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Assessing the influence of landscape on competitiveness of rural areas in Austria

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Abstract

The question how to measure regional competitiveness is subject of an ongoing discussion. Additionally in recent literature increasingly the question is raised how and to which extent landscape can contribute to regional competitiveness. The cause-effect chains between the supply of goods from landscapes and the development and competitiveness of rural regions are still mostly unclear and difficult to assess. Against these backgrounds a two stage approach is applied to test if landscape has an influence on the competitiveness of rural areas. In the first stage a regional competitiveness index (CI) of rural municipalities is developed applying Data Envelopment analysis (DEA), a method originally developed for efficiency analysis. The results show that DEA is an appropriate method to measure regional competitiveness and the results can be explained by up-stream qualitative research in four selected case study municipalities. In the second stage the influence of landscape-related but also non-landscape-related factors on regional competitiveness is assessed, applying correlation analysis as well as two regression models. The results show that influences of landscape-related factors exist on a low level and non-landscape-related factors like tourism and the distance to urban areas are drivers of regional competitiveness.

Kurzfassung

Die Frage nach der Messung von regionaler Wettbewerbsfähigkeit ist Gegenstand einer lang andauernden wissenschaftlichen Diskussion. Ebenfalls kam in neuerer Literatur zu dem Thema die Frage auf, inwieweit „Landschaft“ einen Einfluss auf regionale Wettbewerbsfähigkeit ländlicher Gebiete haben kann. Die Ursache-Wirkungsketten zwischen der Externalitäten von Landschaft und ruraler Wettbewerbsfähigkeit/Entwicklung sind meist nicht klar und schwierig zu erheben. Vor diesem Hintergrund wird in dieser Arbeit ein zweistufiges Modell entwickelt, um zu testen ob Landschaft einen Einfluss auf regionale Wettbewerbsfähigkeit hat. In einem ersten Schritt wird ein Index für regionale Wettbewerbsfähigkeit (CI) von ländlichen Gemeinden entwickelt, wobei als Berechnungsmethode die Data Envelopment Analysis (DEA) zur Anwendung kommt, die ursprünglich zur Effizienzmessung entwickelt wurde. Es kann gezeigt werden, dass DEA ein geeignetes Verfahren zur Messung von regionaler Wettbewerbsfähigkeit ist. Die Ergebnisse einer qualitativen Up-Stream Untersuchung in vier ausgewählten Fallstudien-Gemeinden bestätigen die Plausibilität der Ergebnisse. In einem zweiten Schritt wird mittels Regressionsanalysen und Korrelationsanalysen der Einfluss von landschaftsbezogenen und nicht-landschaftsbezogenen Faktoren auf die regionale Wettbewerbsfähigkeit bestimmt. Die Ergebnisse zeigen, dass der Einfluss von ausgewählten landschaftsbezogenen Faktoren gering ist. Die Nicht-landschaftsbezogene Faktoren Tourismus und die Entfernung zu urbanen Gebieten haben einen höheren Einfluss auf regionale Wettbewerbsfähigkeit.

List of Abbreviations

CI	Regional Competitiveness Index
CORINE	Coordination of Information on the Environment
DEA	Data Envelopment Analysis
DMU	Decision Making Unit
e.g.	For example
etc.	et cetera
EU	European Union
GCI	Global Competitiveness Index
GDP	Gross Domestic Product
IMD	International Institute for Management Development
INVEKOS	Integriertes Verwaltungs- und Kontrollsystem
LAU	Local Administrative Unit
MCDA	Multi Criteria Decision Analysis
NUTS	Nomenclature des unités territoriales statistiques
OLS	Ordinary Least Square regression model
RCI	European Regional Competitiveness Index
STD	Structural Territorial Development
SFA	Stochastic Frontier Analysis
Tobit	Tobit Regression model

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1 Introduction

The framework of regional competitiveness with regard to definition and measurement is subject to a rather long-standing and still ongoing discussion – both on scientific and political level (BRISTOW, 2005, 2010; EUROPEAN COMMISSION, 1999a, b; KRUGMAN, 1994b; PORTER and KETELS, 2003; THOMSON and WARD, 2005). There is broad consensus that the crux of measuring regional competitiveness is the sound definition of the term and finding indicators which are suitable and – moreover – available on regional level. Such indicators are necessary for a reliable and comprehensive assessment (BRISTOW, 2010; HAGUE et al., 2011). Literature reveals that a strictly economic definition of competitiveness has clear shortages. Economic factors alone cannot represent all characteristics of a region. That is why, for a deeper insight and a comprehensive assessment of regional competitiveness, social and sustainability factors must also be taken into account (EUROPEAN COMMISSION, 1999a, b; KRUGMAN, 1994a, b; PORTER, 2008; PORTER and KETELS, 2003; THOMSON and WARD, 2005). Many of the approaches of measuring competitiveness aim at considering and implementing this understanding (e.g. ANNONI and DIJKSTRA, 2013; CHARLES and ZEGARRA, 2014; HUGGINS, 2003; SNIEŠKA and BRUNECKIENĖ, 2015). Furthermore, when setting up indices to benchmark competitiveness of regions it is crucial to apply appropriate methodology, particularly with regards to the weighting procedure of different indicators and indicator groups. Besides the methodologies with predefined weighting factors, other methodologies are implemented which calculate the weighting factors out of the existing data.

Recently the question arises how and to which extent landscape is a factor of territorial development and regional competitiveness (FIELDSEND, 2011; VAN ZANTEN ET AL., 2014). In particular it is discussed that landscapes hold the potential to provide private as well as public good-type ecosystem services. These services represent a resource not only for local inhabitants but also for different sectors of the rural economy, such as agriculture, forestry, tourism or the trade and services sector (COOPER et al., 2009b; DE GROOT et al., 2010; FIELDSEND, 2011; HAINES-YOUNG et al., 2010; SUKHDEV et al., 2010; VAN ZANTEN et al., 2014).

The use of private and public good-type services from rural landscapes can create 'linear' socioeconomic benefits, e.g. from the production of agricultural goods or from the direct use of recreation possibilities by both, local population and tourists. Here, at least with regards to benefits of the direct use of private good-type services, the quantification of the impact on the development and competitiveness of a region appears comparatively easy. In contrast, the assessment of economic benefits from the direct use of public good–type services is often complicated due to the mostly missing market price for such services (DIAZ-BALTEIRO and ROMERO, 2008; RUDD, 2009; SCHAEFFER, 2008).

Moreover, the use of services provided by a landscape can also create and 'non-linear' socioeconomic benefits (COOPER et al., 2009a; ENRD, 2010; FIELDSEND, 2011). For example, the use of the landscape's beauty in combination with the agricultural products can enable new marketing concepts of regional speciality products (COOPER et al., 2009a). Here, one can speak of 'multiplier effects', whereas 'multiplication' can go through various stages before it dies out (DOMAŃSKI and GWOSDZ, 2010). The aesthetic value of a landscape, can lead to the establishment of businesses in a special area. BALDERJAHN and SCHNURRENBERGER (1999) showed in a qualitative survey with top managers, that attractiveness of landscape does influence the choice of the location of a company. Such economic activities in turn can create, influence and alter other economic activities, for example by developing the regional income side due to creating jobs for the local population or by developing the supplier side due to enhanced demand. Regional economics and migration studies indicate that landscape amenities possibly influence specific variables like migration, income or employment (WALTERT and SCHLÄPFER, 2010).

However, the cause-effect chains between the supply of services from landscapes and the development and competitiveness of rural regions still remain unclear. In particular this is due to the fact that the socio-economic effects and benefits resulting from the use of landscape services often are multi-staged and multi-faceted and therefore difficult to assess.

Against these backgrounds, in a first step the method of Data Envelopment Analysis (DEA) is applied to gain a regional competitiveness index (CI), including social and economic indicators to be able to benchmark the various regions according to their level of competitiveness. DEA creates a relative index which calculates the weighting factors out of the existing data. In a second step, both correlation analysis and regression analysis are applied to find influences of landscape variables on regional competitiveness. In contrast to classical regional economics and migration studies, this approach attempts to give a broader picture of possible influences since landscape variables are tested to influence an integrated and holistic competitiveness index. The measurement is done on municipality level in the rural and also particularly in the alpine area of Austria. A special focus lies on four case study municipalities, whose results of the first stage are compared with empirical qualitative-up stream research of these municipalities. The aim is to explain the empirical findings with the theoretical results to check the reliability of the model.

The study starts with an introduction to the theoretical background on regional competitiveness with the topic's definitions, indicators, spatial resolution and appropriate methods, which are considered to be important, when setting up an index for regional competitiveness. Next, a literature review is presented describing the influence of a landscape on the social and economic development of a region including different methods for measuring influences and quantitative indicators expressing landscape. The following chapter comprises the technical background of the calculations with a general explanation of efficiency analysis and DEA as a special tool to measure efficiency, which is applied in a first stage to measure regional competitiveness. After that, technical descriptions of correlation analysis and regression analysis are presented, that are applied in the second stage of the model. The next chapter constitutes the model specifications with the description of the indicators and factors of the calculations of the two stages, the selected model regions, where the model is applied and a description of the case study municipalities. A special discussion of using an efficiency score as competitiveness index as well as applying municipality as Decision Making Unit (DMU) is also included in this chapter. After that, the results of the first and the second stage as well as the special results of the case study municipalities are presented. Finally the results are discussed along with final conclusions and a future outlook.

2 Assessing Regional Competitiveness

On micro-economic level, e.g. for companies or firms, the concept of competitiveness as a measure of economic viability is broadly accepted. MARTIN et al. (1991) define competitiveness as the sustainable ability of a company, to gain or save profit-making market shares, or, very straight forward, the capacity of a company to compete, grow and be profitable. Another definition describes competitiveness as the ability to produce the right goods and services of the right quality, at the right price, at the right time' in a competitive market, while meeting customers' needs more efficiently and more effectively than other firms do (EDMONDS, 2000).

On the macro-economic level (countries, regions, etc.), the reasonableness of measuring competitiveness is intensively discussed (EUROPEAN COMMISSION, 1999a; KRUGMAN, 1994b; PORTER, 2008). KRUGMAN (1996) points out that applying the concept of competitiveness on countries or region implies a competition between them. Nations or regions, failing to achieve the productivity of competing nations or regions, will face the same challenges as a company competing with the productivity of its rivals. However, such a comparison is problematic, since goals and circumstances of countries, regions and companies differ significantly. Furthermore, a nation or region that does not compete, will still not cease to exist and go out of business like a non-competitive company (THOMSON and WARD, 2005). Nevertheless, to measure competitiveness of nations or regions still appears useful, since quantitative and comparable assessment could help to identify regional weaknesses and uncover reasons that drive these weaknesses. This knowledge can support regions in the catching up process (ANNONI and KOZOVSKA, 2010). The assessment needs to be done in a framework, where regional competitiveness has to be defined clearly.

2.1 Definition of regional competitiveness

Until now, various definitions of competitiveness have been formulated in order to more comprehensively describe the competitive potential of nations or regions: On macro-economic, national level, one of the most important definitions is given by the World Economic Forum in line with the development of the Global Competitiveness Index (GCI): Here, competitiveness is defined as the 'set of institutions, policies, and factors determining the level of productivity of a country' (SCHWAB and SALA-I-MARTIN, 2014). On regional level, e.g. the EU's Sixth Periodic Report on the Regions defines competitiveness as 'the ability […] to generate, while being exposed to international competition, relatively high levels of income and employment' (EUROPEAN COMMISSION, 1999a). Another approach goes beyond this still rather productivity-driven definition and describes an area's competitiveness by the ability 'to face up to market competition whilst at the same time ensuring environmental, social and cultural sustainability' (EUROPEAN COMMISSION, 1999b). Also more recent definitions go beyond the sole productivity meaning of competitiveness by including social and sustainability aspects. The focus is set on the link between regional competitiveness and regional prosperity while competitiveness is characterised as the ability of a locality or a region to generate high and rising incomes, enhancing the overall standards of living and improving the livelihoods of the people living there (BRISTOW, 2005; DIJKSTRA ET AL., 2011; HUGGINS, 2003; MEYER-STAMER, 2008). In this study the definition of DIJKSTRA et al. (2011), applied in the European Regional Competitiveness Index (RCI) of 2011, will be used, which includes on the one hand the productivity based approach of the GCI and on the other hand the residents' prosperity based approach of MEYER-STAMER (2008): 'Regional competitiveness is the ability to offer an attractive and sustainable environment for firms and residents to live and work (DIJKSTRA et al., 2011).'

2.2 Indicators for measuring competitiveness

A key task for the assessment of regional or local competitiveness is the choice of appropriate indicators. On national level a range of widely accepted indicator systems and competiveness indices exist, such as the IMD's World Competitiveness Yearbook (IMD INTERNATIONAL, 2013), the World Economic Forum's Global Competitiveness Index (ANNONI and KOZOVSKA, 2010), or the European Competitiveness Index (HUGGINS and DAVIES, 2006). However, national indices cannot be easily transferred to a regional scale, since data is often unavailable or meaningless on regional level (HUOVARI et al., 2001).

MARTIN (2004) describes two approaches to assess competitiveness on regional level. The first approach explores the influence of particular single drivers on competitiveness, such as demographical development (FLORIDA, 2002), business environment and innovative milieu (RITSILA, 1999), governance and institutional capacity (MOERS, 2001) or industrial structure (EUROPEAN COMMISSION, 1999a, 2001). The second approach analyses competitiveness as a cumulative outcome of factors, where potential drivers are incorporated in a model to examine competitiveness.

Prominent examples for the latter approach are the UK's regional and local competitiveness index (HUGGINS, 2003; THOMSON AND WARD, 2005), the European Commission's reports on economic, social and territorial cohesion (EUROPEAN COMMISSION, 2001) and the RCI (ANNONI and KOZOVSKA, 2010). Here, the different approaches use a variety of different factors and indicators to describe and measure competitiveness on a rather small scale. Depending on the approach,

- 'economic factors' like the Gross Domestic Product (GDP), , labour productivity, labour market efficiency,
- 'human factors' like education and training, income levels or quality of life,
- 'innovation factors' like patents, business sophistication or technological readiness, or other
- 'basic factors' like infrastructure, investments, institutions or also health are considered and combined.

A broad body of literature deals with the framework of 'regional development' using similar indicators like competitiveness. A main difference is that regional development literature depicts dynamics and growth, while regional competitiveness shows a static picture. However, when looking at the literature, both approaches include similar indicators like change in population growth, employment, economic variables like tax income or income level. WALTERT and SCHLÄPFER (2010) review studies, which use the indicators 'Population', 'Net migration', 'Employment' and 'Income' as indicators for measuring and explaining regional development. SÁNCHEZ-ZAMORA et al. (2014) build their model on the concept that rural territorial dynamics refer to the process of development in the socio-economic structure, institutional framework and environmental capital of rural areas.

One set of factors particularly suitable for Austria is suggested by STATISTICS AUSTRIA (2006b), which was a project to identify possible indicator for measuring regional development in Austria especially on NUTS2, NUTS3 and LAU2 level. It considers the factor groups

- ‘Demography’ – migration (population change, net migration, natural population change);
- ‘Economy’ – human capital (forms of employment, importance of different sectors, importance of public sector, capacity of collective tourist accommodation, occupancy of collective tourist accommodation, weight of manufacturing, weight of tertiary sector, relative changes of unemployment, human capital, potentially available resources, relative changes of employment);
- Accessibility to services – infrastructure (availability of roads/rails, supply with schools, and proximity to primary schools and
- Social well-being (relative wealth of the population, poverty, quality of life).

2.3 Spatial level of measurement

Regional competitiveness has not just been a phenomenon on national level, but it is also assumed to have key significance at sub-national (e.g. states, counties), urban and local scales. Within governmental circles the performance evaluation of individual regions and cities is of growing interest (KITSON et al., 2004). PORTER (1995, 1998, 2003) implies that the concept of regional competitiveness is applicable on a broad range of geographical scales including cities, regions or countries. A broad literature exists measuring regional competitiveness on national level (HUGGINS et al., 2005; IMD INTERNATIONAL, 2013; SCHWAB and SALA-I-MARTIN, 2014) and on sub-national level (e.g. ANNONI and KOZOVSKA, 2010; CHARLES and ZEGARRA, 2014; HUGGINS and THOMPSON, 2010; HUOVARI et al., 2001; PORTER and KETELS, 2003; SNIEŠKA and BRUNECKIENĖ, 2009, 2015) as well as applications on urban levels (JIANG and SHEN, 2010; PORTER, 1995; SO and SHEN, 2004; ZHANG). On smaller scales local competitiveness studies are examined mostly on LAU1 level (e.g. HUGGINS, 2003; IVANOV, 2008; LENGYEL, 2003; LUKOVICS, 2007). Few works measure competitiveness on the smaller municipal level (e.g. HJALMARSSON et al., 1996; MARSHALOVA et al., 2007; SZEKELY and CZAPIEWSKI, 2007; SZEKELY and MICHNIAK, 2006; USAID, 2014).

When choosing a specific scale it has to be noted that with respect to the selected indicators some processes of regional competitive advantages are highly localized, while others operate on a broader regional or even national scale. HAGUE et al. (2011) draw attention to the fact that competitiveness of a smaller region is often intertwined with the general level of the wider regional or national economy. For example economic growth rates of the particular region under examination may be caused by the performance of decision makers in the broader region. For example a municipality A in a strong developing region may be seen to perform better than a municipality B located in a declining region. Comparing the two municipalities with regard to the economic growth can produce a skewed result when municipality A falls behind the other municipalities within the region and municipality B performs better compared to the municipalities within its region. Therefore (HAGUE et al., 2011) suggest to benchmark regions in areas of similar kind.

2.4 Application of DEA for spatial analysis

Once decided the appropriate indicators and the spatial resolution are decided on, it is crucial to apply a suitable methodology to measure and benchmark competitiveness of regions. Different approaches exist, setting up competitiveness indices. The core of the process to gain a single index of competitiveness is to aggregate and weight various indicators. BRISTOW (2010) points out that the difficult part in creating such a composite index is the selection of the weights of the indicators. They should be selected from a pertinent theoretical framework with respect to their overall importance. Such a theoretical universal framework is non-existent. Hence researchers apply different approaches to gain weighting factors including regression analysis (LUKOVICS, 2007; PORTER, 2004a) or expert opinions (KOURILOVA et al., 2012; SNIEŠKA and BRUNECKIENĖ, 2009).

Creating a composite index can be seen as Multi Criteria Decision Analysis (MCDA) problem. A frequently used practice is to group indicators according to the subject matter (e.g. economy, government, quality of life, infrastructure, environment) and giving these groups either different (e.g. ANNONI and DIJKSTRA, 2013; ANNONI and KOZOVSKA, 2010; KOURILOVA et al., 2012; SNIEŠKA and BRUNECKIENĖ, 2009) or equal weights (e.g. HUGGINS and THOMPSON, 2010).

HUGGINS and DAVIES (2006) apply DEA for calculating the RCI for 2006-07 on NUTS2 level. After standardizing with factor analysis and grouping the regional variables into pillars (‘Creativity’, ‘Economic performance’ and ‘Infrastructure and Accessibility’) a sub-composite index for each pillar is calculated by applying factor analysis. Subsequently, DEA is applied to obtain a single index of competitiveness.

CHARLES and ZEGARRA (2014) published a paper applying DEA on sub-national scale. They set up five pillars ‘Economy’, ‘Firms’, ‘Government’, ‘Infrastructure’ and ‘Persons’ where each pillar is calculated as a simple average of respective sub-pillars. The pillars are incorporated in a DEA as inputs with a standard output. DEA is applied as MCDA with a ‘pure-input-model’ primarily proposed by LOVELL and PASTOR (1999). Although the aims are different, these two sub-fields of Operations Research address rather similar problems (BOUYSSOU, 1999; STEWART, 1996). ADOLPHSON et al. (1990) were the first to portend the possibility to apply DEA in a broader perspective, comparing a set of homogeneous units on multiple dimensions. Since then many researchers from various fields followed this path (e.g. BEZERRA NETO et al., 2012; LEE and KIM, 2014; SEOL et al., 2011).

The main advantage of DEA is the fact that unlike similar approaches like MCDA, no prior weighting of different indicators or pillars needs to be done. CHARLES and ZEGARRA (2014), HUGGINS (2003) and HUGGINS and DAVIES (2006) particularly mention this advantage as the main argument to apply DEA. A further strength of DEA is the possibility to incorporate multiple inputs and outputs with differing units. Consequently, even factors that cannot (or only at great expense) be expressed in monetary units can be included in the assessment. This technique thus allows the integration of multiple economic, environmental and social aspects.

2.5 DEA in the context of regional economics

Besides competitiveness analysis DEA is also applied in a broader context of regional economics. STANÍČKOVÁ and SKOKAN (2012) apply DEA on a national level to measure national efficiency of the European member states, by using the factors ‘Gross domestic expenditure on research and development’, ‘Employment rate’, ‘Gross fixed capital formation’ and ‘Number of students as input variables’ and ‘Gross domestic product’ and ‘Labour productivity’ as output variables. The resulting efficiency score is seen as competitive potential or in other words, a ‘mirror’ of competitiveness. NEVIMA and RAMÍK (2010) likewise apply almost the same practice to measure the efficiency of European regions.

An example of DEA in regional development studies is SÁNCHEZ-ZAMORA et al. (2014). They apply a DEA model similar to CHARLES and ZEGARRA (2014) to analyse the determinants of successful territorial dynamics in Andalusia from 2000 to 2009. At first, five types of rural areas are identified with factor analysis based on 56 indicators, that can be categorized into 'Economic capital', 'Human capital', 'Social capital', 'Cultural capital' and 'Environmental capital'. Secondly, for each of the five rural types one DEA is applied with the respective municipalities as units under observation to identify municipalities with 'Structural territorial development (STD)', as the results of DEA are interpreted as a composite index. The indicators for STD – are 'Rural population', 'Income per capita', 'Employment rate' and an 'Environmental index'. Thirdly, regression analysis is applied to explore influences of the indicators categorizing rural types on each output factor, which are the indicators.

DEA is also a widely used method for analysing the institutional performance of municipalities as local government. These studies can be divided into two different approaches depending on the focus of the different studies (DE BORGER and KERSTENS, 2000). Local governments can be either evaluated with respect to their overall performance including the major governmental services and duties. (e.g. AFONSO and FERNANDES, 2006; BALAGUER-COLL et al., 2007; DE BORGER and KERSTENS, 1996; NOLD HUGHES and EDWARDS, 2000; SOUSA, 1999), or the performance evaluation focusses on particular services and aspects of a local government as for example general administration (KALSETH and RATTSØ, 1995), solid waste management (HUANG et al., 2011; WORTHINGTON and DOLLERY, 2001), bond issuing (ROBBINS and SIMONSEN, 2002), water supply (GARCÍA-SÁNCHEZ, 2006) or local police units (NYHAN and MARTIN, 1999). A general overview on evaluating local governments using frontier analysing methods is provided in the work of WORTHINGTON and DOLLERY (2000a).

3 Influence of landscape on a region

In the second part the study the focuses on the influence of ‘landscape’ on regional competitiveness. Therefore it is crucial – similarly to the framework of regional competitiveness – to define landscape as well as well as giving a theoretical introduction and an overview of applications to assess influences of landscape on particular factors of development and competitiveness of regions.

COOPER et al. (2009b) at the beginning of the Final Report ‘Provision of public goods through agriculture in the European Union’ point out that ‘In certain regions of Europe, attractive landscapes and the presence of farmland biodiversity and historical features, provide a market opportunity for a wide variety of economic activities, including rural tourism and recreation, speciality products and foods, as well as affording an attractive location for the establishment of businesses. The realisation of these economic opportunities depends on various factors, including an area’s proximity to urban conurbations, the existence of a supporting infrastructure, such as roads, places to stay and visitor facilities, as well as factors such as geography and climate.’ In the report, it is demonstrated that landscape is likely to be the most important public good contributing to the provision of second order effects. COOPER et al. (2009b) conclude that ‘while many of these relationships are documented through case studies, evidence of quantified economic impacts is lacking in many parts of Europe’.

3.1 Definition of landscape-related factors

Landscape is defined as an ‘area, perceived by people, whose character is the result of the action and interaction of natural and/or human factors (EUROPEAN COUNCIL, 2000).’ Different terms and concepts for landscape exist because related variables, like natural amenities, landscape amenities, rural amenities, environmental variables and landscape attributes all have slightly different focus. Hence with regard to human influence, the definition ranges from natural spatial composition and structure to man-made recreation parks. Besides human influence, landscape-related variables differ concerning the human level of usage and benefits.

OECD (1994) defines amenities as landscape features of the countryside having specific societal or economic values. They ‘provide benefits to people through the direct consumption if specific aspects of land, natural resources and human activity (OECD, 1994).'

POWER (1988) describes amenities as 'non-marketed qualities of a locality that make it an attractive place to live and work.' Despite different approaches and definitions of amenities, two generally agreed characteristics are inherent, when considering landscape amenities (DISSART, 2007). Firstly, landscape amenities are site specific and help differentiating locations and, secondly, they make a location a more attractive place to live in and consequently may boost local development.

In this study, landscape amenities are called *landscape-related factors* and are defined according to WALTERT and SCHULZ (2008) as landscape features that are location-specific, latent non-market input goods of an economy (MARCOUILLER, 1998) that directly enter a resident's utility function (DELLER et al., 2001; GREEN, 2001) or attract firms in amenity-based industries (GOTTLIEB, 1994). Furthermore, landscape amenities are seen as a source recreational and aesthetic utilities rather than as a source of raw materials used in the production process (WALTERT and SCHULZ, 2008).

3.2 Applications of assessing influences of landscape-related factors on economic and social development of regions

Basically researchers follow different paths investigating influences of landscape on the economic and social development of its region. The focus lies mainly on explaining influences of landscape amenities on migration, employment, firm settlement and housing prices.

Hedonic pricing models were originally established by ROSEN (1974). 'Hedonic prices are defined as the implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them (ROSEN, 1974).' From regression analysis is deployed an implicit price function from observed property prices is derived. In a second step the influence of exogenous factors on these implicit prices is assessed. In such an implicit price function the property price is typically described by three types of independent variables (WALTERT and SCHLÄPFER, 2010): structural, neighbourhood and environmental attributes, where landscape amenities are part of environmental attributes. To catch specific amenities at small spatial scales, hedonic pricing models is primarily applied on a small spatial levels (neighbourhood, community, county), which comes at the costs of spatial coverage (WALTERT and SCHLÄPFER, 2010). The landscape amenity variables in the various models should reflect the landscape attractiveness of the area under assessment. WALTERT and SCHLÄPFER (2010) review studies, which integrate landscape amenities as explanatory variables in hedonic pricing models and group them in the categories ‘Open space’, ‘Forest’, ‘Preserved land’, ‘Wetland’, ‘Agricultural land’ and ‘Diversity’.

Many classical regional economic and migration studies include landscape amenities as one possible influencing variable on regional development. WALTERT and SCHLÄPFER (2010) summarize hedonic pricing models and regional economic and migration studies comprising landscape amenities in the models. They identify 25 articles mostly using regression analysis to explore influences of various independent variables including landscape amenities on at least one of the dependent variables of ‘Population’ (e.g. ALI et al., 2007; DELLER and LLEDÓ, 2007; NZAKU and BUKENYA, 2005), ‘Migration’ (e.g. FERGUSON et al., 2007; LUNDGREN, 2009), ‘Employment’ (e.g. DELLER and LLEDÓ, 2007; HENDERSON and MCDANIEL, 2005; PARK et al., 2009) or ‘Income’ (e.g. BOOTH, 1999; NZAKU and BUKENYA, 2005). According to WALTERT and SCHLÄPFER (2010) landscape amenities are mostly calculated as proportions of landscape. Typical landscape amenities are land-use categories like national parks, federal forests, wilderness land or conservation land. The advantage of using a classical approach to measure influences of landscape amenities on regional development instead of hedonic pricing models is the possibility to apply the models in broader study regions.

4 Methods

In the following part a basic introduction into general productivity and efficiency analysis is provided. The later applied method of DEA is one particular method to measure efficiency. In this study DEA is also the method to create an index for regional competitiveness. According to CANTNER et al. (2007) productivity in an economic sense is the quotient of outputs to respective inputs of a production unit. Based on the goal and available data, the measurement of either global or partial productivity is possible. Partial productivity compares the produced amount of output with one particular input, which leads to the concept of partial factor productivity (e.g. labour productivity, capital productivity, material productivity) (HORNGREN et al., 2001).

Efficiency is defined as the comparison of actual produced outputs (e.g. products, services, etc.) with the amount that could be produced with the same amount of inputs (material resources, human resources, capital, etc.) (*Equation 1*) (CANTNER et al., 2007).

$$efficiency = \frac{actual\ prodctivity}{highest\ possible\ productivity} \tag{1}$$

To illustrate the topic of productivity, an example of one agent will be elaborated on. The following explanation is based on the assumption that this agent needs one specific resource (input) to produce a special product (output). Productivity analysis looks at the production process, where the input is transferred into the output. When comparing different agents producing the same type of product with the same resources, there are differences in the production process. Therefore different amounts of the specific inputs are needed.

Depending on the goal, the measurement can be generally separated into two different economic principles:

- The *maximum principle* denotes the highest production of outputs that can be achieved with a fixed amount of inputs.
- The *minimum principle* in contrast denotes the production of fixed outputs with lowest possible use of inputs.

In *Figure 1* a graphical description is presented. Every input-output-combination represents one agent with a specific production process. In the illustration the agents with the best production processes are located on the black line. All input-output combinations on this production function line represent fully efficient agents as for every fully efficient observation there is neither one agent that produces more output with given input (maximum principle) nor an agent that is using less input for a fixed output (minimum principle). Such a production function, where agents with the best practice production processes are located, is called production frontier. According to DOMSCHKE and SCHOLL (2005) a production frontier depicts for every input the highest possible amount of output. The shaded space under the production function represents the set of all non-efficient agents. The set of all possible combinations including the production function is called *technology set* (DYCKHOFF, 1994).

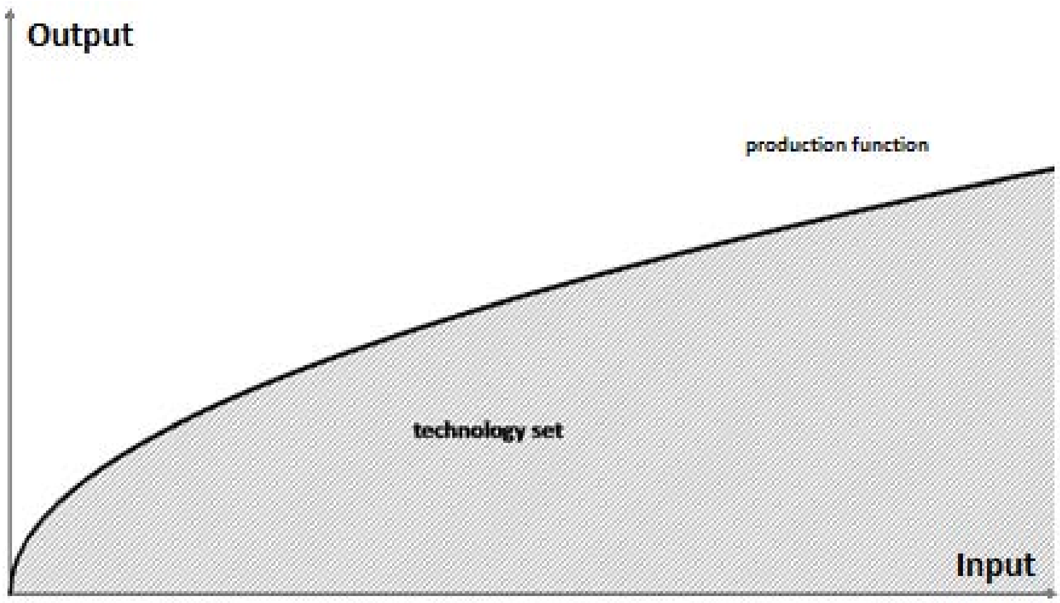

Figure 1: Production function and technology set

Source: Cantner et al.; 2007 / Own Illustration

In *Figure 2*, showing a single input single output situation, empirical production units are plotted, which are points *A, B* and *C*. Looking at *Figure 2* from an economic view, production processes of companies producing the same kind of good (output) are presented, for which they need the same kind of resource (input). For every point the underlying production function could be drawn. This is done for *A* and *C* but it could be also done for B. In grey colour the optimal production function on the top is drawn representing the production function of a company with the theoretically best production process that could be reached under perfect conditions, which is certainly impossible in reality. The production functions of real observed production units are called *actual-practice functions*. In *Figure 2* the actual-practice production function for *C* is illustrated. The production function of agents with the best observed production process, which is represented as *A*, is called *best-practice production function*. *B* and *C* are not located on the production frontier and are therefore considered as inefficient.

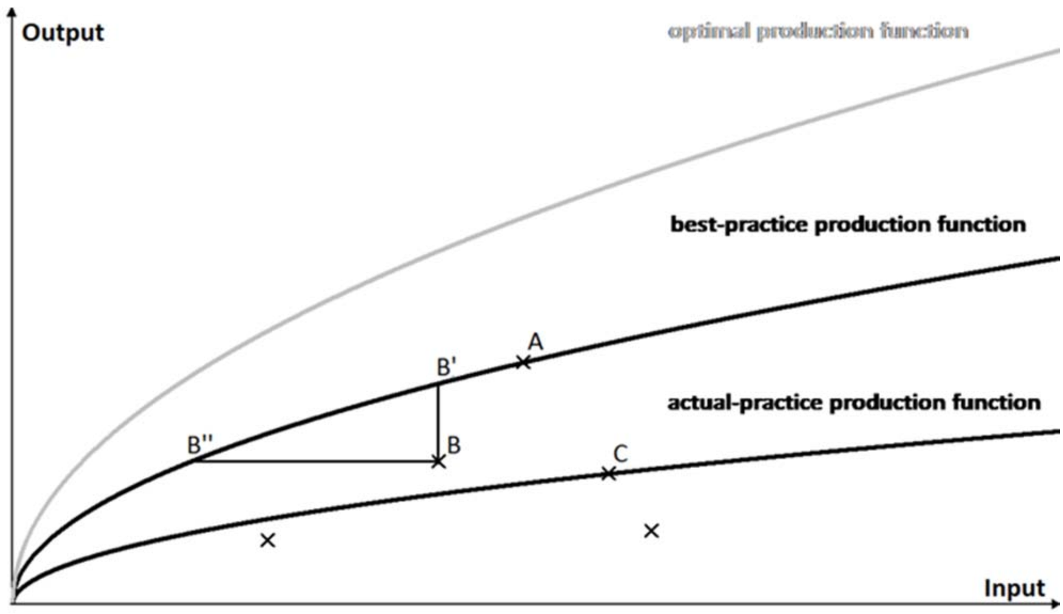

Figure 2: Production functions and level of inefficiency
Source: Cantner et al.; 2007 / Own Illustration

When trying to measure the level of inefficiency, *B'* and *B''* come into consideration. Basically, the distance from each inefficient observation to the production frontier is the inefficiency rate. This distance is sketched for company B as vertical and horizontal line. Depending on the economic principle the horizontal distance to the production frontier represents the input that need to be reduced under the assumption of a fixed output to be on the frontier (minimum principle). The vertical line represents the amount of output that needs to be maximized holding fixed the input (maximum principle). Therefore, the distance *B* to *B'* shows the inefficiency level under the maximum principle and the distance *B* to *B"* shows the inefficiency level under the minimum principle. *Figure 2* represents of one input and one output factor. When looking at more complex production processes with more inputs and/or outputs, more comprehensive methods are required.

Different methods were developed to deal with multi-input-output cases. One approach is to normalize all input and output factors to one basis. In economic sciences usually a monetary basis is determined, where the challenge lies in the conversion and transformation especially for non-monetary factors. One approach to monetize factors is the hedonic pricing models, where the great expanse for detailed information comes at the cost of spatial coverage (WALTERT and SCHLÄPFER, 2010).

MCDA tools are another approach to gain performance information. The aim is to support choice between different alternatives (e.g. companies, municipalities) through gaining the best solution with preference ranking. Therefore, selected criterions (e.g. inputs/outputs) from the alternatives, which are considered as important for the decision making process are weighted regarding their importance. The result is an aggregated weighted sum called total factor productivity, which can be implemented to compare different alternatives concerning the respective aggregated weighted sums. It is possible to derive an index between 0 and 1 by dividing each alternative by the best alternative. In *Equation 2* the calculation of the total factor productivity A_i of alternative is illustrated according to CANTNER et al. (2007).

$$A_i = \frac{\sum_{r=1}^{s} p_r y_{ri}}{\sum_{j=1}^{m} q_j x_{ij}} \quad (2)$$

where x_{ji} is amount of inputs *j (j=1,…,m)*, y_{ri} is the amount of outputs *r (r=1,…,s)* produced by alternative *i*. p_r and q_j represent the respective input and output weighting factors.

Stochastic Frontier Analysis (*SFA*) is a further common parametric approach for efficiency analysis with a special focus on the production frontier. AIGNER et al. (1977) and MEEUSEN and VAN DEN BROECK (1977) almost simultaneously published works, which can be seen as the starting point of SFA (KUMBHAKAR and LOVELL, 2003). It is an econometric method applying regression analysis to estimate a production function, where efficiency of companies is calculated from the residuals from the estimated equation (JACOBS, 2001). The error term is then divided into a stochastic error term and a systemic inefficiency term (JACOBS, 2001). Since the production frontier is estimated before calculating the efficiency analysis, SFA is seen as parametric approach, where multiple input/output cases can be solved. One main advantage comes with the error term, since the method is more robust especially when dealing with outliers.

4.1 Data Envelopment Analysis (DEA)

Another method with the focus on production frontiers is DEA. It is applied in similar cases like SFA and there is a broad discussion and comparison of the relevance application of both methods (HJALMARSSON et al., 1996). In contrast to SFA, DEA is an efficiency analysis tool that comes out of the mathematical programming theory and calculates the production frontier out of the companies' input and output data.

Based on the Work of FARRELL (1957), CHARNES et al. (1978) developed a data oriented method, for the performance evaluation of a set of observations called *Decision Making Units (DMUs*), which convert multiple inputs into multiple outputs (COOPER et al., 2011). DEA compares production processes out of a sample of DMUs, without a priori assumptions of the form of the function. Since DEA is a non-parametric approach, the technology set and the production frontier is calculated out of the DMU's input/output data.

The basic idea of DEA is similar to the above described MCDA since both, the performance of each DMU is measured and the benchmark of the DMUs, are part of DEA. The difference is that DEA benchmarks the DMUs without a priori determining the weighting factors. These weighting factors are endogenous variables and therefore calculated directly. For each DMU a linear programming model is exerted to gain the optimal weights for the inputs and outputs that the quotient of outputs and inputs is maximized. The result of this linear programming is an efficiency score that is between 0 and 1 where 1 represents a fully efficient DMU.

When starting from the general productivity analysis, the efficiency score h_i from a company *i* is the quotient of observed productivity and the highest observed productivity of the companies under examination. In the following *Equation 3* this step is illustrated:

$$\max_{p_r q_j} h_i = \frac{\sum_{r=1}^{s} p_r y_{ri}}{\sum_{j=1}^{m} q_j x_{ij}} \qquad (3)$$

s.t.

$$\frac{\sum_{r=1}^{s} p_r y_{ri}}{\sum_{j=1}^{m} q_j x_{ij}} \leq 1;\ for\ every\ l \in \{1, \dots, n\}$$

$$p_r > 0\ for\ every\ r \in \{1, \dots, s\}$$

$$q_j > 0;\ for\ every\ j \in \{1, \dots, m\}$$

The side constraints make sure that the efficiency score is between 0 and 1 without the possibility to be 0 and that no input or output is 0. The difficulty to solve the maximization problem is because of the quotient, since the equation comprises two aggregation functions where either the numerator needs to be maximized or the denominator needs to be minimized. For such problems different solutions have been developed such as the *Charnes Cooper Transformation* (CHARNES and COOPER, 1962). The exact mathematical transformation can be looked up in CANTNER et al. (2007). The result is a modified linear optimization problem written in a functional form in *Equation 4:*

$$\max_{\mu,v} h = \sum_{r=1}^{s} \mu_r y_{ri} \qquad (4)$$

s.t.

$$\sum_{r=1}^{s} \mu_r y_{ri} - \sum_{j=1}^{m} v_j x_{ji} \leq 0; for\ every\ l \in \{1, \dots, n\}$$

$$\sum_{j=1}^{m} v_j x_{ji} = 1$$

$$\mu_r > 0; for\ every\ r \epsilon \{1, \dots, s\}$$

$$v_j > 0; for\ every\ j \in \{1, \dots, m\}$$

where additionally to the already implemented variables, *μ* and *v* represent adjusted weighting factors. The result of this linear optimization is an efficiency score for every DMU between 0 and 1.

The results can be divided into two different sets separating efficient and inefficient DMUs defined in *Equation 5* and *Equation 6*:

$$eff(i) = i\{i|h_i = 1,\ i = 1, \dots, n\} \quad (5)$$

$$ineff(i) = \{i|h < 1,\ i = 1, \dots, n\} \quad (6)$$

The set of fully efficient DMUs have an efficiency score of 1 and are therefore technically efficient. These DMUs are the basis of further efficiency analysis and the comparison of the DMUs under examination. DEA simultaneously benchmarks the different DMUs and defines the production frontier out of the technically efficient DMUs. For this purpose DEA has various assumptions about the possible space of input-output vectors.

The most important assumptions are *convexity* and *free disposability*. Convexity denotes the integration of linear combination of two different DMUs into the possible input-output vectors. That means that all linear combinations between observations are also part of the possible input-output vectors. Free disposability means that DMUs, which produce less output (or input) holding the input (or output) fixed are also considered in the calculation. An example with three DMUs (*A, B* and *C*) is given in *Figure 3*, which represents a case with two outputs and one input. The line between *A* and *B* represents all convex combinations of A and *B*. The sample of all efficient DMUs and all its convex combinations envelop all inefficient DMUs.

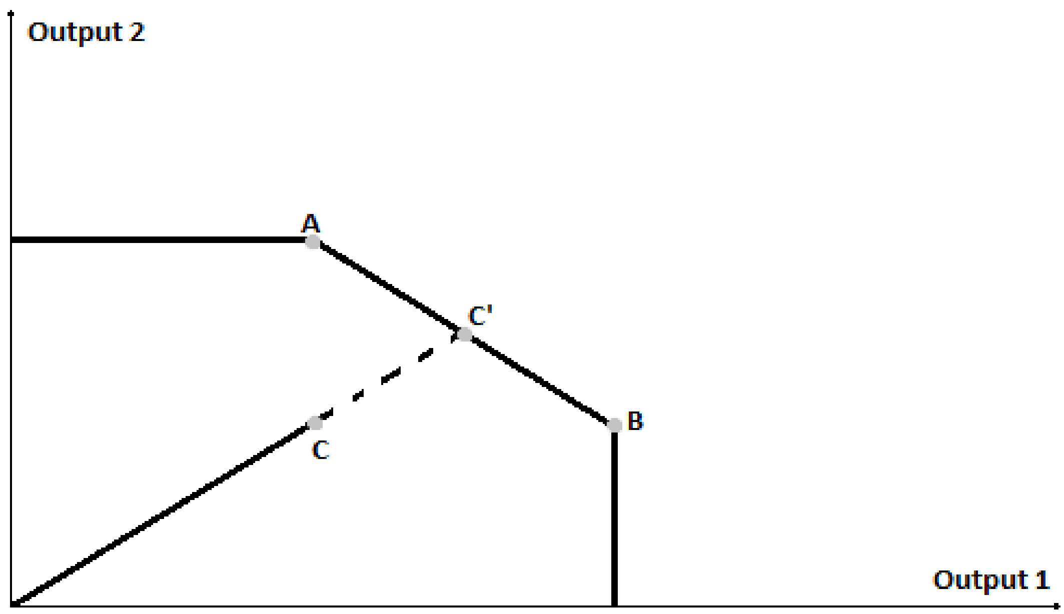

Figure 3: Convex combinations and frontier

Source: Own illustration

Point *A* and *B* represent fully efficient DMUs. Point *C'* is not a real observation but it is a convex combination of *A* and *B*. The set of favourable weights of *C* is inefficient because it is dominated by *A* and *B*. The efficient DMUs and the convex combinations envelop the inefficient DMUs (in this case only *C*).

When DEA computes the efficiency level the radial distance from +*C* to the efficient frontier is measured. The efficiency of the *C* is the line from 0 to *C* which is on the frontier and the distance between *C* and *C'* is the amount of outputs *C* needs to maximize to be efficient (COOPER et al., 2006).

4.2 Second Stage Analysis

A variety of scientific disciplines are implementing a second step finding determinants of estimated DEA efficiency scores, which is in this case the CI (e.g. BINAM et al., 2003; JOHNSON and KUOSMANEN, 2012; LOIKKANEN and SUSILUOTO, 2002; MCDONALD, 2009; O'DONNELL and VAN DER WESTHUIZEN, 2002; OTSUKI et al., 2002; RĄCZKA, 2001; SUSILUOTO, 2003; TURNER et al., 2004; WANG et al., 2003; WORTHINGTON and DOLLERY, 2000b). In this study different methods for the second stage are implemented to measure the influence of environmental variables on competitiveness of regions, namely *correlation analysis*, *Ordinary-Least Square* regression *model (OLS)* and *Tobit regression model (Tobit)*. Correlation analysis is chosen firstly to check the single factors of the second stage if influences on regional competitiveness exist and secondly to check the reliability of the established index for competitiveness (correlation analysis with 'Value of land'). OLS and Tobit regression are applied to test the importance of various factors on regional competitiveness.

4.2.1 Correlation Analysis

Correlation analysis basically means to calculate the Pearson's correlation coefficient, which measures the strength of the linear association between two metric variables. The result is always between -1 and 1, while -1 indicates a perfect negative and 1 indicates a perfect positive correlation. It is computed with the following *Equation 7*:

$$r = \frac{1}{n-1} * \sum\left(\frac{x-\bar{x}}{s_x}\right) * \left(\frac{y-\bar{y}}{s_y}\right) \quad (7)$$

r = Correlation coefficient

n = Number of observations

x = Values of the dependent variable

y = Values of the explanatory variable

$\bar{x}$ = Mean of the dependent variables

$\bar{y}$ = Mean of the explanatory variables

s_x= Standard deviation for x

s_y= Standard deviation for y

4.2.2 Linear Regression models

OLS is one specific method of linear regression. Basically regression analysis attempts to model the causal linear relationship between two or more variables, where one or more dependent variables are considered to have an influence on an independent variable. The former is called simple linear regression model and the latter is called multiple linear regression model. The general *Equation 8* illustrates the influence of between two variables, where the subscript $i = 1, \dots, N$ indicates the observation (HELLBRÜCK, 2009):

$$y_i = \beta_0 + \beta_1 * x_i + u_i \quad (8)$$

y_i= Independent variable

x_i= Matrix of the dependent variable

β_0= Coefficient for x_i=0 (intercept)

β_1= Coefficient for inclination (slope)

n= Number of observations

u_i= Error term

In most of the cases only the values of x and y are given and the influence of x on y needs to be estimated, implying the calculation of the coefficients β_0 and β_1. Therefore regression models are applied to estimate the coefficients with the goal to minimize the difference of the observed data with the estimated values of the regression model. Generally the estimation of the parameters is expressed in *Equation 9:*

$$\hat{y_i} = \widehat{\beta_0} + \widehat{\beta_1} x_i \tag{9}$$

$\hat{y_i}$= *Estimator for explanatory variable*

$\widehat{\beta_0}$= *Estimator of the intercept*

$\widehat{\beta_1}$=*Estimator of the slope*

The difference of the estimated values of the regression model and the real observed values is an error term which is also called *residual* (*Equation 10*):

$$\hat{u_i} = y_i - \hat{y_i} \tag{10}$$

$\hat{u_i}$= *Error term (residual)*

When incorporating more than one independent variable in a linear regression model, the general form for the model is (*Equation 11*):

$$y_i = \beta_0 + \beta_1 * x_{i1} + \ldots + \beta_2 * x_{i2} + u_i \tag{11}$$

OLS as one particular method of regression analysis estimates the model parameters $\hat{y_i}$, $\widehat{\beta_0}$ and $\widehat{\beta_1}$ while minimizing the minimizing the sum of squared residuals, illustrated in *Equation 12*:

$$\min \sum_{i=1}^{N} {u_i}^2 \tag{12}$$

Before starting a regression there are several important assumption of a classical linear regression model called the *Gauss-Markov Theorem* (GUJARATI, 2004). In order to be best linear and unbiased estimators (BLUE), these estimators (e.g. $\widehat{\beta_1}$) should be:

1. *Linear*; a linear function of random variable, such as the dependent variable *Y* in the regression model
2. *Unbiased*; its average expected value is equal to the true value
3. *Efficient estimators*; a minimum variance in the class of all such linear unbiased estimators.

The properties of the OLS estimators are derived from the general Gauß-Markov Theorem properties. In the literature different classifications and arrangements of the different properties can be found. GUJARATI (2004) gives ten assumptions where the most important are listed below:

- The regression model is linear in the parameters
- The mean or expected value of the error variable/random disturbance (u_i) is 0
- The conditional variance of u_i is the same for all observations (*homoscedasticity*)
- The correlation between different random disturbances is 0 (no *autocorrelation*)
- The regression model is correctly specified (causal effects are correctly incorporated)
- There are no perfect linear relationships among the explanatory variables (no *multicollinearity)*

Before establishing and running the model these assumptions need to be observed. While several assumptions are of general character, others need to be tested before.

Homoscedasticity/Heteroscedasticity

If the conditional variances of the observations differ it is called heteroscedasticity, which is the opposite of homoscedasticity. Methods to test if homoscedasticity occurs are e.g. the *Goldfeld-Quandt test, White test, Levene test, Glejser test* or *Breusch-Pagan* test. In this case of heteroscedasticity a generally used practice is to use the logarithm or the square root of the values to reach homoscedasticity (GUJARATI, 2004).

Specification bias

If the expected value of the error term differs from 0 the wrong functional form has been chosen. The main underlying errors are excluding important independent variables or intending wrong causal effects in the model. In practice selecting the right indicators is often more than just selecting according to statistical rules and axioms. According to GUJARATI (2004) it is often a trial and error process in testing different models to gain a robust and meaningful model. However, different methods help to select and test different independent variables to be eligible for the regression model. Before starting a regression it might be useful to create a scatterplot with the various variables to see if there might be a relationship. The *Ramsey RESET test* is one statistical method to test for specification errors.

4.2.3 Tobit

In the following explanation the description is based on HENNINGSEN (2010). As mentioned before the efficiency scores are restricted between 0 and 1. TOBIN (1958) introduced a statistical model to deal with such censored data. In this model a latent variable $\dot{y}$ is introduced with the general *Equation 13*. The original dependent variable can either be left censored, right censored or both. :

$$\dot{y}_i = \dot{x}_i \beta + \varepsilon_i \tag{13}$$

$$y_i = \begin{cases} a \text{ } if \text{ } \dot{y}_i \leq a \\ \dot{y}_i \text{ } if \text{ } a < \dot{y}_i < b \\ b \text{ } if \text{ } \dot{y}_i \geq b \end{cases}$$

$\dot{y}_i$= *latent variable*

x_i= *explanatory variables*

β= *unknown parameter*

ε_i= *disturbance term*

a= *lower limit*

b= *upper limit*

In the case of DEA efficiency scores, representing the dependent variable in the second stage is both, left and right censored. An often applied method to deal with censored data in regression models is to apply the parametric *Maximum Likelihood (ML)* method. Basically ML selects the values that fit an underlying distribution best. Assuming that the disturbance term ε follows a normal distribution with mean 0 and σ^2, the so called *log-likelihood function* L is maximized under the assumption that $\dot{y}_i$ follows a normal distribution (*Equation 14*):

$$\log L = \sum_{i=1}^{N} \left[I_i^a \log \Phi\left(\frac{a - \dot{x}_\iota}{\sigma}\right) + I_i^b \log \Phi\left(\frac{\dot{x}_\iota \beta - b}{\sigma}\right) + \left(1 - I_i^a - I_i^b\right)\left(\log \varphi\left(\frac{y_i - \dot{x}_\iota \beta}{\sigma}\right) - \log \sigma\right)\right] \quad (14)$$

$\Phi(.)$=*probability density function*

$\varphi(.)$= *cumulative distribution function*

$$I_i^a = \begin{Bmatrix} 1 \; if \; y_i = a \\ 0 \; if \; y_i > a \end{Bmatrix}$$

$$I_i^b = \begin{Bmatrix} 1 \; if \; y_i = b \\ 0 \; if \; y_i > b \end{Bmatrix}$$

5 Model Specifications

In the study three different model regions are chosen and a single-input, multiple-output DEA is applied for each of these three model regions to gain a CI. The model is applied on municipality level; consequently municipalities are treated as DMUs. The data is pre-processed with *Microsoft Excel*® and *Microsoft Access*® and the assessment is done with *RStudio*®, which contains the package *Benchmarking* to perform efficiency analysis. Moreover, the study follows a spatial approach. Therefore the results are combined with a spatial analysis with *ArcMap 10.1* from *Esri*®.

The CI might be influenced by factors, which do not directly explaining regional competitiveness, but may have influence on the DMU. To test the potential influence of such external factors, a two-stage DEA is applied. This means that the CI is utilized as dependent variable and regressed on the contextual variables. In the literature, there are numerous studies applying two stage models with DEA and regression models also on municipal level (BALAGUER-COLL ET AL., 2007; DE BORGER ET AL., 1994; STORTO, 2013; WORTHINGTON AND DOLLERY, 2001).

The second stage analysis consists of three forms, which are applied on three model regions: in form of a correlation analysis, OLS and Tobit regression. It is not obligatory to apply both regression models but the reason to apply OLS and Tobit is to check the results concerning reliability. It is assumed that both models should show similar results. Tobit is conducted by applying the *RStudio*® package *AER*. In order to deal with heteroscedasticity, the contextual variables with the exception of the indicator ‘Openness of landscape’ are logarithmized.

5.1 Municipality as DMU

In this study the spatial boundaries are set on LAU2 level, which is municipality level in Austria. The question arises if a municipality can be seen as DMU. Numerous studies exist, which benchmark the efficiency of municipal governments to provide services but this study goes beyond the benchmarking of governmental services. The reason is that its focus lies on competitiveness including indicators, which are not directly in control of the local governments. Typical indices of regional competitiveness include spatial resolutions on national or sub-national level but applications on local level like municipalities are rather seldom. Lower resolutions have the advantage to be able to include more indicators in the indices. Nevertheless, there are several arguments for establishing a competitiveness index on such a small scale level.

Firstly, a municipality is a governmental unit where political decisions are made, which are assumed to influence the economic and social structure as well as the landscape of an area. Politicians of municipalities have the economic decision-making power of local zoning and economic subsidies as well as decision-making power to change and form social factors that may influence competitiveness. Of course not all indicators that influence regional competitiveness are in responsibility of local governments. For example firm settlements are often pushed by political actors with responsibilities of lower spatial resolutions.

Secondly, it is important to find a way to define a homogenous landscape. That is why in the second step the possible influence of landscape and its attributes is tested on the competitiveness results with quantitative data. When also considering the ideas of the geographical literature, municipalities are politically bounded territories with social character. In Austria LAU2 level the smallest political unit. On the other hand, the description of the landscape characteristics and compositions of a territory has a more spatial character. It is clear that these variables and data should represent an area with homogenous landscape. Therefore the spatial resolution needs to be as small as possible. It is clear that landscape areas often vary also within the LAU2 level concerning different structures, compositions or land-use types. Homogenous landscapes are not necessarily bordered by municipality borders but the decisive advantage to apply the measurement on a spatial unit as small as possible is a higher explanatory power of the landscape factors describing its appearance. Hence the probability to find influences of these landscape factors on the competitiveness of the spatial unit is higher on a small scale.

5.2 Efficiency score as competitiveness index

In competitiveness and spatial economics literature DEA is mostly applied as MCDA tool but in all applications the topic of generate an efficiency score to express a competitiveness index is poorly discussed.

Basically, indices are set up in order to compare and rank different regions concerning the level of competitiveness. SNIEŠKA and BRUNECKIENĖ (2009) argue that the measurement of competitiveness itself is a complex topic because different social and economic indicators need to be aggregated. However, their argument is important since they proved that the measurement by a composite index helps to solve the problem of complexity. This assumption is also backed up by OECD, which considers composite indices as an increasingly useful tool when tracking economic health from different perspectives. A composite index includes different indicators to gain one overall index. When looking at the efficiency score of DEA, the same pattern of summarizing all outputs into one score is observed. Furthermore, with DEA it is also possible to integrate different kind of indicators, which makes it also possible to deal with the specific economic and social indicators expressing competitiveness.

One further argument to apply DEA is that it compares municipalities with similar structure due to the measurement of the radial distance to the frontier. Different municipalities have diverging potentials and strategies for regional development and therefore not every indicator plays an equal role in competitiveness of the different municipalities (CHARLES and ZEGARRA, 2014).

In this study the indicators for measuring competitiveness are seen as outputs of a municipality, while the sole input is the number of the inhabitants of the municipality. The question arises if the DEA efficiency score is appropriate to measure competitiveness since originally production processes are benchmarked converting inputs into outputs. The selected approach should be rather seen as the proportion of the outputs (economic performance, education rate, working places, population development) per capita or in other words, an overview on the extent to which extend the municipality provides working places, is attractive to educate people and generally to live in or is attractive for firms to do business in this municipality. The efficiency score of DEA compares the municipalities regarding the ability to generate outputs per capita applying weight flexibility. So the proportion per capita is seen as appropriate way to benchmark municipalities concerning their level of competitiveness. A special focus needs to be lied on the weight flexibility, which is one argument why the method is applied to measure competitiveness since no prior weighting needs to be done (e.g. HUGGINS and DAVIES, 2006). The disadvantage is that one factor may get too much influence on the efficiency score while others are given low weights. For this reason the weights need to be controlled and if the weights for specific outputs are unbalanced, weight restrictions can be implemented. In this study no weight restriction needs to be implemented since the weights show a balanced distribution.

5.3 Selection of model regions

This study focuses on the competitiveness of rural areas. Rural areas are defined on basis of European Commission and OECD typologies of territorial units (EUROPEAN COMMISSION, 2012; OECD, 2011; STATISTICS AUSTRIA, 2014). Three different model regions are set up differing with regards to specific selection criteria.

Model region 1 comprises all rural municipalities according to STATISTICS AUSTRIA (2014) based on the classification system of the European Commission (EUROPEAN COMMISSION, 2012). The idea is to harmonize the sample of municipalities under examination since DEA requires the assumption of homogeneity of the units under assessment (DYSON et al., 2001). Firstly the characters, aims and goals of governments in urban and rural areas differ (PORTER, 2004b; THOMSON and WARD, 2005) and secondly rural areas generally lag behind urban areas in most indicators of development (RAHE and WEBER, 2015). Therefore it is appropriate to also exclude urban municipalities from the sample.

The idea in *model region 2* is to analyse especially municipalities located in mountain areas to set the focus on alpine regions. Harmonizing the sample gives a clearer picture of the performance of mountain municipalities. In this study the term ‘mountain municipalities’ will be applied for all municipalities of model region 2. Also a more homogenous sample may show a clearer picture of possible influences especially of mountainous landscape compositions on a region. Another reason is that the case study municipalities lie in mountain areas and the results of the case studies give better insight in the performance of municipalities in alpine areas. 710 alpine municipalities are identified as part of model region 2. The proxy for alpine municipalities of is the existence of agriculturally used mountain pastures within a municipality. Basically, alpine landscape is characterized by sharp vertical areal zoning with a broad range of climatic conditions, which lead to complex natural habitats and different landscape types. Traditionally agriculture plays an important socio-demographic and landscape forming and role in the Alpine region. Alongside the decreasing importance in the employment sector and nutrition functions, the maintenance of the cultural heritage and preservation of habitats and landscapes with high ecological and amenity values are becoming more and more focal points of alpine agriculture and its policy (HOVORKA, 2002). Socio-economically the area is characterized by disparate spread of population density. Due to the fact that large tracts are unsuitable for human habitation because of extreme altitude and adverse topographic and ecological conditions and, subsequently, usable areas in valleys are the predominant living places (TAPPEINER and BAYFIELD, 2004).

In *model region 3* a special focus lies on municipalities with active tourism. The composition is very similar to model region 2 with the difference of investigating only municipalities with active tourism since it is assumed that landscape especially in mountain areas plays an important role in attracting tourism and hence pushing competitiveness. It is broadly acknowledged that especially in areas where there are few alternative economic activities tourism can have positive impacts on regional development (LEMKY, 2006). Spending of tourists are direct revenues for the regions and has positive effects on employment (PESSOA, 2008). Furthermore tourism increases public spending in infrastructure like roads and water supply but also in cultural infrastructure like museums or hiking trails. PESSOA (2008) argues that investments in tourism can produce positive externalities. For example in rural tourism all investors benefit when typical farms are available in the region, which raise the level of attraction for visitors as well as the work of farmers has positive effects on the attractiveness of landscape. The proxy for the selection of touristic alpine municipalities for model region 3 are overnight stays as well as only municipalities of model region 2 are the basis for the selection for model region 3. 649 out of the 710 municipalities of model region 2 are identified having overnight stays.

In the succeeding *Table 1, Figure 4, Figure 5* and *Figure 6* Figure 6: Model regionthe various model regions are presented.

Table 1: Model regions

Model region	**Number of municipalities**	**Selection criteria**
Model region 1	1988	'Rural municipalities' defined by (STATISTICS AUSTRIA, 2014)
Model region 2	710	'Rural municipalities' including agriculturally used mountain pastures
Model region 3	649	Municipalities of Model region 2 with existing tourism measured in overnight stays.

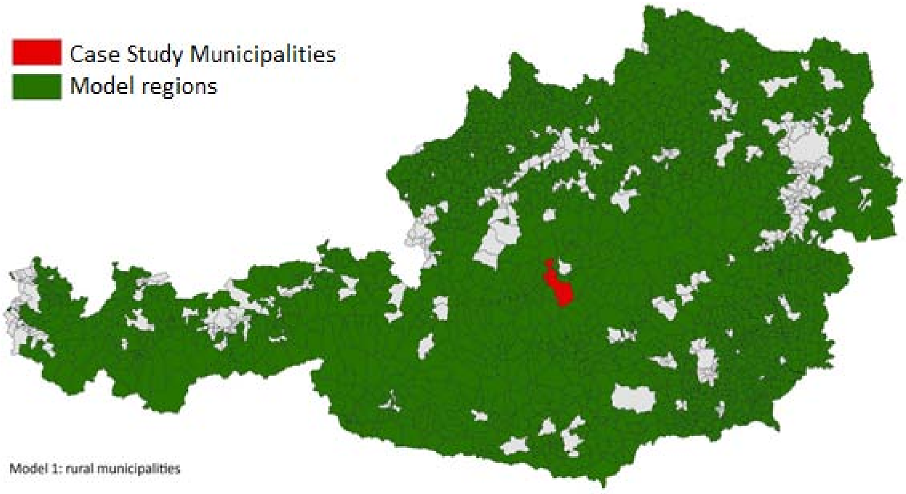

Figure 4: Model region 1 with Case Study Municipalities

Source: Own Illustration

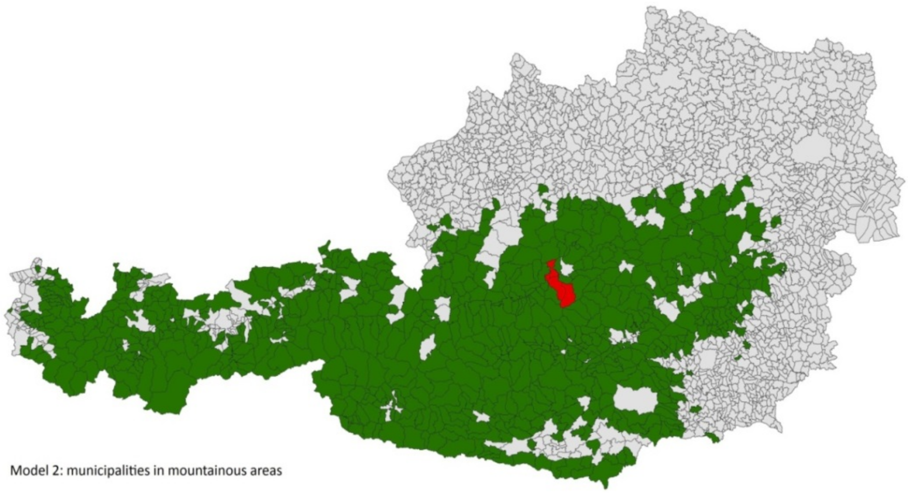

Figure 5: Model region 2

Source: Own Illustration

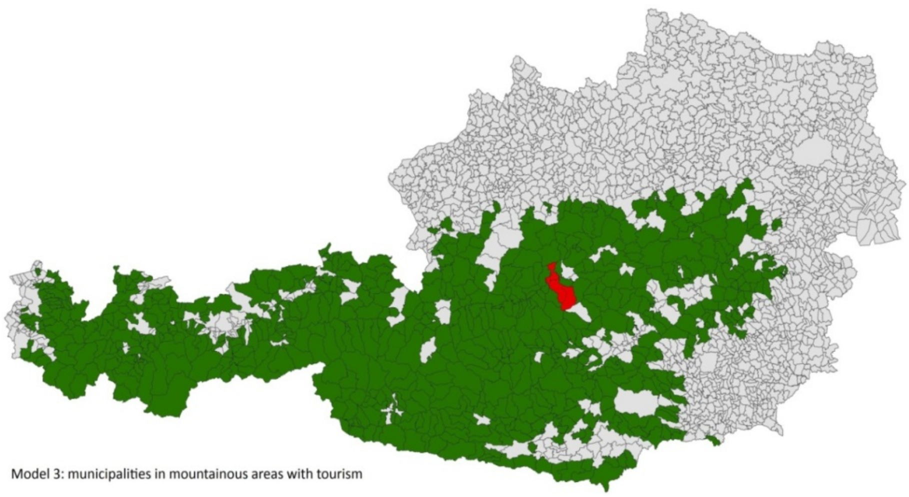

Figure 6: Model region 3

Source: Own illustrations

5.4 Case Study Municipalities

A more in depth analysis of DEA results of four selected mountain municipalities located in Styria is provided through case study municipalities. In these municipalities further qualitative analysis is established, which allows a triangulation of DEA results and results of the second stage with qualitative results in order to be able to explain the results of competitiveness analysis and get insights into the relation between landscape and competitiveness in mountain municipalities. The case study municipalities *Aigen im Ennstal, Oppenberg, Pürgg-Trautenfels* and *Stainach* are located in the region *Mittleres Ennstal* in the northern Austrian Alps. The region represents a typical mountain area covering a main and two side valleys, including a higher agglomeration area (possibilities of shopping, labour, social services, etc.) and a couple of small villages. The landscape is characterised by sheer rock walls and block heaps as well as gentle mountainous formations and the plains of the valley. The valley has the river *Enns* and a multitude of landscape elements. The higher regions are characterized by typical alpine scenery that consists of alpine meadows, pastures and forests.

As regards agricultural land management the case study municipalities could be described as rather small, traditional, family farms specialised on dairy or mixed farming. Small structured grassland is the predominant type of agricultural land use. Only small areas in the river-valley are arable land nearly exclusively for forage production. Grassland is managed, to a high percentage, with comparatively low intensity in form of alpine meadows and pastures and other extensive grassland.

As regards economy, the case study municipalities fall behind the country’s average in Austria. The income level in the district is by nine percent lower than the Styrian average and by eleven percent lower than the national average. The average tax revenues (all municipal taxes) per inhabitant in three of the municipalities among the lowest of the district *Liezen*, only in the municipality including the agglomeration area (*Stainach*) tax revenues are comparatively high (LAND STEIERMARK, 2011). At the moment, the municipalities in the study region are faced by a constant and severe emigration especially of young and educated people (WIRTSCHAFTSKAMMER STEIERMARK, 2013).

5.5 Definitions of DEA input and output factors

The selection of the input and output factors follows the underlying definition of regional competitiveness to integrate economic and social components. However, taking into account existing indicator systems assessing regional competitiveness, it becomes clear that many of the suggested economic indicators, measuring ‘GDP’, ‘GVA’, ‘Wage level’, etc., and of the social indicators measuring ‘Wellbeing of the local population’, ‘Quality of life’, ‘Development of human capital’, etc. are either not suitable for describing rural areas or not available on municipal level.

Therefore, appropriate and available factors are chosen while not losing the target to cover competitiveness in both economic and social dimensions. Finally, the basic idea of the model is that ‘Population’ living in a specific community, is the main input for economic and social outcome. The respective outcome is defined by four output factors ‘Education level’, ‘Economic performance’, ‘Employment’ and ‘Population development’. The DEA is applied in all three model regions. The data for all input and output factors is taken from *Statcub*e, a statistical database compiled by Statistics Austria.

Table 2: DEA model with variables

Input	Unit	Outputs	Unit
Population	Number of inhabitants	**Education level**	Highest education level (Index)
		Economic performance	Municipal tax (in €)
		Employment	Number of employed inhabitants
		Population development	Population growth from 2002-2010 (Δ 2002-2010)

Input factor *Population*

‘Population’ is the sole input factor of the model. It represents all inhabitants living in the respective municipalities in the year 2010. In order to be counted as an inhabitant principal residence must be located in the respective municipality. The purpose to include the number of inhabitants as input factor is to be able to compare the level of regional competitiveness, since the size of each municipality is different in terms of number of inhabitants and spatial expansion. It is also possible to break down the level of regional competitiveness on spatial units (e.g. per square meter) but this approach is not reasonable since the competitiveness indicators, in this case the output factors, are related to the respective inhabitants.

Output factor *Education level*

The first output factor is 'Education level'. As for example ROMER (1986) shows, education is a key factor for the competitiveness of a region. Most of the regional competitiveness studies include education as one indicator in the models (e.g. ANNONI and KOZOVSKA, 2010; HUGGINS, 2003; HUOVARI et al., 2001). In this study the indicator is based on the different levels of the highest educational achievements, which has to be aggregated into a single value. For this reason the highest achievements of different education forms of the 2010 are weighted and multiplied with the number of inhabitants with the same level of education. *Appendix A* gives an overview on the different education levels and the respective factors in Austria.

Output factor *Economic performance*

'Economic performance' is the second output factor of the DEA model. Many other studies use different taxes as economic indicator (e.g. HUGGINS and DAVIES, 2006; LUKOVICS, 2007). The Austrian municipal tax has to be paid by every employer (with the exception of institutions caring for elderly people, youth, families, handicapped people, ill people, blind people and health); the rate tax is 3 % of the overall gross income of all employees in the company. Consequently, the revenue for the municipality generated by this tax indicates the number of workers and also the amount of income. It is assumed that higher incomes are positively correlated with higher revenues and higher gross domestic product, which indicates a better economic performance. It is important to note, that it would be preferred to use the regional GDP, but this data is solely available on NUTS3 level. A correlation analysis with the average gross domestic product per capita out of the NUTS3 data and the municipal tax data showed a Pearson's correlation coefficient of 0.99. Hence municipal tax can be used as an appropriate proxy for regional economic performance.

Output factor *Employment*

The third output factor is 'Employment rate', also implemented in most competitiveness indices (e.g. ANNONI and KOZOVSKA, 2010; BEACON HILL INSTITUTE, 2013; CHARLES and ZEGARRA, 2014; HUGGINS, 2003; HUGGINS and DAVIES, 2006; HUGGINS and THOMPSON, 2010; LENGYEL, 2003; USAID, 2014). The availability of skilled workers is an essential part for economic growth and innovation in a region. There is also a social component when looking at employment as a factor for competitiveness. Work is an essential part of human`s life and the basic source of prosperity. There are numerous studies that focus on the link between quality of life and employment (E.G. LANE, 1993; WARR, 1999; WILSON, 1996). The quality of the jobs is not displayed in the factor, since only the number of employed workers is measured. The factor 'Employment' is measured by the number of working places in the municipality in the year 2010.

Output factor *Population development*

The fourth output factor is 'Population development'. In literature this factor is often used to express the economic attractiveness of municipalities (e.g. PORELL, 1982; WALTERT and SCHLÄPFER, 2010; WILLIAMS, 1981). For instance, WALTERT ET AL. (2011) measure the attractiveness of residential areas via migration rates, which is directly linked to population development. Population development is calculated with the following *Equation 15*:

$$P_{\Delta t} = (B_{\Delta t} + D_{\Delta t}) + (I_{\Delta t} - E_{\Delta t}), \tag{15}$$

P= Population development

B= Number of births

D= Number of deaths

I= Immigration

E= Emigration

Δt= respective period of time

The population development of a period is influenced by natural growth *(B+D)* and the mechanical growth *(I-E)*, which is mostly driven by social factors. For the analysis in particular the second part of the formula is important, since it indicates the migration rate. In our study the migration rate is calculated as follows:

$$M_{\Delta t} = (Z_{\Delta t} - W_{\Delta t}) + (V_{\Delta t} - W_{\Delta t}), \tag{16}$$

M= Migration rate

Z= Immigrants from foreign countries

W= Emigrants into foreign countries or other municipalities

V= Immigrants from other municipalities

Δt= respective period of time.

The implementation of the migration rate into DEA requires a transformation, since resulting values might be even negative and DEA allows only for positive values. For this reason a transformation method of FRANZEL (2013) is applied. The values are transformed into multiplicative inversed values into positive values to be able to use in DEA. This is done with applying the following *Equation 17*. The disadvantage is the loss of the scale of the data but the main advantage is that the intervals of the data almost stay the same.

$$\frac{1}{\frac{neagtive\ output}{input}} * input \tag{17}$$

The population development is calculated as the difference of population from 2002 to 2010 including natural growth. The correlation coefficient of the migration rate and the population development is calculated to see if there are changes in the results when using population development instead of migration rate. The result is a correlation coefficient of 0.99. So this replacement does not highly influence the results.

Table 3 shows the statistical characteristics of the DEA input and output factors. The information in the table is sub-grouped with regard to the model regions.

Table 3: Statistical characteristics of DEA variables

		Population Number of Persons	Education level Index	Economic perfor-mance €	Population develop-ment Number of persons	Employ-ment situation Number of persons
Model 1	Min	61	57	1	4	60
	Max	11341	14318	438000000	7041	11981
	Mean	1732	2066	492932	516	1760
	Median	1410	1651	137497	324	1428
	SD	1306	1634	9825031	602	1362
Model 2	Min	61	57	1	10	64
	Max	10385	13445	3035923	5638	10060
	Mean	1673	2006	295448	535	1687
	Median	1312	1545	150748	315	1319
	SD	1344	1726	399821	657	1389
Model 3	Min	61	57	979	10	64
	Max	10385	13445	3035923	5638	10823
	Mean	1725	2055	313992	550	1742
	Median	1351	1579	165847	327	1355
	SD	1352	1708	410837	640	1419

5.6 Indicators of the second stage analysis

The second stage analysis aims to identify factors driving regional competiveness. When selecting landscape variables for the assessment several considerations need to be made. One basic factor, where free choice is limited, is data availability. Furthermore it is crucial to select landscape variables with respect to the spatial resolution of the regions under examination. For example a climate variable is not reasonable when the examination is done on municipality level, since the level of measurement is too small. As well as the spatial resolution, the relevance of the landscape variables for the region under examination has to be considered. When looking at mountain areas, different landscape describing variables need to be considered than in lowland regions, for example different types of land use.

As the focus of the study lies in the mountain area, specific landscape-related factors with connection to mountainous landscape are chosen. A set of contextual factors are selected, which can be subdivided into two groups:

- non-landscape-related factors are not directly explaining landscape and landscape elements but are of special interest, which will be explained further
- landscape-related factors shall help to determine the influence of landscape on regionals competitiveness

Distance to the next urban area (ND)

The first non-landscape-related factor is the distance to the next urban area. This factor is chosen in order to analyse, if the adjacency of to urban areas influences the level of regional competitiveness. Rural regions are considered as less competitive among others due to larger distances to attractive metropolitan markets (PORTER, 1995). Different studies prove that accessibility to urban areas is one of the major determinants for economic development in rural areas (e.g. DEFRA, 2004).

In order to calculate the distance of rural municipalities to the next urban area, all municipalities are classified with regard to rurality based on the classification of STATISTICS AUSTRIA (2006a). All 'Type 3 municipalities' (thinly-populated areas) are set as rural municipalities and 'Type 2 municipalities' (intermediate populated areas) and 'Type 1 municipalities' (densely populated areas) are set as urban municipalities. From the central point of every municipality the linear distance to each central point of the nearest central point of an urban municipality is calculated.

Intensity of tourism (T)

As further non-landscape-related factor the intensity of tourism is chosen. The indicator for this factor is the number of overnight stays in 2010, which is a quantitative indicator for tourism intensity. Municipalities without tourism, which are part of model region 1 and 2 are given the value 0. The reason why incorporating a tourism variable into the model is the special link to landscape. Tourism largely depends on cultural and amenity services provided by the agrarian landscape. The relation between tourism and landscape is explored in numerous studies (BOSMAN, 2011). HOFBAUER (1990) considers landscape as the main pillar for Austrian tourism. A survey from PRUCKNER (1993) underlines this importance of landscape for Austrian tourism: 84% of foreign tourists consider cultivated landscapes as important for the choice of their holiday destinations.

Openness of landscape (OL)

The results of a survey of local residents and tourists conducted within the *KuLaWi project,* which focusses on the future of cultural land and land use in the alpine land of *Tyrol* and *South Tyrol*, show that the preservation of the traditional cultural land is considered as one of the most important outputs of agriculture (SCHERMER et al., 2011). Particularly in mountain areas open, non-forest land is perceived as attractive. The indicator for 'Openness of landscape' is the proportion of non-forestry area to total area is used. Land use is calculated on basis of CORINE land cover data (UMWELTBUNDESAMT, 2015) (*Appendix B*).

- Forest land includes: deciduous forests, conifers forests and mixed forests.
- Non-forest land includes: non-irrigated arable land, vineyards, grassland and pastures, complex landscape area, land for agricultural use with significant level of natural land included, natural grassland, heathen and moorland, land with bush vegetation, barren ground with vegetation, barren ground without vegetation, glaciers, swampland and peat land.

Degree of mountainous landscape (ML)

The factor 'Degree of mountainous landscape' is expressed as the altitude difference between the highest and the lowest agricultural field of a municipality, which indicates the slope and the 'mountainous level' of the respective municipality. The data is taken from the INVEKOS data set of 2009. Further is has to be mentioned that there are limitations when measuring the level of mountainous landscape in municipalities since municipalities in the alpine area which are either solely located in the valley area or solely in the higher mountain area would not be considered as highly mountain municipalities according to this categorization. In this case the altitude does not express the mountainous character. The reason to include this factor in the assessment is on the one hand to test use it as a structural parameter for describing remoteness. On the other hand especially for tourism mountain landscape plays a crucial role for different outdoor sports like skiing, hiking, climbing, etc. Tourism then again can raise the level of competitiveness.

Characteristic landscape (CL)

SCHERMER et al. (2011) show that complex and diverse structures of landscape are highly attractive for tourists and consequently may determine the attractiveness of landscapes for inhabitants as well as tourists, which may influence regional competitiveness through a higher level of tourism and the attractiveness to live in. In order to measure this characteristic and attractive type of landscapes, characteristic types of land use out of the CORINE land cover data are chosen and the area (in m²) is summated to gain one value. The following types of land use are considered: complex landscape area, land for agricultural use with significant level of natural land included natural grassland, heathen, land with bush vegetation, swampland, peat land and barren ground with vegetation.

Mountain Pastures (MP)

Mountain pastures are considered as determining the attractiveness of landscapes. For instance, it is very common to use pictures of mountain pastures in tourism-related advertising campaigns. Mountain pastures are areas for recreation and hiking, which are considered as highly attractive landscape areas (KIRCHENGAST, 2006). Based on INVEKOS data of 2009 the extent of mountain pastures (in m^2) is measured.

Value of land (VL)

A third non-landscape-related factor is the value of land. As indicator for this factor the municipal land tax revenues in 2010 are used. This tax is raised for construction land and for agricultural land. The basic rate is determined by the Austrian government, but municipalities are allowed to raise it individually within a predefined frame. Land tax revenues can indicate the economic attractiveness and as well attractiveness to live in the various municipalities (CHAPMAN and FACER II, 2005). Consequently land tax revenues should be clearly correlated to with DEA results. The reason to include the value of land in the second stage is mainly to prove the reliability of the DEA results. Therefore the variable is not included it in the OLS and Tobit model, only in the correlation analysis. The data is taken from Statistics Austria.

Table 4 gives a summarising overview on the statistical characteristics of the contextual factors. The information is sub-grouped with regard to the three spatial models.

Table 4: Statistical characteristics of contextual factors

		OL %	ML m	CL m²	MP m²	T overnight stays	ND m	VL €
Model 1	Min	0.002	3.0	0.0	2.9	0.0	883.3	923.0
	Max	1	2098	5642	23130	2180000	50900	1389000
	Mean	0.54	486	273	1212	45560	12270	11680
	Median	0.56	273	68.28	646.8	3452	10390	80320
	SD	0.35	460	524.87	1689.9	145706	8013	118471
Model 2	Min	0.002	9	0	2.8	0	883	3794
	Max	1.00	2098	2088	23130	2180000	50900	980200
	Mean	0.30	985.8	297	1212	105900	14600	130100
	Median	0.22	987	219.30	646.8	23040	12290	82350
	SD	0.25	390	298.32	1689.9	224197	9512	139362
Model 3	Min	0.001	15	0	2.86	66	883	3794
	Max	0.96	2098	2088	23130	2180000	50900	980200
	Mean	0.30	1018	308.90	1304	115900	15030	137500
	Median	0.24	1017	239.30	734.3	28710	13060	89170
	SD	0.25	379	301.60	1737.2	232035	9585	142915

6 Results

The results are divided in two main parts, the first one includes the results of the first stage measuring regional competitiveness on municipality level and the second includes the regression analysis on the results of the first stage to explain the results of regional competitiveness. Additionally, the results of the case study municipalities in the first stage are compared with the findings of the qualitative up-stream analysis. For a better readability, the discussion of the results is included in the chapter 'Results'. The discussion of the data and methodology is separately in chapter 'Discussion'.

6.1 Results of the competitiveness analysis (first stage)

The results of the CI calculations are presented in *Table 5*. The competitiveness index scores range from 0.7 to 1, indicating similar municipalities concerning the level of competitiveness. The lowest value is observed in model region 1, whereas the lowest CI is higher in model region 2 and 3 (being identical in both models). These results indicate that the municipalities in model region 2 and 3 are more homogenous. The average level of competitiveness is also higher in the models 2 and 3.

Table 5: Summary of DEA results

	Model region 1		Model region 2		Model region 3	
Number and share of DMUs						
	obs.	share	obs.	share	obs.	share
Total DMUs	1988	100.0%	710	100.0%	649	100.0%
DMUs with CI of 1	7	0.4%	11	1.6%	11	1.7%
Distribution of efficiency scores (number of municipalities)						
No of decile	obs.	share	obs.	share	obs.	share
1st	17	0.9	5	0.7	4	0.6
2nd	137	6.9	24	3.4	21	3.2
3rd	425	21.4	84	11.8	74	11.4
4th	585	29.4	131	18.5	114	17.6
5th	438	22.0	142	20.0	133	20.5
6th	227	11.4	138	19.4	132	20.3
7th	90	4.5	89	12.5	83	12.8
8th	39	2.0	48	6.8	44	6.8
9th	17	0.9	24	3.4	19	2.9
10th	6	0.3	14	2.0	14	2.2
Statistical parameters of efficiency score distribution						
Minimal CI	0.70		0.76		0.76	
Mean CI	0.82		0.88		0.88	
Standard deviation	0.04		0.05		0.05	
Kurtosis	1.33		0.07		0.15	
Skewness	0.82		0.45		0.46	

Looking at the distribution of the most competitive municipalities (CI of 1) it is to note that the number of municipalities building the frontier is low in all three model regions. In model region 1, seven out of 1988 municipalities (0.4%) gain the highest CI, while 59 (3.5%) municipalities are located in the last three deciles. The majority of the municipalities are located in the fourth decile. In model region 2 eleven out of 710 municipalities gain a CI of 1 (1.6%), which is a slightly higher percentage than in model region 1. With 13.6% there are also more highly competitive municipalities in the last three deciles in model region 2. Model region 3 shows similar results to model region 2. Eleven municipalities out of 649 (1.7 %) have a CI of 1 and 13.6% are in the last 3 deciles. In *Figure 7* histograms of the level of competitiveness of the three model regions are presented to illustrate the distribution graphically.

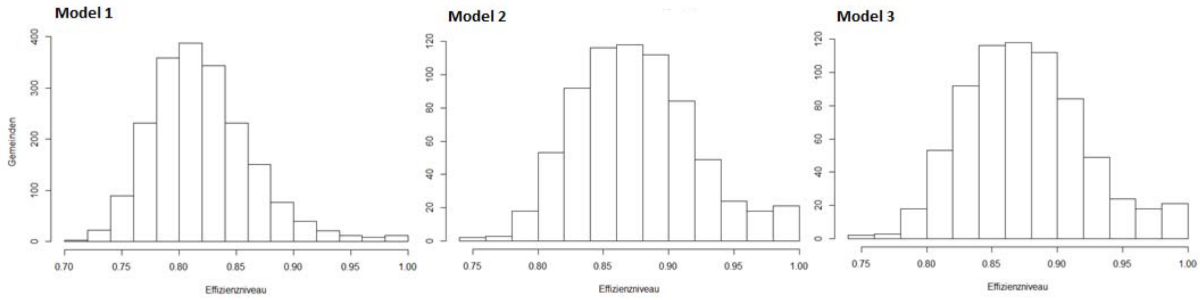

Figure 7: Distribution of DEA results in the three model regions

Source: Own illustration

A special focus is lies on the comparison between municipalities in flat and open areas and mountain municipalities. The CI results of model region 1 are taken as basis for this comparison. The CI results (of model region 1) from all mountain municipalities of model region 2 are compared with the CI results of all other municipalities of model region 1 which are not comprised in model region 2. An independent t test with unequal sample size is performed to test if the differences are random or not. In *Table 6* the results are presented, which show that municipalities in flat and open regions have significantly higher CI results than mountain municipalities.

Table 6: Comparison flat/open area and mountain area

	Flat and open area	**Mountain area**
Number of municipalities	1278	710
Average CI	0,825	0,810
T-Test	3,058E-15***	

Concerning the set municipalities building the frontier, in model region 1 the frontier consists of seven municipalities, which is a rather low number. Four of the municipalities are best performing concerning at least one of the fours outputs per capita. *Krumpendorf am Wörther See* (‘Education’), *Rohrbach in Oberösterreich* (‘Employment’), *Haslau-Maria Ellend* (‘Population development’), *Obdach* (‘Economic performance’). Two out of the three remaining municipalities have intensive tourism (*Maria Wörth, Bad Tatzmannsdorf*) and one is second best performing concerning migration rate (*Rohrberg*). In model region 2 and 3 the municipalities building the frontier are identical. The municipalities *Teufenbach* (‘Employment’), *Mutters* (‘Education rate’), *Rohrberg* (‘Population development’) and *Obdach* (‘Economic performance’) are best performing concerning one output per capita. Furthermore five municipalities (*Untertauern, Patsch, Straß im Zillertal, Lech* and *Warth)* are municipalities with intensive tourism. Two municipalities are municipalities with active industry and job possibilities (*Feistritz ob Bleiburg, Murau*). The remaining municipality *Mieming* shows an extraordinary performance in 'Population development'.

Generally, in DEA models the DMUs in the frontier play a crucial role for the quality of the results and it is very sensitive to outliers. Five out of the seven frontier municipalities of model region 1 are located in flat and open area. The two municipalities *Rohrberg* and *Obdach*, located in the Alpine area are also in the frontiers of model region 2 and 3. The results generally show that municipalities in flat and open areas are more likely to have a higher level of competitiveness. Especially job possibilities and business activities are higher in these regions and hence pushing competitiveness. The two mountain municipalities *Rohrberg* and *Obdach* in the frontier of model region 1 show an extraordinary performance concerning the factor 'Population development'. These results indicate that mountain municipalities not surprisingly lack behind flat and open regions in economic way but can compete concerning specific indicators like 'Attractiveness of living' and 'Quality of life'. One suggestion for decision makers based on the results is to focus on individual strengths to raise the level of regional competitiveness and not to impose external mainstream solutions and paths e.g. to focus solely on economic issues to raise the level of competitiveness.

The frontier of model regions 2 and 3 consists of eleven municipalities each. When looking at possible key success factors for the high level of competitiveness the municipalities can be divided into three groups. *Untertauern, Lech, Rohrberg* and *Strass im Zillertal*, are municipalities with intensive tourism, especially skiing tourism. *Mieming, Mutters* and *Patsch* are municipalities next the urban are Innsbruck. One effect because of the nearness to an urban area is a high education rate as well as positive population development. *Feistritz ob Bleiburg, Obdach, Murau* and *Teufenbach* are municipalities with a high density of companies driving the economic performance. When comparing the findings with the results of the second stage analysis, it is obvious that when looking at the frontier municipalities especially 'Intensity of tourism' and 'Distance to the next urban area' can push regional competitiveness. The regression analysis with all municipalities affirms these findings concerning ‘Tourism’ and ‘Distance to the next urban area’, with a generally positive influence is on a small level. This suggests that some municipalities benefit from both factors but In general both factors play a limited role in the influence on regional competitiveness.

In *Figure 8, Figure 9* and *Source:* Own illustration the CIs of each municipality of the three model regions are displayed geographically. The map displaying model region 1, illustrates that municipalities with a high CI are particularly located near to densely populated areas (indicated in green colour). Such agglomerations of highly competitive municipalities can be especially found in the areas around the cities of *Vienna, Graz, Klagenfurt* and *Linz*. Also municipalities located in the valley of the river *Inn* near *Innsbruck* show a better performance with regard to competitiveness. Municipalities located in the mountain areas generally show a lower CI. There are only a few exceptions, such as the municipalities *Sölden* (0.923), *Tweng* (0.892) and *Lech* (0.923), which are mostly of high touristic importance.

With regard to the results of model region 2, it is to note that agglomerations of highly competitive municipalities are particularly observed along the *Inn valley* close to *Innsbruck*. Municipalities with a lower CI are agglomerated in the south of *Tyrol*, in Eastern *Tyrol*, as well as in region of *Liezen*, in-between the *Mur valley* and the *Enns valley* (not considering the municipalities located directly in these main valleys). It is to annotate that the results of model region 3 are very similar to model region 2.

Summarizing the DEA results for regional competitiveness, it can be said that they are consistent to a high degree. This becomes clear particularly when putting the results into a spatial context. The municipalities for which the DEA models depicts the highest CI ranks, turn out to be located either in close proximity to cities (e.g. around *Vienna*, *Graz*, *Linz* or *Innsbruck*) or along major infra-structural routes, such as the important west-east connection between *Salzburg* and *Vienna*, or along the northwest – south connection throughout the Alps. In contrast, the lower ranked municipalities are located in more remote areas. The model also depicts single municipalities within very remote areas, which show exceptional high levels of regional competitiveness. These outstanding municipalities surrounded by low efficient, remote municipalities represent touristic strongholds, characterised mostly by high-level skiing tourism.

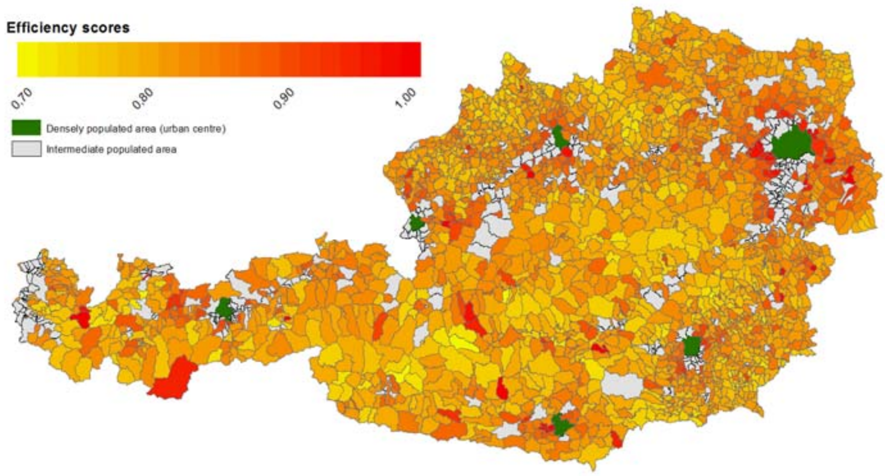

Figure 8: Results CI model region 1

Source: Own Illustration

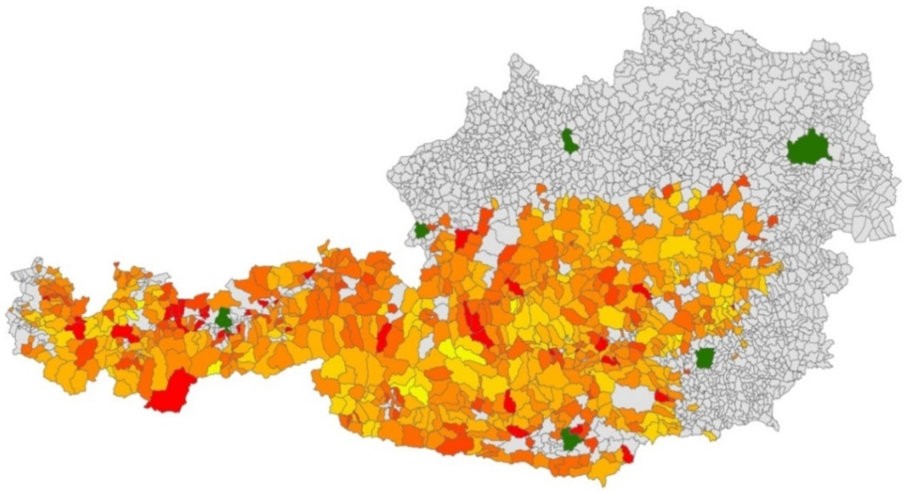

Figure 9: Results CI model region 2

Source: Own Illustration

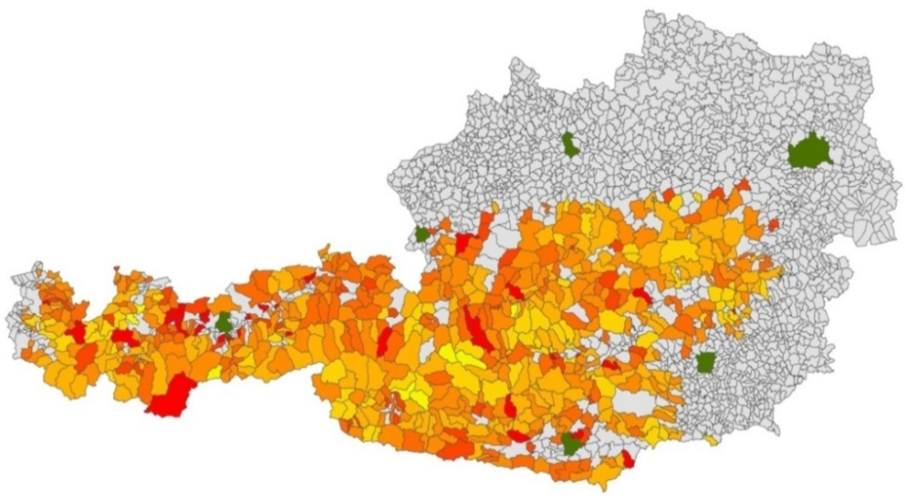

Figure 10: Results CI model region 3

Source: Own illustration

A special interest lies in the comparison of the results with findings of other studies although the comparison of the results is limited. The main limitation lies in the difference of spatial resolutions. This is the first study in Austria to measure regional competitiveness on such a small level as well as it is the first attempt to assess influences of landscape on regional competitiveness.

In Austria regional competitiveness indices are mostly incorporated on NUTS2 level (e.g. ANNONI and KOZOVSKA, 2010). Direct comparisons with studies on such spatial levels like NUTS2 give very limited information. These competitiveness studies do not solely focus on Austria but on regions from all the countries of the EU.

One interesting comparison is between Austria's regional GDP and the CI. In *Figure 11* a map of the regional GDP per capita on NUTS3 level is provided. Regional GDP is one crucial indicator published by STATISTICS AUSTRIA (2015), which is incorporated in most regional competitiveness benchmarks. On municipality level, the indicator is not available but the comparison of the regional GDP on NUTS3 level with the CI is worth to be discussed. It is obvious that the regional GDP is the highest in regions with the major cities and the surrounding area. Furthermore the regions in *Tyrol* show regional GDPs per capita above average. These results confirm the findings of this study concerning CI.

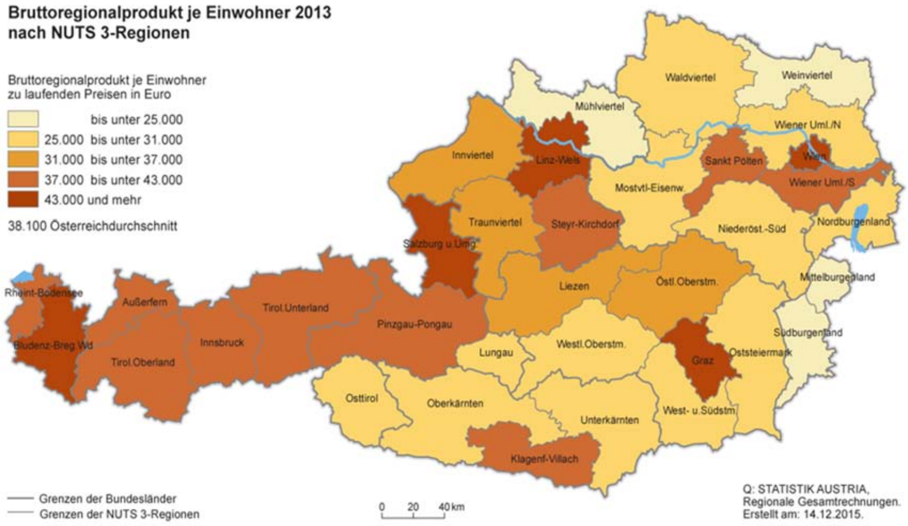

Figure 11: Regional GDP on NUTS3 level 2013 in Austria
Source: STATISTICS AUSTRIA, 2015

One further interesting study to compare the findings of this study is the study of REISINGER (2001). It is one of the few approaches to measure regional competitiveness in Austria in smaller regions on the level of all political districts. Based on the four categories 'Regional export quota', 'Regional net domestic product', 'Regional patent registration' and 'Share of investment on gross production value', the best performing district is identified in each category and the distance from each district to the best performing is measured. These results are aggregated to one composite index. The methodology has similarities with DEA and the results show that the big cities are the most competitive areas, which are excluded in this study. In *Figure 12* a map of the results is provided. Despite the difference in spatial resolution as well as the limitation, that in this study only rural areas are included in the assessment, the comparison between the maps generally shows similar results. The areas around *Vienna* - especially southern *Vienna* – as well as the areas around *Graz,* and *Linz* and the areas along the *Inntal* and especially around Innsbruck show a higher level of regional competitiveness in both studies. Both studies show that less competitive areas are especially located in the northern area of *Mühlviertel* and *Waldviertel and* the central Alpine area of Austria, containing the district *Liezen*, where the case study regions are located. A further less competitive area is observed in *Osttyrol* as well as the bordering are to *Carinthia* and generally the south east of *Styria.*

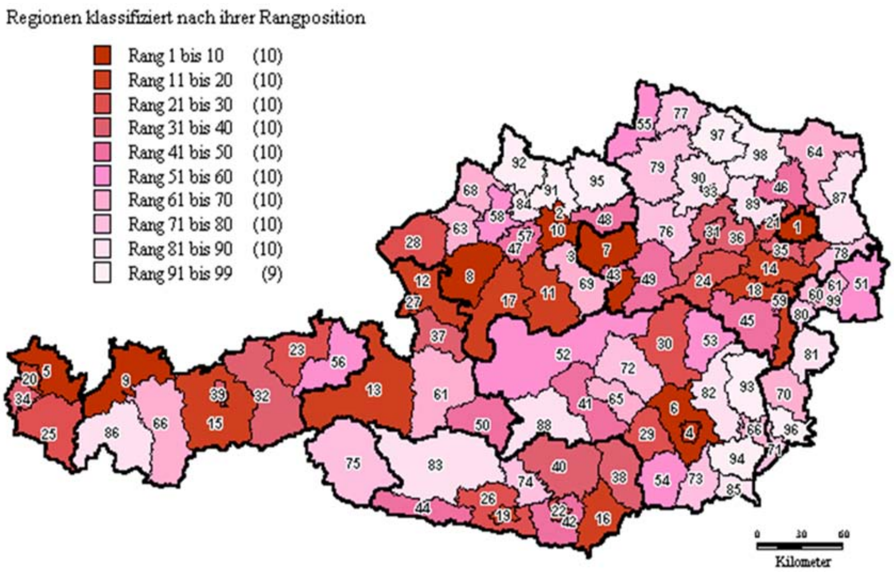

Figure 12: Regional Competitiveness on district level in Austria

Source: REISINGER, 2001

6.2 Results of case study municipalities

In Table 7 the CI with the rankings of the case study municipalities is presented. According to the analysis of the case study municipalities, *Stainach* is the highest ranked case study municipality; which applies with regard to all three models regions. Furthermore *Stainach* is the only case study municipality with a CI distributed in the first quantile. The CI of the remaining case study municipalities *Aigen im Ennstal*, *Pürgg-Trautenfels* and *Oppenberg* are by far lower than in *Stainach*. The rank order of case study municipalities is identical in all three models: the two municipalities located in the main valley show higher CIs than the two municipalities located in side valleys.

Table 7: Summary results, study region

Municipality	**Type of valley**	**Model region 1**		**Model region 2**		**Model region 3**	
		CI	Rank n=1988	CI	Rank n=710	CI	Rank n=649
Stainach	Main valley	0,8584	369	0,9279	95	0,9278	86
Aigen im Ennstal	Main valley	0,8111	1108	0,8745	340	0,8745	317
Pürgg-Trautenfels	Side valley	0,8046	1237	0,8652	400	0,8652	373
Oppenberg	Side valley	0,7750	1728	0,8377	562	0,8377	521

The CIs of the case study municipalities confirm the DEA results. The two municipalities located in the main valley show a higher level of competitiveness than the ones located in the more remote side valleys. The highest CI ranks are detected in the main-valley municipality *Stainach*. Referring to the up-stream qualitative research results, this is not surprising. In *Stainach*, on the one hand an urban centre is located, and on the other hand a major local food industry company is offering broad employment possibilities. Also with regards to agriculture, the main valley production conditions are significantly better than in the side valleys, where agricultural production is shaped by low-intensive grassland use. The least competitive municipality within the case study area is *Oppenberg*. This result is reasonable since *Oppenberg* is the highest located of the four surveyed municipalities and characterized only by agricultural activities. At the moment the municipality is faced with severe migration. The low CI ranks of this municipality are therefore clearly reliable.

6.3 Results of the second stage analysis

In the following chapter the results of the second stage analysis are presented starting with the results of the correlation analysis, followed by the results of OLS and Tobit. Correlation analysis is implemented with the CIs and all factors of the second stage both non-landscape- and landscape-related factors (*Table 8*). Basically the results reveal that the influence of landscape-related factors on regional competitiveness is far lower than the influence of non-landscape related factors. The highest correlated landscape-related factor is 'Value of land' – whereas it has to be noted that the overall correlations are generally on a low level; the correlation in all three models is clearly positive and highly significant. After 'Value of land' 'Distance to next urban area', 'Intensity of tourism' and 'Value of land' show the highest significant influences on the CI of rural regions. With regard to 'Intensity of tourism' there is a significant correlation in model region 2 and 3, the indicator 'Distance to the next urban area' is significant in model region 1 showing a negative correlation, which implicates a higher competitiveness of municipalities closer to urban areas.

Correlations of landscape-related factors with the CI are generally lower than the correlations of non-landscape-related factors. However, the indicator 'Degree of mountainous landscape' shows significant correlations in all three model regions and is therefore the factor with the highest in measured influence on the Cis of this group. The analysis also shows that the more 'mountainous' a municipality is located, the less competitive it is.

In contrast to this, the correlation between the CI and 'Openness of landscape' is only significant in model region 1, with a correlation coefficient of 0.17. The positive influence expresses a higher CI when having a higher share of open land in the municipality. With regard to the mountain municipalities, the results reveal that such factors have no significant influence on regional competitiveness – if any non-significant correlation can be detected, the influence appears to be rather negative.

The non-landscape related factor 'Value of land' is included in the correlation analysis to assess the reliability of the competitiveness results. The consistency of the competitiveness results are proven since the highest correlation is found between the level competitiveness of a municipality and the factor 'Value of land'. In other words the model indicates that the higher the level of regional competitiveness of a municipality, the higher is the monetary value of land. This correlation is rather convincing as it can be regarded as undisputed, that the value of land, representing on the one hand the quality of agricultural area and on the other hand the real-estate and building values, to a high extent mirrors the regional competitiveness of a region.

Table 8: Results of correlation analysis

	Model region 1		**Model region 2**		**Model region 3**	
Non-landscape-related factors	**r**	**sig.**	**r**	**sig.**	**r**	**sig.**
Intensity of tourism	0.14	***	-		0.24	***
Dist. next urban area	-0.34	***	-0.17		-0.20	
Value of land	0.42	***	0.46	***	0.48	***
Landscape-related factors	**r**		**r**		**r**	
Openness of landscape	0.17	***	-0.04		-0,05	
Mountainous landscape	-0.19	***	-0.09	**	-0.12	***
Characteristic landscape	<0.01		-0.02		-0.04	
Mountain pastures	-		0.01		-0.01	

Significance levels: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

The OLS results are very similar to the results of the correlation analysis (*Table 9*). R^2 is the highest in model region 1 (0.1898) followed by model region 3 (0.1592) and model region 2 (0.0981). The p-value indicates a high significance of all three models. In model region 1 four indicators have a significant influence on competitiveness, namely 'Intensity of tourism', 'Distance to the next urban area', 'Openness of landscape' and 'Degree of mountainous landscape'. In model region 2 three indicators are significant, which are 'Intensity of tourism', 'Distance to the next urban area' and 'Degree of mountainous landscape' and in model region 3 four indicators show a significant influence ('Intensity of tourism', 'Distance to the next urban area', 'Openness of landscape' and 'Degree of mountainous landscape').

Table 9: Results of OLS regression

	Model region 1		Model region 2		Model region 3	
R²	0.1898		0.0981		0.1592	
Adj. R²	0.1878		0.0905		0.1513	
p-value	<2e-16		1.076e-13		6.371e-08	
T	0.0015	<2e-16***	0.0025	<2.0e-16***	0.0094	<2e-16***
ND	-0.0215	<2e-16***	-0.0131	9.74e-09***	-0.0121	<2e-16***
OL	0.0083	0.0099**	-0.0133	0.061.	-0.0211	0.0049**
ML	-0.0098	<2e-16***	-0.0159	1.57e-05***	-0.0168	3.44e-05***
CL	0.0002	0.6360	-0.0003	0.713	-0.0009	0.211
MP	-	-	0.0021	0.130	-0.0006	0.688

Significance levels: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

With regard to Tobit regression, it is to annotate, that the results are very similar to the OLS regression results; all in all no substantial differences exists and OLS results are confirmed (*Table 10).*

Table 10: Results of Tobit regression

	Model region 1		Model region 2		Model region 3	
p-value	<2e-16***		<2e-16***		<2e-16***	
T	0.0015	<2e-16***	0.0025	<2e-16***	0.0095	<2e-16***
ND	-0.0215	<2e-16***	-0.0132	<2e-16***	-0.0122	6.5e-07***
OL	0.0083	0.0096**	-0.0135	0.0606.	-0.0212	0.0049**
ML	-0.0098	<2e-16***	-0.0159	<2e-16***	-0.0168	3.5e-05***
CL	0.0002	0.513	-0.0002	0.7349	-0.0008	0.2274
MP	-	-	0.0021	0.1353	-0.0006	0.6786

Significance levels: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

When discussing the results of the second stage analysis, it has to be noted that the focus was on finding and showing influences of landscape on regional competitiveness especially in rural regions. The idea behind the assessment was to select indicators for landscape attributes as well as relevant non-landscape related factors, which may have positive influences on regional competitiveness. The selected landscape-related factors may not only represent the attractiveness of a landscape but are also seen as structural indicators. The degree of mountain landscape also reflects information about remoteness, which has negative influence on regional competitiveness. This is also reflected in the results of this study.

One goal was to find positive influences of landscape-related factors on regional competitiveness. For that reason the municipalities in the model regions needed to be as homogenous as possible. The selection was a trade-off between the quantity and the similarity of the municipalities. To use existence of mountain pastures as a proxy for mountain areas as well as the definition of rural areas by OECD for the identification of rural and mountain municipalities is seen as an appropriate selection feature. Other selection features like ‘Main production areas’ were also considered. Nevertheless, the existence of mountain pastures as an indicator to select municipalities with alpine character is considered to be more accurately. It has to be noted, however, that every municipality with at least one area of mountain pastures is included. Hence it is possible that a municipality mostly located in a valley area without a real alpine character only having small shares of alpine area is also included.

With respect to the need of homogeneity concerning the character of municipalities under assessment, especially model region 2 and 3 fulfil this requirement. Model region 1 contains a broader variety of municipalities but especially the differences between municipalities in flat and open areas and mountain areas were of interest.

The first non-landscape related factor to be discussed is ‘Distance to next urban area’. The factor shows the highest influences on the CIs of all factors included in the assessment. These findings are confirmed when looking on the best performing municipalities since the frontiers of model region 2 and 3 contain municipalities next to urban areas. Especially when looking at the municipalities in the frontier, it becomes obvious that nearness to urban areas positively influences especially education rate of inhabitants as well as population development. In model region 1 the influence on the CI is higher than in the other two models. One possible explanation is that transport infrastructure in flat and open areas can be constructed more direct than in mountain areas with less natural barriers. The linear distance measured in the study is more similar to road distance in flat and open areas than to the road distances in mountain areas. It is assumed that a road distance indicator would show higher influence on regional competitiveness since accessibility would be expressed in a better way. Hence an indicator for road distance in further studies would lead to more descriptive information.

The second non-landscape related factor to be discussed is ‘Intensity of tourism’. Tourism is considered to be one of the factors to be able to use landscape as a resource to influence regional development and competitiveness in a positive way (MIKHÁZI and FILEPNÉ KOVÁCS, 2011; WIGGERING et al., 2006). The results of this study show that tourism can play an important role in enhancing regional competitiveness but the general influence is lower than expected. The problem of data limitations plays a role in the results concerning the level of influence. But based on the results it can be derived that some municipalities are able to generate a high level of competitiveness based on tourism but in general tourism plays minor important role than expected.

One further finding is that the influence of the intensity of tourism is higher in model region 3 than in model region 1, which suggests that in mountain regions tourism plays a bigger role concerning regional competitiveness than in flat and open areas. When thinking of skiing tourism in mountain areas in Austria this is not surprising.

The assessment focuses on the influence of tourism on regional competitiveness. The connection between landscape and tourism was not assessed. In future studies such assessment can be included in such models.

In model region 1 a positive connection of higher shares of open land and reginal competitiveness is observed. The factor can be interpreted as structural parameter since flat and open areas generally have higher shares of open land than mountain municipalities. In these areas the level of regional competitiveness is also higher than in mountain areas. From an agricultural perspective this result is not surprising, as model region 1 includes high percentages of productive, flat and open landscapes with good agricultural side-conditions. Also most Austrian cities and infrastructural strongly developed regions are located rather in flat and open areas. In contrast, in the mountain regions the percentage of open land is significantly lower, while open land is to a high share of bad quality and managed with low intensity.

In model region 2 and 3 the results did not show any significant influences. It is assumed that by selecting a homogenous sample of mountain municipalities, the factor does not reflect the structural information but makes possible influences of open space especially in mountain areas visible. It has to be noted that the non-significant results do not prove that conserving landscapes especially by farming does not generate values but by applying these indicators the influence could not be made visible with the selected data.

In general, the factor ‘Degree of mountainous landscape’ can be taken as a structural parameter, as the more a region is located in the mountains, the more remote it is as regards access to infrastructure, education and labour markets. It is surprising that also in model region 2 and 3 the influence is still significantly negative. From these results it can be deduced that even in mountain areas the level of mountainous area has still negative influence on regional competitiveness. The assumption that tourism can make use of mountain landscape especially for recreational purposes like skiing, hiking or climbing and hence pushing regional competitiveness could not be proven. One interpretation can be the fact that on the one hand the mountain landscape is needed to provide infrastructure of skiing but on the other hand active involvement of people is needed to use this potential. It is hard to show such an involvement in quantitative studies. Furthermore the existence of infrastructure is crucial to attract tourism and the degree mountain landscape does not necessarily reflect the ability of an area to be attractive for recreational purposes. For example attractive places for climbing do not need high mountains but specific conditions of rock faces.

The last results of the analysis to be discussed are the influence of the factors ‘Characteristic landscape’ and ‘Mountain pastures’ on regional competitiveness. Both consider very specific landscape elements within the Austrian mountainous landscape and, consequently, match clearly the aesthetic and intrinsic value of landscapes. The results reveal that such factors have no significant influence on regional competitiveness. Especially when referring to the qualitative research, which was part of the project CLAIM alongside this study, such factors, being crucial for the aesthetic values of alpine rural landscapes and the related cultural services provided in a landscape, are to a high degree appreciated and valued by the local society. Nevertheless, up to now this valorisation is obviously not reflected in terms of regional competitiveness. One suggestion for further studies applying quantitative methods to assess such influences of attractiveness of landscape on regional competitiveness is to lower the spatial resolution and try to apply more informative indicators concerning attractiveness of landscape.

To summarize the findings of the second stage, the results do not show such a positive influence of landscape on regional competitiveness. Generally, the assessed correlations are on a rather low level. One explanation is the limited data availability. Regional competitiveness cannot be expressed in its fullness, as well as attractiveness of landscape. Nevertheless, it was showed that especially landscape related-factors compared to others have very limited influence on regional competitiveness and other ‘drivers’ like distance to urban areas are more important.

7 Discussion

Measuring regional competitiveness on municipality level is a seldom procedure. Furthermore it was the first attempt measure the influence of landscape on a regional competitiveness index. In previous studies the main procedure was to assess the influence of landscape variables on single variables of development like income or population development. As well, many previous studies focussed on setting up indices to measure regional competitiveness but did not consider landscape variables as possible influencing factors.

It has to be noted, that the first step of the study was to establish an ‘ideal’ model of measuring regional competitiveness, considering social and economic factors derived from existing indices for measuring regional competitiveness. However, it became obvious, that the main problem for using such an ‘ideal’ model was data availability. For example, data on average income per head or household, regional GDP or data on the characteristics or even number of companies was not available on LAU2 level. Many economic data in Austria as well as on EU level is collected on national level but on regional level adequate data e.g. for regional competitiveness is missing (REISINGER, 2001). An ‘ideal’ model of measuring regional competitiveness would also consider the approach of dynamic benchmarking, to analyse the performance of the municipalities over a period of time. Again, only few periodically recorded data is available on municipal level so also this idea had to be discarded due to data-shortages. Consequently, the applied static DEA model with its indicators is not seen as concluded and self-contained model but for future studies it is open to integrate further indicators.

In the second stage, quantitative data is incorporated to test the influence of landscape on regional competitiveness. The focus of the study was not to assess primary data of landscape attributes but to use existing quantitative data. The difficulty was to find quantitative data defining and expressing an aesthetic and intrinsic value of landscape. For example aesthetic values are often subjective and often in literature primary data is assessed to ‘measure’ attractiveness of landscapes. The aesthetic value of landscapes also varies in different regions. Open landscape is generally seen as a positive aesthetic feature in mountain areas but in flat and open areas of intensive arable farming, forests areas can produce benefits and areas without forests are generally considered to have lower aesthetic value.

Landscape also varies within municipalities. Equal spatial scales of municipalities and homogenous regions concerning landscape would be preferable but a trade-off existed to measure regional competitiveness and expressing landscape in quantitative data. The benefit of using quantitative data was to be able to include a high number of municipalities in the assessment. This is seen as one of the advantages of the study to apply existing data and therefore being able to include a high number of municipalities and no costly data assessment needed to be done. Other possible spatial units like political districts, or NUTS3 level were not considered because of the advantage of municipalities to be the smallest spatial unit with structural data.

When looking at the methodology to measure the level of regional competitiveness, DEA is a common methodology to create a regional competitiveness index (e.g. CHARLES and ZEGARRA, 2014; HUGGINS and DAVIES, 2006). One difference between this study and others is that in comparable works the variables are mostly aggregated grouped into sub-pillars. These sub-pillars are basis then incorporated in DEA as input and output factors to gain one composite index. In this study the indicators are directly incorporated in DEA without the intermediate state of sub-pillars. The main reason for this difference is the data limitation.

A further strength of DEA to be discussed is weight flexibility and the procedure, that in the assessment municipalities are compared with similar best practice municipalities. REISINGER (2001) applies a method with a similar logic called *Wroclaw Taxonomic Method*. This method ranks and classifies regions starting from an ideal region. The advantage of DEA, to compare similar municipalities with similar structure due to the measurement of the radial distance, is reflected in the results. The municipalities in the frontier show high levels of competitiveness because of the performance in different indicators. This suggests that municipalities have different structural potentials and therefore, when thinking of regional policy, different approaches of enhancing regional development and competitiveness should be considered. For example the frontier in model region 2 and 3 consists of municipalities, where three key success factors (intensive tourism, nearness to urban areas, high density of companies) can be identified, which was discussed in the results. Hence the advantage of DEA is that municipalities with similar structure and strategies are compared.

A further argument to apply DEA is the reliability of the available data sources. DEA requires reliable data sources and the assessment and the reliability of the results is very sensitive to outliers. Data mistakes can shift the efficient frontier, which may cause crucial changes in the results. Most indicators of regional competitiveness indices are based on public data sources, which are, in case of Austria, reliable. Otherwise different methods like SFA would be more applicable, if data sources are vague, since SFA is more robust concerning data mistakes as well as outliers.

In the second stage the major challenge lied in separation of the model variables concerning first and second stage. The distinction of variables defining regional competitiveness and variables that influence regional competitiveness is based on the conception of regional competitiveness. In this study a major challenge lied in the attribution of the indicators to the two stages. Especially ‘Intensity of tourism’ and ‘Distance to the next urban area’ can be attributed to both stages. On the one hand – according to the definition of regional competitiveness in this study – both indicators play a role in enhancing the attractiveness and sustainable environment for firms and residents to live and work. On the other hand ‘Distance to the next urban area’ has also a spatial character and cannot be influenced. ‘Intensity of tourism’ is seen as an in-between tool being able to utilize aesthetic landscape and as well push regional competitiveness. Hence both variables are part of the second stage analysis. For further studies this separation will remain a challenge.

8 Conclusions and Outlook

It is rather seldom to measure regional competitiveness on municipal level as well as it was the first quantitative attempt to measure the influence of landscape on regional competitiveness. It is not surprising, that the influences are on a rather small scale as well as other indicators such as the intensity of tourism and the distance to urban areas are influencing regional competitiveness on a much higher level. The study results reveal that the more remote an area, the less competitive it is, even if the landscape is beautiful and rich of potential landscape services.

For constitutive works the major challenge will be to elaborate the model regarding spatial resolution and indicators, either to downsize the region under examination or to enlarge the spatial resolution. Downsizing the region under examination may give the opportunity to be able to minimize the data limitation by integrating and a higher number of appropriate indicators especially for measuring regional competitiveness. It may help to understand the interactions and influences between landscape and competitiveness in a better way. Regarding future research topics it is suggested to integrate qualitative approaches measuring landscape and landscape amenities next to the quantitative analysis to dissolve the complexity of interactions and also to be able to define aesthetic landscape attributes for various regions in a greater detail. It is also an interesting approach to apply a dynamic model over a period to understand the development of regional competitiveness over time. An applicable technique would be the Malmquist index, which extends the static DEA into a dynamic approach.

Improving the quality of the data is a key factor for the quality of future studies. Three specific proposals were identified based on the empirical experience of the study. Using road distances instead of linear distances would be an interesting approach, since such a factor can be influenced by policy makers. Similarly to the distance to urban areas, the accessibility to infrastructure would be a further indicator. To measure the degree of mountainous landscape, the altitude of the highest to the lowest point would be a more expressive indicator than the applied altitude of the highest to the lowest agricultural fields. Lastly an integration of the data of landscape elements would be a further step to express landscape aesthetics. At the time of the assessment the underlying spatial data of landscape elements were not already fully available.

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Appendix

Appendix A

Type of education	Facto r	Additional information
Compulsory School Compulsory Schools (Pflichtschule)	1	- Compulsory School, - -Elementary School (4y) +Secondary School (5y) - 9 years - Usual age:6-15
Apprenticeships (Lehre)	1	- Practical education - Working based learning with additional school - 4 years - Usual age: 15-18
Intermediate Technical and Vocational Schools(BMS)	2	- Practically job-related based learning - No permission for universities (Matura) - 3 years - Usual age:15-17
Academic Secondary Schools (AHS)	2	- General education - No specific job-related education - 8 years - Usual age: 10-18 - Permission for university (Matura)
Higher Technical and Vocation Schools (BHS)	2	- Specific job-related education - Specialization mostly in technical or economic education - 9 years - Usual age: 10-19 - Permission for university (Matura)
Post-Secondary Courses (College)	2	- Specific job-related education - Specialization mostly in technical or economic - Additional education for graduates from Grammar School to get a job related education similar to Higher Vocation Schools - 2 years - Matura needed
Post-Secondary Colleges	3	- Institutions similar to university - Most common example is Nursing School - Mostly 3 years
University/Universities of Applied Sciences (Universität/ Fachhochschule)	3	- Matura required - Bachelor studies, 3 years - Master studies, 2 years - Diploma studies, 4 years

Appendix B

1. Bebaute Fläche	1.1. Städtisch geprägte Flächen	1.1.1. durchgängig städtische Prägung 1.1.2. nicht durchgängig städtische Prägung
	1.2. Industrie-, Gewerbe- und Verkehrsflächen	1.2.1. Industrie/Gewerbeflächen 1.2.2. Straßen/Eisenbahnnetze, funktionell zugeordnete Flächen 1.2.3. Hafengebiete 1.2.4. Flughäfen
	1.3. Abbauflächen, Deponien, Baustellen	1.3.1. Abbauflächen 1.3.2. Deponien, Abraumhalden 1.3.3. Baustellen
	1.4. Künstlich angelegte nicht landwirtschaftlich genutzte Flächen	1.4.1. Städtische Grünflächen 1.4.2. Sport/Freizeitanlagen
2. Landwirtschaft	2.1. Ackerflächen	2.1.1. Nicht bewässertes Ackerland 2.1.2. Regelmäßig bewässertes Ackerland 2.1.3. Reisfelder
	2.2. Dauerkulturen	2.2.1. Weinbauflächen 2.2.2. Obst/Beerenobstbestände 2.2.3. Olivenhaine
	2.3. Grünland	2.3.1. Wiesen und Weiden
	2.4. Heterogene landwirtschaftliche Flächen	2.4.1. Einjähr. Kulturen in Verbindung mit Dauerkulturen 2.4.2. Komplexe Parzellenstruktur 2.4.3. Landwirtschaftlich genutztes Land mit Flächen natürlicher Vegetation von signifikanter Größe 2.4.4. Land/Forstwirtschaftliche Flächen
3. Wälder und naturnahe Flächen	3.1. Wälder	3.1.1. Laubwälder 3.1.2. Nadelwälder 3.1.3. Mischwälder
	3.2. Kraut/Strauchvegetation	3.2.1. Natürliches Grünland 3.2.2. Heiden und Moorheiden 3.2.3. Hartlaubbewuchs 3.2.4. Wald/Strauch Übergangsstadien
	3.3. Offene Flächen ohne oder mit geringer Vegetation	3.3.1. Strände, Dünen, Sandflächen 3.3.2. Felsflächen ohne Vegetation 3.3.3. Flächen mit spärlicher Vegetation 3.3.4. Brandflächen 3.3.5. Gletscher/Dauerschneegebiet
4. Feuchtflächen	4.1. Feuchtflächen im Landesinneren	4.1.1. Sümpfe 4.1.2. Torfmoore
	4.2. Feuchtflächen an der Küste	4.2.1. Salzwiesen 4.2.2. Salinen 4.2.3. In der Gezeitenzone liegende Flächen
5. Wasserflächen	5.1. Wasserflächen im Landesinneren	5.1.1. Gewässerläufe 5.1.2. Wasserflächen
	5.2. Meeresgewässer	5.2.1. Lagunen 5.2.2. Mündungsgebiete 5.2.3. Meer und Ozean

Tabelle 1: Nomenklatur (Klassen in grau kommen in Österreich nicht vor)