: $W^i(t,1) = t[N_i + M]I(\gamma_i - t)$ and $W^i(t,0) = tN_i I(\gamma_i - t)$.
- $\hat{t}_i$ maximizes $W^i(t, m_i)$. We have $\gamma_i > \gamma_j \Rightarrow \hat{t}_i > \hat{t}_j$.
- Define $\tilde{t}_i < \hat{t}_i$ so that $\tilde{t}_i$ solves $W^i(\hat{t}_i, 0) = W^i(\tilde{t}_i, 1)$.
- Payoffs are depicted in Figure 2 for $\gamma_i > \gamma_j \Rightarrow \tilde{t}_i > \tilde{t}_j$.
- We only examine sequential games.

$\star$ Whatever the order of moves, mobile capital locates in the country with the largest per unit net return $\gamma_j - \tilde{t}_j$. Suppose γ_g is the largest productivity level. Then mobile capital locates inefficiently if $\max_j\{\gamma_j - \tilde{t}_j\}_{j=1}^{J} \neq g$.

Question: Can we find a $\Delta_{gj} = \gamma_g - \gamma_j > 0$ such that $\tilde{t}_j < \tilde{t}_g - \Delta_{gj}$, i.e. such that mobile capital locates in a (relatively) low productivity country?

Answer I:

- Impossible when the most productive country also has less immobile capital than the other countries ($N_g \leq N_j$ for all $j \neq g$). Mobile capital always efficiently locates in most productive country g in such a case.

Answer II:

- Possible if there is a country j such that $N_j < \bar{N}_{gj}$, where $\bar{N}_{gj}$ is given by:

$$\hat{t}_g \frac{N_g}{N_g + M} \frac{I(\gamma_g - \hat{t}_g)}{I(\gamma_g - \tilde{t}_g)} - \hat{t}_j \frac{\bar{N}_{gj}}{\bar{N}_{gj} + M} \frac{I(\gamma_j - \hat{t}_j)}{I(\gamma_j - \tilde{t}_j)} - \Delta_{gj} = 0$$

- Capital inefficiently locates in a low productivity country like j (and not in g).

7. Preferential versus Non-Preferential Regimes

- Non-Preferential regimes:
  - There can be inefficiently low tax rates on both types of capital.
  - The worst a country can obtain is $W^j(\hat{t}, 0)$. The smallest country does at least $W^J(\tilde{t}_{J-1}, 1) > W^J(\hat{t}, 0)$.
  - This type of regime disciplines countries engaged in tax competition for mobile capital by tying their tax rate on mobile capital to that on the immobile one.
  - Mobile capital may locate in a low productive country.

- Preferential regimes:
  - No distortion on immobile capital ($\hat{t}$ is chosen).
  - Intense competition for mobile capital. Extreme distortion. Tax on mobile capital is $t = 0$ in all countries.
  - All countries obtain $W(\hat{t}, 0)$.
  - Mobile capital always locates in the most productive country.

⋆ Our conclusion:

- A non-preferential regime is better at reducing the under-taxation inefficiency;
- A preferential regime is better at reducing the locational inefficiency.

8. Conclusion / Extentions

▷ **Endogenizing the order of moves.**

- The small country does better when it plays at the end.
- Large countries obtain the same payoffs for any order.

⇒ War of attrition: Small country attempts to play last. No distortion !!

▷ **Dynamic setting:**

- Imagine that each country starts with N_0^i immobile capital.
- Each period, M_t new mobile capital is created.
- Then, $N_t^i = \delta N_{t-1}^i + m_t^i M_t$.

⇒ Convergence in the stock of capital, even with constant returns to scale. Generated by tax competition.