流通科学大学論集—経済・経営情報編—第 18 巻第 1 号，1-11（2009）

Preferential Tax Regimes and Asymmetries of Countries

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Preferential tax regimes have been controversial among policy makers, as well as among theorists, whether they are harmful or not. The current paper introduces an extension to Keen's (2001) model, where we assume asymmetric productivity across countries and show that non-preferential regimes can generate larger tax revenue, and that transition from one regime to another may have opposite effects on different countries.

Keywords: tax competition; tax discrimination; asymmetric productivity

I. Introduction

Tax competition between countries has long been among major issues in international public policies and has a large literature.[1] On the other hand, the literature on preferential tax regimes is relatively new and is now growing. It is often observed that governments compete with each other to attract certain types of tax bases by setting lower tax rates on those bases than on other bases. This is called tax discrimination or preferential tax regimes, which is among major issues in international tax policies. Ireland, for example, used to set a corporate tax rate of 10% on industries such as manufacturing mainly invested by foreigners, and 40% on others mainly invested by domestic investors. Such policies, however, had been criticized by the European Commission and OECD as leading to harmful tax competition, and in 2003 Ireland basically made the transition to the non-preferential regime, with a single tax rate of 12.5%.

It has been controversial among theorists whether preferential tax regimes are desirable or not. Janeba and Peters (1999) considered two asymmetric countries and two types of tax bases, internationally mobile and immobile, and showed that tax preference is not desirable. Keen (2001), on the other hand, assumed two mobile tax bases and two

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（2009 年 2 月 24 日受理）

identical countries, and argued that tax preference can limit the scope of tax competition and increase tax revenues. Janeba and Smart (2003) generalized the model of Keen (2001) and analyzed the cases where preferential treatment or the difference of tax rates is not prohibited but restricted. Then they showed that if a coordinated reduction in tax rates makes the tax bases grow and both types of capital are highly mobile, restrictions on preferential treatment is revenue-increasing, although a complete ban on tax preferences is undesirable. Haupt and Peters (2005) argued that with a home bias of investors, restrictions on preferential treatments increase tax revenues.

Another possible extension to Keen's (2001) model is the asymmetry of countries. Bucovetsky and Haufler (2007) extended the model to asymmetric countries in population and showed that preferential tax regime generates larger tax revenue in both countries as in the symmetric model. Marceau et al. (2007) assumed linear production functions with asymmetric productivity across countries and argued that non-preferential regime generates larger tax revenue. In general, however, production technology of an industry is not necessarily linear or identical across countries. If you assume different production technologies, the results may be changed.

The rest of the paper is organized as follows. Section II, as a benchmark, sets up a model with two identical countries and two types of mobile capital as in Keen (2001), but more explicit in production technologies. Then it is shown that the tax revenue is larger under preferential regime than under non-preferential regime. Section III considers a model where productivity of one industry differs across countries, in which we first employ linear marginal productivity, and then Cobb-Douglas production functions. Then it is shown that non-preferential regime may generate larger tax revenues, and transition from one regime to another can have opposite effects on different countries. Section IV concludes.

II. Basic Model

Suppose that the world consists of two identical countries, Country 1 and 2, and assume two types of capital, K and H, total amount of which are fixed respectively:

$$K^1 + K^2 = \bar{K}$$

$$H^1 + H^2 = \bar{H}$$

where the superscripts denote the country in which the capital is employed.

Each country has two representative firms (or industries). They employ labor, as well as capital K^i and H^i respectively and their production functions are expressed as follows:

$$F^i = F(K^i, L^{iF}), \qquad G^i = G(H^i, L^{iG})$$

which we assume are homogeneous of degree one. L^{iF} and L^{iG} are the labor employed in the two industries. Labor is immobile across countries and industries. Because two countries are identical, the market clearing conditions of per-capita amount of capital are expressed as below:

$$k^1 + k^2 = \bar{k} \tag{1}$$

$$h^1 + h^2 = \bar{h}. \tag{2}$$

We assume here as in Keen (2001) that the location of each capital is unaffected by the tax on the other. The per-capita production functions are as follows:

$$f^i = f(k^i), \qquad g^i = g(h^i).$$

1. Preferential tax regimes

Governments set tax rates t^i and T^i on the capital k^i and h^i respectively. Therefore, from the profit maximization we have,

$$f'(k^i) = r + t^i \tag{3}$$

$$g'(h^i) = R + T^i \tag{4}$$

where r and R are the net-of-tax returns from the capital k and h respectively. Solving (3) and (4) for k^i and h^i respectively yields,

$$k^i = k^i(r + t^i), \quad h^i = h^i(R + T^i). \tag{5}$$

Substituting (5) into (1) and (2) and solving for r and R we have,

$$r = r(t^1, t^2), \quad R = R(T^1, T^2).$$

Assume, as in the literature, that the government i maximizes its tax revenue $Rev^{P,i}$ (P stands for "Preferential"), that is,

$$\max_{t^i, T^i} Rev^{P,i} = t^i k^i + T^i h^i.$$

The first order conditions for this problem are,

$$t^i : \; k^i + t^i k^{i\prime} (1 + r_{ti}) = 0 \tag{6}$$

$$T^i : \; h^i + T^i h^{i\prime} (1 + R_{Ti}) = 0 \tag{7}$$

where $k^{i\prime} \equiv \partial k^i / \partial r$ (or $\partial k^i / \partial t^i$), $r_{ti} \equiv \partial r / \partial t_i$, and so on. From (6) and (7) the tax rates are expressed as,

$$t^i = -\frac{k^i}{k^{i\prime}(1 + r_{ti})}, \quad T^i = -\frac{h^i}{h^{i\prime}(1 + R_{Ti})}. \tag{8}$$

The equilibrium is obtained from (1) – (4) and (8).

2. Non-preferential regimes

If the governments give up tax preference and adopt equal tax treatment, or the non-preferential regimes, they can determine only one tax rate τ^i levied on two types of capital. Then we have,

$$f'(k^i) = r + \tau^i \tag{9}$$

$$g'(h^i) = R + \tau^i \tag{10}$$

and hence,

$$k^i = k^i(r + \tau^i), \quad h^i = h^i(R + \tau^i). \tag{11}$$

Substituting (11) into (1) and (2) and solving for r and R we have,

$$r = r(\tau^1, \tau^2), \quad R = R(\tau^1, \tau^2).$$

Therefore the revenue maximization problem is as follows:

$$\max_{\tau^i} Rev^{NP,i} = \tau^i(k^i + h^i)$$

where the superscript *NP* stands for "Non-Preferential". Solving this we have,

$$\tau^i = -\frac{k^i + h^i}{k^{i\prime}(1 + r_{\tau i}) + h^{i\prime}(1 + R_{\tau i})}. \tag{12}$$

The equilibrium is obtained from (1), (2), (9), (10) and (12).

Because countries are identical, the locations of capital are the same under the two tax regimes. In addition, from total differentiation of (1) and (2) using (5) and (11) we have,

$$r_{ti} = r_{\tau i} \quad (= -\frac{k^{i\prime}}{k^{1\prime} + k^{2\prime}})$$
$$R_{Ti} = R_{\tau i} \quad (= -\frac{h^{i\prime}}{h^{1\prime} + h^{2\prime}}).$$

Therefore the difference of tax revenues under preferential regimes $Rev^P(= Rev^{P,1} = Rev^{P,2})$ and non-preferential regimes $Rev^{NP}(= Rev^{NP,1} = Rev^{NP,2})$ can be expressed as,

$$\begin{aligned} Rev^P - Rev^{NP} &= t^i k^i + T^i h^i - \tau^i(k^i + h^i) \\ &= -\frac{(k^i)^2}{k^{i\prime}(1 + r_{ti})} - \frac{(h^i)^2}{h^{i\prime}(1 + R_{Ti})} + \frac{(k^i + h^i)^2}{k^{i\prime}(1 + r_{ti}) + h^{i\prime}(1 + R_{Ti})} \\ &= -\frac{[k^{i\prime} h^i(1 + r_{ti}) - k^i h^{i\prime}(1 + R_{Ti})]^2}{k^{i\prime} h^{i\prime}(1 + r_{ti})(1 + R_{Ti})[k^{i\prime}(1 + r_{ti}) + h^{i\prime}(1 + R_{Ti})]}. \end{aligned}$$

Since r_{ti} and $R_{Ti} \in (-1, 0)$, the denominator is negative, and hence $Rev^P - Rev^{NP} \geq 0$. That is, tax revenue under preferential regimes is at least as large as that under non-preferential regimes, just as Keen's conclusion.

III. Asymmetric productivity

Bucovetsky and Haufler (2007) extended Keen's model to asymmetric countries where only population differs and showed that Keen's conclusion holds, that is, preferential regimes generate larger tax revenues. In this section we investigate the case where production technology differs across countries. We first employ linear marginal productivities as in Bucovetsky and Haufler (2007), and then consider Cobb-Douglas production functions.

1. The model with linear marginal productivities

Suppose two countries $i \in \{1,2\}$ and two types of capital k and h employed in industries f and g respectively. The share of country i in the total population is $s^i = 1/2$ and this applies to the share of workers in both industries. Therefore the capital markets clearing are expressed using per-capita notation as,

$$\frac{1}{2}(k^1 + k^2) = \bar{k}, \qquad \frac{1}{2}(h^1 + h^2) = \bar{h} \tag{13}$$

where $\bar{k}$ and $\bar{h}$ are the average per-capita amounts of capital. Labor is immobile across countries and industries. In order to obtain reduced-form expressions we assume quadratic production functions $f^i = a^{ik}k^i - b^k(k^i)^2/2$ and $g^i = a^h h^i - b^h(h^i)^2/2$. Hence the marginal productivities are,

$$f_k^i = a^{ik} - b^k k^i, \qquad g_h^i = a^h - b^h h^i. \tag{14}$$

The parameter a^k of industry f may differ across countries while a^h of industry g is the same. We assume here that $a^{1k} > a^{2k}$, that is, f^1 is more productive than f^2. Because of the arbitrage conditions,

$$f_k^1 - t^1 = f_k^2 - t^2 \qquad \text{and} \qquad g_h^1 - T^1 = g_h^2 - T^2.$$

Using (14) and rearranging we have,

$$t^2 - t^1 = b^k(k^1 - k^2) + a^{2k} - a^{1k} \tag{15}$$

$$T^2 - T^1 = b^h(h^1 - h^2). \tag{16}$$

Substituting (13) into (15) and (16) we have per-capita tax bases as functions of tax rates:

$$k^i = \frac{1}{2b^k}(t^j - t^i + a^{ik} - a^{jk}) + \bar{k} \tag{17}$$

$$h^i = \frac{1}{2b^h}(T^j - T^i) + \bar{h} \tag{18}$$

where $j \in \{1, 2\}$ and $i \neq j$. Governments solve the following revenue-maximization problem:

$$\max_{t^i, T^i} Rev^{iP} = t^i k^i + T^i h^i.$$

Solving this we have the Nash equilibrium tax rates and tax bases as follows:

$$t^i = 2b^k \bar{k} + \frac{a^{ik} - a^{jk}}{3} \tag{19}$$

$$T^i = 2b^h \bar{h} \tag{20}$$

$$k^i = \bar{k} + \frac{a^{ik} - a^{jk}}{6b^k} \tag{21}$$

$$h^i = \bar{h}. \tag{22}$$

Then the tax revenues of two countries under preferential regime are expressed as below:

$$Rev^{iP} = 2b^h \bar{h}^2 + \frac{(a^{ik} - a^{jk} + 6b^k \bar{k})^2}{18b^k}.$$

On the other hand, under non-preferential regime the revenue maximization problem for the governments is as follows:

$$\max_{\tau^i} Rev^{iNP} = \tau^i (k^i + h^i).$$

Solving this yields the Nash equilibrium tax rates and tax bases:

$$\tau^i = \frac{b^h [a^{ik} - a^{jk} + 6b^k (\bar{k} + \bar{h})]}{3(b^k + b^h)} \tag{23}$$

$$k^i = \frac{(a^{ik} - a^{jk})(3b^k + b^h)}{6b^k (b^k + b^h)} + \bar{k} \tag{24}$$

$$h^i = \frac{a^{jk} - a^{ik}}{3(b^k + b^h)} + \bar{h}. \tag{25}$$

Therefore we have the tax revenues under non-preferential regime:

$$Rev^{iNP} = \frac{b^h [a^{ik} - a^{jk} + 6b^k (\bar{k} + \bar{h})]^2}{18b^k (b^k + b^h)}.$$

Subtracting Rev^{iNP} from Rev^{iP} we can see which regime generates larger tax revenue.

$$\Delta = Rev^{iP} - Rev^{iNP} = \frac{(a^{ik} - a^{jk} + 6b^k \bar{k} - 6b^h \bar{h})^2}{18(b^k + b^h)} \geq 0$$

that is, preferential regime generates equal or larger tax revenues than non-preferential regime.[2]

2. Numerical examples with Cobb-Douglas technologies

Linear marginal productivity may fail to represent some characteristics of the economy. The model can be written in general forms as follows:

$$s^1k^1 + s^2k^2 = \bar{k}, \qquad s^1h^1 + s^2h^2 = \bar{h} \tag{26}$$

$$f_k^1 - t^1 = f_k^2 - t^2 \tag{27}$$

$$g_h^1 - T^1 = g_h^2 - T^2. \tag{28}$$

Substituting (26) into (27) and (28) and differentiating we have,

$$\frac{dk^i}{dt^i} = \frac{s^j}{s^j f_{kk}^i + s^i f_{kk}^j}$$

$$\frac{dh^i}{dT^i} = \frac{s^j}{s^j g_{hh}^i + s^i g_{hh}^j}.$$

Therefore, solving the revenue maximization problem of preferential regime yields the following conditions:

$$k^i + \frac{s^j}{s^j f_{kk}^i + s^i f_{kk}^j} t^i = 0 \tag{29}$$

$$h^i + \frac{s^j}{s^j g_{hh}^i + s^i g_{hh}^j} T^i = 0. \tag{30}$$

Similarly, solving the problem of non-preferential regime we have,

$$k^i + h^i + \left(\frac{s^j}{s^j f_{kk}^i + s^i f_{kk}^j} + \frac{s^j}{s^j g_{hh}^i + s^i g_{hh}^j}\right)\tau^i = 0. \tag{31}$$

We now employ the Cobb-Douglas production functions and calculate the equilibria. They are expressed with per-capita notations as follows:

$$f^1 = 1.5(k^1)^{0.3}, \quad f^2 = (k^2)^{0.3}, \quad g^1 = (h^1)^{0.3}, \quad g^2 = (h^2)^{0.3}$$

and we assume $s^1 = s^2 = 1/2$ and $\bar{k} = \bar{h} = 5$. Then we obtain the equilibria as in Table 1. Note that in the "non-preferential" row, $t^i = T^i = \tau^i$, $i = 1, 2$. The table shows that both $Rev^{1P} - Rev^{1NP}$ and $Rev^{2P} - Rev^{2NP}$ are negative, that is, non-preferential regime generates larger per-capita tax revenues.

Table 1: Equilibria with Cobb-Douglas production functions

	k^1	k^2	h^1	h^2	t^1	t^2	T^1	T^2	Rev^1	Rev^2
preferential	5.48	4.52	5.00	5.00	0.18	0.15	0.14	0.14	1.69	1.37
non-preferential	6.00	4.00	4.47	5.53	0.16	0.15	0.16	0.15	1.70	1.41

To compare this result with the one using quadratic technologies, let us assume production functions as follows:

$$f^1 = 0.3k^1 - 0.008(k^1)^2, \quad f^2 = 0.2k^2 - 0.008(k^2)^2$$

$$g^1 = 0.2h^1 - 0.008(h^1)^2, \quad g^2 = 0.2h^2 - 0.008(h^2)^2$$

so that the tax revenues are about the same size as in the Cobb-Douglas case. The equilibria are calculated as in Table 2. One can see that revenues are larger under preferential regime as shown in the previous subsection. This suggests that quadratic production function (linear marginal productivity) may not be appropriate in dealing with technological asymmetry.[3]

Table 2: Equilibria with quadratic production functions

	k^1	k^2	h^1	h^2	t^1	t^2	T^1	T^2	Rev^1	Rev^2
preferential	6.04	3.96	5.00	5.00	0.19	0.13	0.16	0.16	1.97	1.30
non-preferential	7.08	2.92	3.96	6.04	0.18	0.14	0.18	0.14	1.95	1.28

Next let us assume asymmetric distribution of population, in addition to asymmetric Cobb-Douglas production functions used in Table 1. Let $s^1 = 0.1$ and $s^2 = 0.9$, that is, country 1 is smaller than country 2. Table 3 shows the equilibria. One can see that the large country can gain if both countries make the transition from preferential to non-preferential regimes. On the other hand, tax revenue of the small country decreases if non-preferential regime is enforced. An implication is that when Ireland was forced to accept the non-preferential regimes, other countries in EU may have benefited at the expense of Ireland. Although the result above is not always the case but depends on

Table 3: Equilibria with asymmetric productivity and population

	k^1	k^2	h^1	h^2	t^1	t^2	T^1	T^2	Rev^1	Rev^2
preferential	18.39	3.51	16.18	3.76	0.09	0.16	0.07	0.15	2.81	1.10
non-preferential	19.52	3.39	15.14	3.87	0.08	0.15	0.08	0.15	2.80	1.11

parameters,[4] it shows the possibility that transition from one regime to another may have opposite effects on different countries.

IV. Conclusion

Researchers and practitioners have discussed whether preferential tax regimes are desirable or not. In the society of practitioners, organizations such as OECD have criticized preferential regimes as a source of harmful tax competition. In the academic world, while some studies supported non-preferential regimes, Keen's (2001) conclusion has also been forceful.

The current paper first reviewed Keen's model as a benchmark, but with a model more explicit in production technologies and confirmed that preferential tax regime raises larger tax revenue. Next we assumed asymmetric productivity across countries and analyzed which tax regime raises larger tax revenue. Then it was shown that with linear marginal productivity the tax revenue was larger under preferential tax regime. Using Cobb-Douglas production functions, however, tax revenue can be larger under non-preferential regime. It was also shown that the transition from one regime to another may have opposite effects on large and small countries.

The result with Cobb-Douglas production functions rests on numerical approaches. Some kind of analytical approach is desirable, which is left for future work.

Acknowledgment

This work was supported by KAKENHI (19530295), Grant-in-Aid for Scientific Research (C).

Notes

1. See Wilson (1999) and Zodrow (2003) for surveys on tax competition.
2. One can obtain the same result with b^k different across countries, such as $b^{1k} < b^{2k}$.
3. The result with asymmetric distribution of population and symmetric Cobb-Douglas production functions was consistent with that of Bucovetsky and Haufler (2007).

4. For example, if one assume $f^1 = (k^1)^{0.3}$ and $f^2 = 1.5(k^2)^{0.3}$ instead of $f^1 = 1.5(k^1)^{0.3}$ and $f^2 = (k^2)^{0.3}$, tax revenues are larger under non-preferential regime in both countries.

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