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ABSTRACT

This paper aimed at a statistical analysis of competition for tourists between regions within Baltic states (Estonia, Latvia, Lithuania) and estimation relative efficiency levels of regions. We apply a modern approach called Spatial Stochastic Frontier and corresponded to spatial modification of a stochastic frontier model. We specify two alternative spatial stochastic frontier models – distance and travel-time based to identify an influence of existing transport network on research results.

Using the model we analyse region-specific factors (tourism infrastructure, employment, geographical position and natural attractors) having an effect on a number of visitors and estimate regions' efficiency values.

We discover a significant level of inefficiency of Baltic states regions and propose some ways to improve the situation.

Keywords: spatial stochastic frontier, efficiency, competition, regional tourism, transport network

Introduction

The growing importance of tourist industry and its influence on overall development of destination countries and regions turn tourist policies into one of the most important strategies and attract attention of researchers world-wide to this area.

During the last decade tourism became to be considered as a competition point [1, 2] between countries or regions for visitors. Competition forces regions to be more attractive for tourists and use their resources more efficiently. Now regions can be examined not as a geographical area with natural or heritage attractors, but as a business which should use all possible resources to beat competitors and attract more tourists.

When we consider regions within a country (or several adjacent countries) as competitors, the efficiency indicator should be brought into the forefront. How efficiently does a region use its own resources and how can it be improved? – this is the first question about a economic unit in a competitive environment. Unfortunately, the analysis of regions' efficiency in tourist literature is very scant. The majority of researches in this area are oriented to the microeconomic level and contain efficiency analysis of hotels, restaurants, and other business units. There are few researches which designed to analyse the efficiency at the regional level; we can refer to the analysis of Italian tourist destinations [3], executed on the base of DEA and Malmquist Index as to one of not many related studies.

This research is aimed to analysis of competitiveness and efficiency of regions within Baltic states (Estonia, Latvia, and Lithuania). Tourism is one of the most important industries for these countries, but there are no researches known to us and intended for analysis of competition between regions in this area.

Regional spatial structure and existing transport network play a very important role in modelling of regions' competition and efficiency. Spatial modifications of the standard stochastic frontier model for efficiency estimation are recently presented.

In this research we specify a spatial stochastic frontier model for analysis of regions' competition for tourists and their efficiency and estimate it for regional Baltic states' data. Also we analyse model' estimation results and provide some recommendations.

Spatial stochastic frontier model

Short review of a standard stochastic frontier model

The well-known stochastic frontier model is usually presented as [4]:

$$y = f(x, \beta) + \varepsilon,$$
$$\varepsilon = v - u, v \sim N(0, \sigma_v^2), u \geq 0,$$

where

y – an output;

x – a vector of resources;

f – a production function;

β – a vector of unknown coefficients;

ε – a composite error term.

The first component of composite error term, v, shows the random variation of the efficiency frontier, and the second one, u, shows the technical inefficiency of regions (as a distance to the efficiency frontier). An efficiency level of a given region *i* can be estimated as [5]:

$$TE_i = e^{-E(u_i|\varepsilon_i)},$$

where $E(u_i|\varepsilon_i)$ – conditional expectation of u_i given estimated ε_i.

In this research we used the truncated normal distribution for the second error term component *u* with a conditional mean (the first distribution parameter depends on the set of factors z):

$$u \sim N^{+}(\delta z, \sigma_u^2)$$

The Cobb-Douglass functional form of the efficiency frontier was used:

$$\ln(y) = \beta \ln(X) + \nu - u$$

We have used a standard γ value to test the stochastic frontier specification versus a simple OLS regression:

$$\gamma = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2}$$

If a value of γ statistics is close to 1, we accept the hypothesis about presence of inefficiency in data and preference of the stochastic frontier model.

Spatial modification of the stochastic frontier model

Spatial econometrics considers the possibility of geographic interaction between economics of neighbour regions. The general spatial autoregressive model is specified [6, 7] as:

$$y = \rho W y + \beta X + \varepsilon,$$
$$\varepsilon = \lambda W \varepsilon + \upsilon, \ \upsilon \sim N(0, \sigma^2)$$

where

y – a vector of dependent variable values;

x – a matrix of explanatory variables' values;

ε – a vector of residuals;

W – a matrix of contiguity.

The feature of the model is designed in the components with the contiguity matrix *W*. This square matrix contains the information about inverse distances between data points, so higher value means closer points, and have zero values on the main diagonal (to exclude *y* values self-dependence). The authors assume that a value of the dependent variable *y* in a given data point depends on its own neighbour values, and closer neighbours have stronger influence. The same assumption is specified for the residuals ε.

One of possible spatial modifications of the stochastic frontier model [8] with the Cobb-Douglass form of the efficiency frontier and the truncated normal inefficiency component is:

$$\begin{aligned}&\ln(y) = \rho \ln(Wy) + \beta \ln(X) + v - u,\\&u \sim N^{+}(\lambda Wy + \delta z, \sigma_u^2),\\&v \sim N(0, \sigma_v^2)\end{aligned}$$

Definition of the *W* contiguity matrix can be different and vary in researches. Usually distances are specified as geometrical Euclidean distances or as great-circle distance in case of significant geographical remoteness of data points). This specification is the most popular, but not the only one. In some researches (includes this one) it is necessary to include real travels into the model, so the matrix with inverse travel time or cost values betters match the real situation. In our research we used and compare both approaches and compared; detailed analysis is presented in the Model Specification section.

One of the main points of the research is values of ρ and λ parameters. Parameter ρ shows the influence of model output values (a number of tourists) in neighbour regions on the output in a given region. Our reasoning states that this influence can be as positive (cooperation of regions), as negative (competition between regions) [9]. The analysis of the ρ value will answer this major research question.

Parameter λ shows the influence of output values in neighbour regions on the efficiency in a given region. We expect the positive influence here, because both cooperation and competition should improve economic unit's efficiency in healthy economics.

Data

Panel data used in the research includes information about regions of Latvia, Estonia and Lithuania from 2005 to 2008 years (data for 2009 is not completely available yet).

Division of the countries into regions is not well-defined and can cause some problems. We used the Nomenclature of Units for Territorial Statistics level 3 (NUTS 3) approach for defining regions in Estonia and Lithuania (15 and 10 regions respectively), but not for Latvia. In NUTS3 Latvia includes only 4 regions which are significantly larger than regions in Estonia and Lithuania, and looks very heterogeneous. Due to this reason we used the approach of the national statistical office of Latvia for regions' division. 26 regions of Latvia fit (in terms of size and population) with NUTS3 regions of Estonia. Lithuania's regions are significantly (approximately twice, see Table 1) larger, but their separation was impossible due to shortage of information. Statistical data about smaller Lithuanian regions (municipalities) is provided by the national statistical office starting from 2009 only. We think that this discrepancy is a matter of scale only (and not the matter of "production" differences, which is critically important for a frontier model) and it doesn't affect received results significantly. Anyway we have included dummy variables into the model, which captured as this difference in Lithuanian regions' definition as all other "production" and efficiency differences.

The statistical information was collected from the next sources:

1. National statistical offices of the Baltic states provided the information about a number of tourists visited a given region, number of beds offered in hotels, number of enterprises in tourism-related sectors (according to NACE rev.2 classification), and also about regions' area, population and road coverage. Parameters are described in details in the Model Specification section.
2. Schedules of railways and regional coaches are used for collecting travel times between regional centres.
3. TomTom (a digital mapping and routing company) for information about road distances and travel times by car between regional centres.

4. Latvian, Lithuanian, and Estonian Associations of Museums for a number of museums by regions.
5. GIS system (Google Earth) from information about geographical coordinates of regions and natural tourist attractors (sea-side, national parks).

Table 1. Descriptive statistics for used indicators

	Total	**Estonia**			**Latvia**			**Lithuania**		
Variable	*Mean*	*Mean*	*Min*	*Max*	*Mean*	*Min*	*Max*	*Mean*	*Min*	*Max*
Tourists, people	73902	79276	8975	257930	23147	2043	97580	182576	13073	755013
Beds offered, count	1609.8	1400.9	184	4752	516.2	71	1673	4766.5	263	16975
Labour, enterprise	1976.4	974.6	183	3019	618.6	177	2364	7009.3	1395	23987
Museums, count	15.9	16.5	4	38	4.8	1	14	43.8	22	86
Area, sq. km	3390	2895	1023	4806	2467	1628	3652	6530	4350	9731
Population, people	113713	62887	10118	170719	57613	24159	167774	335811	126717	848956
Roads/area ratio, km/sq.km	0.706	0.397	0.273	0.546	0.805	0.549	1.081	0.911	0.652	1.128

Model Specification

Specification of the spatial stochastic frontier model includes output and resource parameters selection and definition of the contiguity matrix.

In this research we consider a region as an economic unit which uses its own resources to attract and service tourists. The definition of the “tourists” is a unique expression; it can be based on people, accommodated in a region, or on people just visited the region – transit or one-day trip tourists. Also it can be classified by a purpose of a trip – business or private. We assume (and data collected by national statistical offices support this assumption) that the most important for region’s economy tourists are accommodated ones. Usually a tourist, accommodated in a given region, spends a significant time in this region and "supports" region's economy – spends money, uses local services. That why as a dependent variable we chose a number of tourists (*tourists*), who stay at least one night in a hotel, motel or any other kind of collective accommodation establishment. This definition of the dependent variable should add a value to a "competition" scale pan of the "competition-cooperation" scales.

The set of explanatory variables includes resources used in a given region for tourist attraction and service. We include region's tourism infrastructure into the model in form of a number of beds offered in hotels and other accommodation places (*beds*). It conforms to our definition of tourists and also we assume a strong relationship between a number of beds offered and other tourism infrastructure objects.

We included a number of enterprises in sectors, related with tourism, as a service quality and labour force parameter. Generally it is impossible to separate enterprises serving tourists and residents, that's why we used total number of enterprises in chosen sectors of economy. We used the NACE rev.2 classification and selected the following economic sectors as related with tourism – wholesale and retail trade; repair of motor vehicles and personal and household goods (G class); transportation and storage (H); accommodation and food service (I), information and communication (J). The final used parameter (named *services*) was calculated just as a total number of enterprises in the sectors chosen.

Transport infrastructure was included into the model in two different forms. The first one is related with a level of region accessibility for international tourists. We considered a distance to the nearest airport/sea port (*nearestGate*) as an accessibility metrics. The distance was measured in kilometres, travel time by car, train and coach. Usually regions in the Baltic countries have good connections of all types with the nearest airport, so all 4 parameters were highly correlated. We chose only one region's accessibility parameter (travel time by car) to avoid of the multicolleniarity problem. No distance decay functions were applied.

The second transport-related parameter was constructed to include local transport infrastructure into the model. We used a ratio of region's roads length and region's area as a metric (*road_coverage*), because usually all tourists' movement inside a region in the Baltic states are done by car/bus.

We considered museums, castles and palaces as artificial tourist attractors. After data collection we discovered the strong relationship between numbers of this kind of attractors, that why we left only one of them (a number of *museums*) in the final model specification.

Natural attractors were included into the model in form of a dummy variable for sea-side (*sea*, yes/no) and a number of national nature parks (*natparks*) in a region.

The very important parameter of the spatial stochastic frontier model is a contiguity matrix *W*. This matrix presents distances between regions in the model and can be defined in different ways [10].

The simplest method of the *W* matrix definition is an inverse Euclidian distance between regions. According to this approach we calculate a distance between regions in kilometres between their main cities. The method can be modified by taking the spherical surface of the Earth into account (a great-circle distance). In this study we filled this matrix with simple Euclidian distances between regional centres and restricted the distance with 1 (about 110 km). The model with this continuity matrix is called as Model DIST.

The main disadvantage of this approach is obvious – be geographically close generally doesn't mean be easy accessible. A road may absent between two points or be significantly longer than a direct distance. Matrix definition is a critical point for spatial models, so we used an alternative approach to compare the estimation results. We defined an alternative contiguity matrix on the base of travel times between regional centres by car. This alternative model specification is noted as Model ROAD. Travel times reflect a real distance between regions more precisely and differ from a geographical distance significantly (see Figure 1). We calculate the coefficient of correlation between models' distance and travel time spatial components ($W \cdot tourists$) and discovered absence of the significant relationships (correlation = 0.06, p-value = 0.37).

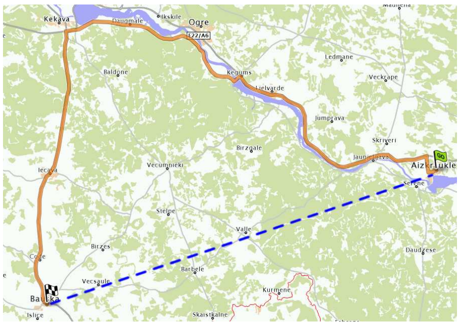

Figure 1. Geographical and road distances

The travel time-based contiguity matrix is good enough in case of economic units without area. Obviously regions have areas, so a distance between regional centres not always reflects a distance between regions fairly.

Another possible approach is based on a binary contiguity matrix, which constructed on the base of direct borders between regions only. We refused this method as too information-thriftless.

An efficiency frontier form can vary during the observable time interval (2005-2008). The variation can be caused by changes in economics of the Baltic states and other general factors. We included the time variable (*years*) into the specification of the efficiency frontier and as an explanatory variable for regions' inefficiency level. We received insignificant values of the considered parameters in both cases and decided to exclude the time variable from the model. So we conclude that no significant changes in regional tourism efficiencies happened during the study time interval.

Another model specification hypothesis was related with countries' specifics. Estonia, Latvia, and Lithuania are significantly different in economics and politics, and differences in regional tourism are also possible. We included dummy variables for Estonia (*EE*) and Lithuania (*LT*) into the models to check the permanent differences of the regional tourism efficiency frontiers between countries.

In addition to country-specific differences in the efficiency frontier position we investigated possible differences in the main "competition-cooperation" area. It is possible that the level of competition (or cooperation) between regions varies between countries. We have included cross dummy variables $EE \cdot \ln(W \cdot tourists)$ and $LT \cdot \ln(W \cdot tourists)$ to test this hypothesis.

The final model specification with the Cobb-Douglass form of the efficiency frontier and truncated normal distribution of the inefficiency component after removing insignificant explanatory variables is:

$$\begin{aligned}\ln(tourists) = {}& \rho \ln(W \cdot tourists) + \beta_1 \ln(beds) + \beta_2 \ln(services) + \beta_3 \ln(museums) + \\ & + \beta_4 \ln(nearestGate) + \beta_5 sea + \beta_6 EE + \beta_7 LT + \\ & + \beta_8 EE \cdot \ln(W \cdot tourists) + \beta_9 LT \cdot \ln(W \cdot tourists) + v - u, \\ u \sim N^+(\lambda \ln(W \cdot tourists), \sigma_u^2)&, v \sim N(0, \sigma_v^2)\end{aligned}$$

Empirical Results

Using the presented specification of a spatial stochastic frontier model we constructed three alternative models:

1. Model NOSPAT – stochastic frontier model without spatial components;
2. Model DIST – spatial stochastic frontier model with distance-based contiguity matrix;
3. Model ROAD – spatial stochastic frontier model with travel time-based contiguity matrix

Models' estimation results are presented in the Table 2.

Table 2. Estimation results of three alternative models: Model NOSPAT (without spatial components), Model DIST (distance contiguity matrix), and Model ROAD (travel time contiguity matrix)

	Model NOSPAT		**Model DIST**		**Model ROAD**	
Dependent variable	ln(*tourists*)		ln(*tourists*)		ln(*tourists*)	
Frontier Estimates	*Coefficient*	*p-value*	*Coefficient*	*p-value*	*Coefficient*	*p-value*
ln(*beds*)	0.878	0.000	0.890	0.000	0.843	0.000
ln(*nearestGate*)	0.003	0.896	0.043	0.027	0.028	0.307
ln(*services*)	0.300	0.000	0.387	0.000	0.306	0.000
ln(*museums*)	-0.107	0.094	-0.264	0.000	-0.214	0.002
ln(*W·tourists*), *ρ*			-0.091	0.002	-0.094	0.014
Sea	0.163	0.043	0.099	0.078	0.271	0.000
EE	0.502	0.000	3.706	0.000	1.579	0.025
LT	-0.271	0.087	2.213	0.000	0.610	0.120
EE·ln(*W·tourists*)			-0.227	0.002	-0.114	0.132

LT·ln(*W·tourists*)			-0.174	0.000	-0.066	0.083
Constant	2.841	0.000	3.682	0.000	4.161	0.000
Inefficiency component						
ln(*W·tourists*), *λ*			-0.491	0.000	-0.152	0.011
Constant	-1.179	0.745	6.603	0.000	1.753	0.001
Statistics						
Log likelihood	-78.393		-50.518		-59.226	
γ	0.921		0.983		1.000	

Firstly we need to test the validity of stochastic frontier models' usage and their dominance over the simple regression. The γ-statistic's values for all three models are near to 1 (significantly higher than 0), so we state the presence of inefficiency in data and prefer stochastic frontier models.

We used the likelihood-ratio test to compare spatial and non-spatial model specification:

$$P\{LR > \chi^2_{crit}(4)\} = P\{2(Ln(H_1) - Ln(H_0)) > \chi^2_{crit}(4)\} =$$
$$= P\{2(-59.226 - (-78.393)) > \chi^2_{crit}(4)\} = P\{38.334 > \chi^2_{crit}(4)\} = 0.000$$

So we reject the model without spatial components and accept spatial stochastic frontier models. A difference in efficiency estimates between spatial and non-spatial models will be discussed later in this section.

Comparison of two alternative spatial model specifications is not only the statistical task, but also a matter of interpretation. The essence of these two models is different, and a researcher can choose one or another depending on goals of his research. We chose the model, based on travel times, (Model ROAD) for analysis in this research.

The majority of Model ROAD coefficients' estimates are significant and match our expectations. A number of beds in hotels and a number of enterprises in tourism-related sectors have significant positive influence on the number of tourists, so predictably can be considered as important resources for regional tourism. This relationship is bidirectional – businesses adapt to a real economic situation and develop in regions with higher tourists' attention.

Locational characteristics of regions are also significantly influence of tourist attendance. Sea-side is one of the most powerful attractor in the Baltic states and have a significant positive value as expected. The influence of travel time from the nearest airport/port is significant in the Model DIST, but not significant in the Model ROAD. It can be easily explained using the fact that the travel time is already included into the Model ROAD for regions, located near to main gates (in form of the contiguity matrix), and possibly there is no significant difference for other regions (due to the law of distance-decay).

The only unexpected parameter's value is the negative influence of the number of museums in a region. The fact that a big number of specialised museums can't be used as good tourist attractor is predictable, but the explanation of the negative sign is not so unambiguous. We don't make any assumptions and conclusions about this result in this study, this point requires additional investigations.

The dummy variable *EE* (specifics of Estonia) has a significant positive sign, so we conclude higher position of the efficiency frontier for Estonian regions. This can be explained by strong relationships between Estonia and Finland (including in the tourism area) – more than 35% of tourists visited Estonia in 2008 are arrived from Finland. Also better crime and politics atmosphere can be considered as a reason of positive distinction of Estonia (for example, according to Transparency International's Corruption Perception Index 2009, Estonia occupies 27th place while Lithuania and Latvia – 52nd and 56th respectively). The dummy variable for Lithuania also tends to be positive, but in the Model ROAD it is insignificant, so we don't state the difference between Latvia and Lithuania in tourist attraction.

Analysis of competition and cooperation between regions in the Baltic states is one of the main points of this research. The spatial component $\ln(W \cdot tourists)$, included into the models, have a significant negative value (ρ) for both cases. It means that tourists, accommodated in the neighbour region, cannot be considered as a resource for a given region, but quite the contrary – have a negative influence on region's tourist attendance. So we state that the **competition between regions for tourists presents in all Baltic States**.

This fact can be explained in different manners. Firstly, as we used the number of accommodated tourists as a dependent variable, this conclusion shows that tourists prefer to accommodate in a particular region and visit neighbour regions (if any) as one-day trip.

The second reason for competition between regions is a shortage organisation of good tourist routes in the Baltic states. The most of routes are still country-oriented and usually have a base region to stay with several one-day tours to neighbour regions. Development of routes with several nights of stay in different regions will improve the level of region's cooperation.

Also we analysed cross-dummy variable to discover differences in competition levels between countries, but in our final model these effects are insignificant (though with a tendency to higher competition levels in Estonia and Lithuania).

As we stated the competition between regions for tourists, we expect a relation between the spatial component and regions' efficiency levels. Economic theory postulates that higher level of competition leads to higher efficiency of economic units. In our case we observe this effect via the value of λ coefficient. According to stochastic frontier model specification, the negative sign of this coefficient decrease the value of regions inefficiency u, and so has a positive influence on region's efficiency. This can be stated as another very important conclusion of this research.

Stochastic frontier approach allows calculate efficiency level values for a given region for every time point. We presented average efficiency values (2005-2008 years) in the Table 3 and their geographical distribution on the Figure 2.

Table 3. Estimates of regions' efficiency levels

Latvia			**Estonia**			**Lithuania**		
Region	*Efficiency**, %	*Diff.***, %	*Region*	*Efficiency**, %	*Diff.***, %	*Region*	*Efficiency**, %	*Diff.***, %
Ventspils	93	0	Laane	93	0	Taurage	87	-5
Valmiera	89	0	Saare	82	+1	Siauliai	84	-3
Cesis	80	0	Viljandi	77	-5	Alytus	79	-3
Ogre	75	-8	Parnu	73	-5	Vilnius	79	-1
Jekabpils	70	-9	Polva	70	-2	Marijampole	61	-17
Preili	68	-6	Voru	69	-3	Kaunas	59	-10

Bauska	68	-11	Tartu	69	-5	Klaipeda	41	-15
Saldus	68	-12	Jarva	67	-11	Utena	38	-23
Kuldiga	67	-14	Jogeva	66	-9	Telsiai	32	-22
Riga region	64	-3	Harju	65	-2	Panevezys	27	-12
Madona	58	-15	Hiiu	64	-13			
Jelgava	57	-17	Laane-Viru	62	-13			
Valga	56	-6	Valka	48	-16			
Liepaja	54	-29	Rapla	40	-13			
Limbazi	48	-28	Ida-Viru	38	-18			
Aizkraukle	46	-16						
Daugavpils	46	-17						
Talsi	45	-20						
Kraslava	41	-23						
Tukums	39	-15						
Aluksne	34	-16						
Ludza	30	-19						
Rezekne	20	-11						
Average	**59%**			**70%**			**60%**	

[*] – average efficiency levels, estimated using Model ROAD

[**] – differences between average efficiency levels, estimated using Model ROAD and Model NOSPAT ($Eff_{Model\ ROAD} - Eff_{Model\ NOSPAT}$)

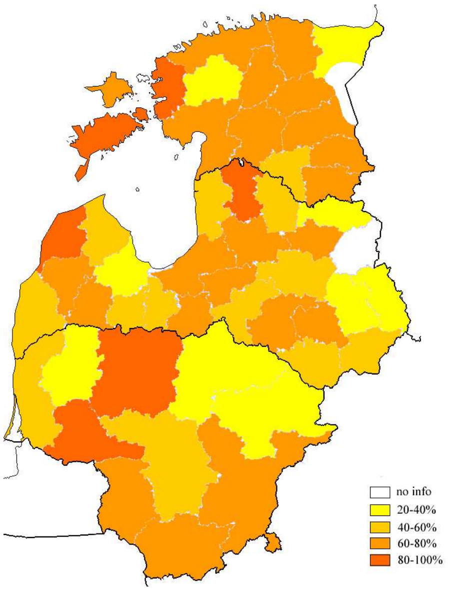

Figure 2. Map of regions' efficiency levels (Model ROAD)

The average value of regions' efficiency levels is 63%, so regions have a significant internal potential and can attract on 58.7% more tourists (37/63 = 0.587) using available resources and increasing efficiency of their utilization.

Estonian regions are relatively more efficient (70%) than Latvian and Lithuanian (59% and 60% respectively), and there is no significant difference between Latvian and Lithuanian regions. Also it can be noted that Latvian and Lithuanian regions are more heterogeneous than Estonian ones. A complete analysis of regions is outside the scope of this research.

One of the main goals of this research is comparison of spatial and non-spatial stochastic frontier models. Estimates of parameters (Table 2) included into both models correlates to each other and the models looks similar. Differences between models' efficiency estimates are presented in the Tables, but they should not be analysed directly, because generally efficiency estimate of different model specifications are noncomparable. Values presented in the table allow making conclusion about the pattern of efficiency estimates, not the number themselves. We can conclude that application of the spatial model doesn't significantly affect central regions (Riga, Vilnius, Harju) and regions without powerful neighbours (Saare). On the contrary efficiency estimates of regions located near to attractive tourist accommodation places are significantly changed under the influence of spatial structure inclusion (Liepaja, Rapla, Telsiai). This result is economically explainable and can be considered as an evidence for benefit of spatial stochastic frontier models.

Conclusions

In this research we examine efficiency of regions in Baltic states as places of tourist accommodation. We use information about spatial structure to estimate effects of agglomeration and competition for tourists between regions and their influence on regions' relative efficiency levels.

We suggest a spatial stochastic frontier model and estimate its parameters for Estonian, Latvian, and Lithuanian regions from 2005 to 2008 year. This model allows us to distinguish the effects of different factors (inputs) on the regions' attractiveness for tourist and efficiency levels. We estimate the suggested spatial model using two different approach to distances – geographical (Euclidean) and travel-time based. We also control unobservable country-specific effects. We compare spatial models and a model without spatial components and note the advantages (theoretical and empirical) of the spatial ones.

We discover that the competition effects in the Baltic states are stronger than the effects of the agglomeration. We note that tourism in Baltic countries is still significantly separated, and development of transport network and international tourism routes is highly desirable.

We find out the significant positive relationship between completion between adjacent regions and regions' efficiency levels, which match our economic expectation.

We also calculate and review values of regions' efficiency and find a significant level of inefficiency (average efficiency is 63% only) in all three Baltic states.

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