РОЗДІЛ 2

Інноваційні процеси в економіці

The Welfare Effects of Regional Competition with Infrastructure Projects*

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In this paper, we analyze the competition between regions, where regions have the opportunity to invest in infrastructure to attract firms. Here we take airports as an example for infrastructural investment. We will show that in a model with two regions and monopolistic competition, the regional competition will lead to inefficiencies and bad investments, even though investments in airports are in general an important and useful public investment opportunity. However, the regional competition leads to oversized investments.

Keywords: regional competition, infrastructure, regional development, subsidies.

УДК 332.1 *JEL Codes:* H54, H23, O18

1 Introduction

Without any doubt the available infrastructure – like roads, ports and airports – is an important factor for companies to settle or to stay in a specific region. A well-developed infrastructure lowers the transaction costs of firms and hence makes them also more competitive.

Therefore, the European Union (EU) supports European regions with its structural funds to improve the regional infrastructure. Additionally, it is in the declared objective of the EU to enhance the competition of European regions, because the underlying idea is that competition will increase the efficiency of resource allocation and the competitiveness of the EU on aggregate.[1] From the view of the EU and its member states, the support of less-developed regions seems to be a way to increase the speed of convergence of European regions. The EU has set up the European Regional Development Fund (ERDF), the European Social Fund (ESF) and the Cohesion Fund, to reach three objectives: economic convergence, enhancement

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• *We have thank Gert-Jan Hospers, Carlie Geerdink, Bert Steenge and Sereyvath Ky for helpful comments and suggestions. All remaining errors are ours. Peter J. Stauvermann acknowledges the financial support of the Changwon National University in 2017-18.*

[1] According to Krugman (1994), this view of competiveness is nothing else than a ‘dangerous obsession’ of policy-makers.

of regional competiveness and employment opportunities and territorial cooperation. The overall budget of the funds was around 347 billion EUR for the period 2007-14. A region will get support from these funds, if it applies for support and certain conditions are met. It is in the hand of regional and local policy-makers how much support they will get.

The justification for giving subsidies is based on the general believe in politics that attracting additional firms will cause positive externalities in the sense of Arrow (1962)[2] and of course will directly create jobs and an additional tax revenue in the long run. Additionally, it is a general believe in politics that competition between regions will enhance the efficiency of local authorities and local administration.

Certainly, airports are a means to create positive externalities and to attract additional firms, but airports also have – to some extend – the characteristics of natural monopoly (Macário and Silva 2009, Button and Taylor 2000). However, if local and regional policy-makers are eager to attract additional firms by offering the infrastructure for aviation and not taken into account the behavior of competing regions, then at the end the question remains whether this policy is welfare increasing or maybe welfare decreasing.

To answer this question we have developed a new model, which is based on well-known economic theories. To incorporate positive externalities created by new firms we use the model of Stauvermann (1997), who modified an approach of Romer (1990), which is based on the ideas of Dixit & Stiglitz (1977). The fundamental idea of this model is that an increasing diversity of intermediate goods will increase the productivity of all existing intermediate goods producing firms.

To model the behavior of policy-makers we make use of the so-called "information cascades" model, which is based on Bannerjee (1992) and Bikhchandani, Hirshleifer & Welch (1992). This approach explains why, under uncertainty, it is rational to copy the behavior of other agents.

To explain the competition between different regions we apply an approach, which goes back to Hirshleifer (1989) and Skaperdas (1996)[3]. We will show why such a competition between regions emerges and probably will fail in the sense that it does not contribute to economic welfare, but instead creates only economic distortions. Here we take an airport as a means of regional competition into account. Our approach is related to the contributions of Geerdink & Stauvermann (2008), Geerdink, Stauvermann & Steenge (2010) and Geerdink (2010). In the second section we will go into the empirics of the situation in Germany and especially the situation in North-Rhine Westfalia (NRW). In the third section we explain the behavior of regional policy-makers; in the fourth we model an economy consisting of two regions. The fifth section contains an analysis of the regional competition of these regions, whereby the welfare effects of this competition are derived. Finally, we conclude the results in section six.

2 Some Empirical Facts

In this section, we want to take a short look at the economic reality of airports, their economic impacts and subsidies. We concentrate on the airports in Germany and then as a reference case on the German region North-Rhine Westfalia. We know that there are many other regions around the world, which are confronted with similar economic problems. For example, in 2001 the overall public support for airports added up to EUR 158 million in

[2] See below for an explanation.
[3] For an overview and details see Stauvermann (2012), Garfinkel & Skaperdas (2006) and Konrad (2007).

Germany[4], and in 2009 the US federal government[5] supported airports with US-$ 182.9 million. Most of these subsidies went to small airports.

In general, it is obvious that air traffic has positive impacts on economic activity and growth (Chin and Tay 2001, Ishutkina and Hansman 2009, Marazzo et al. 2010, Chi and Baek 2013, Profillidis and Botzoris 2016).

The Air Transport Action Group (ATAG) (2008) calculated that in 2006 the air transport industry was responsible for around 32 million jobs worldwide, whereby 26.5 million jobs are located outside the air transport industry, 35 % of the trade value worldwide[6] and 7.5 % of the world Gross Domestic Product. According to ATAG (2008), 29 % of all passengers and 18 % of all airfreight (in tons) worldwide were attributed to Europe in 2006.

In so far it is not surprising that investments in airports in low developed countries lead to high rate of returns, even if the direct returns by investors and users are not taken into account. For example, the International Aviation Transport Association (IATA) (2008) estimated the annual rate of return of aviation investments in Kenya to 59%, in Cambodia to 19 %, in Jordan to 28%, El Salvador to 16% and Jamaica to 16%. However, the rate of return depends strongly on the increase of national and international connectivity[7] generated by aviation investments. This relationship will become clear by the following example: the growth of aviation services between Poland and the UK between 2003-06 has increased the connectivity of Poland as percentage of its GDP by 27 %, whereas the connectivity as percentage of the GDP of the UK rose only by 0.5 %, because the UK was very well served by aviation before 2003. As a consequence, the additional boost of GDP generated by aviation investments is $ 634 million per year in Poland and only $ 45 million per year in the UK. Obviously, the aviation industry is confronted with decreasing rates of return with respect to the number of airports. However, the IATA (2006) estimates that an increase of 10 % of the connectivity of EU countries will lead to a long-run GDP increase of 1.1 %.

Oxford Economic Forecasting undertook a survey of 625 businesses in China, Chile, USA, France and Czech Republic to analyze their use of air services and the value they place on air network. The firms stated that 25 % of their sales depend on good air transport links, regarding high technology sectors it is 40 %. Further on, 80 % of the firms reported that air services are important for the productivity of production, where 50 % of the firms reported that air services are vital for their business.[8]

With respect to Germany, ECAD (2008) undertook a survey of 100 businesses in Germany and reported similar results.[9] According to the survey:

- 86 % of the firms reported that the availability of air services is very important for their business;
- therefore, the availability of air services is the third most important factor for their choice of location;
- 97 % of the firms use passenger flights for business trips and 32 % for freight transport;

[4] See Hopf, Linke & Ladewig (2001) and own calculations.

[5] See U.S. Department of Transportation Office of Aviation & International Affairs (2010a, 2010b) and own calculations.

[6] Only 0.5 % of the volume of trade shipments (measured in tons) are transported by air transport.

[7] Connectivity is defined as (number of destinations x frequency x seats per flight weighted by the size of destination airport)/1000. The denominator is a scale factor. The indicator measures the number of available seats to a particular destination in a certain period, where the available seats are weighted by the size of the destination airport.

[8] See IATA (2006).

[9] The 95% confidence interval leads to a range of deviation of +/- 6-10% of the results.

- the time distance between the most used airport and firm location is for 87 % of the firms less than 40 minutes.

Additionally, ECAD (2008) estimates that the elasticity of direct investment per worker regarding the aviation connectivity is 0.12 %, the elasticity of employment regarding aviation connectivity is 0.22 %, the elasticity of the labor productivity with respect to connectivity is 0.65 % and the elasticity of number of patents with respect to the connectivity is 4.96 %.

These results lead to the conclusion that the aviation connectivity is crucial for the economic performance of a region.

Germany has 39 civil airports, which are able to handle international flights. Seven or 17% of these airports are located in NRW, where NRW represents 9.5 % of the total area in Germany, 21 % of the German population, 22 % of Germany's GDP. Because of the fact that the region is disproportionately small, the distances between these airports are also small, which leads to strong competition between the airports; therefore, the connectivity is only slightly increased. For example: the distance between the airport Dortmund (DTM) and the Airport Dusseldorf International (DUS) is only 64 km and a train or car needs between 30-40 minutes to go from one to the other. Table 1 represents the distances between the airports in NRW, the share of passengers of each airport related to all NRW flights, the share of flights of each airport to all NRW flights, the number of employees in 2014 and the profits in 2015.

As we see in the last row, only the airports Cologne-Bonn (CGN) and Dusseldorf International (DUS) realize sustainable profits, where it should be noted that CGN is the third biggest freight airport in Germany. In so far DUS and CGN are in some sense complements. Except, DUS and CGN all other airports depend strongly on the activities of low-cost carriers like Ryanair, Easy Jet, Wizz Air, Airarabia, Sun Express, Germanwings, Air Berlin, TUIfly, and so on.

Table 1

Distances between airports, utilization and shares of passengers and flights

Distances between airports								Number of employees (2014)	Share pass. (2014)	Share flights (2014)
Airports	DUS	FMO	DTM	NRN	PAD	ESS	CGN			
DUS	0	113	64	56	134	17	54	16,556	0.52	0.45
FMO	113	0	69	122	86	96	146	1600	0.05	0.08
DTM	64	113	0	102	70	49	80	1679	0.06	0.08
NRN	56	122	102	0	171	60	108	603	0.02	0.02
PAD	134	86	70	171	0	119	132	369	0.03	0.08
ESS	17	96	49	60	119	0	61	0.0	0.00	0.00
CGN	54	146	80	108	132	61	0	12,500	0.31	0.30
pre-tax operational profits[10] (million EUR) 2015	53.7	-3.8	-17.9	2.0	-2.5	-0.9	5.1	Total employees: 33,307	Total passengers: 34.09 million	Total flights: 512.021

[10] In the past 15 years the yearly profits were very similar.

The disadvantage regarding these airlines is, that they often want to be subsidized by the airport, and that they do not offer a network or connection flights, and therefore are less attractive for business flights. Hence, the effect of these airlines on the index connectivity is low. If, for example, the Flughafen Niederrhein (NRN) would lose Ryanair as a customer, it would lose around 98 % of all flights.

Additionally, it should be noted that all investments of the airports PAD, DTM, ESS, NRN and FMO were financed by public money; except NRN all airports are owned by public entities and all airports are highly indebted.[11] We have to conclude that a ruinous competition between the airports takes place in NRW and that public resources are misallocated and wasted. The main reason for these inefficiencies is the competition between the different regions of NRW, which are very close to each other. In the next section we will show that this kind of inefficiency always occurs, if competition with the help of public infrastructural investments is like a zero-sum game; that is the case, if the regions are close to each other. However, this problem does not only occur in this specific part of Germany: all other regional airports realize losses as well. For example, also the UK faces this problem, where the airports Blackpool, Cambridge, Manston and Plymouth were closed in the last years.[12]

3 Herd Behavior of Policy-Makers, Innovations and Welfare Gains

The decision of a firm to settle down in a specific region is determined by the expected profits, which it will realize after settlement. For policy-makers, the overall impact of attracting companies from outside on regional welfare is of major importance. Typically, policy-makers measure the regional welfare in terms of the regional aggregate income. Therefore, policy-makers should consider all regional income effects, generated by attracting an additional firm. In general, we can expect the settlement of new firms to create positive externalities and spillovers, which influence the overall economic outcome of a region positively. Policy-makers have an intrinsic incentive to attract new firms, because it leads to a higher employment rate, an increase of the regional income and therefore the tax basis, and at a consequence of these positive economic effects, the policy-makers' probability to become reelected increases.

According to the models of new growth theory, new firms create positive externalities, which are reflected by a decline of the average production costs of settled firms already operating in the region. Because of these advantages, most regions in Europe and the USA are offering subsidies in terms of public infrastructure investments, like construction of roads, airports, ports and so on. However, policy-makers are confronted with the fact that they do not know ex-ante which kind of firms will generate the highest additional regional income, because the positive spillover effects differ from industry to industry.

To model this policy problem, we assume that policy-makers are risk-averse regarding their own position, but they are at best risk-neutral regarding public expenditures, because even if the expenditures are wasted, they will be not personal liable. Without any doubt, policy-makers do not want to waste taxpayer's money; but it can happen, and to what extent they will be made politically liable for a failure case-dependent. The underlying reason is that

[11] Even though NRN is for the most part in private ownership (99.93 %), the private owner financed his investments with a credit from public entities. Until now, the private owner was not able to pay back the credit. The credit of around 26.5 million EUR itself is secured by a mortgage effected on the airport. Thus, from an economic view, the airport is in fact in public ownership.

[12] See The Economist-ups and downs, 28th January, 2016. http://www.economist.com/news/britain/21689632-despite-rising-demand-flights-small-airports-are-closing-ups-and-downs.

voters cannot judge about the absolute performance of policy-makers; they can only judge about their relative performance. If the majority of regional policy-makers fail, then it is less spectacular as if only one policy-maker fails, who applied a different policy than the majority of other regional policy-makers. In the latter case, the policy-maker is incompetent in the view of the voters and will probably not be re-elected. If all regional policy-makers fail, the voters will accept the failure as a kind of accident or inevitable destiny. In the view of the voters, the responsibility of the regional policy-maker is minor, because policy-makers in other regions did not perform better. Therefore, the best strategy of a policy-maker is to copy the behavior of other policy-makers – to follow the "herd". With respect to their own re-election, the relative performance resulting from their policy is important. Consequently, policy-makers have an incentive for "herding". This kind of behavior is well known in financial and behavioral economics (see e.g. Bannerjee (1992), Bikhchandani, Hirshleifer & Welch (1998), Bikhchandani & Sharma (2001), Anderson & Holt (1996)).

To illustrate herd behavior, we adopt an example from Bannerjee (1992). A husband and his wife are searching for a good restaurant in an unknown city. They are walking in a street with two restaurants, of which they do not know the quality. During the time, they are discussing where to go, and suddenly they notice that other people are entering one restaurant. Because of this observation, they will adjust their beliefs about the quality of the two restaurants. After observing people entering one of the restaurants, they will assume that the quality of that particular restaurant is superior. Let us now assume that the husband has to decide where to go. If the husband would choose the restaurant without customers and the meal would taste bad, the wife would argue that he could have known that the quality of this restaurant is bad, because nobody else is visiting it. However, if the husband would choose the overcrowded restaurant and the meals taste bad, the wife would argue that the meals do taste not so good, but that it is probably the best restaurant in town. In the former case, the husband runs into trouble with his wife, and in the latter, his wife assumes that her husband cannot be hold responsible for the bad food. Given these considerations, the husband will always choose the overcrowded restaurant. It is rational to follow previous decision makers and to copy their behavior, because on average it is the most successful strategy. The disadvantage of this strategy is that the couple has to stay in an overcrowded restaurant while the herd can be wrong regarding its choice.

This behavior can also be observed regarding the behavior of regional policy-makers: if all decision makers were trying to attract a firm by offering an extended infrastructure, the expected pay-offs will decrease. If everybody is betting on the same horse, the pay-off gets rather low. The logic behind that is that the number of attractable firms is rather limited and in so far the competition between regions is like an auction. The fundamental problem is that the additional information gathered by policy-makers may lead to information cascades, which lead to "herd" behavior – that means the copying of the policy of the successful regions.[13] Do regional policy-makers really behave like it is described above with respect to investments in airport infrastructure? The answer is yes, and this has some good reasons. The first is: many impact studies on the economic effects of airports from all around the world are available and the studies mostly conclude that airports create huge positive externalities. Thus, an interested policy-maker will get the impression that investments in airports will be highly profitable. Additionally, if one policy-maker would refuse to enter the competition while the policy-makers in neighboring regions do enter, then the former policy-makers will come under

[13] See for formal proof Geerdink (2010) or Geerdink & Stauvermann (2008).

political pressure exerted by the political opposition. Observing the obvious success of the neighboring region (because of a missing competitor), the political opposition will argue that the regional government has wasted an opportunity of development. Moreover, a third aspect is based on policy-maker's psychology. An airport is of high prestige in the public and if it operates successfully, the name of the policy-maker will be high-lighted in history books and encyclopedias. In so far, investments in airports are more preferable from the policy-maker's view than investments in the improvement and maintenance of roads, bridges or train tracks.

4 Firms, Innovations and Welfare Gains

In this section, we develop a model of regional competition and monopolistic competition between firms. Without loss of generality, we assume that only two identical regions, together representing the total economy, compete to attract one firm, where an airport induces regional spillover effects.[14] From the consideration of the former section, we assume that an airport is the preferred infrastructure-project of the regions. Before we investigate into the competition of the regions, we look at the economic impacts of an airport. In general, airports generate four effects: the direct effect, the indirect effect, the induced effect and the catalytic effect. The direct effect is created by the investments, the production and employment generated by on-airport firms and visitors. The indirect effect is created by economic off-airport activities resulting from the demands of on-airport activities, and the induced effect is generated by multipliers of re-spending the flow of incomes generated through the direct and indirect effects.[15] For simplicity, we assume that these effects are distributed equally between the two regions. Usually, the fourth effect, which is called the catalytic effect, is a result of spillover effects on the supply-side of the economy, for example increased investment and productivity improvements. To make the catalytic effect tractable, we assume that the productivity of all settled firms in both regions will increase by the same factor and we assume that the additional investments are represented by the settlement of the attracted firm, which also induces a positive spillover effect on the supply-side of the total economy. Of course, these assumptions are only fulfilled as long as the two regions are close to each other or - in other words - that one airport could serve the whole country.

Therefore, we have to compare two scenarios, and the different outcomes for the regions and the whole economy. The first scenario is: there is only one airport in the whole economy, located in one of the two regions. In the second scenario the country has two airports, one in each region. From the point of view of the regions, the crucial aspect is where the additional firm will settle. From a national perspective, this does not matter. Here we will specifically pay attention on the role of the additional firm and its contribution to the overall regional and national economic activity. An important aspect of an additional firm is the appearance of positive externalities. These externalities can lead to an overall decrease in the average costs of other firms. This increases the productivity of both, the region and the nation, whereby only the former is in the focus of regional policy-makers. We use an idea of Stauvermann (1997), which is based on Romer (1989, 1990) to model our economy.

There are three basic features underlying the Romer model. The first one is that technological change lies at the core of economic growth. The second is that technological change is based on additional knowledge. Knowledge differs from other economic goods: it is a non-rivaling good and can be accumulated without bounds per capita. Treating knowledge as

[14] It is no problem to extend the number of regions and the number of new firms.
[15] See ACRP (2008) and ECAD (2008).

a non-rivaling good makes it possible to incorporate externalities[16]. The third premise is: the new firm owns additional knowledge, which is represented by a patent. Consequently, we consider monopolistic competition. To model this, we use a standard Dixit & Stiglitz (1977) model of monopolistic competition in line with Romer (1990). The purpose is to find out the gains of an additional firm settling down in the region. The economy consists of two sectors; a final good sector, which is producing under perfect competition and an intermediate goods sector, which is producing under monopolistic competition. The aggregate production function of the final goods sector can be represented by:

$$Y = L^{\alpha} \sum_{j=1}^{m} k_j^{1-\alpha} \ . \tag{1}$$

Aggregate labor input of the final goods sector is represented by L. Next to that, this sector uses the quantity of k_j units of intermediate inputs, interpretable as capital goods, which are depreciated within one period by 100 %. These *m* intermediary goods are produced by *m* firms, where *m* should be an even number for simplicity. The production function is additively separable in the different types of intermediate goods. Without loss of generality we normalize the price of the final product to one. Then the following profit maximization problem for the final goods sector with respect to labor and intermediate goods results:

$$\max_{L,k_j} L^{\alpha} \sum_{j=1}^{m} k_j^{1-\alpha} - wL - \sum_{j=1}^{m} p_j k_j \ . \tag{2}$$

We get the following first order conditions:

$$w = \alpha L^{\alpha-1} \sum_{j=1}^{m} k_j^{1-\alpha} \tag{3}$$

and

$$p_j = L^{\alpha}(1-\alpha) k_j^{-\alpha}, \ \forall j \in \{1,...,m\}. \tag{4}$$

Because of perfect competition in the final goods sector, the profits will be zero and the wage rate equals the marginal product of labor and therefore is the same for each firm. Equation (4) represents *m* inverse demand functions of the final good sector for each of the *m* intermediate goods.

For the intermediate goods sector we assume each producer of an intermediate good to be a monopolist. The rationale behind the monopoly is the following: after having invested in developing an innovation, each producer of an intermediate good holds an infinitely lasting patent. Because of the fact that there are many intermediate goods producers, the market structure results in monopolistic competition on the intermediate goods market. Further, we assume that one intermediate good is produced using one unit of final output. Additionally, we

[16] Arrow (1962) and Lucas (1988) developed similar ideas.

assume that a fixed investment of F_j units of the final product is necessary to invent one new type of intermediate good. This results in the following total cost function of a producer *j*;

$$TC_j(k_j) = k_j + F_j. \tag{5}$$

All intermediate goods producing firms maximize their profits. This leads to the following maximization problem of the *j*-th intermediate goods producing firm:

$$\max_{k_j} p_j(k_j)k_j - k_j - F_j = \max_{k_j}(1-\alpha)L^{\alpha}k_j^{1-\alpha} - k_j - F_j \quad \forall j \in \{1,...,m\}. \tag{6}$$

Substituting $p_j(k_j)$ by equation (4), leads to the necessary condition of this maximization problem:

$$(1- a)^2 L^a k_j^{- a} - 1 = 0, \ \forall j \in \{1,...,m\}. \tag{7}$$

Let us now normalize *L* to one. Because the symmetry of all *m* intermediate goods firms, we derive the equilibrium values for all intermediate good firms:

$$k_j = \bar{k} = (1- a)^{\frac{2}{a}} L, \ \forall j \in \{1,...,m\}. \tag{8}$$

Because of the symmetry of all *m* firms, we can add up all intermediate goods used in the production of the final goods.

$$\sum_{j=1}^{m} k_j = m\bar{k} = m(1-\alpha)^{\frac{2}{\alpha}} L = \overline{K}. \tag{9}$$

Substituting (9) into the final goods production function (1), we get:

$$Y = m(1- a)^{\frac{2(1- a)}{a}} L. \tag{10}$$

Now we are able to calculate the equilibrium prices of the intermediate goods. Inserting equation (8) in equation (4), we get the following result:

$$p_j = \bar{p} = \frac{1}{1- a}, \ \forall j \in \{1,...,m\}. \tag{11}$$

Given this result, we are able to calculate the profit of an intermediate goods firm:

$$\pi_j = \bar{\pi} = \frac{\alpha}{1-\alpha}\bar{k} - F_j = \alpha(1-\alpha)^{\frac{2-\alpha}{\alpha}} L - F_j, \forall j \in \{1,...,m\}. \tag{12}$$

Consequently, the equilibrium wages are given by:

$$w_m = m\alpha(\bar{k})^{(1-\alpha)} = m\alpha(1-\alpha)^{\frac{2(1-\alpha)}{\alpha}}. \quad (13)$$

Please note: the wage rate depends on the number of existing intermediate goods firms. Therefore, we have attached the subscript to the wage rate to indicate the number of intermediate goods firms. Now we have determined all equilibrium prices and quantities of the static model.[17] From the perspective of a policy-maker, the aggregate income of a region is an indicator for its welfare. The aggregate income is given by the sum of the wages plus the profits of the intermediate goods sector. From (13) we can derive the national wage income:

$$W_m = Lw_m = m\alpha(1-\alpha)^{\frac{2(1-\alpha)}{\alpha}} L. \quad (14)$$

The regional total wage income W_m^i of each region i=1,2 is the half of it, because of the assumed identity of both regions. Let us define Y_m as the national net income and $Y_m^i = \frac{Y_m}{2}$ as the regional net income of region *i*, if *m* intermediate goods firms are operating in the country. Then the national income equates to the sum of the total labor income plus the aggregate profits of the intermediate goods sector.

$$Y_m = m\alpha(1-\alpha)^{\frac{2(1-\alpha)}{\alpha}} L + m\alpha(1-\alpha)^{\frac{2-\alpha}{\alpha}} L - mF = m\left(\alpha L\left((1-\alpha)^{\frac{2(1-\alpha)}{\alpha}} + (1-\alpha)^{\frac{2-\alpha}{\alpha}}\right) - F\right). \quad (15)^{18}$$

Obviously, the national income depends positively on the number of intermediate goods producing firms and the labor supply. For convenience, let us define:

$$\Omega \equiv \alpha\left((1-\alpha)^{\frac{2(1-\alpha)}{\alpha}} + (1-\alpha)^{\frac{2-\alpha}{\alpha}}\right). \quad (16)$$

5 Regional competition

Before we model the regional competition, we have to calculate the payoffs of the competition. Let us assume that an additional firm will settle in region 1. Usually, this additional firm would bear the investment costs of the airport by itself, but it will exploit the competition of the regions so that it will realize a windfall gain.[19]

In order to determine the additional contribution of a new firm to the regional economic activity, we calculate the effect on the regional net incomes, if a new firm enters the

[17] A dynamic version of the model can be found in Stauvermann (1997), where an OLG approach is used. The present model can be easily extended to an OLG growth model, where the savings of the workers will be spent for patents, which generate the profit incomes.

[18] The subscript of *Y* indicates the number of intermediate goods firms in the region.

[19] In reality, airports often offer firm-specific facilities at the airport. For example, the airport CGN invested 70 million EUR in 2008 in a new freight center to attract the US American express freight carrier FedEx.

intermediate goods sector and an airport is available. After settling, we have on aggregate m+1 intermediate goods producing firms. At first, we ignore the costs of the airport; we will consider them later on.

Additionally, we assume that the availability of an airport decreases the variable costs of the intermediate goods producing firms by a factor c<1, where the cost reduction is independent of the number of airports. This assumption can be justified by fact that finally only one airport will be in use serving the whole economy while the other turns out to be a bad investment. From the viewpoint of an airline, it is much more efficient to use only one airport than two, because typically an airline realizes economies of scale and the bigger an airport the more attractive it is for customers and airlines. Or, in other words: for airlines, it is clearly cheaper to use only one airport instead of two as long as the distance between two airports is relatively small. Because of the fact that the productivity of all firms in the country will increase with the availability of an airport, we will ignore this positive effect for simplicity and assume that c=1. Giving these assumptions, the resulting national income in a scenario with m+1 intermediate goods firms settled in the country and one airport can be denoted as follows:

$$Y_{m+1} = (m+1)(\Omega L - F). \tag{17}$$

Because of the fact that the new firm can only settle in one region, we have to take both regions into account. Without loss of generality, we assume that region 1 attracts the new firm. Then the resulting regional income of region 1 is given by;

$$Y_{m+1}^1 = \left(\frac{m+1}{2}\right)\alpha(1-\alpha)^{\frac{2(1-\alpha)}{\alpha}} L + \frac{m}{2}\alpha(1-\alpha)^{\frac{2-\alpha}{\alpha}} L - \frac{m}{2}F + \alpha(1-\alpha)^{\frac{2-\alpha}{\alpha}} L - F\,. \tag{18}$$

We have to note: the advent of an additional firm leads to an increase of the wage rate in the final product sector, which is distributed equally within the country. Consequently, the regional income of region 2 becomes

$$Y_{m+1}^2 = \left(\frac{m+1}{2}\right)\alpha(1-\alpha)^{\frac{2(1-\alpha)}{\alpha}} L + \frac{m}{2}\alpha(1-\alpha)^{\frac{2-\alpha}{\alpha}} L - \frac{m}{2}F\,. \tag{19}$$

Comparing both regional incomes with the regional incomes in the former section, it is obvious that the income with an airport and an additional firm is higher. The regional income increase is maximized, if the firm settles in this region. Consequently, we now calculate the additional income of a region that manages to attract the new firm to settle in its region. This is the difference between the income with an airport and the new firm and the income with only m firms. So we have to calculate the difference between the income of the "winning" region (by assumption: region 1) and the income of the same region before the additional form has settled. This results in

$$\Delta Y^i = Y_{m+1}^i - Y_m^i = \frac{\alpha(1-\alpha)^{\frac{2(1-\alpha)}{\alpha}} L}{2} + \alpha(1-\alpha)^{\frac{2-\alpha}{\alpha}} L - F\,. \tag{20}$$

The income difference equals the profit of the additional firm and half of the income increase of all workers[20].

To model the competition, we use an approach introduced by Geerdink & Stauvermann (2008), who applied some ideas of Skaperdas (1996) and Skaperdas & Gan (1995). Both regions try to attract the courted firm by offering the availability of an airport, whereby it is assumed that an increasing investment in the airport increases the attractiveness of the region from the point of view of the firm, because the availability of the airport reduces the firm's costs.[21] This type of competition is a game – a so-called "winner take all" game. Both regions invest in their airports to attract the firm. The firm decides for one of the two regions – so finally there is a "winning" region and a "losing" region. The losing region has invested in the airport to attract the firm, but these investments are lost because the firm settles elsewhere. Typically, policy-makers do not take into account that in our model also the loser of the competition gains the half of the increase of the wage incomes.[22] In reality, this loser's gain is difficult to estimate and usually this estimation will not be performed. In our model, the policy-makers assume that the loser's gain is zero.

In principle, this kind of competition can be applied to all firm-specific infrastructure investments, which could only be used by the competed firm(s).

The winning region has invested in an airport and receives the prize (additional income, employment, positive externalities) associated with the settlement of a new firm.

In order to calculate the optimal investments under these circumstances, the regions have to calculate the expected payoff of attracting a firm. The gross payoff consists of the probability to attract the firm times the additional regional income associated with the new firm. However, the probability to attract a firm depends positively on the amount of investments. On the other hand, the probability of the firm to settle down also depends on what the competing region is offering. That means that the probability to settle down depends on the relative efforts (relative amount of investments) of the regions. Additionally, we assume that the central government co-finances the regional infrastructure expenditures by a fixed share, so that the region has only to pay the share 1/a of the total expenditures. The co-financing rate then is (a-1)/a. According to Florio and Vignetti (2003), the co-financing rate of the structural fund of the EU for infrastructural investments lies usually between 50-85%. Temporarily, the rates have been increased by 10 per cent points in order to fight the economic depression caused by the financial crisis 2007/8. That means that the two regions have the following expected pay-off of attracting a firm:

$$E(PO_i) = \frac{e_i}{e_1 + e_2}\Delta Y^i - \frac{e_i}{a} \text{ , where } i = 1,2 . \qquad (21)$$

[20] For simplicity and without loss of generality we assume an evenly distributed workforce over the two regions.

[21] In principle, this effect is reflected by lower variable costs, but we have assumed that c=1. Readers might object that these two assumptions are inconsistent; and – in fact – this is the case. However, if we assume that c<1, the general results will not change, but the formulas will become more complicate without adding additional analytic insights. Here, we only want to concentrate on regional competition, and in so far the inconsistency can be accepted. On request, the authors will send an extended version of the model, where c<1.

[22] If the policy-makers would take into account a positive loser's gain, then the results will not change qualitatively, but the formulas will become more complicate.

The variables e_1, e_2 represent the amount of investments made by each of the two regions respectively. The functions $E(PO_1)$ and $E(PO_2)$ are the expected net pay-offs of the regions resulting from attracting the innovative firm. The resulting maximization problem for the two regions then is described by:

$$\max_{e_i}\left\{\frac{e_i}{e_1+e_2}\Delta Y^i-\frac{e_i}{a}\right\}, \text{ where } i=1,2. \tag{22}$$

Obviously, this competition is like a Cournot-Nash competition. Alternatively, we could also assume a Stackelberg competition; under the given assumptions both approaches are equivalent.[23] The first order conditions are given by:

$$\frac{\partial E(PO_1)}{\partial e_1}=\frac{e_2}{(e_1+e_2)^2}\Delta Y^i-\frac{1}{a}=0 \text{ and } \frac{\partial E(PO_2)}{\partial e_2}=\frac{e_1}{(e_1+e_2)^2}\Delta Y^i-\frac{1}{a}=0\cdot \tag{23}$$

Solving this system of equations gives the following two best response functions:

$$e_1=-e_2+\sqrt{e_2 a(\Delta Y^i)} \tag{24}$$

and

$$e_2=-e_1+\sqrt{e_1 a(\Delta Y^i)}\,. \tag{25}$$

The gains from attracting an additional firm are the same for both regions, as we already know from (20). Looking at the equations (24) and (25), it is easy to see that $e_1=e_2$, which is the Cournot-Nash equilibrium solution. The amount of investments made by the two regions is equal because the regions are identical. Solving the two best response functions simultaneously, we get the equilibrium effort levels (the subsidies offered by the regions to the firm):

$$e_i^*=\frac{1}{4}a\Delta Y^i \text{ for } i=1,2\,. \tag{26}$$

This means that 25 % of the potential gain of a region is invested in the construction of an airport if the central government does not support the regional investment expenditures (a=1). If the co-financing rate of the government is 50 % (a=2), 50 % of the potential gain will be invested. It also should be noted that the equilibrium investments will exceed the economic gains caused by the additional firm, if the co-financing rate exceeds 75 %. The simple explanation is that the regional government is not considering the welfare of the whole economy. Equation (26) shows that the regions will increase their expenditures if the co-financing rate increases.

[23] For a proof see Stauvermann (2012).

Proposition 1: If the central government co-finances infrastructural investments, then the costs of the regions will remain unchanged, but their expenditures will be increased with an increasing co-financing rate.

Proposition 1 covers the fact that can be observed very often all around Europe: whenever central governments and/or the European structural funds reimburse a part of regional or municipal investment projects, these projects are often oversized. Unfortunately, co-financing is a usual way to subsidize regions. Although the basic idea behind this subsidy policy is well intentioned to develop disadvantaged regions, it creates inefficiencies.

Given these results, we are able to calculate the probabilities for the regions to attract innovative firms. The equilibrium probability of a region to win the game then is $P_i = \frac{e_i}{e_1 + e_2}$, $i = 1,2$. From the perspective of policy-makers the probabilities to win are the same for both regions:

$$P_1^* = P_2^* = \frac{1}{2}. \tag{27}$$

Of course, the firms realize that regions are competing for their favor. Therefore, we have to assume that the firms will exploit this competition. While announcing a fair settlement decision, the decision in reality is often made beforehand. The firms enforce the regional competition to increase the regional investments in their favor. However, from the point of view of the regions nothing will change. After calculating the equilibrium probabilities, it is easy to determine the expected payoffs of the competition: we find them by using equation (21), (23) and (27):

$$E(PO_i) = \frac{1}{2}\Delta Y^i - \frac{1}{4}\Delta Y^i = \frac{1}{4}\Delta Y^i = \frac{1}{4}\left(\frac{\alpha(1-\alpha)^{\frac{2(1-\alpha)}{\alpha}} L}{2} + \alpha(1-\alpha)^{\frac{2-\alpha}{\alpha}} L - F \right), \; i = 1,2. \tag{28}$$

Equation (28) represents only the expected payoffs of the regions. However, in fact both regions invest the amount $\frac{1}{4}\Delta Y^i$ in airports and this money is spent. Let us again assume that region 1 will be the winner of the contest, and therefore the new firm settles in region 1.

Then the resulting income of the winning region including the regional expenditures is given by:

$$Y_{m+1}^1 = \frac{4m+3}{8}\alpha(1-\alpha)^{\frac{2(1-\alpha)}{\alpha}} L + \frac{2m+3}{4}\left(\alpha(1-\alpha)^{\frac{2-\alpha}{\alpha}} L - F \right). \tag{29}$$

The resulting income of the loosing region is then given by

$$Y_{m+1}^2 = \frac{4m+3}{8}\alpha(1-\alpha)^{\frac{2(1-\alpha)}{\alpha}}L + \frac{2m-1}{4}\left(\alpha(1-\alpha)^{\frac{2-\alpha}{\alpha}}L - F\right). \quad (30)$$

The resulting national income including the expenditures of both regions is

$$Y_{m+1} = Y_{m+1}^1 + Y_{m+1}^2 = \frac{4m+3}{4}\alpha(1-\alpha)^{\frac{2(1-\alpha)}{\alpha}}L + \frac{2m-1}{2}\left(\alpha(1-\alpha)^{\frac{2-\alpha}{\alpha}}L - F\right). \quad (31)$$

Up to now, we assumed that a=1. Abandoning this assumption and recalculating the national income including the expenditures of both regions leads to:

$$Y_{m+1} = Y_{m+1}^1 + Y_{m+1}^2 = \left(m + \frac{4-a}{4}\right)\alpha(1-\alpha)^{\frac{2(1-\alpha)}{\alpha}}L + \left(m + \frac{2-a}{2}\right)\left(\alpha(1-\alpha)^{\frac{2-\alpha}{\alpha}}L - F\right). \quad (32)$$

From a national perspective, the profit of the additional firm is halved and the additional wage income is reduced by 25 %, if the central government does not support the regions.

The problem from the national point of view is that half of all investment expenditures are invested in an actually bad investment; the second airport is superfluous. Additionally, if we assume that an airport realizes economies of scale, then we have to assume that the second airport will never become competitive. Furthermore, if the central government co-finances regional infrastructure investments, then the loss increases and a co-financing rate equal to 75% or more guarantees a decrease of the national income compared to the situation with only m firms.

Proposition 2: From an efficiency point of view, regional competition to attract an additional firm with the help of public infrastructure investments like airports is always inefficient.

Proposition 3: If the co-financing rate is 75 % or more, the whole economy is always worse off with the airports. If the co-financing rate is higher than 50% and less than 75 %, the whole economy is worse off, if the wage income share is lower than (2a – 4)/a.

Proof: Because of the linear homogeneity of the total income in the number of intermediate goods firms, the additional income generated by the firm minus the total expenditures for the airports can be rewritten as:

$$m\frac{\Delta Y}{Y} = m\dot{Y} = \left(\frac{4-a}{4}\right)\frac{W}{Y} + \left(\frac{2-a}{2}\right)\frac{P}{Y}, \quad (33)^{24}$$

where W is the total wage income and P is the total profit income. Solving (33) for W/Y leads to the following statement:

[24] Equation (33) additionally shows that the growth rate of the economy depends on the number of firms, the share of wage and profit incomes and the co-financing rate via parameter a.

If a>2, then $\Delta Y < 0$, if $\frac{W}{Y} < \left(\frac{2a-4}{a} \right)$.

That means: if the central government reimburses for example 2/3 of the regional investment expenditures, the wage income share must be bigger than 2/3, otherwise a loss will occur. The problem arises, because the regions compete against each other, and they take only into account their regions and the gain in case of winning the competition. However, here the bad story does not stop. There are two airports, and airports serve business activities and of course they are also serving direct consumption activities like tourist flights. Doubtlessly, airports are operating with economies of scale. Consequently, we can assume the following cost function for an airport for simplicity:

$$C^i\left(x^i\right) = F_A + c_A x^i, \tag{34}$$

where F_A are the fixed costs, c_A the marginal costs per passenger, and x^i the number of passengers at the airport in region *i*. Certainly, the airport in region 1 has an advantage and it should not be surprising that the airport in region 2 has no chance to succeed in this competition. In reality, this often leads to a permanent subsidy policy like the one observable in NRW. Given that region 2 subsidizes its airport to increase its competitiveness, airlines have an opportunity to exploit the region.[25] This of course makes the airport in region 1 less profitable.

In general, we can learn from this model that regional competition in infrastructure leads to bad outcomes, if the infrastructure is of nation-wide interest. In our model, it would be much better, if the central government would decide about infrastructural investments.

6 Conclusions

In this paper, we have shown that regional competition with the help of infrastructural investments, which affects the whole country or the competing regions, is inefficient. From the work of Stauvermann and Wernitz (1998), it can be concluded that the inefficiency rises with the number of competing regions. Additionally, the inefficiency increases, if the central government supports the regions in their efforts to win the competition. Here we have concentrated on airport infrastructure, and from our analysis we can derive that regional governments should not plan the airport infrastructure; to avoid inefficiencies, it should instead at best be done – with respect to the EU - at the European level. Otherwise, the regional competition of regions is nothing else than a ruinous zero-sum contest, leading to ruinous competition. These results of the paper can be seen as a normative reasoning for the point of view of the scientific council of the German ministry of spatial planning (Wissenschaftlicher Beirat beim Bundesminister fuer Verkehr, Bau und Stadtentwicklung (2011)), which also proposes the development of an Europe-wide master plan for aviation.

The general problem with regional competition is that regions cannot go bankrupt or vanish from the ‘market’ of regions. Therefore, the whole idea of regional competition is questionable. The idea that poor regions can catch-up with rich regions with the support of co-

[25] See for example Barbot (2006).

financing seems to be an illusion and a misinterpretation of competition and economic efficiency. Both concepts cannot be applied to regional development as for example the development of East Germany since the Reunification of Germany demonstrates drastically. Despite that East Germany received more than two trillion EUR from the West in the last 27 years, the East was not able to catch-up with West Germany in economic terms. What we could observe in East Germany is a huge amount of bad investments and an oversized public infrastructure, especially transport infrastructure. Of course, we can observe similar developments in the rest of Europe as well.

Further, if the national government or the EU supports regional competition by co-financing the overall investment costs, we must fear that the investments will be oversized. If the co-financing rate is relatively high like for low-developed regions in the EU, where the co-financing rate can be at maximum 95 % for infrastructural investments, we have to assume that the costs of the financed projects exceed the societal benefits from the perspective of the EU as a whole. According to our model, a share of 95 % implies a=20, leading to huge losses for the EU. Of course, even though we ignored the aspect that firms will increase their productivity caused by the infrastructural investments, it must be assumed that they realize windfall profits. This is because they do not pay for the additional infrastructure especially if we take into account that in general regional competition leads to inefficient low levels of regional corporate taxes (Stauvermann and Kumar, 2016).

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Manuscript received 22 February 2017

Соціальні ефекти регіональної конкуренції інфраструктурних проектів

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У статті подано аналіз регіональної конкуренції інфраструктурних проектів, а саме проектів, що передбачають інвестиції в розвиток інфраструктури аеропортів. Згідно запропонованої моделі, яка передбачає аналіз двох регіонів в умовах монополістичної конкуренції, і сама регіональна конкуренція, й інвестиції будуть неефективні, хоча в цілому інвестиції в розвиток інфраструктури аеропортів – це досить важливий і корисний приклад соціальних інвестицій.

У дослідженні доведено, що регіональна конкуренція, основу якої складають інвестиції в інфраструктурні проекти на рівні окремих країн або конкуруючих регіонів, є неефективною. Із нашої наукової роботи 1998 р. можна зробити висновок, що зі збільшенням числа конкуруючих регіонів ефективність знижується. Крім того, ефективність також знижується, якщо центральні органи влади всіляко сприяють регіонам завойовувати конкурентні позиції на ринку. У даній статті аналізуються проблеми розвитку інфраструктури аеропортів. Із проведеного аналізу можна зробити висновок, що в плани регіонального розвитку не варто включати розвиток інфраструктури аеропортів у кожному регіоні в рамках однієї країни. На рівні Європейського Союзу (ЄС) для ефективного розвитку регіонів найкращим варіантом є розвиток інфраструктури аеропортів загальноєвропейського рівня. У іншому випадку регіональна конкуренція буде зведена до нуля. Результати даного дослідження можна розглядати в якості офіційної точки зору наукової ради Федерального міністерства транспорту, будівництва і міського розвитку (Wissenschaftlicher Beirat beim Bundesminister fuer Verkehr, Bau und Stadtentwicklung, 2011), яке також запропонувало розробити Загальноєвропейський генеральний плану розвитку авіації.

Основна проблема даного питання полягає в тому, що регіональна конкуренція не передбачає виходу з ринку конкуруючих регіонів або їх банкрутства, а сама регіональна конкуренція викликає чимало запитань. Теза про те, що співфінансування/субсидування бідних регіонів буде ефективним і вони зможуть зрівнятися за рівнем економічного розвитку із багатими регіонами, здається ілюзорним і помилковим тлумаченням конкуренції та економічної ефективності. Ці поняття неможливо використовувати стосовно аналізу розвитку окремих регіонів, наприклад, Східної Німеччини після возз'єднання. Незважаючи на те, що за останні 27 років Східна Німеччина отримала більше двох трильйонів євро на регіональні проекти розвитку, вона так і не змогла зрівнятися із Західною Німеччиною за рівнем економічного розвитку. У Східній Німеччині, наприклад, існує практика неефективного інвестування, особливо в транспортну інфраструктуру. Звичайно, подібну ситуацію можна спостерігати і в інших країнах Європи.

Крім того, якщо національні уряди або керівництво ЄС підтримують регіональну конкуренцію шляхом співфінансування спільних інвестиційних витрат, слід побоюватися збільшення обсягів інвестицій. Якщо рівень співфінансування відносно високий, наприклад, для слаборозвинених регіонів ЄС, де рівень співфінансування може становити максимум 95 % для інфраструктурних проектів, доцільно припустити, що витрати на фінансування проектів перевищать соціальні вигоди ЄС у цілому. Згідно нашої моделі, 95 %-ий рівень співфінансування у цілому буде збитковим для ЄС. Звичайно, незважаючи на те, що модель не враховує збільшення фірмами своєї продуктивності, викликаної інфраструктурними інвестиціями, слід припустити, що вони отримають надприбуток. Це пов'язано з тим, що фірми практично не фінансують розвиток додаткової інфраструктури, особливо якщо врахувати ще й те, що в цілому регіональна конкуренція призводить до дуже низьких регіональних корпоративних податків (Stauvermann and Kumar, 2016).

Ключові слова: регіональна конкуренція, інфраструктура, регіональний розвиток, субсидії.

Mechanism of Economic Regulation, 2017, No 3, 26–46
ISSN 1726-8699 (print)

Социальные эффекты региональной конкуренции инфраструктурных проектов

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В статье представлен анализ региональной конкуренции инфраструктурных проектов, а именно проектов, предусматривающих инвестиции в развитие инфраструктуры аэропортов. Согласно предложенной модели, которая предусматривает анализ двух регионов в условиях монополистической конкуренции, и сама региональная конкуренция, и инвестиции будут неэффективны, хотя в целом инвестиции в развитие инфраструктуры аэропортов – это достаточно важный и полезный пример социальных инвестиций.

В статье доказано, что региональная конкуренция, основу которой составляют инвестиции в инфраструктурные проекты на уровне отдельных стран или конкурирующих регионов, является неэффективной. Из нашей научной работы 1998 г. можно сделать вывод, что с увеличением числа конкурирующих регионов эффективность снижается. Кроме того, эффективность снижается, если центральные органы власти всячески способствуют регионам завоевывать конкурентные позиции на рынке. В данной статье анализируются проблемы развития инфраструктуры аэропортов. Из проведенного анализа можно сделать вывод, что в планы регионального развития не стоит включать развитие инфраструктуры аэропортов в каждом регионе в рамках одной страны. На уровне Европейского Союза (ЕС) для эффективного развития регионов лучшим вариантом является развитие инфраструктуры аэропортов общеевропейского уровня. В противном случае региональная конкуренция будет сведена к нулю. Результаты данного исследования можно рассматривать в качестве официальной точки зрения научного совета Федерального министерства транспорта, строительства и городского развития (Wissenschaftlicher Beirat beim Bundesminister fuer Verkehr, Bau und Stadtentwicklung, 2011), которое также предложило разработать Общеевропейский генеральный плана развития авиации.

Основная проблема данного вопроса состоит в том, что региональная конкуренция не предусматривает выхода из рынка конкурирующих регионов или их банкротства, а сама региональная конкуренция вызывает довольно много вопросов. Положение о том, что софинансирование/субсидирование бедных регионов будет эффективным и они смогут сравняться в уровне экономического развития с богатыми регионами, кажется иллюзорным и ложным толкованием конкуренции и экономической эффективности. Эти понятия невозможно использовать применительно к анализу развития отдельных регионов, например, Восточной Германии после воссоединения. Несмотря на то, что за последние 27 лет Восточная Германия получила более двух триллионов евро на региональные проекты развития, она так и не смогла сравняться с Западной Германией по уровню экономического развития. В Восточной Германии, например, существует практика неэффективного инвестирования, особенно в транспортную инфраструктуру. Конечно, подобную ситуацию можно наблюдать и в других странах Европы.

Кроме того, если национальные правительства или руководство ЕС поддерживают региональную конкуренцию путем софинансирования общих инвестиционных затрат, следует опасаться увеличения объёмов инвестиций. Если уровень софинансирования относительно высок, например, для слаборазвитых регионов ЕС, где уровень софинансирования может составлять максимум 95 % для инфраструктурных проектов, следует предположить, что расходы на финансируемые проекты превысят социальные выгоды ЕС в целом. Согласно нашей модели, 95 %-й уровень софинансирования в целом будет убыточным для ЕС. Конечно, несмотря на то, что модель не учитывает увеличение фирмами своей производительности, вызванной инфраструктурными инвестициями, следует предположить, что они получат сверхприбыль. Это связано с тем, что фирмы практически не финансируют развитие дополнительной инфраструктуры, особенно если учесть еще и то, что в целом региональная конкуренция приводит к очень низким региональным корпоративным налогам (Stauvermann and Kumar, 2016).

Ключевые слова: региональная конкуренция, инфраструктура, региональное развитие, субсидии.

JEL Codes: H54, H23, O18 Table: *1;* Formulas: *34;* References: *40*

Language of the article: English