Political Competition and Leadership in Tax Competition

Rupayan Pal

Indira Gandhi Institute of Development Research, Mumbai (India)

Ajay Sharma[1]

Indian Institute of Management, Indore (India)

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Abstract

This paper analyzes the issue of political delegation in the context of international tax competition for foreign-owned mobile capital. Considering heterogeneous preferences over public goods in countries, it shows that political delegation occurs only in the follower country, but not in the leader country, under sequential tax competition. In contrast, both countries delegate policymaking in the case of simultaneous move tax competition. It also shows that the intensity of tax competition depends on citizens' preferences over public goods. Moreover, political competition in countries does not necessarily lead to higher tax rates.

Keywords: Political delegation, Public good, foreign-owned mobile capital, Sequential tax competition, Simultaneous tax competition

JEL Code: F21, H25, D70, H42, R50

[1] **Corresponding Address:** Ajay Sharma, Indian Institute of Management Indore, Prabandh Shikhar, Rau-Pithampur Road, Indore, M.P. (India) - 453556. Ph: +91-7312439622. E-mail: ajays@iimidr.ac.in; ajaysharma87@gmail.com

1. Introduction

The issue of international tax competition for foreign-owned mobile capital has received considerable attention in the literature. Standard models of horizontal tax competition predict counties engage themselves in ‘race to the bottom’ and, thus, end up with lower tax rates and under provision of public goods in equilibrium (Wilson, 1999). However, empirical evidence seems to contradict such predictions (Marceau et al, 2010). Several attempts have been made to explain this contradiction. For example, Janeba and Peters (1999) and Marceau et al (2010) argue that, if countries differ in terms of size and endowment of immobile capital, competition for mobile capital does not lead to lower tax rate in all the countries involved. On the other hand, Kempf and Rota-Graziosi (2010) show that the equilibrium tax rates are higher under sequential tax competition compared with that under simultaneous tax competition, even in the case of symmetric countries. These studies implicitly assume homogenous preferences over public goods and, thus, sidestep issues related to intraregional political competition and policymaking process.

There is another strand of literature that attempts to analyze the equilibrium outcomes of tax competition by considering heterogeneous consumers and political competition. For example, Persson and Tabellini (1992) demonstrate that in the presence of representative democracies each region’s median voter appoints a policy maker who prefers higher tax rate than that of the median voter, if capital endowments of citizens of a region are different from each other. In other words, political delegation takes place in each region due to tax competition and, thus, harmful race-to-the-bottom in tax rates is restricted.[2] Considering alternative scenarios, Brueckner (2001) and Ihori and Yang (2009) argue that this result is quite robust.[3] However, these studies assume that the policy makers simultaneously and independently decide the tax rates of their respective regions. The issue of timing of move in tax competition remains neglected in this body

[2] Osborne and Slivinski (1996) and Besley and Coate (1997) emphasize the role of political competition on policy making in the case of representative democracy.

[3] Fuest and Huber (2001) consider capital and labour tax as well as political competition. We note here that these papers also deal with the issue of tax coordination, which is beyond the scope of the present paper. Other papers in this stream of literature do not consider representative democracy. Rauscher (1998) and Edwards and Keen (1996) consider that governments are concerned about size of public sector as in “Leviathan models”, Wilson (2005) assume self interested bureaucrats decide the public expenditure policy while electorates decide the tax policy, and Perroni and Scharf (2001) assume direct democracy in competing regions.

of literature, even though sequential move tax competition is often observed in real life (Altshuler and Goodspeed, 2002). Therefore, it seems to be important to answer the following questions. Does timing of move in tax competition affect the prospect of political delegation? How does the equilibrium look like in the case of intraregional political competition and interregional sequential move tax competition? Is it possible to avoid race-to-the-bottom in tax rates under sequential move tax competition in the presence of heterogeneous consumers? To the best of our knowledge, these questions have not received much attention in the literature so far. This paper attempts to fill this gap.

Considering that individuals have heterogeneous preferences for public goods, as in Brueckner (2001), in this paper we develop a model of sequential move tax competition for mobile capital between two otherwise identical regions. However, unlike Brueckner (2001), we consider that capital is completely foreign owned. There are two stages of the game involved. In the first stage, in each region a policy maker is selected through political competition, which is guided by majority voting rule. In the second stage, policy makers of the two regions sequentially decide their respective tax rates. We characterize the equilibrium of this game and compare that with the equilibrium under simultaneous move tax competition.

We show that the follower region's voters delegate the task to decide its tax rate on capital to a candidate whose preference for public good is stronger than that of the median voter, as in the case of simultaneous move game. In contrast, no such political delegation takes place in the leader region, in which the median voter herself decides the tax rate. These are new results. The intuition behind this result is as follows. In the first stage, the median voters of both the region anticipate that, for any given tax rate of the leader region, the follower region has the incentive to set a lower tax rate in the second stage. However, if the follower region can credibly covey to the leader region that it would prefer not to engage in tax undercutting, which is possible only by delegating the task to decide the tax rate to a policy maker with stronger preference for public goods than that of the median voter, the leader region would set a higher tax rate compared to that in the case of no delegation in the follower region. That is, by making political delegation in the first stage the follower region can induce the leader region not to engage in race-to-the-bottom. On the other hand, the leader region being at a disadvantageous position, since it needs to set the tax rate first, does not have any incentive to set a tax rate that is higher than its median voter's preferred tax rate. Moreover, the leader region also recognizes that it is harmful to set a tax rate that is lower than the median voter's preferred rate, since that would induce the follower region to set a lower tax rate. As result, no political delegation takes place in the leader region, unlike as in the follower region or in the case of simultaneous move tax competition. Clearly, timings of moves in tax competition have implications to political competition, which, in turn, affect the equilibrium tax rates.

The rest of the paper is organized as follows. Section 2 presents basic framework of the model. The benchmark case is analyzed in Section 3. Section 4 analyzes the implications of timing of move in tax competition. Section 5 concludes.

2. Basic Framework

Let us consider that there are two symmetric regions, region 1 and region 2, competing for foreign owned mobile capital in terms of tax rates. Each of the two regions provides local public goods, which is fully financed by tax revenue collected from mobile capital. We also assume that each of the two regions is inhabited by N individuals/voters. There are two factors of production: labour and capital. Labour is considered to be immobile, while capital is considered to be mobile.

For simplicity, we consider that each region has a fixed endowment of labour, which is normalized to be one: L=1. Moreover, each individual is endowed with equal amount of labour. That is, a typical individual has $\theta = \frac{1}{N}$ amount of labour. Total amount of available capital is assumed to be X, which is allocated between the two regions through a perfectly competitive capital market.

The production function of the representative firm of region i is assumed to be given by $y = F(X_i, L_i)$, , i = 1, 2, where X_i is the amount of capital allocated to region i and $L_i = 1$, assuming full employment in each region. We can write this production function in an intensive form as $y = f(x_i)$, where $x_i = \frac{X_i}{L_i} = X_i$, $f'(x_i) > 0$, $f''(x_i) < 0$, $f'''(x_i) \geq 0$ and $f'''(x_i) = f'''(x_j)$, as in Laussel and Le Burton (1998).

Capital allocation: It is evident that allocation of capital between the two regions depends on productivity of capital as well as on tax rates. Since capital market is assumed to be perfectly competitive, capital is paid according to its marginal productivity. So, if x_i amount of capital is allocated in region *i*, the net return from the last unit of capital invested in region *i* is $[f^{'}(x_i) - t_i]$, where t_i is the tax rate in region *i*.[4] Clearly, to rule out the possibility of arbitrage, we must have $[f^{'}(x_i) - t_i] = [f^{'}(x_j) - t_j]$; $i, j = 1, 2$; $i \neq j$. We consider that available mobile capital is fully allocated between the two regions ($x_1 + x_2 = x = X$) and net return from the last unit of investment is positive ($[f^{'}(x_i) - t_i] > 0, \forall i = 1, 2$). Therefore, for any t_1, t_2, the arbitrage proof allocation of mobile capital between the two regions is given by,

$$f^{'}(x_1) - t_1 = f^{'}(x_2) - t_2 > 0 \qquad (1a)$$

$$x_1 + x_2 = x \qquad (1b)$$

From (1a) and (1b), we get the equilibrium allocation of capital, given the tax rates, between the two regions as follows. $x_1 = x_1(t_1, t_2)$, $x_2 = x_2(t_1, t_2)$. Also, (1a) and (1b) implies the following.

$$\frac{\partial x_i}{\partial t_i} = \frac{1}{f^{''}(x_i) + f^{''}(x_j)} = -\frac{\partial x_i}{\partial t_j} < 0, \qquad (2a)$$

$$\frac{\partial^2 x_i}{\partial {t_i}^2} = \frac{-\left(f^{'''}(x_i) - f^{'''}(x_j)\right)\frac{\partial x_i}{\partial t_i}}{\left(f^{''}(x_i) + f^{''}(x_j)\right)^2} = 0 \qquad (2b)$$

$$\text{and } \frac{\partial^2 x_i}{\partial t_j t_i} = \frac{\left(f^{'''}(x_i) - f^{'''}(x_j)\right)\frac{\partial x_i}{\partial t_i}}{\left(f^{''}(x_i) + f^{''}(x_j)\right)^2} = 0, \qquad (2c)$$

where $i, j = 1, 2$, $i \neq j$; since $f^{''}(x_i) < 0$ and $f^{'''}(x_i) = f^{'''}(x_j)$. Condition (2a) implies that the amount of capital in region i is decreasing in its own tax rate, but increasing in its rival region's tax rate. Conditions (2b) and (2c) indicates that the rate of decrease in amount of capital in any region due to increase in that region's tax rate is not affected by any of the two regions tax rate. To ensure existence of interior

[4] Price of good *y* is assumed to be one.

solution, we assume that the elasticity of capital allocation to a region with respect to that region's tax rate (η_i) is less than one:

$$\eta_i = -\frac{t_i}{x_i}\frac{\partial x_i}{\partial t_i} < 1, \qquad i = 1,2. \tag{2d}$$

Individuals' (citizens') characteristics: We consider that the utility function of a typical individual *n* of region *i* is as follows.

$$U^{n,i}(c_{n,i}, g_i) = c_{n,i} + \alpha_{n,i} v(g_i), \tag{3}$$

where $c_{n,i}$ is the amount of private good consumed by individual *n* of region *i*, g_i is the amount of public good available in region i, $\alpha_{n,i}$ (> 0) represents the preference of that individual for public good and $v'(g_i) > 0 > v''(g_i)$, $i = 1,2,\ n = 1,2,\dots,N$. Clearly, higher value of $\alpha_{n,i}$ indicates stronger preference for public good, and each individual has singled peaked preference for public good.[5] We assume that distribution of α_n is symmetric across regions, which implies that $\alpha_{n,i} = \alpha_{n,j} = \alpha_n$. The median of the distribution of α_n is assumed to be β. That is, each region's median voter's preference for public good is represented by β.

For simplicity, we assume that the measure of relative risk aversion with respect to public good consumption is less that one.

$$-\frac{g_i\, v''(g_i)}{v'(g_i)} < 1, \qquad i = 1,2 \tag{4}$$

Condition (4) implies that, due to increase in public good, marginal utility of public good decreases less than proportionately than the increase in public good. In simple terms, marginal utility of public good decreases slowly. Needless to mention that, a fairly large set of utility functions satisfy this property.

Now, note that, if x_i amount of mobile capital is invested in region i, gross returns to the owners of mobile capital from investment in region *i* is $[x_i f'(x_i)]$, since capital is paid according to its marginal productivity. And, the total wage bill paid to region *i* is $[f(x_i) - x_i f'(x_i)]$. Since capital is foreign owned, each individual supplies $\theta = \frac{1}{N}$

[5] We demonstrate it in the following section.

amount of labour and in each region public good is provided by the government, we can write the budget constraint of a typical individual *n* of region *i* as follows.

$$c_{n,i} = \theta[f(x_i) - x_i f'(x_i)],\ i = 1, 2 \tag{5}$$

Governments' budget constraints: Since public good is fully financed by the tax revenue, the budget constraint of the government of region *i* can be written as,

$$g_i = t_i x_i,\ i = 1, 2. \tag{6}$$

Note that, from (1a), (1b), (3), (4), and (5), we can write the utility function of a typical individual *n* of region *i* is as follows.

$$U^{n,i}(t_i, t_j) = \theta\, c_{n,i}(t_i, t_j) + \alpha_{n,i}\, v(t_i, t_j)$$

$$= \theta\left[f\left(x_i(t_i, t_j)\right) - x_i(t_i, t_j)\, f'\left(x_i(t_i, t_j)\right)\right] + \alpha_{n,i} v\left(t_i\, x_i(t_i, t_j)\right), \tag{7}$$

where $x_i(t_i, t_j)$ is obtained by solving (1a) and (1b); $i, j = 1, 2$. To keep the analysis tractable, we assume that the utility function $U^{n,i}(t_i, t_j)$ is concave in (t_i, t_j); $i, j = 1,2$.

***Lemma 1**: Utility of public good increases at a decreasing rate due to increase in own tax rate, and the positive effect of increase in own tax rate on utility of public good is increasing in rival region's tax rate:* $\frac{\partial[\alpha_{n,i}\, v(g_i)]}{\partial t_i} > 0$, $\frac{\partial^2[\alpha_{n,i}\, v(g_i)]}{\partial t_i^2} < 0$ *and* $\frac{\partial^2[\alpha_{n,i}\, v(g_i)]}{\partial t_j \partial t_i} > 0\ \forall\ i, j = 1, 2; i \neq j.$

Proof: See Appendix A1.

Political setup and voting mechanism: We consider that there is representative democracy in each of the two regions. First, in each region, the representative of citizens, i.e., the policy maker, is determined through political competition guided by the majority voting rule, as in Osborne and Slivinski (1996) and Besley and Coate (1997). Next, the policy makers of the two regions decide tax rates.

We assume that there is no cost attached to contest in election and, thus, each individual is a possible candidate. The winner (policy maker) in the political competition is elected by the majority voting rule. Moreover, individuals' preferences over tax rates are assumed to be single peaked.[6] That is, an individual prefers a particular tax rate the most, and her utility is decreasing in absolute difference between that tax rate and the actual tax rate. Therefore, by the median voter theorem, the median voter of a region decides the policy maker of that region.[7] In other words, if we use Condorcet rule for selection of the representative, the equilibrium coincides with the median voter.[8]

Note that the median voter of a region herself need not necessarily be the policy maker of that region. Following the tradition of existing literature, if the policy maker is someone different from the median voter, we say that there is political delegation. On the other hand, we say that there is no political delegation, if median voter herself is the policy maker. Nevertheless, in the case of political delegation, the median voter selects such a policy maker whose optimum policy maximizes the objective of the median voter, since the policy maker must have the support of the majority.

To illustrate it further, note that according to the public choice and voting literature, if the preferences of the voters are single peaked in the choice of policy variable, there is always a unique equilibrium policy choice which coincides with the median voter's choice. In the present context, we define the single peaked property and the median voter theorem as follows.

Definition 1[9]: Given any tax rate of region j, t_j*, a tax rate* t_i^* *is the most preferred tax rate of voter n in region i, iff* $U^{n,i}(t_i^*,\ t_j) > U^{n,i}(t_i,\ t_j)$ *for all* $t_i \neq t_i^*,\ i,j = 1,2.$ *n=1, 2, …N.*

Definition 2[10]: Let t_i'*and* t_i''*are any two tax rates among the possible tax rates for region i, such that either* $t_i', t_i'' \leq t_i^*$ *or* $t_i', t_i'' \geq t_i^*$*. Then voter's preferences are single peaked if and only if* $[U^{n,i}(t_i',\ t_j) > U^{n,i}(t_i'',\ t_j)] \leftrightarrow [|t_i' - t_i^*| < |t_i'' - t_i^*|];\ \ i,j = 1,2; n = 1,2,\ldots N.$

[6] The policy preference of a voter is said to be single peaked, if his preference ordering for alternative choices is dictated by their relative distance from his\her bliss point (Persson and Tabellini, 2000).

[7]If the individual voters have single peaked preferences over a given ordering of the policy alternatives, a Condorcet winner always exists and coincides with the median voter's policy choice. See, Persson and Tabellini (2000) for an excellent discussion on voting mechanism and median voter theorem.

[8] Since, in our setup, individuals' preferences are single peaked and the well known median voter theorem is applicable, we do not describe the voting mechanism in this paper.

[9], Dennis Mueller (2003)

[10] Dennis Mueller (2003)

That is, given any two tax rates on the either side of the optimal (ideal) tax rate, a voter prefers one tax rate over the other only if the first tax rate is nearer to the her ideal tax rate compared to the second tax rate. Clearly, if the individuals' utility functions are concave in tax rate, their preferences are single peaked in terms of tax rate. Since, $U^{n,i}(t_i, t_j)$ is assumed to be concave in (t_i, t_j), for all *i, j = 1,2* and *n=1,2,...N*, individual preferences are single peaked in terms of tax rate. Therefore, the median voter theorem, as stated below, holds true in the present context.

Theorem[11]*: If tax rate* (t) *is a single dimensional choice and all the voters have single peaked preferences defined over tax rate, the selection of the median voter cannot lose under majority voting rule.*

Proof: See Appendix A2.

3. Simultaneous move tax competition: Benchmark case

In this section, we consider that the policy makers of the two regions are engaged in simultaneous move tax competition. The stages of the game involved are as follows.

Stage 1: Policy makers of the two regions are elected through political competition, guided by majority voting rule, in the two regions. In other words, each region's median voter decides whether to delegate the task to determine its tax rate or not.

Stage 2: Policy makers of the two regions decide their respective tax rates simultaneously and independently.

Stage 3: Owners of mobile capital decide the allocation of capital between the two regions.

We note here that Brueckner (2001) also consider a similar setup. In this section, we characterize the equilibrium of this game. Since our primary interest is to examine the implications of timing of move in tax competition, it is important to present the results corresponding to simultaneous move tax competition in order to alienate the effects of timing of move.

[11] Dennis Mueller (2003)

We solve the game using standard backward induction method, starting from Stage 3. Note that, in Stage 3, allocation of capital between the two regions is determined by condition (1a) and (1b), irrespective of the nature of tax competition (simultaneous or sequential) and outcome of Stage 1. Moreover, conditions (2a)-(2d) always hold true, irrespective of timing of move in tax competition.

Now, in Stage 2, the problem of the policy maker of region *i*, denoted by (*p*,*i*), can be written as follows.

$$\underset{t_i}{Max}\ U^{p,i}(t_i, t_j) = \theta\, c_{p,i}(t_i, t_j) + \alpha_{p,i}\, v(t_i, t_j), \tag{8}$$

Where expressions for $c_{p,i}(t_i, t_j)$ and $v(t_i, t_j)$ are as in (7) corresponding to $n = p$; $\forall\, i, j = 1, 2;\ i \neq j$.

The first order condition of problem (8) can be written as,

$$\frac{\partial\, U^{p,i}(t_i, t_j)}{\partial t_i} = \theta\left[-x_i f''(x_i)\frac{\partial x_i}{\partial t_i}\right] + \alpha_{pi} v'(g_i)\left[t_i\frac{\partial x_i}{\partial t_i} + x_i\right] = 0 \tag{9a}$$

The second order condition of maximization is satisfied, since *U* (.) is assumed to be concave. Therefore, the tax reaction functions of the two policy makers are given by (9a).

Lemma 2*: The slope of the tax reaction function of the region j's policy maker, in* $t_i - t_j$ *plane, is less than one :* $\left.\frac{\partial t_j}{\partial t_i}\right|_{p,j} < 1,\ i, j = 1, 2,\ i \neq j.$

Proof: See Appendix A3.

Lemma 2 implies that the slope of the region *i*'s policy maker in $t_i - t_j$ plane, is greater than one, $\left.\frac{\partial t_j}{\partial t_i}\right|_{p,i} > 1$, since by Lemma 2 $\left.\frac{\partial t_i}{\partial t_j}\right|_{p,i} < 1$.

Now, note that

$$\frac{\partial^2\, U^{p,j}(t_i, t_j)}{\partial t_i \partial t_j} = \left\{\theta\left[x_j\, f'''(x_j) + f''(x_j)\right]\left(\frac{\partial x_j}{\partial t_j}\right)^2\right\}$$

$$+\{\alpha_{p,j}\left[v'(g_j) + v''(g_j)g_j(1-\eta_j)\right]\frac{\partial x_j}{\partial t_i}\},\ \ i, j = 1, 2,\ i \neq j,$$ which can be positive or negative, depending on the nature of the functional forms considered.

Because, though the second term is positive (by Lemma 1), the sign of the first term is ambiguous. Therefore, for $\frac{\partial^2\, U^{p,j}(t_i, t_j)}{\partial t_i \partial t_j}$ to be negative, the first term must be negative and its magnitude must be greater than the magnitude of the second term. Otherwise, $\frac{\partial^2\, U^{p,j}(t_i, t_j)}{\partial t_i \partial t_j}$ is positive. In other words, marginal effect of own tax rate on utility of a policy maker increases due to increase in the rival region's tax rate, i.e. tax rates are strategic complements, if $\frac{\partial^2[\theta\, c_{p,j}\,(.)]}{\partial t_i\ \partial t_j} > 0$ or $\left|\frac{\partial^2[\theta\, c_{p,j}\,(.)]}{\partial t_i\ \partial t_j}\right| < \left|\frac{\partial^2[\alpha_{p,j}\, v(g_j)]}{\partial t_i\ \partial t_j}\right|$. Otherwise, tax rates are strategic substitutes. We summarize these results in Lemma 3.

Lemma 3*: Tax rates can be either strategic substitutes or strategic complements. If* $\frac{\partial^2[\theta\, c_{p,j}\,(.)]}{\partial t_i\ \partial t_j} > 0$ or $\left|\frac{\partial^2[\theta\, c_{p,j}\,(.)]}{\partial t_i\ \partial t_j}\right| < \left|\frac{\partial^2[\alpha_{p,j}\, v(g_j)]}{\partial t_i\ \partial t_j}\right|$*, tax rates are strategic complements. Alternatively, if* $\frac{\partial^2[\theta\, c_{p,j}\,(.)]}{\partial t_i\ \partial t_j} < 0$ and $\left|\frac{\partial^2[\theta\, c_{p,j}\,(.)]}{\partial t_i\ \partial t_j}\right| > \left|\frac{\partial^2[\alpha_{p,j}\, v(g_j)]}{\partial t_i\ \partial t_j}\right|$*, tax rates are strategic substitutes.*

It is straight forward to check that, if tax rates are strategic complements (substitutes), tax reaction functions are positively (negatively) sloped. That is, when tax rates are strategic complements (substitutes), it is optimal for a region to reduce (increase) its tax rate, if there is a decrease in its rival region's tax rate. We note here that exiting studies on tax competition either undermines the case for tax rates to be strategic substitutes or such possibilities does not arise due to the choice of specific objective functions of the government. To illustrate it further, for example, if $\alpha_{p,j} = \theta$ and $v(g_j) = g_j$ $(j = 1, 2)$, we get $\frac{\partial^2\, U^{p,j}(t_i, t_j)}{\partial t_i \partial t_j} > 0\ \forall i, j = 1, 2;\ i \neq j$. That is, if each individual has same preference for public good, utility function is linear in both public and private good and individuals prefer public good and private good equally, as in Kempf and Rota-Graziosi (2010), tax rates are strategic complements. This is because, we can write $\frac{\partial\, U^{p,j}(t_i, t_j)}{\partial t_j} = \theta\left[x_j f''(x_i) + t_j\right]\frac{\partial x_j}{\partial t_j} + [\alpha_{p,j} v'(t_j x_j) - \theta][x_j + t_j \frac{\partial x_j}{\partial t_j}]$ and, thus, $\frac{\partial^2\, U^{p,j}(t_i, t_j)}{\partial t_i \partial t_j} = \left\{\theta\left[x_j f'''(x_i) - f''(x_i)\right]\frac{\partial x_j}{\partial t_j}\frac{\partial x_i}{\partial t_i}\right\} + \{\alpha_{p,j}[v'\left(t_j x_j\right) + v''(t_j x_j) t_j x_j (1 - \eta_j) - \frac{\theta}{\alpha_{p,j}}\right]\frac{\partial x_j}{\partial t_i}\}$, where the first term is always positive and the second term becomes zero when $\alpha_{p,j} =$

θ and $v(g_j) = g_j$. Therefore, if $\alpha_{p,j} = \theta$ and $v(g_j) = g_j$, $\frac{\partial^2 U^{p,j}(t_i, t_j)}{\partial t_i \partial t_j} > 0$, as in Lemma 2 in Kempf and Rota-Graziosi (2010). However, if $\alpha_{p,j} \neq \theta$ or $v(g_j)$ is not linear in its argument, we may have strategic substitute tax rates.

For simplicity, we assume that tax rates are strategic complements in the remaining part of the analysis. It is easy to check that, in the case of strategic complements, tax reaction functions are positively sloped, since $\left.\frac{\partial t_j}{\partial t_i}\right|_{p,j} = -\frac{\partial^2 U^{p,j}(t_i, t_j)}{\partial t_i \partial t_j} / \frac{\partial^2 U^{p,j}(t_i, t_j)}{\partial {t_j}^2}$ and the denominator is assumed to be negative.

Assumption: Tax rates are strategic complements and, thus, tax reaction functions of the two regions' policy makers are positively sloped: $\left.\frac{\partial t_j}{\partial t_i}\right|_{p,j} > 0,\ i, j = 1, 2,\ i \neq j.$

Now, note that equation (9a) implies that $\theta[f''(x_i)\frac{\partial x_i}{\partial t_i}] = \alpha_{pi} v'(g_i)[1 - \eta_i]$, where $\eta_i = -\frac{t_i}{x_i}\frac{\partial x_i}{\partial t_i} < 1$, by (2d). Rearranging the terms, we can write the implicit form of the tax reaction function of the policy maker of region *i*, given by (9a), as follows.

$$\frac{1}{v'(g_i)} = \frac{\alpha_{p,i}[1 - \eta_i]}{\theta[f''(x_i)\frac{\partial x_i}{\partial t_i}]}, \qquad i, j = 1, 2 \qquad (9b)$$

The second order condition of maximization is satisfied, since U (.) is assumed to be concave. Solving the above two equations, given by (9b), we get the stage 2 equilibrium tax rates t_1^S and t_2^S, where the superscript denotes simultaneous move tax competition:

$$t_1^S = t_1^S(\alpha_{p,1},\ \alpha_{p,2}) \qquad (10a)$$

$$t_2^S = t_2^S(\alpha_{p,1},\ \alpha_{p,2}) \qquad (10b)$$

Before moving to Stage 1 of the game, let us examine the effects of policy makers' preferences for public good ($\alpha_{p,i}$'s) on equilibrium tax rates. Since public good is financed by tax revenue collected, stronger preference for public good of the policy maker induces the policy maker to ensure higher tax revenue. Also, note that tax revenue of a region is increasing in that region's tax rate: $\frac{\partial\,(t_i x_i)}{\partial t_i} = t_i \frac{\partial\, x_i}{\partial t_i} + x_i = x_i(1 - \eta_i) > 0$, since $\eta_i < 1$ (by (2d)). Therefore, it seems that a policy maker would set a higher tax rate, if he has stronger preference for public good. And, since tax rates are assumed to be strategic complements, increase in preference for public good of a policy maker would induce his rival to set higher tax rate too.

Proposition 1*: In the case of simultaneous move tax competition, degree of preference for public good of a policy maker has positive impact on tax rate of both the regions:* $\frac{\partial t_i^S}{\partial \alpha_{p,i}} > 0$ *and* $\frac{\partial t_j^S}{\partial \alpha_{p,i}} > 0,\ i,j = 1,2$. *Moreover, increases in tax rate of a region, due to increase in preference of the policy maker of that region, is more than the corresponding increase in rival region's tax rate:* $\frac{\partial t_1^S}{\partial \alpha_{p,1}} > \frac{\partial t_2^S}{\partial \alpha_{p,1}}$.

Proof: See Appendix A4.

Finally, we turn to analyse the equilibrium choice of policy makers in the two regions in Stage 1. In particular, we are interested to examine whether the median voter delegates the task of tax determination or not. Note that, in stage 1, the decisive median voter of a region selects the policymaker so that her own utility is maximized. In other words, in Stage 1, the median voters of the two regions decide whether to delegate the task of tax determination or not, simultaneously and independently.

In Stage 1, the problem of the median voter of region *i* can be written as follows.

$$\underset{\alpha_{p,i}}{Max}\ U^{\beta,i}\left(t_i^S, t_j^S\right) = \theta\ c_{\beta,i}\left(t_i^S, t_j^S\right) + \ \beta\ v\left(t_i^S, t_j^S\right) \tag{11}$$

$$= \ \theta\left[f\left(x_i\left(t_i^S, t_j^S\right)\right) - x_i\left(t_i^S, t_j^S\right) f'\left(x_i\left(t_i^S, t_j^S\right)\right)\right] + \beta\ v\left(t_i^S\ x_i\left(t_i^S, t_j^S\right)\right),$$

where t_i^S and t_j^S are given by (10a) and (10b), and $x_i\left(t_i^S, t_j^S\right)$ is obtained by substituting the expressions for t_i^S and t_j^S to solution of (1a) and (1b).

The first order condition of the above problem yields the following.

$$\frac{1}{v'(g_i)} = \frac{\beta[1 - \eta_i \varphi]}{\theta[f''(x_i)\dfrac{\partial x_i}{\partial t_i}]\varphi}, \qquad i,j = 1,2, \tag{12}$$

where $\varphi = (\frac{\partial t_i^S}{\partial \alpha_{p,i}} - \frac{\partial t_j^S}{\partial \alpha_{p,i}})/\frac{\partial t_i^S}{\partial \alpha_{p,i}}$. Clearly, $0 < \varphi < 1$, since $0 < \frac{\partial t_j^S}{\partial \alpha_{p,i}} < \frac{\partial t_i^S}{\partial \alpha_{p,i}}$ by Proposition 1. Note that both η_i and φ functions of $\alpha_{p,i}$ and $\alpha_{p,j}$.

We get the region i's median voter's desired public good preference parameter ($\alpha_{p,i}$) from (12).[12] However, it appears to be cumbersome to express $\alpha_{p,i}$ in terms of β (or β in terms of $\alpha_{p,i}$), in order to gauge the relative magnitudes of β and $\alpha_{p,i}$, directly from (12). However, note that both (9b) and (12) should be satisfied in equilibrium. Now, from (9b) and (12), we get the following.

$$\frac{1}{v'(g_i)} = \frac{\alpha_{p,i}[1-\eta_i]}{\theta[f''(x_i)\frac{\partial x_i}{\partial t_i}]} = \frac{\beta[1-\eta_i\varphi]}{\theta[f''(x_i)\frac{\partial x_i}{\partial t_i}]\varphi} \tag{13}$$

Clearly, in equilibrium, marginal rate of substitution between the public good and the private good remains the same in Stage 1 and Stage 2 of the game. From equation (13), it is straightforward to observe that $\alpha_{p,i} > \beta$, since $0 < \varphi < 1,\ i = 1,2$. That is, it is optimal for the median voter of region i (=1, 2) to delegate the task to determine the tax rate on her behalf to a policy maker, who has stronger preference for public good than the median voter. And, since the two regions are symmetric and tax rates are chosen simultaneously, we can say that in equilibrium elected policy maker of both the regions will have the same preference for public good: $\alpha^*_{p,1} = \alpha^*_{p,2} > \beta$. We summarize this result in the following Proposition.

Proposition 2*: In equilibrium, political delegation takes place in both the regions, when there is simultaneous move tax competition for foreign owned mobile capital. The policy maker of each region has higher preference for public good than that of the median voter.*

From Proposition 1 and Proposition 2, it is evident that the equilibrium tax rates of both the regions are higher than that in the case of no delegation. Therefore, through political delegation, competing regions can effectively restrict the harmful race-to-the-bottom in tax rates, in the case of simultaneous move tax competition. These results are in line with the findings of the existing literature.

4. Sequential move tax competition

[12] Second order condition of the maximization problem (11) is satisfied.

We now turn to examine the implications of the timing of move in tax competition on political delegation. In order to do so, in this section, we first characterize the equilibrium corresponding to sequential move tax competition between the two regions. Since the two regions are symmetric, without any loss of generality we assume that region 1 is the leader and region 2 is the follower in tax competition. In this case, the stages of the game involved are as follows.

Stage 1: Policy makers of the two regions are elected through political competition, guided by majority voting rule, in the two regions. In other words, each region's median voter decides whether to delegate the task to determine its tax rate or not.

Stage 2: Policy maker of region 1 (the leader) decides its tax rate.

Stage 3: Policy maker of region 2 (the follower) decides its tax rate, given the tax rate of region 1.

Stage 4: Owners of mobile capital decide the allocation of capital between the two regions.

We use backward induction method to solve this game, starting with stage 4. In Stage 4, the capital allocation is the same as was decided from equation $1(a)$ and $1(b)$, assuming the public good reference parameter and the tax rates of the leader and the follower region as given.

Moving up to Stage 3, we consider the problem of region 2 (follower), assuming region 1's tax rate and public good preference parameters are given. The problem of region 2 is same as in equation (8),

$$\underset{t_2}{Max}\ U^{p,2}(t_2,t_1) = \theta\, c_{p,2}(t_2,t_1) + \alpha_{p,2}\, v(t_2,t_1), \tag{14}$$

The first order condition for region 2 (follower) is as follows:

$$\frac{\partial\, U^{p,2}(t_2,t_1)}{\partial t_2} = \theta\left[-x_2 f''(x_2)\frac{\partial x_2}{\partial t_2}\right] + \alpha_{p,2} v'(g_2)\left[t_2\frac{\partial x_2}{\partial t_2} + x_2\right] = 0 \tag{15a}$$

On simplifying and rearranging the terms we get,

$$\frac{1}{v'(g_2)} = \frac{\alpha_{p,2}[1-\eta_2]}{\theta[f''(x_2)\frac{\partial x_2}{\partial t_2}]} \tag{15b}$$

The second order condition is satisfied due to concave $U(.)$ assumption. We get the tax reaction function of region 2 from $(15a)$.We can write the reaction function of region 2 as,

$$t_2 \ = t_2 \left(t_1^L,\ \alpha_{p,2}\right) \qquad (16)$$

Region 2's tax rate is a function of the public good preference parameters and region 1's tax rate.

Next, we consider the problem of region 1 in Stage 2. Region 1 decides its tax rate by taking into account the strategic effect on region 2's tax rate. In the leadership games, we assume that the leader knows the reaction function of the follower region and incorporates this information in his problem.

$$\underset{t_1}{Max}\ U^{p,1}(t_1,t_2) = \theta\ c_{p,1}(t_1,t_2) + \ \alpha_{p,1}\ v(t_1,t_2) \qquad (17)$$

Subject to the constraint $t_2 \ = t_2 \left(t_1^L,\ \alpha_{p,2}\right)$, as in (16).

The first order condition for region 1 is,

$$\frac{\partial\ U^{p,1}(t_1,t_2)}{\partial t_1} = \theta\left[-x_1 f''(x_2)\frac{\partial x_1}{\partial t_1}\left(1-\frac{\partial t_2}{\partial t_1}\right)\right] + \ \alpha_{p,1} v'(g_1)\left[t_1\frac{\partial x_1}{\partial t_1}\left(1-\frac{\partial t_2}{\partial t_1}\right)+x_1\right]$$
$$= \ 0, \qquad (18a)$$

where $\frac{\partial t_2}{\partial t_1} < 1$, by Lemma 2. Now, rearranging the terms of (18a), we can write

$$\frac{1}{v'(g_1)} = \frac{\alpha_{p,1}[1-\eta_1\left(1-\frac{\partial t_2}{\partial t_1}\right)]}{\theta[f''(x_1)\frac{\partial x_1}{\partial t_1}][1-\frac{\partial t_2}{\partial t_1}]}\ . \qquad (18b)$$

From (18b), we get the optimal tax rate of region 1's policy maker:

$$t_1^L = t_1^L\left(\alpha_{p,1},\ \alpha_{p,2}\right) \qquad (19a)$$

Substituting equation (19), in (16), we also get the optimal tax rate chosen by region 2:

$$t_2^F = t_2^F\left(\alpha_{p,1},\ \alpha_{p,2}\right) \qquad (19b)$$

The properties of the tax rates, as given by (19a) and (19b), are the same as in the case of simultaneous move tax competition, only the magnitude of the outcomes have changed. As in Proposition 1, it is easy to check that both the tax rates are increasing function of $\alpha_{p,1}$ and $\alpha_{p,2}$, i.e. public good preference parameters have tax increasing effect. Moreover, it can be checked that, if there is an increase in the region i' s policy maker's preference for public good $(\alpha_{p,i})$, increment in region *i*'s tax rate would be higher than the increment of the region *j*'s tax rate, as in the case of simultaneous move tax competition.

Finally, we turn to Stage 1, i.e., to the political competition in the two regions. In this stage, the median voter decides such a policy maker to set tax rates, who maximizes the median voter's utility. Here, we are interested to examine whether the median voter delegates the policy making or not.

Now, in Stage 1, the problem of the median voter of region *i* (leader) can be written as follows.

$$\underset{\alpha_{p,i}}{Max}\ U^{\beta,i}\left(t_i^L, t_j^F\right) = \theta\, c_{\beta,i}\left(t_i^L, t_j^F\right) + \beta\, v\left(t_i^L, t_j^F\right) \tag{20}$$

$$= \theta\left[f\left(x_i\left(t_i^L, t_j^F\right)\right) - x_i\left(t_i^L, t_j^F\right) f'\left(x_i\left(t_i^L, t_j^F\right)\right)\right] + \beta\, v\left(t_i^L\, x_i\left(t_i^L, t_j^F\right)\right)$$

The first order condition of this problem can be written as,

$$\frac{1}{v'(g_i)} = \frac{\beta[1-\eta_i\varphi]}{\theta[f''(x_i)\frac{\partial x_i}{\partial t_i}]\varphi}, \qquad i,j = 1,2, \tag{21}$$

where $\varphi = (\frac{\partial t_i^L}{\partial \alpha_{p,i}} - \frac{\partial t_j^F}{\partial \alpha_{p,i}})/\frac{\partial t_i^L}{\partial \alpha_{p,i}}$. Clearly, $0 < \varphi < 1$, since $0 < \frac{\partial t_j^F}{\partial \alpha_{p,i}} < \frac{\partial t_i^L}{\partial \alpha_{p,i}}$ would hold true in the case of sequential move as well, as in Proposition 1. Note that both η_i and φ functions of $\alpha_{p,i}$ and $\alpha_{p,j}$. Similarly, we can solve for the public good preference parameter of the follower region *j*. Since regions are symmetric, the first order condition for the region *j*'s median voter's maximization problem would be similar to that in (22), except that we need to interchange the subscripts *i* and *j*.

Note that, we are more concerned about the position of the policy maker in comparison to the median voter and not about the exact magnitude of the public good preference parameter. Now, note that, in equilibrium, the marginal rate of substitution between public good and private good remains constant. We utilise this property to get the relation between the median voter's and the policy maker's public good preferences. In sequential move tax competition, both the regions charge different tax rates. So we analyze their political equilibrium separately.

First, we consider region 2 (the follower). On comparing equation (15b) and (21) we get,

$$\frac{1}{v'(g_2)} = \frac{\alpha_{p,2}[1-\eta_2]}{\theta[f''(x_2)\frac{\partial x_2}{\partial t_2}]} = \frac{\beta[1-\eta_2\varphi]}{\theta[f''(x_2)\frac{\partial x_2}{\partial t_2}]\varphi} \tag{22}$$

The equation for region 2 (follower) is the same as in the benchmark case (13). For $0<\varphi<1$, we can easily observe that $\alpha_{p,2}>\beta$. This indicates that the policy maker in region 2 (follower) is on the right side of the median voter. We can say that the median voter of the follower region delegates the tax rate decision to the policy maker, who has higher preference for the public good compared to the median voter herself. So in the case of the follower region, there is political delegation with a tax increasing effect.

Next, we analyze the scenario in region1 (leader). On comparing equation (18b) and (21), we obtain,

$$\frac{1}{v'(g_1)} = \frac{\alpha_{p,1}[1-\eta_1\left(1-\frac{\partial t_2}{\partial t_1}\right)]}{\theta[f''(x_1)\frac{\partial x_1}{\partial t_1}][1-\frac{\partial t_2}{\partial t_1}]} = \frac{\beta[1-\eta_1\varphi]}{\theta[f''(x_1)\frac{\partial x_1}{\partial t_1}]\varphi} \tag{24}$$

We can easily show that $\frac{\left(\frac{\partial t_2^F}{\partial \alpha_{p,1}}\right)}{\left(\frac{\partial t_1^L}{\partial \alpha_{p,1}}\right)} = \frac{\frac{|B|}{|H|}}{\frac{|A|}{|H|}} = \frac{|B|}{|A|} = \frac{\left(\frac{\partial^2 U^{p,2}}{\partial t_1 \partial t_2}\frac{\partial^2 U^{p,1}}{\partial \alpha_{p,1}\partial t_1}\right)}{-\left(\frac{\partial^2 U^{p,1}}{\partial \alpha_{p,1}\partial t_1}\frac{\partial^2 U^{p,2}}{\partial {t_2}^2}\right)}$[13] $= -\left(\frac{\frac{\partial^2 U^{p,2}}{\partial t_1 \partial t_2}}{\frac{\partial^2 U^{p,2}}{\partial {t_2}^2}}\right) = \frac{\partial t_2}{\partial t_1}$.

So we can write, $\varphi = \frac{\frac{\partial t_1^L}{\partial \alpha_{p,1}} - \frac{\partial t_2^F}{\partial \alpha_{p,1}}}{\frac{\partial t_1^L}{\partial \alpha_{p,1}}} = \left(1-\frac{\frac{\partial t_2^F}{\partial \alpha_{p,1}}}{\frac{\partial t_1^L}{\partial \alpha_{p,1}}}\right) = \left(1-\frac{\partial t_2}{\partial t_1}\right)$. Substituting in (24), we get,

[13] $\frac{\partial^2 U^{p,2}}{\partial \alpha_{p,1}\partial t_2}\frac{\partial^2 U^{p,1}}{\partial t_2 \partial t_1} = -\frac{\partial^2 U^{p,1}}{\partial {t_1}^2}\frac{\partial^2 U^{p,2}}{\partial \alpha_{p,1}\partial t_2} = 0$

$$\Rightarrow \frac{\alpha_{p,1}[1-\eta_1\varphi]}{\theta[f''(x_1)\frac{\partial x_1}{\partial t_1}]\varphi} = \frac{\beta[1-\eta_1\varphi]}{\theta[f''(x_1)\frac{\partial x_1}{\partial t_1}]\varphi} \qquad (25)$$

From this simplified equation (25), we can easily deduce that $\alpha_{p,1} = \beta$. This indicates that in political competition the median voter of region 1(leader) does not delegate the tax rate decision. She decides to become the policy maker herself. This result is in contrast to the benchmark simultaneous tax competition game, where both the regions delegate the tax rate decision task. So we observe that, if the regions move sequentially, it is not necessary that a region delegates the tax rate decision. We can say that a region delegates the policy making task only if that region is the follower in the case of sequential move tax competition; but does not delegate, if he chooses to be the leader.

Proposition 3: *In a sequential equilibrium, there is political delegation in the follower region only. There is no political delegation in the leader region, in equilibrium. In the follower region, the policy maker has higher preferences for public good compared to the median voter, while in the leader region the median voter herself decides to become the policy maker and the median voter's public good preference level is the optimum.*

The intuition behind this result is as follows. In a sequential move tax competition game, if a region opts to become the follower, then due to strategic complement nature of tax rates, the follower region's tax rate is below the leader region's tax rate, provided no political competition is considered (see Kempf and Rota Greziosi (2010) for proof). At the first stage of the game, the median voter of the follower region anticipates that the policy maker will charge lower tax rate compared to the leader region, given other things constant, and the provision of public good will be lower than desired by her. We know that $\frac{\partial\,(t_i x_i)}{\partial t_i} = x_i(1-\eta_i) > 0$, i.e. higher tax rate leads to higher tax revenue. So there is a scope for tax rate increase without loss of tax revenue. Therefore in political competition, she delegates the tax rate decision to such a candidate who values the public good more than her. This puts an upward pressure on tax rates in the follower region $\frac{\partial t_2^F}{\partial \alpha_{p,2}} > 0$ leading to higher tax rate, compared to the no delegation situation, with increased public good provision. Conversely, in the leader region tax rates are higher and there is higher public good provision compared to the simultaneous move game (no political competition). So in stage 1, i.e. in the case of political competition, the median voter takes into consideration this result while deciding the political equilibrium. She does not delegate the tax rate decision making because the tax rate decided by her (median voter) is optimal to provide public good at the median voter's desired level.. If she delegates the policy making to a candidate with higher public good preference, then the corresponding public good provision would have been too high compared to the median voter's desired level. These results point out that there is an optimal tax rate and corresponding public good provision desired by the representative median voter in each region. It is not always beneficial for a region to desire higher and higher tax rate to get more public good. In the case of the leader region, there is a possibility to charge a higher tax rate; still the median voter opts for no delegation to restrict the increase in the tax rate.

5. Conclusion

This paper investigates the impact of political competition and leadership in intraregional tax competition on equilibrium tax rates in a modified Wildasin (1988) model. We consider that there is heterogeneity in the preference for public good by the individuals (voters) in both the regions. The political equilibrium is decided by the median voter (due to majority rule) and leadership in tax competition is decided randomly because of symmetric regions. We show that, due to political competition through delegation of tax rate decisions, both the regions charge higher tax rates in the case of simultaneous move tax competition, since the median voter of each region delegates the task to decide tax rate to a policy maker who has stringer preference for public good than that of the median voter.

However, if the regions move sequentially (i.e. there is leadership in tax competition), it is not necessary that there is delegation of tax rate decision. We show that only in the follower region there is political delegation, whereas in the leader region, median voter becomes the policy maker and no political delegation is exercised in equilibrium. This result is in sharp contrast to the findings of the existing literature (Ihori and Yang (2009), Brueckner (2001), Persson and Tabellini (1992)).

The above result also indicates that political delegation is less effective to control race-to-the-bottom in tax rates in the case of sequential move tax competition compared to that in the case of simultaneous move tax competition, since in the former case there is political delegation only at the follower region.

It seems to be interesting to extend the present analysis to the case of asymmetric regions. However, that is beyond the scope of the present study. We leave that for future research.

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Appendix

A1. Proof of Lemma 1

(a) $\frac{\partial[\alpha_{n,i}\, v(g_i)]}{\partial t_i} = \alpha_{n,i}\, v'(g_i)\left(t_i \frac{\partial x_i}{\partial t_i} + x_i\right) = \alpha_{n,i}\, v'(g_i)\, x_i(1-\eta_i) > 0$, since $\alpha_{n,i} > 0$, $\eta_i < 1$ and $v'(g_i) > 0$.

(b) $\frac{\partial^2[\alpha_{n,i}\ v(g_i)]}{\partial t_i^2} = \alpha_{n,i}\ \left(v^{'}(g_i)\left[t_i\frac{\partial^2 x_i}{\partial {t_i}^2} + 2\frac{\partial x_i}{\partial t_i}\right] + v^{''}(g_i)[t_i\frac{\partial x_i}{\partial t_i} + x_i]^2\right) =$ $\alpha_{n,i}\ \left(v^{'}(g_i)2\frac{\partial x_i}{\partial t_i} + v^{''}(g_i)x_i^2[1-\eta_i]^2\right)$, since $\frac{\partial^2 x_i}{\partial {t_i}^2} = 0$. Clearly $\frac{\partial^2[\alpha_{n,i}\ v(g_i)]}{\partial t_i^2} < 0$, since $\alpha_{n,i} > 0$, $\frac{\partial x_i}{\partial t_i}$<0, $v^{'}(g_i) > 0$ and $v^{''}(g_i) < 0$.

(c) $\frac{\partial^2[\alpha_{n,i}\, v(g_i)]}{\partial t_j \partial t_i} = \alpha_{n,i}\ \left[v^{'}(g_i) + v^{''}(g_i)\left(t_i\frac{\partial x_i}{\partial t_i} + x_i\right)t_i\right]\frac{\partial x_i}{\partial t_j} = \alpha_{n,i}\ [v'(g_i) + v''(g_i)g_i(1-\eta_i)]\frac{\partial x_i}{\partial t_j}$. Now, since $[-\frac{g_i\, v''(g_i)}{v'(g_i)}] < 1$ and $0 < \eta_i < 1$, $\left[-\frac{g_i\, v''(g_i)}{v'(g_i)}(1-\eta_i)\right] < 1$. Therefore, $\alpha_{n,i}\ [v'(g_i) + v''(g_i)g_i(1-\eta_i)]\frac{\partial x_i}{\partial t_j} > 0$, since $\alpha_{n,i} > 0$, $v'(g_i) > 0$ and $\frac{\partial x_i}{\partial t_j} > 0$. QED.

A2. Proof of Theorem

Suppose that, in region i, the median voter's most preferred tax rate is ${t_i}^{\beta}$. That is the median voter selects the tax rate ${t_i}^{\beta}$. Assume that ${t_i}' \neq {t_i}^m$, say ${t_i}' < {t_i}^{\beta}$. Let R^{β} are the number of ideal tax rates to the right of ${t_i}^{\beta}$. By the definition of single peaked preferences all R^{β} voters prefer ${t_i}^{\beta}$ over ${t_i}'$. As the median position is ${t_i}^{\beta}$, we have $R^{\beta} \geq n/2$. Thus, the voters preferring ${t_i}^{\beta}$ over ${t_i}'$ are at least $R^{\beta} \geq n/2$ and in the majority voting rule the median voter is selected as the decision maker or the tax rate selected by median voter is preferred by the majority.

A3. Proof of Lemma 2

Note that, to prove Lemma 2, it is sufficient to show that the slope of the tax reaction function of the region 2's policy maker, in $t_1 - t_2$ plane, is less than one. Now note that the slope of the tax reaction function of the region 2's policy maker, in $t_1 - t_2$ plane, is given by $\left.\frac{\partial t_2}{\partial t_1}\right|_{p,2} = -\frac{\partial^2\ U^{p,2}(t_1,t_2)}{\partial t_1 \partial t_2}\Big/\frac{\partial^2\ U^{p,2}(t_1,t_2)}{\partial t_2^2}$, where $\frac{\partial^2\ U^{p,2}(t_1,t_2)}{\partial t_1 \partial t_2}$ and $\frac{\partial^2\ U^{p,2}(t_1,t_2)}{\partial t_2^2}$ are obtained by differentiating (9a), for *i=2*, with respect to t_1 and t_2, respectively. That is,

$\left.\frac{\partial t_2}{\partial t_1}\right|_{p,2} = -\left[\frac{\partial^2[\theta\ c_{p,2}\ (.)]}{\partial t_1 \partial t_2} + \frac{\partial^2[\alpha_{p,2}\ v(g_2)]}{\partial t_1 \partial t_2}\right]\Big/\left[\frac{\partial^2[\theta\ c_{p,2}\ (.)]}{\partial t_2^2} + \frac{\partial^2[\alpha_{p,2}\ v(g_2)]}{\partial t_2^2}\right] = -\frac{A+B}{C+D}$, where

$C = \frac{\partial^2[\theta\, c_{p,2}\,(.)]}{\partial t_2^2} = -\theta\left[x_j\, f'''\left(x_j\right) + f''(x_j)\right]\left(\frac{\partial x_j}{\partial t_j}\right)^2 = -\frac{\partial^2[\theta\, c_{p,2}\,(.)]}{\partial t_1\,\partial t_2} = -A$, $B = \frac{\partial^2[\alpha_{p,2}\, v(g_2)]}{\partial t_1\,\partial t_2}$ and $D = \frac{\partial^2[\alpha_{p,2}\, v(g_2)]}{\partial t_2^2}$. We have $(C + D) < 0$, since $U^{p,2}(.)$ is concave. Therefore, $\left.\frac{\partial t_2}{\partial t_1}\right|_{p,2} < 1 \Leftrightarrow A + B < -(C + D) \Leftrightarrow B + D < 0$, since $A + C = 0$. Now,

$$B + D = \alpha_{p,2}\left\{v'(g_2)2\frac{\partial x_2}{\partial t_2} + v''(g_2)x_2^2[1-\eta_2]^2 + [v'(g_2) + v''(g_2)g_2(1-\eta_2)]\frac{\partial x_2}{\partial t_1}\right\}$$

$$= \alpha_{p,2}\{v'(g_2)2\frac{\partial x_2}{\partial t_2} + v''(g_2)x_2^2[1-\eta_2]^2 - [v'(g_2) + v''(g_2)g_2(1-\eta_2)]\frac{\partial x_2}{\partial t_2}\}$$

$= \alpha_{p,2}\{v'(g_2)\frac{\partial x_2}{\partial t_2} + v''(g_2)x_2^2[1-\eta_2]^2 - v''(g_2)g_2(1-\eta_2)\frac{\partial x_2}{\partial t_2}\} < 0$, since $\frac{\partial x_2}{\partial t_2} < 0$, $\eta_2 < 1, v''(g_2) < 0$ and $v'(g_2) > 0$. Hence, $\left.\frac{\partial t_2}{\partial t_1}\right|_{p,2} < 1$. QED.

A4. Proof of Proposition 1

Differentiating (9a) with respect to $\alpha_{p,1}$, we get

$$\frac{\partial^2 U^{p,1}}{\partial {t_1}^2}\frac{\partial t_1^S}{\partial \alpha_{p,1}} + \frac{\partial^2 U^{p,1}}{\partial t_2 \partial t_1}\frac{\partial t_2^S}{\partial \alpha_{p,1}} + \frac{\partial^2 U^{p,1}}{\partial\, \alpha_{p,1}\partial t_1} = 0$$

$$\frac{\partial^2 U^{p,2}}{\partial t_1 \partial t_2}\frac{\partial t_1^S}{\partial \alpha_{p,1}} + \frac{\partial^2 U^{p,2}}{\partial {t_2}^2}\frac{\partial t_2^S}{\partial \alpha_{p,1}} + \frac{\partial^2 U^{p,2}}{\partial \alpha_{p,1}\partial t_2} = 0$$

From the above two equations, we can write $\frac{\partial t_1^S}{\partial \alpha_{p,1}} = \frac{|A|}{|H|}$ and $\frac{\partial t_2^S}{\partial \alpha_{p,1}} = \frac{|B|}{|H|}$, where $|H| = \frac{\partial^2 U^{p,1}}{\partial {t_1}^2}\frac{\partial^2 U^{p,2}}{\partial {t_2}^2} - \frac{\partial^2 U^{p,2}}{\partial t_1 \partial t_2}\frac{\partial^2 U^{p,1}}{\partial t_2 \partial t_1}$, $|A| = -\frac{\partial^2 U^{p,1}}{\partial\, \alpha_{p,1}\partial t_1}\frac{\partial^2 U^{p,2}}{\partial {t_2}^2} + \frac{\partial^2 U^{p,2}}{\partial \alpha_{p,1}\partial t_2}\frac{\partial^2 U^{p,1}}{\partial t_2 \partial t_1}$ and $|B| = -\frac{\partial^2 U^{p,1}}{\partial {t_1}^2}\frac{\partial^2 U^{p,2}}{\partial \alpha_{p,1}\partial t_2} + \frac{\partial^2 U^{p,2}}{\partial t_1 \partial t_2}\frac{\partial^2 U^{p,1}}{\partial\, \alpha_{p,1}\partial t_1}$. Now, note that $|H| > 0$ (since the equilibrium is assumed to be stable), $\frac{\partial^2 U^{p,1}}{\partial \alpha_{p,1}\partial t_1} = v'\left(g_1\right)x_1[1-\eta_1] > 0$ (since $\eta_1 < 1$), $\frac{\partial^2 U^{p,2}}{\partial {t_2}^2} < 0$ (by second order condition of maximization), $\frac{\partial^2 U^{p,2}}{\partial \alpha_{p,1}\partial t_2} = 0$ (since $U^{p,2}(.)$ does not depend on $\alpha_{p,1}$), $\frac{\partial^2 U^{p,2}}{\partial t_1 \partial t_2} > 0$. Therefore, $|A| > 0$ and $|B| > 0$. So, we get, $\frac{\partial t_1^S}{\partial \alpha_{p,1}} > 0$ and $\frac{\partial t_2^S}{\partial \alpha_{p,1}} > 0$. Now, note that $\frac{\partial t_1^S}{\partial \alpha_{p,1}} - \frac{\partial t_2^S}{\partial \alpha_{p,1}} > 0 \Leftrightarrow -\frac{\partial^2 U^{p,2}}{\partial {t_2}^2} > \frac{\partial^2 U^{p,2}}{\partial t_1 \partial t_2}$. Since, $\left.\frac{\partial t_2}{\partial t_1}\right|_{p,2} =$

$-\frac{\partial^2 U^{p,2}(t_1,t_2)}{\partial t_1 \partial t_2} \Big/ \frac{\partial^2 U^{p,2}(t_1,t_2)}{\partial t_2^2} < 1$, by Lemma 2, and $\frac{\partial^2 U^{p,2}(t_1,t_2)}{\partial t_2^2} < 0$, we have $\Leftrightarrow -\frac{\partial^2 U^{p,2}}{\partial {t_2}^2} > \frac{\partial^2 U^{p,2}}{\partial t_1 \partial t_2}$. Therefore, $\frac{\partial t_1^S}{\partial \alpha_{p,1}} > \frac{\partial t_2^S}{\partial \alpha_{p,1}}$. QED.