

# Is Competition Between Regions Welfare Increasing?

Gerhard C. Geerdink<sup>1</sup>(corresponding author) & Peter J. Stauvermann<sup>2</sup>

University of Twente,

School of Business, Public Administration & Technology, Enschede, The Netherlands

<sup>1</sup>[g.c.geerdink@utwente.nl](mailto:g.c.geerdink@utwente.nl)

<sup>2</sup>[p.j.stauvermann@utwente.nl](mailto:p.j.stauvermann@utwente.nl)

## Abstract

*It is generally assumed that competition increases welfare. The main idea behind this assumption is that competition in a market is the best incentive mechanism to produce efficient market outcomes. This is good for social welfare and therefore stimulating competition is welfare increasing. According to this view, a lot of emphasis has been laid on the conditions to enhance competition in certain areas of the economy.*

*Next to these developments in the markets of goods and services, one sees a similar development in emphasizing competition between regions and semi-public and other kind of institutions. One can generally say that as a result of general development in other sectors and more formally, globalization tends also to increase the intensity of competition.*

*In our paper, we take a closer look at selected aspects of regional competition. Especially, we look at the competition between regions or cities in order to increase their economic activity by subsidizing firms. In daily life, we see the results of increasing competition between regions in form of substantial investments that are financed by the competing regions or cities. However, it also turns out that many of these investments appear to be wasteful at the end of the road. One may say: How is it possible in an economic environment of increasing competition? This apparently does not lead to more efficient outcomes.*

*First, a model is developed which sheds light on specific features on the above-described developments. Our starting point is competition between two regions competing for one firm to settle down. Without competition the firm will settle in a region where it fits best according to the preferred characteristics of the firm matching that of the region. Other regions offer as a kind of reaction the firm specific facilities or subsidies in order to attract the courted firm to settle down in their region. This situation leads to a kind of prisoner's dilemma.*

*There are a number of specific features that have to be incorporated in order to describe these developments. To incorporate these features we compare two different approaches to analyze the problem. The first approach is based on "Rent seeking theory"; the second is based on "The Winner takes all principle". Both approaches differ somewhat in regard to the kind of competition distinguished. The rent seeking approach is used to model a competition with full liability. That means that a fixed specific investment (e.g. the purchase of development areas,*

*investments to develop those areas, the provision of electricity, gas, water, the construction of roads, railroad tracks, et cetera.) has to be made by each of the competing regions to offer it as a subsidy to the courted firm before the firm settles down. Obviously, there is no guarantee that a competing region will receive any payoff after investments are made.*

*The winner takes all contest is applied to model competition with only limited liability. In contrast to competition with full liability, only the winner of the competing regions must contribute a subsidy, and will receive a payoff of the subsidy. Examples of this kind of a subsidy are tax relieves, tax allowances, subsidized electricity, subsidized business premises and so on.*

*In the paper we compare the results of both approaches with regard to efficiency and we compare the results with a situation without any subsidies. In order to see the effect of increasing competition we start in a situation with two competing regions and expand it then to  $n$  regions. The general conclusion of both approaches is that competition between regions cannot be avoided. However, under rather general conditions it is not welfare increasing but in fact inefficient from national point of view.*

*In addition, we show that the larger the number of competitors the less efficient will be the result. Given that competition between regions is unavoidable, it is not clear what kind of competition, with full or limited liability, is preferable with regard to efficiency.*

**Keywords:** Regional competition, Rent seeking, Contest success

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## 1. Introduction

Over the past 30 years, state and local governments have assumed a greater responsibility for economic development. All kind of incentives, like tax breaks, low-cost or free land, the issuance of tax-exempt bonds, training funds, the construction of roads, and other infrastructure investments, are used to attract all kind of firms. The main purpose is to boost regional economic activity in order to meet local economic and political objectives, for example reducing unemployment, increasing the tax revenue, creating a regional image of high tech area, knowledge business center, and so on.

In order to meet these targets, big investments are made by the local governments. Also huge amounts off subsidy are offered to firms and businesses in order to settle down in the region. Local governments and the subsidized companies usually extol the benefits of these deals, while critics complain that they are a waste of public money.

It is difficult to evaluate these competing claims of these policies. The traditional approach to evaluate policies designed to attract new plants is to calculate the number of jobs gained and the cost of the tax breaks etc awarded to firms.

Below some striking examples. It is widely cited that Daimler-Chrysler (former name: Daimler-Benz) received a \$250 million (\$165,000 per job) incentive package for locating in Vance, Alabama (USA), the Toyota plant in Georgetown, Kentucky (USA) was awarded \$200 million (\$80,000 per job) and Boeing was given \$50 million (\$100,000 per job) in tax abatements to locate its corporate headquarters in Chicago, Illinois (USA), the new Airbus plant in Hamburg/ Germany was subsidized by €750

million (€87,000 per job).

It should be noted that aside from the subsidy received by the respective firms, some of public investments or subsidies are wasted. This is because there are regions or cities that took part of the contest but have lost it. In Germany and the Netherlands much examples can be found, where the public investments are bad investments or totally lost, e.g. the Lausitz-Ring in Brandenburg (subsidy €256 million, 50 planned jobs), Communicant in Frankfurt/Oder (subsidy €368 million, 2000 planned jobs).

These examples produce eye-catching statistics, however there are important limitations. First, the calculations are done ex-ante and are rarely verified. Second, and more fundamentally, this approach does not offer a framework for determining whether the policies increase or decrease welfare of the residents of a country. For example, is \$165,000 per job in Vance/ Alabama a good deal for the residents of the USA or is €187,500 per job in Hamburg/Germany a good deal for the residents of Germany?

In this paper we investigate the question if competition between local governments is generally efficient. Without any doubt, attracting an additional firm can locally enhance the welfare, but it need not. This is shown by Greenstone & Moretti (2003) empirically for the US.

Our approach differs from other approaches in some respect<sup>1</sup>. We do not want to give a justification for regional tax or subsidy competition. Our starting point is very different, because we take national welfare into account.

The reason of our approach is, that we do not believe that regional competition will reduce the problems like excessive budgets of the government<sup>2</sup>. Although most politicians claim that regional competition is welfare enhancing for the regions, this cannot be claimed from a national view.

The reasoning is as follows. Suppose, that a firm wants to produce a fixed quantity of goods, it seeks to find the region that is most favorable to produce its goods. Without any doubt, the choice of the firm depends on the specific characters (e.g. wage level, infrastructure, purchasing power of the inhabitants of the region etc.) of the regions. Naturally, the regions are very different and some regions have cost disadvantages from the viewpoint the firms, so it will be difficult to attract a firm. (this is the case for e.g. the low developed regions within the EU.) To compensate this cost disadvantage, regions offers subsidies to the courted firms in order to overcome the disadvantage. However, the reaction of other more favored regions is to offer subsidies also, to avoid being less for the firms. This race of subsidies is like a prisoner's dilemma, where a lot of public money is wasted. Only the profit of the courted firm increases but no additional welfare is gained for the country as a whole. More generally if some of the subsidies in the form of public investments are bad investments, it is welfare decreasing.

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<sup>1</sup> See for e.g. for a survey Glaeser (2001) or Janeba & Schjelderup (2003).

<sup>2</sup> In our view the problem of an excessive budget must be solved in another way. It exists no reason to believe that the problems, which are induced by the distortion of an excessive budget, can be adequately resolved by regional competition in an efficient way. Especially, the results in the literature are not unique with regard to this question. See e.g. Vogel (2000), Oates (2003), Bartik (1994, 2003) and Glaeser (1999, 2001).

As previously remarked, sometimes it is assumed that competition between local governments is welfare enhancing. Tax incentives and local subsidies are able to reduce market distortions (e.g. agglomeration economics, ex-post appropriation of the firms, positive externalities, information problems etc.) and sometimes it is argued that the competition between local governments is harmful (e.g. because of fiscal externalities)<sup>3</sup>. However, these arguments are not convincing. We will show that the value of the offered subsidy depends on different factors, which have nothing to do with efficiency.

Additionally, we argue if there are some positive externalities, we believe there are also some negative externalities like environmental problems, if a firm settles down. From this viewpoint, it seems to be questionable, if a tax reduction would be welfare enhancing.

Our way of reasoning differs in some respects to the usual above mentioned way. To prove and underpin our reasoning we introduce a new approach to model the competition between local governments. The approach is partly based on rent-seeking theory and partly based on conflict theory.

Starting point is that the firm settles down in a region where production cost, given level of output, is lowest. At first it ranks a number of regions that are most favorable. Ranking takes place on the basis of comparative advantage and offered subsidies of the regions in the eyes of the firm.

We assume that firms and regions know this information. Next the firm invites regions, by means of their local governments, to start negotiations about settling down in the region. By inviting more regions the firm assures itself from competition between the local governments. The local government accepts the invitation, and calculates the bid to attract the firm. The local government knows that competing local governments are also invited. Therefore it has to offer the best possible bid. The better the bid compared to the other local governments, the higher the chance to win the contest. Not taking part of the competition will reduce the chance of winning the contest. Calculating the best bid depends on expected payoff. Notice that the local government has knowledge about its comparative advantage with respect to its competitors and it knows how the courted firm values this advantage. In so far, the governments believe that the decision of the firm depends only on the offered subsidy and the known cost advantages<sup>4</sup>. All competing regions will know this and will react in the same way.

Here we assume, that the regions implicitly offer a specific tax rate to a courted firm to attract it. Next the firm will chose for the region on the basis of the best bid that results in the lowest cost.

In the first two sections we analyze two different kinds of competitions between local governments. In the first part we assume that the local governments participate in a competition, where the local governments offer upfront subsidies (e.g. buildings, developed areas, firm-specific infrastructure etc.). That means that the public investments are made before the courted firm settles in the region. In this case all losing local governments have the risk of a bad public investment. This kind of regional competition is omnipresent in Germany and the Netherlands

In the second part we assume that the subsidies are made simultaneously with the investments of the courted firm. (e.g. tax reduction, capital subsidy et cetera). That means that only the winning region have to pay a subsidy. In both sections we will show that the competition is always inefficient from a national point of view. Additionally, we prove that an increasing number of regions will increase the inefficiency.

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<sup>3</sup> See e.g. Garcia-Mila & McGuire (2001), Bond & Samuelson (1986), Janeba & Schjelderup (2003), Wilson (1986), Zodrow & Mieszkowski (1986) and Glaeser (2001).

<sup>4</sup> Naturally, we assume that corruption plays no role.

In the third part we analyze both kinds of competition with regard to efficiency and we prove that it is not clear what kind of competition is preferable with regard to efficiency, given that competition between local governments is unavoidable.

## 2. A simple model

To model the competition between local governments, at first we make some general assumptions. We assume that unemployment is present in all competing regions, but we do not explain the reasons of the unemployment. In order to achieve economic and political objectives the local governments want to maximize their regional gross product<sup>5</sup>. Therefore local governments of cities or regions compete with another to attract firms and companies. In this section, the regional competition is modeled as a rent-seeking competition. Additionally, we assume that the courted firm wants to produce an exogenous fixed output, that is to say the firm maximizes profit or minimizes cost given a fixed output.

The competition is modeled as follows: Each region offers an exogenous given infrastructure or cost advantage  $u_i$  and additionally subsidy and firm-specific investment,  $G_i$ , to win the competition. The infrastructure is defined by numbers of streets, highways, airports, and harbors, which are in the region. The additional investments are specific to the courted firm; they are partly wasted if the region is not able to attract the courted firm. That means that the public investments are sunk costs.

### 2.1 The courted firm

We assume that the courted firm  $m$  searches for a location in a country to settle down and to produce a fixed quantity of goods. That means that the production  $Y_m$ , is given. The production function, of the courted firm  $m$ , is given by the following formula:

$$Y_m = F(L_m, K_m) \quad (1)$$

where the production function fulfills the conventional neoclassical standard assumptions. It is assumed that private capital stock; public capital stock and the given infrastructure are substitutional production factors. The output of the firm is given by  $Y_m$ , the labor-input by  $L_m$ , the capital stock by  $K_m$ . This capital stock consists of the private capital stock  $K_m^i$ , the subsidy of region  $i$ ,  $G_i$  and the given infrastructure or comparative advantage in region  $i$ ,  $u_i$ . This means that the private part of capital stock is given by  $K_m^i = K_m - G_i - u_i$ .

The firm wants to minimize its production costs, where the prize and the quantity of the goods are given. The total cost, of firm  $m$ , given its level of production in region  $i$  is given by

$$TC_m^i = rK_m^i + wL_m = r(K_m - G_i - u_i) + wL_m \quad (2)$$

Where,  $TC_m^i$  is total costs of firm  $m$  in region  $i$

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<sup>5</sup> This assumption is made without any loss of generality and only to simplify the analysis.

This means that the firm will choose the location, where the local government offers the highest subsidy and infrastructure  $G_i + u_i$ .

## 2.2 The local government

The local government, which is assumed to be risk-neutral, tries to attain a regional product<sup>6</sup> as high as possible. In order to do so it wants to attract firm  $m$  by offering a firm specific investment, subsidy and a given infrastructure. This firm specific investment is sometimes referred to as “asset specific” investments. An important problem is that these kinds of investments have high opportunity costs. Of course the more asset specificity of the investments, the higher the opportunity costs. The respective regions will try to estimate the benefits of the firm settling down, and compare this with the opportunity costs of the investments and subsidies. Although the opportunity costs of the investments are known this is not the case with the benefits, because it is not sure that the firm will settle down. To express uncertainty about benefits we will use the term expected pay-off.

We analyze two kinds of competition. In the first case we assume, that the regions make firm-specific investments without knowing if the firm will settle in their regions. That means that all regions have to pay for the investments and only the winning region will get some additional regional product. The expected net pay-off for region  $i$  will amount to:

$$E(PO_i) = p_i Y_m - G_i, \quad i = 1, \dots, n \quad \text{and} \quad \sum_{i=1}^n p_i = 1 \quad (3)$$

where  $E$  is the operator to express the mathematical expectation of a variable,  $PO_i$  is the net pay off for region  $i$ , and  $p_i$  is the probability of firm  $m$  settling down in region  $i$ . To determine this probability,  $p_i$ , a contest success function, which is well known in the rent-seeking and conflict theory literature<sup>7</sup> is used. This will be explained in the next chapter. The variable  $G_i$  represents the opportunity costs of subsidies and specific investment of region  $i$ .

In the second case the regions only offer a subsidy or specific investment to the courted firm and only the winning firm must pay. The expected pay off becomes:

$$E(PO_i) = p_i (Y_m - G_i), \quad i = 1, \dots, n \quad \text{and} \quad \sum_{i=1}^n p_i = 1 \quad (4)$$

The first case is like a rent-seeking competition or like a winner-take-all contest with full liability<sup>8</sup> and the second case is like a winner take all contest with limited liability<sup>9</sup>. Of course, both types of competition will influence the decision making of the firm where to settle down. However looking at both kinds of competition separately we can highlight specific aspects of both kinds of competitions.

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<sup>6</sup> In general the regions want to maximize the number of working-places or tax revenue, but here the production is given and also the number of working-places. As a result it can be assumed without loss of generality that the regions want to maximize the regional product.

<sup>7</sup> See e.g. Tullock (1980), Skaperdas (1996) or Hirshleifer (1989).

<sup>8</sup> This kind of contest can be interpreted as an all pay auction.

<sup>9</sup> This kind of contest can be interpreted as a first prize auction.

### 2.3 The national government

In contrast to the regional view, the national government is interested in maximizing the national domestic product. In the case of a contest with full liability the national pay off is given by:

$$PO = Y_m - \sum_{i=1}^n G_i \quad (5)$$

Which region wins the contest plays no role for the national government, because of the assumption that the firm  $m$  will settle down in the country; only the region or city is unknown. In the case of a contest with limited liability the national pay off is given by

$$PO = Y_m - G_i \quad (6)$$

given that region  $i$  has won the competition. Actually, it does not matter from the national view, which region has won the contest.

### 2.4 The structure of analysis

At first, we analyze both cases when there are two competing regions, which differ with respect to their comparative advantages and infrastructure. We extend the two region case to  $n$  competing regions. After that we assume that there is more than one country in which regions compete for the same firm. Finally, we compare the results of both kind of competition. We restrict our analyses to the competition of regions for attracting one single firm.

## 3. Regional competition with full liability

In this section we assume that the local government makes firm-specific investments to attract the courted firm, without knowing whether the firm will settle down or not. The striking point of this kind of competition is that a region has to invest before the firm decides where to settle. Therefore, the term full liability is used. One more important aspect is that subsidies; the public investments of all losing regions ( $n-1$ ) are lost. To model this kind of competition we make use of the rent-seeking game of Tullock (1980).

The probability that a firm will settle down in a region depends on the level of subsidies and investment of the region and its comparative advantage. The higher the level of subsidies and investments and comparative advantage with respect to competing regions, the bigger the chance the firm will settle down. This can simply be formalized by the following probability function or contest success function, which is taken from Tullock (1980):

$$p_i = \frac{G_i + u_i}{\sum_{j=1}^n G_j + u_j} \quad (7)$$

Contest success functions can be interpreted either as a probability function or as a partition function<sup>10</sup>.

### 3.1 Competition between two different regions

In this section we assume that only two regions ( $i = 1, 2$ ) compete to attract firm  $m$  to settle down in its region. Let us assume that the comparative advantage, for example a better infrastructure, is higher in region 1 than in region 2,  $u_1 > u_2$ . Now region 1 calculates how much investment and subsidies it should offer to attract the firm. Using equation (3), region 1 maximizes the expected net pay off with respect to the offered investment and subsidies:

$$\max_{G_1} \frac{G_1 + u_1}{G_1 + G_2 + u_1 + u_2} Y_m - G_1 \quad (8)$$

We get the following first order condition:

$$G_1 = -G_2 - u_1 - u_2 + \sqrt{Y_m(G_2 + u_2)} \quad (9)$$

Region 2 maximizes

$$\max_{G_2} \frac{G_2 + u_1}{G_1 + G_2 + u_1 + u_2} Y_m - G_2 \quad (10)$$

The first order condition is then given by

$$G_2 = -G_1 - u_1 - u_2 + \sqrt{Y_m(G_1 + u_1)} \quad (11)$$

Equations 10 and 11 are the best response functions of region 1 and 2

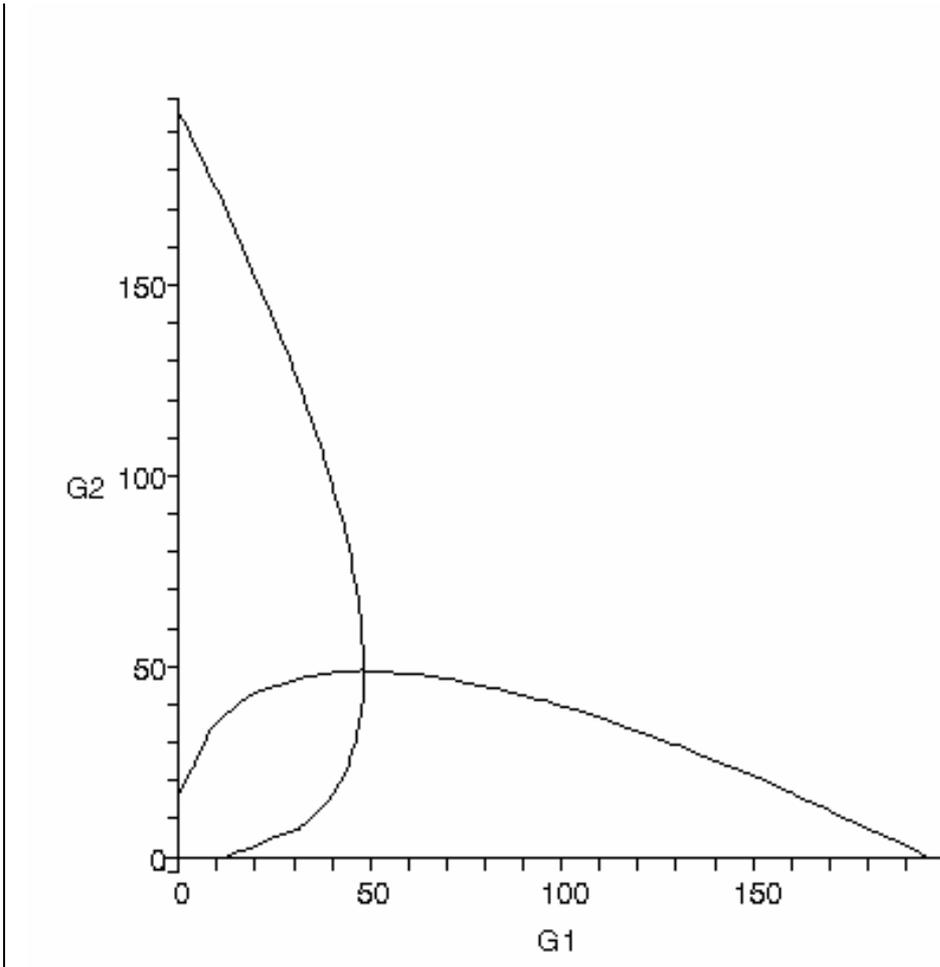
It tells a region what the best response is in terms of investment and subsidies with respect to the investment and subsidies decision made by the competing region. Combining both best response functions and solving for  $G_i$  ( $i = 1, 2$ ) gives the equilibrium quantities of the public investments and subsidies of both regions:

$$G_1^* = \frac{Y_m}{4} - u_1 \quad \text{and} \quad G_2^* = \frac{Y_m}{4} - u_2 \quad (12)$$

One can see that the public investments in region 2 exceed the public investments of region 1, because region 2 wants to compensate its comparative disadvantage ( $u_1 > u_2$ ). To illustrate the above we use the following example,  $u_1 = 1$ ,  $u_2 = 2$  and  $Y_m = 200$ . Using this, the best response curves are calculated. They are depicted in the figure below

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<sup>10</sup> See e.g. Stauvermann (2002).



**Figure 1: Best response curve region 1 and 2 in case of full liability.**

The equilibrium values of investment and subsidies of the two regions is the intersection of the two best response curves. In this example the two equilibrium values are respectively;

$$G_1^* = 48 \text{ and } G_2^* = 49$$

Using equations (12) the equilibrium probability of each region to win the contest becomes:

$$p_i^* = p_1^* = p_2^* = \frac{1}{2} \tag{13}.$$

That means that region 1 by introducing competition loses its advantage. This is possible because region 2 compensates the comparative disadvantage of its region, and so the probability to win the competition is the same for both regions, although region 1 has a comparative advantage with regard to the given infrastructure. Because of  $\frac{Y_m}{4} \geq u_1 \geq u_2$ , the net pay off of region 1 is always higher than the net pay off in region 2. But there is no guarantee that the firm will settle down in region 1, from the view point of the firm it makes no difference if it will settle in region 1 or region 2.

**Lemma:** If  $\frac{Y_m}{4} \geq u_1 \geq u_2$ , then is  $G_1^* < G_2^*$  and  $p_1 = p_2 = p^* = \frac{1}{2}$ .

**Proposition 1:** In this competition between two local governments, the courted firm is indifferent in choosing the optimal location of settlement between both regions, because the profits are the same in both regions.

Proof:

The profits of the firms are implicitly given by equation (2). If we fill in our results from equations (12) and (13) we get:

$$\Pi_m^* = \Pi_m^1 = \Pi_m^2 = F\left(L_m, K_m^i + \frac{Y_m}{4}\right) - r\left(K_m - \frac{Y_m}{4}\right) - wL_m \quad (14).$$

Then the expected pay off of region  $i$  is given by:

$$E(PO_i) = \frac{3}{4}Y_m + u_i \quad (15).$$

The national pay off in this case is given by (notice that that there is no uncertainty with respect to the pay off)

$$PO = \frac{Y_m}{2} + u_1 + u_2 \quad (16).$$

Now we can conclude, that this kind of competition is never efficient from a national viewpoint, because if no region is allowed to pay a subsidy, firm  $m$  would choose region 1 as the favorable location, because of its infrastructure and comparative advantage.

**Proposition 2:** A competition with full liability between two local governments to attract a firm is always inefficient from a national viewpoint.

Proof:

In case of no competition, national pay off would be  $PO^{optimal} = Y_m$  where as in case of

regional competition the pay off is  $PO = \frac{Y_m}{2} + u_1 + u_2$ , which is obvious smaller.

To make this conclusion more clear let us assume that the regions want to maximize the tax revenue ( $TR$ ). That would mean that  $TR = tY_m, 0 < t \leq 1$ . Given that the national payoff without competition would be  $t(Y_m - \frac{1}{2}Y_m + u_1 + u_2) = t(\frac{1}{2}Y_m + u_1 + u_2)$  and in the case with two competing regions it would be  $tY_m$ . This is lower than in the case without competition, because of the assumption that  $u_i \leq \frac{1}{4}Y_m$  holds.

### 3.2 Competition with full liability between $n$ identical regions

Generally there are more than two regions that compete for the settling down of firms. In this extension we investigate the general case with  $n$  ( $n \geq 2$ ) competing identical regions. Consequently, we assume that  $u_i = u, \forall u = 1, \dots, n$ . It is easy to show that in case of  $n$  competing region the optimal public investment equals:

$$G_i^* = G^* = \frac{(n-1)}{n^2} Y_m - u, i = 1, \dots, n \quad (17)$$

Obviously, the offered subsidy decreases as the number of competitors is increasing (see also below). This is caused by the decreasing probability to win the competition.

As in the case with two competitors the optimal investment subsidy has to be positive. Negative offers do not make sense. So we have the following restriction

$$\frac{(n-1)}{n^2} Y_m \geq u \quad (18)$$

Because of the assumption that all regions are identical, the probability to win the contest is given by

$$p^* = p_i^* = \frac{1}{n}, i = 1, \dots, n \quad (19)$$

An increase in competition ( $n$ ) has a negative effect on the optimal offer  $G_i$

**Proposition 3:** If the number of competing regions is increasing, the regional pay off will decrease because the possibility to win will decrease, and the national pay off will decrease, because the number of bad investments is increasing.

Proof:

Inserting equations (17) and (19) into (4) determines the expected regional pay off.

$$E(PO_i) = \frac{Y_m}{n^2} + u \quad (20)$$

This result shows that the regional pay off is decreasing with an increasing number of competitors. Now we calculate the national pay off:

$$PO = n \left( \frac{Y_m}{n^2} + u \right) \quad (21)$$

We see that the national pay off decreases, if the number of competitors is increasing. This is caused by the effect that  $(n-1)$  public investments are bad investments. Notice that if  $n$  gets large the national payoff equals the comparative advantage of a country as a whole (the sum of the comparative advantages of all regions).

### 3.3 The Case of global competition

Next we analyze, what are the consequences if other regions or cities of the rest of the world are also competing to attract firm  $m$ . Here we ignore different taxes, different laws etc.  $N$  represent the number of national regions and  $n$  is the number of all competing regions. The expected national pay off is then:

$$E(PO) = N \left[ \frac{1}{n} Y_m - \frac{(n-1)}{n^2} T + u \right] = \frac{NY_m}{n^2} + Nu \quad (22).$$

This means that the expected national pay off will decrease if the number of foreign competing regions ( $n-N$ ) is increasing.

## 4. Regional competition with limited liability

In this section we assume that the competition is different to the regional competition with full liability. Especially, we assume that only the winning region has to pay the subsidy and there are no costs of all losing regions. In so far the competition is like a first prize auction. We assume that the regions offer a subsidy to attract the firm, but a region only has to pay the subsidy if the firm will settle in the region. If the firm does not settle in the region the losing regions realize no loss. That means that the contest is now a competition with limited liability. The idea of the model goes back to Skaperdas & Gan (1995a, 1995b).

Additionally, it should be noted that the national pay off and the regional pay off is identical, because no public bad investments are possible.

### 4.1 Regional competition between two regions with limited liability

Given this structure of competition, we analyze the same case as in section 3.1. However, because of the changed structure of competition between two regions, the maximization problem of a representative region now becomes:

$$\max_{G_1} \frac{G_1 + u_1}{G_1 + G_2 + u_1 + u_2} (Y_m - G_1) \quad (23)$$

From equation (23), we get the following first order conditions:

$$-\frac{G_1 + u_1}{G_1 + u_1 + G_2 + u_2} + \frac{(Y_m - G_1)}{G_1 + u_1 + G_2 + u_2} - \frac{(Y_m - G_1)(G_1 + u_1)}{G_1 + u_1 + G_2 + u_2} = 0 \quad (24)$$

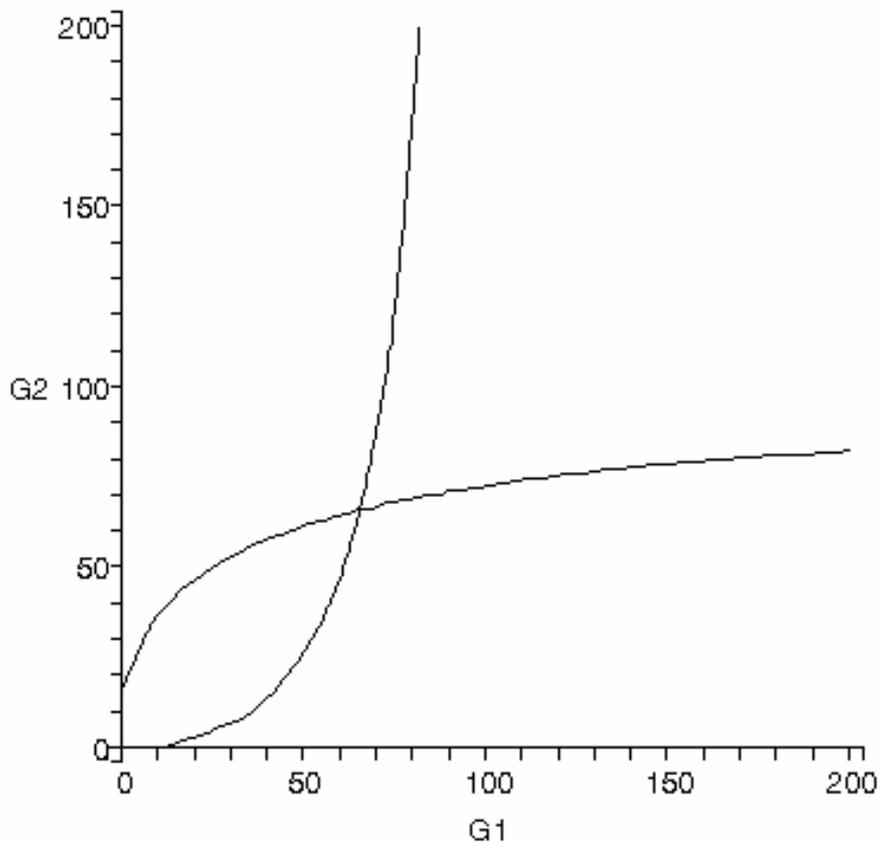
With the help of equation (24) we can derive the best response functions of region one.

$$G_1 = -(G_2 + u_1 + u_2) + \sqrt{(G_2 + u_2)(G_2 + u_2 + Y_m + u_1)} \quad (25)$$

Using the same procedure and maximizing pay off for region 2 leads to the best response function for region two:

$$G_2 = -(G_1 + u_1 + u_2) + \sqrt{(G_1 + u_1)(G_1 + u_1 + Y_m + u_2)} \quad (26)$$

Using the same numbers as in the previous example ,  $u_1 = 2$ ,  $u_2 = 1$  and  $Y_m = 200$ , the two best response curves of both regions results can be calculated. They are depicted in the graph below. In case of limited liability the equilibrium values of investment and subsidies in the two regions are respectively  $G_1=65.3$  and  $G_2=66.1$ , what can be seen in the graph below.



**Figure 2: Best response curve in region 1 and 2 in case of limited liability.**

The analytical solution of this system of two equations is very complex; therefore we make use of the implicit function theorem at the point  $u_i = u, i = 1,2$  to analyze the contest between regions. To do so we first have to find a solution at the point  $u_i = u, i = 1,2$ . That means that we can simply substitute  $u$  for  $u_1$  and  $u_2$

This results in the following system of best response curves for  $G_i, i = 1,2, j = 2,1$

$$G_i = -G_j - 2u + \sqrt{(G_j + u)(2u + T + G_j)} \quad (27).$$

Solving the first order conditions for both regions simultaneously gives the following equilibrium solution of the optimal subsidy or investment:

$$G_i^* = G^* = \frac{Y_m - 2u}{3}, i = 1, 2 \quad (28).$$

Investment or subsidies only make sense if there are positive so we assume that the restriction  $G_i > 0$  holds. This means that:

$$u < \frac{2Y_m}{3}$$

It is now possible to calculate the probabilities of both regions to win the contest:

$$p_i = \frac{1}{2}, i = 1, 2 \quad (29).$$

That means that the firm is indifferent in whatever region settling down. Inserting the probability to win into the expected pay off of the region  $i$  gives:

$$E(PO_i) = \frac{Y_m + u}{3} \quad (30).$$

Now we have to analyze the case of  $u_1 > u_2$ . To do this, we assume that the starting point is at the initial equilibrium point  $u_i = u, i = 1, 2$  and we also assume that  $u_1$  is marginally increased. The starting point is characterized by  $G_i^* = G^*, i = 1, 2$ .

Applying the implicit function theorem we come to the following proposition<sup>11</sup>:

**Proposition 4: (without proof)** In a competition with limited liability between two regions, if the comparative advantage of region 1 exceeds the comparative advantage of region 2, the offered subsidy of region 1 is lower than the subsidy of region 2. and the probability of region 1 to win will exceed the probability of region 2.

That means that the region with the greatest comparative advantage has the highest probability to win the competition. If the comparative advantage of region 1 increases, the offered subsidy of region 1 will decrease and the offered subsidy of region 2 will increase in order to compensate for the comparative disadvantage. In general, this means that the offered subsidy of region 2 is higher than the offered subsidy of region 1. However, the probability to win of region 1 is higher than the probability of region 2.

## 4.2 Competition with limited liability between n identical regions

We extend the analysis to  $n$  ( $n \geq 2$ ) identical regions, which compete to attract a firm to settle in their regions. Using the approach above, we get the following equilibrium results:

$$G_i^* = G^* = \frac{(n-1)Y_m - nu}{2n-1}, \forall i = 1, \dots, n. \quad (31)$$

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<sup>11</sup> The authors will send the interested reader a mathematical appendix on request.

Investment or subsidies only make sense if there are positive so we assume that the restriction  $G_i > 0$  holds. This means that:  $u < \frac{(n-1)Y_m}{n}$

It follows directly, that

$$p_i^* = p^* = \frac{1}{n}, i = 1, \dots, n \quad (32)$$

Now we analyze how the optimal offer will react, if the number of regions will change. Therefore we take the first derivative of the optimal offer (31) with respect to the number of regions ( $n$ ).

$$\frac{\partial G^*}{\partial n} = \frac{(Y_m + u)}{(2n-1)^2} > 0 \quad (33)$$

It is positive so if the number of competing regions is increasing the optimal offer of each region will rise. That means that the expected pay off of the regions decreases with the number of competitors while the profit of the firm increases with the number of competitors. The profit will increase, because the payments from the winning region are higher if the numbers of competitors are higher.

In the  $n$ -competitors case the expected pay off region  $i$  is give by:

$$E(PO_i) = \frac{(Y_m + u)}{(2n-1)} \quad (34)$$

The national pay off in this case is identical to the actual regional payoff of the winning region.

$$PO = \frac{n(Y_m + u)}{2n-1} \quad (35)$$

Obviously, the regional and national pay off decreases with an increasing numbers of competitors, because the offered subsidy increases with an increasing number of competitors.

### 4.3 Global competition with limited liability

Let us assume that the number of national competing regions is  $N$ . In this case, the national pay off becomes to an expected national pay off, because the probability that firm  $m$  will settle within this country is given by  $\frac{N}{n}$ . We assume, that all countries are similar with regard to the wage level, interest rates, and taxes etcetera. All other variables remain unchanged, because from the regional view it makes no difference if its competitor is outside the country. The expected national pay off is given by

$$E(PO) = \frac{N}{n} \left( Y_m - \frac{(n-1)Y_m - nu}{2n-1} \right) = \frac{N(Y_m + u)}{2n-1} \quad (36).$$

Not surprising, we can conclude that the expected national pay off decreases if some of the competing regions are from abroad.

## 5. A comparison between both kinds of competition

In this section we compare the results from section 3 and 4 we try to find out, which kind of competition is favorable from the regional view, the national view and the firm. To do this we conclude our results table 1:

**Table 1:**<sup>12</sup>

	Competition with full liability between n identical regions	Competition with limited liability between n identical regions	No subsidy
$G_i^*$	$\frac{(n-1)}{n^2} Y_m - u$	$\frac{(n-1)Y_m - nu}{2n-1}$	0
$p_i^*$	$\frac{1}{n}$	$\frac{1}{n}$	$\frac{1}{n}$
$E(PO_i)$ regional	$\frac{Y_m}{n^2} + u$	$\frac{(Y_m + u)}{(2n-1)}$	$\frac{Y_m}{n}$
$PO$ national	$\frac{Y_m}{n} + nu$	$\frac{n(Y_m + u)}{2n-1}$	$Y_m$
$E(PO)$ with N national competitors and (n-N) foreign competing regions	$\frac{NY_m}{n^2} + Nu$	$\frac{N}{2n-1} (Y_m + u)$	$\frac{N}{n} Y_m$
The cost saving of firm m ( $G_i + u$ )	$\frac{(n-1)}{n^2} Y_m$	$\frac{(n-1)Y_m + n(3u-1)}{2n-1}$	u

If we compare the results, it is easy to see that the probability to win the competition is always  $\frac{1}{n}$ , independent of the kind of competition. Now we compare the three kinds of competition with regard to efficiency. Here, efficiency means a state of a world, where the national gross product is maximized. Obviously, it is clear that only in a world without subsidy the efficient market outcome can be reached. In so far a world without subsidies is superior to a world where the regions offer subsidies to the firms.

**Proposition 5:** Any kind of regional competition is inefficient from the viewpoint of the national government, if all competing regions are parts of the country.

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<sup>12</sup> Please note that the results for a competition with full liability are only correct if  $u < \frac{Y_m(n-1)}{n^2}$  and the results for a competition with limited liability are only correct if  $u < \frac{Y_m(n-1)}{n}$ . If the condition does not hold, we get equilibrium at a corner.

The problem is, if any region offers a subsidy to a firm all other competing regions must also offer a subsidy to the courted firm to keep the change to win the competition. This is a prisoner's dilemma, because for each local government it seems to be profitable to offer a subsidy to attract the courted firm.

If we compare a competition with full liability with a competition with limited liability with regard to the efficiency criterion, we see that the result depends on the number of competitors. To see this, we compare the national pay offs from the fifth row in table 1.

$$\frac{Y_m}{n} + nu > \frac{n(Y_m + u)}{2n - 1} \quad (37)$$

We get the result, that a competition with limited liability is preferable, if  $n < \frac{Y_m + \sqrt{Y_m^2 - 8Y_m u}}{4u}$ . If the contrary holds, a competition with full liability is preferable.

The reason is that the offered subsidies in a competition with limited liability increase, if the number of competitors increases. In a competition with full liability, the offered subsidies are decreasing when the number of competitors increases.

**Proposition 6:** From the viewpoint of efficiency a regional competition should be a competition with limited liability, if the number of competitors is sufficiently small. If the number of competitors is sufficiently large, competition with full liability is preferable.

Until now we have assumed that all competing regions are a part of one country. Now we look at the case, where a part of the competing regions are foreign regions. Under these circumstances a national government prefers competition with limited liability, if the comparative advantage  $u$  is sufficiently large. Especially, the following condition must hold:  $u > \frac{(n-1)Y_m}{2n^2}$ .<sup>13</sup> If this condition does not hold the national government prefers a competition with full liability.

Now we know what is desirable from the national viewpoint, but does it mean anything with respect to the question what kind of competition will be chosen? Probably not, because firm  $m$  is able to invite tenders for its settlement and the firm is free to decide how to do it. This is an incentive for regions to offer a subsidy to attract firm  $m$ . The firm will choose the kind of competition that will generate the maximal cost-savings. If we look at table 1 we see, that the cost saving will be maximized, if the competition is a one with limited liability. This is obvious, if we look at the differences between the cost-savings:

$$\frac{(n-1)Y_m + n(3u-1)}{2n-1} > \frac{(n-1)}{n^2}Y_m > u \quad (38)$$

The difference between the second and the third term is based on the assumption about  $u$ . The difference between the second and first term becomes:

$$\frac{(1-n)(n^2(Y_m + u) + Y_m(1-2n))}{n^2(2n-1)} < 0 .$$

<sup>13</sup> To get this condition, we compare the expected national pay offs in the 6th row in table 1.

That means that firm  $m$  always will prefer a competition with limited liability. It follows that the firm will always specify the call of tenders as competition with limited liability. The reason is obvious, because the offered subsidy is lower if a region must take into account the risk of losing money if competition is organized in a full liability way. The most governments anticipate this and the result is that we observe mostly competitions with limited liability in the competition between regions and cities.

**Proposition 7:** The courted firm has the power to force the regions into a competition, where the subsidies are decisive. The firm always compels the regions into a competition with limited liabilities, where its cost saving is maximized.

## 6. Conclusion and further research

Only if it is forbidden to offer a subsidy in a competition between regions, the efficient outcome will be reached. But the efficient outcome will not be reached, because the regions have no possibilities to influence the kind of competition, especially if we think about regions in different countries. Our results coincide with the reality in the European Union. Mostly, all competitions between regions to attract a firm are organized as competitions with limited liability. As long as the unemployment rates are high, the regional and national governments are compelled to accept this kind of competition, although it is inefficient. If it is not allowed to introduce penal duties and similar trade restrictions, because of the WTO agreements or EU agreements the governments are captivated in a prisoner's dilemma.

The consequences are alarming for the developed countries, because our results mean that international competition between regions has strong consequences for the welfare of the working people in the developed countries and social security in these countries. This is caused by the fact that the governments are compelled to reduce industrial safety, protection of the environment and social security. These reductions could be interpreted as an enhancement of their international competitiveness.

Especially, if some of the international competitors are dictatorships or less democratic than European countries like China or oligarchies like in south-east Asia, it is clear that a catch-up between the developed and low-developed countries will lead to an adjustment of the level of social security, industrial safety, environmental protection policy in the developed countries on a very low level.

A similar dangerous development threatens the members of the European Union, now the new members of East Europe have joined the EU in May 2004. The standards of social security, environmental protection, and industrial safety are much lower in the new member states than in the old member states. Additionally, the regions in the new member states are allowed to give higher subsidies to attract firms than the regions in the older member states. Additionally, in the following 10 years the labor mobility between the old and new member states is restricted. However, this strengthens the argument. It must be feared that the increasing competition between more regions will lead to more inefficiencies.

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