A Note on Tax Competition in the Presence of Agglomeration Economies

by

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August 2004

Abstract

This paper analyzes tax competition in the presence of agglomeration effects. The obtained results are then compared to the results of the traditional model, without agglomeration effects. In the model with agglomeration effects a new effect shows up. This effect reflects heightened government concern about capital flight, which depresses firm productivity by limiting external economies of scale. As a result, capital tax rates end up being lower than in the case where agglomeration effects are not present, worsening the underprovision of the public good. This conclusion holds in both the competitive and strategic versions of the model.

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1 Introduction

Economic activities tend to concentrate in a small number of places (typically in cities), and agglomeration economies are one force behind this concentration. Given their importance, it is interesting to consider the effect of agglomeration economies on fiscal competition between jurisdictions.[1] The purpose of the present paper is to incorporate agglomeration economies in the analysis of tax competition between jurisdictions, comparing the obtained results to the case where agglomeration economies are not present.

Economic agglomerations are created by the presence of both technological and pecuniary externalities.[2] Technological externalities capture non-market interactions that directly affect the utility of an individual or the production function of a firm. On the other hand, pecuniary externalities are those that arise by economic interactions that take place through the market mechanisms via the mediation of prices. Pecuniary effects reduce the cost of inputs without affecting the productivity of the inputs.

Following Chipman (1970), technological externalities have been considered in various models of city formation. In these models, firms are assumed to have a production function that exhibits external increasing returns to scale. Arnott (1979), Henderson (1974, 1988) are some of the theoretical models that use this specification to show the importance of agglomeration effects in city formation and in the choice of optimal city sizes. Empirical studies also use Chipman's approach to focus on city and industry size as determinants of productivity, and on technological spillovers as a source of agglomeration economies. Moomaw (1981) estimated the effect of city population on productivity, while Henderson (1986) found that industry size in a city has a positive effect on productivity of firms.

The new economic geography literature, following Dixit and Stiglitz (1977), uses the monopolistic competition framework to study agglomeration with internal increasing returns. In this type of model pecuniary externalities are formulated as explicit market mechanisms. Models that focus on city formation using this approach are Abdel-Rahman (1988) and Fujita (1988). This approach is also used to analyze differences across regions, with Krugman (1991) being the main reference for this type of model.

Following Krugman (1991), recent papers are starting to focus on the taxation of mobile factors in economies where agglomeration economies are present, firms face monopolistic competition, and trade is allowed. These models conclude that agglomeration creates rents for the mobile factor that can be taxed, increasing the equilibrium tax rates. For analysis of this

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[*]The model in this paper draws on an idea of Teresa Garcia-Milà and Therese J. McGuire (2001), who analyze the effects of agglomeration economies in the tax competition model of Oates and Schwab (1991). They are not responsible, of course, for any shortcomings in the analysis.

[1]For a survey of the literature that analyzes the formation of economic agglomerations see Fujita and Thisse (2000).

[2]This terminology follows Scitovsky's (1954) classification.

kind of model, see Baldwin and Krugman (2004), Andersson and Forslid (2003), and Kind, Midelfart-Knarvik, and Schjelderup (1998). A key feature of these models is that production, due to demand and supply linkages, agglomerates in a region, tending to get stuck there. Then the mobile factor, being locked in by the existence of an industrial cluster, may not respond to marginal changes in tax rates. This result differs with the standard tax competition framework, where marginal changes in tax rates lead to a marginal movement of factors.

Traditional tax competition models assume two factors of production: labor, which is immobile, and capital, which is mobile. Firms face perfect competition, there are no transportation costs, and there is no trade between regions. Under this setup, tax competition models analyze the distortions that a tax on mobile capital causes in an economy where the tax revenue is used to finance public expenditure. The problem arises when one jurisdiction raises its capital-tax rate in order to increase the level of the public good. The net-of-tax return in that jurisdiction then falls below that prevailing in other jurisdictions, and capital relocates to other communities until net returns are equalized. This capital relocation is perceived as a cost by the community, which tends to reduce its capital tax rates and the level of provision of the public good. This result is due to a critical assumption made by these models: jurisdictions are restricted to one tax instrument (a tax on mobile capital).[3]

The traditional tax competition literature entirely ignores issues of agglomeration economies. In order to fill this gap, the goal of this paper is to incorporate agglomeration economies, maintaining the standard assumptions, in a tax competition model. Instead of pecuniary externalities, technological externalities are considered. Agglomeration economies are modeled as arising through external increasing returns to scale, following the approach of Chipman (1970). Then, even though each competitive firm believes that it is operating under constant returns to scale, an increase in its capital has a productivity effect on all firms in the jurisdiction. Unlike firms, the local government recognizes that an increase in the jurisdiction's aggregate level of capital makes firms more productive, and it takes this effect into account when in maximizing the utility of a representative agent by choosing capital tax rates and public good levels.

By introducing a new externality into the tax competition framework, agglomeration alters the conclusions of the standard analysis. Because lost capital both shrinks the tax base and limits the gains from external increasing returns, government concern about capital flight is heightened relative to the standard model. As a result, the reluctance of local governments to increase their capital tax rates is strengthened, leading to more severe underprovision of public goods than in the standard model. The analysis in the paper establishes this conclusion for both the competitive and strategic cases.

Section 2 of the paper presents the general model. Section 3 analyzes the case with competitive jurisdictions, and the case where jurisdictions have market power is analyzed in Section 4. Finally, Section 5 concludes.

2 The Model

The economy is divided into I jurisdictions where agglomeration economies are present. There are J competitive firms in each jurisdiction producing a numeraire private good, x_i. Firms have the following production function,

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[3]In the competitive case it can be shown that local governments would never use a capital tax if head taxes are available, as in the standard model of tax competition. However, strategic governments would still want to use the capital tax to manipulate the term of trade even when head taxes are available. For a review of the tax competition literature see Wilson (1999).

$$Q_{ij} = F(K_{ij}, N_{ij})G(\sum_{j=1}^{J} K_{ij}/N_i), \tag{1}$$

where K_{ij} gives the capital input for firm j in jurisdiction i and N_{ij} is the labor input. Notice that since each individual inelastically supplies one unit of labor, $\sum_{j=1}^{J} N_{ij} = N_i$ is the fixed population in jurisdiction i. The last term of (1) represents the augmentation to productivity associated with larger aggregate amounts of capital (agglomeration economies). Assuming $F(.)$ is homogeneous of degree one, (1) can be written as $q_{ij} = f(k_{ij})g(k_i)$, where q_{ij} is the output to labor ratio and k_{ij} is the capital to labor ratio (k_i is the aggregate ratio for jurisdiction i). Since k_{ij} and q_{ij} will be equal across firms, this relationship can be written as

$$q_i = f(k_i)g(k_i) \tag{2}$$

Each firm takes the aggregate amount of capital as given when making its choice of capital per worker (firms treat $g(k_i)$ as parametric). A tax per unit of capital is levied in each jurisdiction, with t_i denoting the tax rate in community i. Letting ρ denote capital's net of tax return, the after-tax cost of capital in community i is $\rho + t_i$. Then, when maximizing profits, firms equate capital's marginal product to this after-tax cost, satisfying

$$f'(k_i)g(k_i) = \rho + t_i \qquad \forall i. \tag{3}$$

Letting w_i denote jurisdiction i's wage, then

$$w_i = f(k_i)g(k_i) - k_i f'(k_i)g(k_i) \qquad \forall i, \tag{4}$$

and the resource constraint is given by

$$\sum_{i=1}^{I} N_i k_i = \overline{K}, \tag{5}$$

where $\overline{K}$ is the fixed total amount of capital in the economy. Letting $\theta_i = \frac{N_i}{\overline{N}}$ (where $\overline{N}$ is the total population in the economy) denote the population share of jurisdiction i, (5) can be written as

$$\sum_{i=1}^{I} \theta_i k_i = \overline{k}. \tag{6}$$

Turning to the remaining assumptions of the model, the private good can either be consumed directly as a private commodity, x, or used to produce a public good z at a constant cost of c per unit. Since z is a publicly provided private good, the cost of providing z_i units of the public good in jurisdiction i is $cN_i z_i$.

Consumers have identical preferences represented by a well behaved utility function, $U(x_i, z_i)$. Private good consumption is equal to the consumer's wage income plus income from capital. Since it is assumed that ownership of the total stock of capital is equally shared among all individuals in the economy, utility can be written as $U(x_i, z_i) = U(w_i + \rho\bar{k}, z_i)$.

The local government, taking into account that agglomeration economies are present, chooses the tax rate and public good level to maximize the utility of a representative resident. Formally the problem it faces is

$$\max_{t_i, z_i} U(w_i + \rho\bar{k}, z_i)$$

$$\text{s. t. } t_i k_i = c z_i \, ,$$

replacing the budget constraint in the objective function the above problem is equivalent to

$$\max_{t_i} U(w_i + \rho\bar{k}, t_i k_i / c),$$

where k_i, w_i, and ρ are determined by equations (3), (4), and (6). The solution to this problem is analyzed under different assumptions in the following sections.

3 Competitive Jurisdictions

In the competitive case, jurisdictions are assumed to be small relative to the economy. They do not influence, by their choice of tax rates, capital's after-tax return. Thus, ρ is taken as parametric by all agents in the economy. Then in this case, the only relevant conditions for the jurisdiction are its own conditions (3) and (4). Differentiating them with respect to t_i yields

$$\frac{\partial k_i}{\partial t_i} = \frac{1}{f''(k_i)g(k_i) + f'(k_i)g'(k_i)}, \tag{7}$$

and

$$\frac{\partial w_i}{\partial t_i} = \left[f(k_i)g'(k_i) - k_i \left(f''(k_i)g(k_i) + f'(k_i)g'(k_i) \right) \right] \frac{\partial k_i}{\partial t_i}$$

$$= \frac{f(k_i)g'(k_i)}{f''(k_i)g(k_i) + f'(k_i)g'(k_i)} - k_i. \tag{8}$$

In order for use of capital to decrease as its price increases, the denominator in equation (7) needs to be negative. This condition requires that the derivative of $f'(k_i)g(k_i)$ with respect to k_i be negative, which requires that as k_i increases the decline of $f'(k_i)$ dominates the increase in $g(k_i)$. With (7) negative, negativity of (8) then follows from inspection, indicating that the wage falls as t_i rises.

The first-order condition for the local government problem stated above is

$$\frac{U_z(w_i + \rho\bar{k}, z_i)}{U_x(w_i + \rho\bar{k}, z_i)} = \frac{c}{k_i + t_i \frac{\partial k_i}{\partial t_i}} \left(-\frac{\partial w_i}{\partial t_i} \right). \tag{9}$$

Using conditions (7) and (8), the above expression can be written as

$$\frac{U_z(w_i + \rho\overline{k}, z_i)}{U_x(w_i + \rho\overline{k}, z_i)} = c \left[\frac{\left(1 - \frac{f(k_i)g'(k_i)}{k_i(f''(k_i)g(k_i)+f'(k_i)g'(k_i))}\right)}{1 + \frac{t_i}{k_i}\frac{1}{f''(k_i)g(k_i)+f'(k_i)g'(k_i)}} \right]. \tag{10}$$

A goal of the analysis is to compare the implications of (10) to the traditional results of the tax competition literature. To do so, it is assumed that in the case of no agglomeration effects, $g(k_i) = \overline{g}$ (a constant), implying $g'(k_i) = 0$. Then $\partial k_i / \partial t_i = 1/f''(k_i)\overline{g}$, and the optimality condition in the traditional model is given by

$$\frac{U_z(w_i + \rho\overline{k}, z_i)}{U_x(w_i + \rho\overline{k}, z_i)} = c \left[\frac{1}{1 + \frac{t_i}{k_i}\frac{1}{f''(k_i)\overline{g}}} \right]. \tag{11}$$

If taxes are increasing in t_i, i.e. if the elasticity of capital with respect to the tax rate is less than one in absolute value, then the denominator of the RHS of (11) is between zero and one and thus the term in brackets is greater than one. Equation (11) then implies that the marginal benefit is bigger than the marginal cost of the public good (c). This is due to the presence of what is known in the tax-competition literature as a fiscal externality. With the MRS tending to be greater than c, the fiscal externality tends to make equilibrium tax rates too low.

This externality is also present in (10), but the effect is compounded by the negative agglomeration impact of the lost capital, which depresses the productivity of individual firms. The government takes this impact into account in choosing the tax rate, and to see the effect on its choice, a closer comparison of (10) and (11) is needed.

To do so, first notice that for each jurisdiction, capital per worker in both symmetric equilibria equals $\overline{k}$. Then, to make the equilibria comparable, suppose that $\overline{g} = g(\overline{k})$. This assumption ensures that, in the symmetric equilibrium, output per worker is identical with and without agglomeration effects. Under this assumption, consider the question of whether the equilibrium with agglomeration effects could have the same value of z_i as the equilibrium without agglomeration. For this to happen, t_i has to be equal across equilibria. Under these conditions, however, it can be seen that the MRS expression in (10), which is equal to that in (11) given equality of arguments, is less than the RHS expression in (10). With the MRS less than the RHS expression in (10), the implication is that z_i is too large, suggesting that its value must be reduced relative to the value in the equilibrium with no agglomeration effects to satisfy the optimality condition for the agglomeration case. This conclusion in turn implies that underprovision of the public good is more severe in the presence of agglomeration effects.

To see this result formally, observe that

$$f''(\overline{k})g(\overline{k}) < f''(\overline{k})g(\overline{k}) + f'(\overline{k})g'(\overline{k}) < 0 \tag{12}$$

holds, which in turn implies

$$\frac{1}{f''(\overline{k})g(\overline{k}) + f'(\overline{k})g'(\overline{k})} < \frac{1}{f''(\overline{k})g(\overline{k})} < 0. \tag{13}$$

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Letting t_i^* denote the tax rate in the equilibrium without agglomeration, (13) implies

$$1 + \frac{t_i^*}{\overline{k}} \frac{1}{(f''(\overline{k})g(\overline{k}) + f'(\overline{k})g'(\overline{k}))} < 1 + \frac{t_i^*}{\overline{k}} \frac{1}{f''(\overline{k})\overline{g}}. \tag{14}$$

It follows that the denominator of (10) is smaller than the denominator of (11). Since the numerator of the term in brackets in (10) (evaluated at $k_i = \overline{k}$) exceeds one, it can be concluded that the RHS of (10) exceeds the RHS of (11). As a result, if (11) holds as an equality when $t_i = t_i^*$, (10) is not satisfied at this value of t_i, with the MRS expression less than the RHS. Therefore, the agglomeration equilibrium must have a lower t_i (and a lower z_i) than the equilibrium without agglomeration.

Summarizing the preceding discussion yields,

Proposition 1 *In the competitive case, agglomeration effects make the underprovision of the public good more severe.*

To understand the result in the proposition, recall that lost capital both shrinks the tax base and limits the gains from external increasing returns. Then, government concern about capital flight is heightened relative to the standard model. As a result, the reluctance of local governments to increase their capital tax rates is strengthened, leading to more severe underprovision of public goods than in the standard model.

4 Jurisdictions with Market Power

This section shows that the effect of agglomeration economies in the strategic model largely parallels the effect in the standard model. While this conclusion is natural, it is nevertheless useful to present the details of the analytics, which are not straightforward.

Consider now the case where strategic interaction among communities is present, with jurisdictions being large relative to the economy. Then each jurisdiction, by changing its capital tax rate, is able to affect the net of tax return to capital (ρ). Therefore, in choosing their optimal tax rates, jurisdictions take into account interjurisdictional capital flows and their effects on the net return to capital, viewing tax rates chosen by other jurisdictions as parametric. Differentiating equations (3), (4), and (6) with respect to t_i yields

$$\frac{\partial k_i}{\partial t_i} = \frac{\sum_{j \neq i} [\theta_j / (f''(k_j)g(k_j) + f'(k_j)g'(k_j))]}{(f''(k_i)g(k_i) + f'(k_i)g'(k_i)) \sum_{j=1}^{I} [\theta_j / (f''(k_j)g(k_j) + f'(k_j)g'(k_j))]} < 0, \tag{15}$$

$$\frac{\partial k_j}{\partial t_i} = -\frac{[\theta_i / (f''(k_i)g(k_i) + f'(k_i)g'(k_i))]}{(f''(k_j)g(k_j) + f'(k_j)g'(k_j)) \sum_{j=1}^{I} [\theta_j / (f''(k_j)g(k_j) + f'(k_j)g'(k_j))]} > 0 \quad \forall j \neq i, \tag{16}$$

$$\frac{\partial \rho}{\partial t_i} = -\frac{\theta_i / (f''(k_i)g(k_i) + f'(k_i)g'(k_i))}{\sum_{j=1}^{I} [\theta_j / (f''(k_j)g(k_j) + f'(k_j)g'(k_j))]} < 0, \tag{17}$$

$$\frac{\partial w_i}{\partial t_i} = [f(k_i)g'(k_i) - k_i (f''(k_i)g(k_i) + f'(k_i)g'(k_i))] \frac{\partial k_i}{\partial t_i} < 0, \tag{18}$$

An increase in the tax rate in jurisdiction i thus lowers capital's net return ρ. As before, capital relocates, flowing from jurisdiction i to other jurisdictions, and the wage falls.

Solving the maximization problem the government is facing,[4] the following optimality condition is obtained:

$$\frac{U_z(w_i + \rho\overline{k}, z_i)}{U_x(w_i + \rho\overline{k}, z_i)} = \frac{c}{1 + \frac{t_i}{k_i}\frac{\partial k_i}{\partial t_i}}\left[1 + \frac{(k_i - \overline{k})}{k_i}\frac{\partial\rho}{\partial t_i} - \frac{f(k_i)g'(k_i)}{k_i}\frac{\partial k_i}{\partial t_i}\right]. \qquad (19)$$

As was done in the competitive case, this condition is compared to the one emerging from the standard model. When there are no agglomeration effects, the optimality condition for the strategic case is

$$\frac{U_z(w_i + \rho\overline{k}, z_i)}{U_x(w_i + \rho\overline{k}, z_i)} = \frac{c}{1 + \frac{t_i}{k_i}\frac{\partial k_i}{\partial t_i}}\left[1 + \frac{(k_i - \overline{k})}{k_i}\frac{\partial\rho}{\partial t_i}\right], \qquad (20)$$

where

$$\frac{\partial k_i}{\partial t_i} = \frac{\sum_{j\neq i}[\theta_j/f''(k_j)\overline{g}]}{f''(k_i)\overline{g}\sum_{j=1}^{I}[\theta_j/f''(k_j)\overline{g}]} < 0, \qquad (21)$$

and

$$\frac{\partial\rho}{\partial t_i} = -\frac{\theta_i/f''(k_i)\overline{g}}{\sum_{j=1}^{I}[\theta_j/f''(k_j)\overline{g}]} < 0. \qquad (22)$$

Equation (20) shows that the marginal benefit differs from the marginal cost of production of the public good (c). This is due to the presence of two externalities. As in the competitive case, there is a fiscal externality. The second externality is known as a pecuniary externality.[5] This externality shows up when the jurisdictions are big enough to influence the "terms-of-trade" by changing ρ when they change their tax rates. The direction of this effect, which is captured by the second term in brackets in (20), depends on whether the jurisdiction is a net importer or net exporter of capital. When the jurisdiction is a net importer of capital (when $k_i > \overline{k}$), the community benefits from a lower value of ρ. The government then has an extra incentive to increase the tax rate, and as a result, overprovision of the public good may occur. This follows because the second term in (20) is negative when $k_i > \overline{k}$, tending to decrease the RHS expression below c. On the other hand, net-exporter jurisdictions are harmed by the lower value of ρ caused by a higher capital tax. This effect aggravates underprovision of the public good (in this case, the second term in (20) is positive, reinforcing the tendency of the RHS to exceed c).

The two externalities mentioned above are also present in the model with agglomeration effects. And, as in the competitive case, the effect of the presence of agglomeration effects shows up. This effect is captured by the third term in brackets in (19). Since that term is positive, the tendency towards underprovision is strengthened for the net exporter jurisdiction, and any tendency to overprovide the public good is weakened for the net importer jurisdiction.

In the symmetric case, where jurisdictions have the same population share ($\theta_i = 1/I, \forall i$), jurisdictions do not export or import capital ($k_i = \overline{k}, \forall i$), and the pecuniary externality vanishes

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[4]Stated in section 2.

[5]See DePater and Myers (1994).

in (19) and (20). In the absence of agglomeration effects, public goods are then underprovided in all jurisdictions, as in the competitive case ((19) then has the same form as the competitive condition (11)). With agglomeration effects, however, the third term in brackets in (19) is still present. As a result, with symmetric jurisdictions, underprovision tends to be more severe in the presence of agglomeration effects, as in the competitive case. To confirm this result, however, the denominator expressions in (19) and (20) must be compared. Notice that in the symmetric case when agglomeration effects are present,

$$\frac{\partial k_i}{\partial t_i} = \left(1 - \frac{1}{I}\right) \frac{1}{f''(\overline{k})g(\overline{k}) + f'(\overline{k})g'(\overline{k})}. \tag{23}$$

The above result differs from the case with no agglomeration effects, where

$$\frac{\partial k_i}{\partial t_i} = \left(1 - \frac{1}{I}\right) \frac{1}{f''(\overline{k})\overline{g}}. \tag{24}$$

Then since

$$\frac{1}{f''(\overline{k})g(\overline{k}) + f'(\overline{k})g'(\overline{k})} < \frac{1}{f''(\overline{k})\overline{g}} < 0, \tag{25}$$

the denominator in (19) is smaller than the denominator in (20), reinforcing the tendency towards underprovision. Summarizing the preceding discussion yields

Proposition 2 *(i) In the symmetric case, where population shares are the same in all jurisdictions, both models (with and without agglomeration effects) predict underprovision of the public good. However, the underprovision is more severe when agglomeration effects are present.*

(ii) In the asymmetric case, when population shares are different across jurisdictions, the model with agglomeration effects predicts underprovision of the public good in the jurisdiction that is a net exporter of capital, but over or underprovision may occur in the net-importer jurisdiction. These results are the same as in the standard model.

5 Conclusion

This paper analyzes tax competition in the presence of agglomeration effects. The obtained results are then compared to the results of the traditional model, without agglomeration effects.

As is well known, the presence of a fiscal externality affects the provision of the public good in the standard competitive model of tax competition. In the model with agglomeration effects, in addition to this externality, a new effect shows up. This effect reflects heightened government concern about capital flight, which depresses firm productivity by limiting external economies of scale. As a result, capital tax rates end up being lower than in the case where agglomeration effects are not present, worsening the underprovision of the public good. This conclusion holds in both the competitive and strategic versions of the model.

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