Yardstick competition: a rent-taking equilibrium in presence of fiscal disparities

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Abstract

Recent research (Allers, 2012) shows that horizontal fiscal imbalances bias the yardstick competition between local administrators. We extend the analysis and we examine which are the consequences on the rent-taking equilibrium in presence of fiscal disparities.

The result suggests that, under certain conditions, jurisdictions with higher fiscal advantage can extract higher per capita rents, computed as a fraction of local public expenditure, compared to jurisdictions with lower fiscal advantage, without compromising the re-election.

Furthermore, equalization transfers based on fiscal capacity (standard tax rates) and expenditure needs can only reduce the bias of the yardstick competition but can not eliminate the advantage of fiscal advantaged administrators.

In order to obtain perfect yardstick competition, equalization transfers should be based on historical tax rates instead of standard tax rates, however the existing literature does not recommend this solution for a number of reasons.

Keywords: Yardstick competition Decentralization Horizontal fiscal imbalance Fiscal disparities

1. Introduction

By comparing their local administrators' performance with the performance of administrators in similar jurisdictions, voters decide to re-elect good politicians and to not re-elect bad politicians. For this reason political yardstick competition is seen as an instrument which improve the efficiency of local administrations (Besley and Smart, 2007) giving administrators an incentive to perform better.

The policy competition which follows the yardstick competition has been empirically tested by a number of studies (Allers and Elhorst, 2005; Besley and Case, 1995; Bordignon et al., 2003; Revelli, 2006).

All this literature is based on the existence of "similar" jurisdictions. There is an aspect of yardstick competition that has received little attention: the existence of fiscal disparities. In fact, jurisdictions, even if they operate in the same institutional setting, have the same service responsibilities, and are susceptible to common exogenous shocks, differ with respect to fiscal capacity and spending need.

When such fiscal disparities exist, politicians in jurisdictions with a large fiscal capacity relative to expenditure needs can take more rent than their counterparts, and still keep a good reputation which in turn makes possible to be re-elected.

There are still few paper which investigates the possible effects of fiscal disparities and fiscal equalization on accountability of local administrators. Kotsogiannis and Schwager (2008) argue that yardstick competition is more effective if differences in revenue capacities are equalized. They argue that such a system has two effects on accountability: a direct and an indirect one. The direct effect, which is conducive to less rent-taking and therefore beneficial for the citizens, of the equalization scheme is in place in situations in which citizens observe a reduction in public good in presence of equalization grants. Since the equalization scheme partly compensates jurisdictions for the loss in own resources this, given the reduction in public good supply, reveals an even larger reduction in own resources than in the case without equalization. As a consequence, citizens attribute an even lower competence level to the incumbent.

The indirect effect works through the lack of transparency of the equalization transfer, that is when the equalization scheme is not properly designed in order to equalize fiscal capacities (FC) and expenditure needs (EN) between local jurisdictions (distortions in the estimation of FC and EN or absence of formula-based transfers). The consequence of this is that, even knowing the equalization rate, citizens cannot perfectly derive fiscal capacities from the supplies of public goods observed in jurisdictions. Hence, the informational content of observing public good supplies in both jurisdictions is reduced. As a consequence, the adverse effect of increased rent-seeking on voters' assessment of the incumbent's performance is mitigated by equalization transfers.

In the view of Kotsogiannis and Schwager (2008) the equalization scheme is viewed as an instrument which helps citizens in the evaluation of FC and EN of local jurisdictions. In their approach, voters are interested in rent-taking only indirectly, because there are only two periods, every administrator they choose after the first period will take maximum rent in the second.

Allers (2012) shows the positive effect of the equalization transfers on yardstick competition by means of a different reasoning. They argue that for citizens is very difficult to evaluate fiscal disparities and take them into account. Citizens only look at the ratio between level of public services and tax burden.

They show that, if fiscal disparities are equalized to the extent that every jurisdiction is able to provide the same service level at the same tax sacrifice, subnational government output levels, combined with tax rates, provide an unbiased indicator of subnational government performance, without taking into account FC and EN.

Starting by different reasoning both Kotsogiannis and Schwager (2008) and Allers (2012) argue that equalization systems, which aim to reduce or eliminate fiscal disparities, can have another justification, different from the traditional role in improving locational efficiency (as it removes an incentive to move to jurisdictions with favorable fiscal conditions) and in improving the equity of multi-level systems of public finance (Boadway, 2006). According to their view, equalization transfers could be used in order to improve yardstick competition too.

We will propose a theoretical model which includes some elements of Kotsogiannis and Schwager (2008) and Allers (2012) in order to investigate deeply which is the effect of fiscal disparities on the rent-taking equilibrium of the game which involves two jurisdiction characterized by fiscal disparities.

2. Yardstick bias

We will follow the framework and the notation provided by Allers (2012) with few changes.

For the sake of simplicity consider two jurisdictions, which are identical except for their revenue-raising capacities and their spending needs. Jurisdictions provide a public service and finance this through tax revenues. The jurisdiction's budget constraint is

$$E_i = \theta_i B_i \tag{1}$$

where E_i is jurisdiction i's per capita expenditures, B_i is jurisdiction i's per capita tax base and θ_i is jurisdiction i's tax rate, defined as the share of the tax base that the jurisdiction collects($0 < \theta_i < 1$). Thus, $\theta_i B_i$ is per capita tax revenue. Administrators know B_i; voters do not.

Each jurisdiction is governed by an elected politician, who extracts a fraction ρ_i of public expenditures as rent ($0 \leq \rho_i < 1$). As a result of common exogenous shocks ω, the service level corresponding to a certain amount of spending varies. Following Besley and Case (1995) and Allers (2012), we assume that jurisdictions experience identical shocks.

Apart from ω, the per capita service level S_i depends on per capita spending on the public service $(1-\rho_i)E_i$, and on spending need, which may be expressed as the jurisdiction's cost index γ_i:

$$S_i = \omega \frac{(1-\rho_i)E_i}{\gamma_i}. \tag{2}$$

In equation (2), γ_i reflects both demographic and other factors outside the control of the subnational that determine the differences in expenditure needs of the two jurisdictions ($\gamma_i > 0$).

Voters do not observe ρ_i, they only observe service levels and tax rates. Voters value high service levels and low tax rates. They either re-elect the incumbent, or elect a challenger. Voters use a relative performance yardstick φ_i to judge the incumbent. If $\varphi_i \geq 1$, jurisdiction i's incumbent's is re-elected. If $\varphi_i < 1$, i's incumbent is considered inferior; he or she is not re-elected.

Following Allers (2012) we define the benchmark for jurisdiction i's incumbent's relative performance φ_i as $\frac{S_i}{\theta_i}$, the value for money relative to the level of local public services and the local tax rate:

$$\varphi_i = \frac{\frac{S_i}{\theta_i}}{\frac{S_j}{\theta_j}}. \tag{3}$$

where $i \neq j$. Substituting (2) and (1) in (3), the performance benchmark becomes

$$\varphi_i = \frac{(1-\rho_i)}{(1-\rho_j)}\lambda_i \tag{4}$$

where $\lambda_i = \frac{B_i/\gamma_i}{B_j/\gamma_j}$ is is the relative fiscal advantage of jurisdiction i,compared with jurisdiction of reference j.

When they notice that $\varphi_i \geq 1$, voters think jurisdiction i's incumbent's performance is in line or superior to that of his or her counterpart in the other jurisdiction and they re-elect he or she.

If $\lambda_i = 1$, this requires $\rho_i < \rho_j$, and φ_i gives a true picture of the incumbent's performance. If $\lambda_i \neq 1$, φ_i is clearly a biased performance indicator.

At this point Allers (2012) correctly states that "As a result, yardstick competition does not result in reaction functions with an identical slope for different jurisdictions, as has been assumed in the literature. In fact,the slope of the reaction function (of the two local government) depends on the relative fiscal advantage of the municipality."

3. Description of the model

We consider a model with career concerns and yardstick competition[1] between the incumbents of two jurisdictions labelled $i = 1, 2$ which are ex ante identical, except for their revenue-raising capacities and their spending needs, as described in the previous section.

In particular we assume that $B_1/\gamma_1 > B_2/\gamma_2$, so $\lambda_1 > 1$, i.e. jurisdiction 1 has a relative fiscal advantage compared to jurisdiction 2.

Furthermore we assume that it is impossible to obtain a rent higher than $\bar{\rho}$, where $0 < \bar{\rho} < 1$ has a reasonably value[2]. A possible convincing reason for this restriction is that a too small provision of public goods triggers an immediate investigation by an independent authority, such as the constitutional court, into the workings of the government. From this point of view $\bar{\rho}$ represents a parameter of the higher level authorities' efficiency in the control process of local administrations (or justice system's efficiency).

As for many political system (UK, Italy etc.) it is impossible to be re-elected more than one time. As consequence it seems realistic to follow Kotsogiannis and Schwager (2008), assuming a two period game, in which incumbents can be re-elected just one time.

3.1. Payoffs and second period decisions

The model is analyzed using the Nash equilibrium concept under which the decisions by incumbents in the first period are simultaneously optimal, given a correct assumption on the other player behaviour.

In period 2 the incumbent administrator doesn't care about the possibility to be re-elected, it follows that in period two each local government set the level of rent $\rho_i = \bar{\rho}$, where $i = 1, 2$. So, if re-elected, the expected payoff in period two is equal to $\bar{\rho}\theta_i B_i$, where $i = 1, 2$.

[1] As in Persson and Tabellini (2000), chapter 9.

[2] The meaning of this statement will be clear later, in fact $\bar{\rho}$ plays a crucial role in the game equilibrium.

3.2. Payoffs and first period decisions: equilibrium analysis

Once computed the payoffs in second period, the incumbents' payoffs in period 1 depends on the re-election in period two, i.e. on the choice of the other player.

In particular the payoff π_i of jurisdiction i's (player i) incumbent can be represented as:

$$\pi_i = \begin{cases} \rho_i \theta_i B_i, & \text{if } \varphi_i < 1 \\ \rho_i \theta_i B_i + \bar{\rho} \theta_i B_i, & \text{if } \varphi_i \geq 1 \end{cases}. \quad (5)$$

Given ρ_2, player 1 will not be re-elected if

$$\varphi_i < 1 \quad (6)$$

that is:

$$\rho_1 < 1 - \frac{1}{\lambda_1}(1 - \rho_2). \quad (7)$$

It follows that we can have two cases[3]. In the first case, if $\bar{\rho} \leq 1 - \frac{1}{\lambda_1}$, player 1's optimal strategy is to fix $\rho_1 = \bar{\rho}$ independently on the possibility to be re-elected or not[4]. In the second case, if $\bar{\rho} > 1 - \frac{1}{\lambda_1}$, the player 1's reaction function is given by:

$$\rho_1(\rho_2) = \begin{cases} 1 - \dfrac{1}{\lambda_1} + \dfrac{1}{\lambda_1}\rho_2, & \text{if } 0 \leq \rho_2 \leq 1 - \lambda_1(1 - \bar{\rho}) \\ \bar{\rho}, & \text{if } 1 - \lambda_1(1 - \bar{\rho}) < \rho_2 \leq \bar{\rho} \end{cases}. \quad (8)$$

The intuition is that in correspondence of small values of ρ_2, the best response of player 1 is to fix a value of ρ_1 which allows he or she to be re-elected. If player 2 choose an high value of ρ_2, player 1 will be re-elected anyway, so his best response is to choose the maximum rent available.

The relative expected player 1's payoffs are then given by[5]:

$$\pi_1(\rho_2) = \begin{cases} \left(1 - \dfrac{1}{\lambda_1} + \dfrac{1}{\lambda_1}\rho_2\right)\theta_1 B_1 + \bar{\rho}\theta_1 B_1, & \text{if } 0 \leq \rho_2 \leq 1 - \lambda_1(1 - \bar{\rho}) \\ 2\bar{\rho}\theta_1 B_1, & \text{if } 1 - \lambda_1(1 - \bar{\rho}) < \rho_2 \leq \bar{\rho} \end{cases}. \quad (9)$$

Given ρ_1, player 2 will find convenient to be re-elected only if

$$(1 - \lambda_1 + \lambda_1 \rho_1)\,\theta_2 B_2 + \bar{\rho}\theta_2 B_2 > \bar{\rho}\theta_2 B_2, \quad (10)$$

that is if $\rho_1 > 1 - \frac{1}{\lambda_1}$. It follows that if $\bar{\rho} \leq 1 - \frac{1}{\lambda_1}$, since $\rho_1 \leq \bar{\rho}$, player 2 will choose $\rho_2 = \bar{\rho}$ and he or she will not be re-elected.

[3]In order to make the reading simpler,the complete equilibrium analysis is presented in appendix A

[4]The computation of the reaction functions and the relative payoffs is illustrated in appendic

[5]Notice that player 1, when $\bar{\rho} > 1 - \frac{1}{\lambda_1}$, will be always re-elected.

If $\bar{\rho} > 1 - \frac{1}{\lambda_1}$ the player 2's best response to player 2 choice is[6]:

$$\rho_2(\rho_1) = \begin{cases} \bar{\rho}, & \text{if } 0 \leq \rho_1 \leq 1 - \dfrac{1}{\lambda_1} \\ 1 - \lambda_1 + \lambda_1 \rho_1, & \text{if } 1 - \dfrac{1}{\lambda_1} < \rho_1 \leq \bar{\rho} \end{cases}. \tag{11}$$

The relative expected player 2's payoffs[7] are then given by:

$$\pi_2(\rho_1) = \begin{cases} \bar{\rho}\theta_2 B_2, & \text{if } 0 \leq \rho_1 \leq 1 - \dfrac{1}{\lambda_1} \ (NR) \\ (1 - \lambda_1 + \lambda_1 \rho_1)\,\theta_2 B_2 + \bar{\rho}\theta_2 B_2, & \text{if } 1 - \dfrac{1}{\lambda_1} < \rho_1 < \bar{\rho} \ (R) \end{cases}. \tag{12}$$

Nash equilibria

The game has multiple Nash equilibria.

First of all, when authorities which control subnational governments are enough efficient in their activity, that is when $\bar{\rho} \leq 1 - \frac{1}{\lambda_1}$, there is a unique Nash equilibrium in which incumbent 1 plays $\rho_1 = \bar{\rho}$ ad incumbent 2 plays $\rho_2 = \bar{\rho}$. As consequence the incumbent of the jurisdiction characterized by the highest relative fiscal advantage (jurisdiction 1) will be re-elected and his payoff will be $\pi_1 = 2\bar{\rho}\theta_1 B_1$. The incumbent of the disadvantaged jurisdiction wil not be re-elected and his payoff will be $\pi_2 = \bar{\rho}\theta_2 B_2$.

So, even if the two incumbents extract the same percentage of per capita rent ($\rho_1 = \rho_2 = \bar{\rho}$), the first will be re-elected, the second will not. This is given by the bias of the yardstick φ_1, which in turn is caused by the differences in fiscal capacities of the two jurisdictions.

When $\bar{\rho} > 1 - \frac{1}{\lambda_1}$, then there are multiple Nash equilibria. In particular the equlibria are given by

$$(\rho_1^*, \rho_2^*) = (1 - \lambda_1(1 - \rho_2), \rho_2), \tag{13}$$

where $\rho_2 < 1 - \lambda_1(1 - \bar{\rho})$.

It's easy to verify that, for all this equilibria, even if $\rho_1 > \rho_2$, incumbent 1 will be re-elected and his payoff will be $\pi_1 = \left(1 - \frac{1}{\lambda_1} + \frac{1}{\lambda_1}\rho_2\right)\theta_1 B_1 + \bar{\rho}\theta_1 B_1$. In this case incumbent 2 will be re-elected too. His payoff will be $\pi_2 = \rho_2\theta_2 B_2 + \bar{\rho}\theta_2 B_2$.

4. Comments

From the equilibrium analysis it emerges an important factor which has not been properly taken into account in the previous analyses of Kotsogiannis and Schwager (2008) and Allers (2012): the role of control authorities. In fact if the control activity is enough efficient ($\bar{\rho} \leq 1 - \frac{1}{\lambda_1}$) the yardstick bias is still present but the amount of rent captured by both incumbents is relatively small and the incumbent of the fiscal disadvantaged jurisdiction will never be re-elected.

[6]When $\rho_1 = \bar{\rho}$ player 2 can play indifferently $\rho_2 = \bar{\rho}$ and obrtain $\bar{\rho}\theta_2 B_2$ in the first period (without be re-elected) or play $\rho_2 = 0$ in order to be re-electad and gain the same payoff in period 2.

[7]In parenthesis we indicate "NR" if player 2 is not re-elected, "R" if re-elected.

If the control activity is inefficient ($\bar{\rho} > 1 - \frac{1}{\lambda_1}$) both incumbent can extract more rent and there is room to a more complex strategic behaviour. The result are multiple Nash equilibria in which both incumbent will be re-elected but the incumbent of the fiscal advantaged jurisdiction will be able to capture more rent compared to the incumbent of the fiscal disadvantaged jurisdiction. It's easy to verify that in equation (A.4), if $\lambda_1 = 1$ than the equilibrium became $\rho_1 = \rho_2$ since a deviation will cause jurisdiction i to be not re-elected.

According to Allers (2012) "if fiscal disparities are equalized to the extent that every jurisdiction is able to provide the same service level at the same tax sacrifice, subnational government output levels, combined with tax rates, provide an unbiased indicator of subnational government performance". On the other hand the presence of equalization grants changes the budget constraint of the disadvantaged jurisdiction. In particular, for jurisdiction 2, the equation (1) becomes:

$$E_2 = \theta_2 B_2 + G_2, \tag{14}$$

where G_2 indicates grant.

The level of services of jurisdiction 2 will be equal to:

$$S_2 = \omega \frac{(1 - \rho_2)(\theta_2 B_2 + G_2)}{\gamma_2}. \tag{15}$$

It follows that the benchmark for jurisdiction 1?s incumbent's relative performance φ_1 becomes:

$$\varphi_1 = \frac{\frac{S_1}{\theta_1}}{\frac{S_2}{\theta_2}}. \tag{16}$$

Substituting equation (15) into equation (17) we obtain

$$\varphi_1 = \frac{(1 - \rho_1)}{(1 - \rho_2)} \lambda_1^{eq}, \tag{17}$$

where

$$\lambda_1^{eq} = \frac{\dfrac{B_1}{\gamma_1}}{\dfrac{B_2}{\gamma_2} + \dfrac{G_2}{\gamma_2 \theta_2}}. \tag{18}$$

In order to obtain an unbiased benchmark grants should be designed to give $\lambda_1^{eq} = 1$, the amount of transfers to the fiscal disadvantaged jurisdiction should be:

$$G_2 = \gamma_2 \theta_2 \left(\frac{B_1}{\gamma_1} - \frac{B_2}{\gamma_2} \right). \tag{19}$$

It follows that the equalization transfers should be function of the tax rate decided by jurisdiction 2 (θ_2). The problem is that it is not recommendable to relate equalization transfers to the tax rates chosen by jurisdictions. It is well known in the literature (see for example Bird and Tarasov (2004)) that in order to avoid a series of disincentives in raising revenues, in federal systems equalization transfers are based on measures of *potential* revenue-raising capacity. In other words, equalization formulas are usually based on measures of fiscal capacities which involve directly or indirectly the “standard tax rates” which are, usually, smaller than effective tax rate, since the last one includes the fiscal effort exerted by each jurisdiction. Furthermore, even if full equalization will be achieved only if the revenue raising capacity is equalized to the level of the richest SNG, “in most countries, budgetary constraints lead to lower the standards” (Bird and Tarasov, 2004).

To conclude, since usually standard tax rates are smaller than effective tax rates, it follows that equalization transfers may reduce the amount of rent extracted by both jurisdictions, but λ_1^{eq} will remain greater than one and φ_1 will remain a biased benchmark.

It is possible to obtain an unbiased benchmark only paying the price of disincentives in raising revenues (less fiscal effort) and strategic behaviour in the process of tax rates choices which can modify the future amount of grants.

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Appendix A. First period reaction functions derivation

If $\bar{\rho} > 1 - \frac{1}{\lambda_1}$, in the first period the expected payoffs of incumbents of jurisdictions 1 and 2 are respectively:

$$\pi_1 = \begin{cases} \rho_1\theta_1 B_1, & \text{if } \varphi_1 < 1 \\ \rho_1\theta_1 B_1 + \bar{\rho}\theta_1 B_1, & \text{if } \varphi_1 \geq 1 \end{cases}; \quad \text{(A.1)}$$

$$\pi_2 = \begin{cases} \rho_2\theta_2 B_2, & \text{if } \varphi_1 \geq 1 \\ \rho_1\theta_2 B_2 + \bar{\rho}\theta_2 B_2, & \text{if } \varphi_1 < 1 \end{cases}. \quad \text{(A.2)}$$

Given ρ_2 then:

$$\varphi_1 < 1 \iff \rho_1 < 1 - \frac{1}{\lambda_1}(1 - \rho_2). \tag{A.3}$$

So we can describe the possible output of the elections by means of the figure A.1.

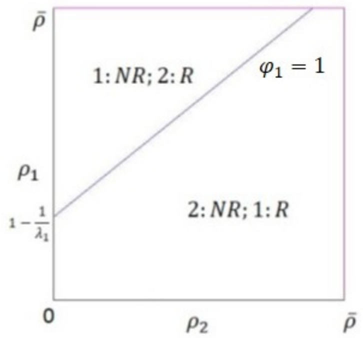

Figure A.1: Conditions for re-election of incumbents 1 and 2

In the figure A.1 if incumbents set values of ρ in correspondence of the line $\varphi_1 = 1$, they will be both re-elected. Above the line incumbent 2 will be re-elected while incumbent 1 will not; under the line incumbent 1 will be re-elected while incumbent 2 will not.

Appendix A.1. Reaction function of incumbent 1

If incumbent 2 sets $\rho_2 = \bar{\rho}$ then the value of rho_1 that maximizes incumbent 1's payoff is $1 - \frac{1}{\lambda_1}(1 - \rho_2)$. However it is easy to verify that $1 - \frac{1}{\lambda_1}(1 - \rho_2) > \bar{\rho}$ when $\bar{\rho} < 1$. It follows that the best response to $\rho_2 = \bar{\rho}$ is $\rho_1 = \bar{\rho}$; incumbent 1 will be re-elected and his payoff will be $\pi_1 = 2\bar{\rho}\theta_1 B_1$, incumbent 1 will not be-re-elected and his payoff will be $\pi_2 = \bar{\rho}\theta_2 B_2$.

If incumbent 2 set $1 - \lambda_1(1 - \bar{\rho}) < \rho_2 < \bar{\rho}$ incumbent 1 will be re-elected even if he or she sets $\rho_1 = \bar{\rho}$ while incumbent 2 will not, so the best response for incumbent 1 is to choose $\rho_1 = \bar{\rho}$. The intuition is that for high values of ρ_2 it is convenient for incumbent 1 to set $\rho_1 = \bar{\rho}$ in order to be re-elected and gain $\pi_1 = 2\bar{\rho}\theta_1 B_1$.

If incumbent 2 sets a small value of ρ_2, that is if $0 \leq \rho_2 \leq 1 - \lambda_1(1 - \bar{\rho})$, then incumbent 1 maximizes his payoff setting $\rho_1 = 1 - \frac{1}{\lambda_1}(1 - \rho_2)$ in order to be re-elected, extracting a payoff $\pi_1 = \left(1 - \frac{1}{\lambda_1} + \frac{1}{\lambda_1}\rho_2\right)\theta_1 B_1 + \bar{\rho}\theta_1 B_1$. The reaction function of incumbent 1 is described by the red line in figure A.2.

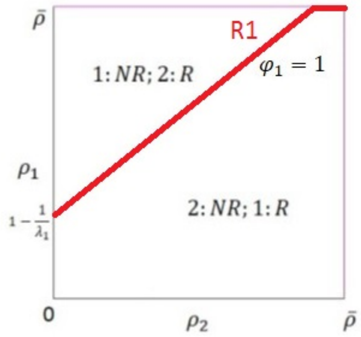

Figure A.2: Reaction function of incumbent 1

Appendix A.2. Reaction function of incumbent 2

If incumbent 1 sets $\rho_1 < 1 - \frac{1}{\lambda_1}$ then the values of ρ_2 that maximizes incumbent 2's payoff is $\bar{\rho}$. In fact in this case incumbent 2 will not be re-elected in any case, so his best response is gain $\pi_2 = \bar{\rho}\theta_2 B_2$ in the first period, setting $\rho_2 = \bar{\rho}$.

If incumbent 1 sets $\rho_1 = 1 - \frac{1}{\lambda_1}$ then the values of ρ_2 that maximizes incumbent 2's payoff are 0 and $\bar{\rho}$. In both cases incumbent 2 will gain $\pi_2 = \bar{\rho}\theta_2 B_2$, the difference is that in the first case he or she will be re-elected, in the second case he or she will not. For simplicity we assume that for incumbent 2 it is easier to set $\rho_2 = \bar{\rho}$ in order to capture the full rent in the first period.

If incumbent 1 sets $1 - \frac{1}{\lambda_1} < \rho_1 \leq \bar{\rho}$ then the values of ρ_2 that maximizes incumbent 2's payoff is $1 - \lambda_1 + \lambda_1 \rho_1$. In this case he or she will be re-elected and he or she will improve his outcome gaining $\pi_2 = (1 - \lambda_1 + \lambda_1 \rho_1)\,\theta_2 B_2 + \bar{\rho}\theta_2 B_2$.

The reaction function of incumbent 2 is described by the red line in figure A.3.

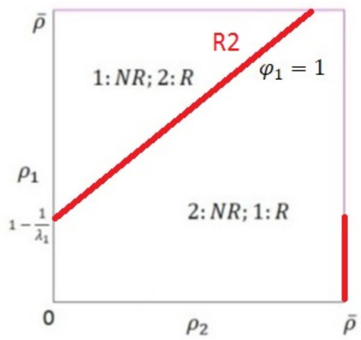

Figure A.3: Reaction function of incumbent 2

Appendix A.3. Equilibria

The Nash equilibria of the game are given by the intersections of the two reaction functions illustrated by figures A.2 and A.3.

The blue line in figure A.4 reports the multiple Nash equilibria of the game, which corresponds to all combinations $(\rho_1^*, \rho_2^*) = (1 - \lambda_1(1 - \rho_2), \rho_2)$ where $\rho_2 < 1 - \lambda_1(1 - \bar{\rho})$.

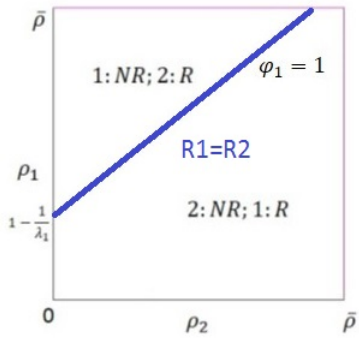

Figure A.4: Nash equilibria of the game