ECONOMIC POWER AND STRUCTURE OF STYRIA IN THE MIRROR OF THE TAX POWER PER CAPITA RATIO IN TIMES OF COVID-19

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ABSTRACT

Especially in times when unpredictable events such as pandemics strain both the economy and society to their limits, knowledge about the current state of public welfare or about the financial situation of the associated spatial units is particularly interesting. In this context, the per capita tax performance in the administrative units (tax power per capita ratio, hereafter STKKQ) is considered a very reliable indicator for estimating the economic performance of a municipality, especially since it is composed, on the one hand, of the municipal taxes and, on the other hand, of the so-called "shared public income" of the state of Austria; this allows not only the nationwide comparison but also the annual review of the development of this value. In the present paper, the STKKQ on the basis of municipalities (which corresponds to the smallest administrative unit for which statistical ratios are available at mostly annual intervals) was used to examine a number of focal points: First, not least in view of the numerous governmental programs during the COVID-19 pandemic, the temporal development of the indicator in the years until 2021 was examined before the distribution of the STKKQ value in the province of Styria was investigated via the quantification of the global and local autocorrelation. Finally, a significant spatial correlation between the STKKQ and certain socio-economic parameters (population size, number of jobs in the Styrian municipalities, high tourism share, ...) was tried to be proven.

Keywords: community budget, fiscal capability, spatial analysis, Styria

INTRODUCTION

Despite its relatively long history, the Central Places Model - although repeatedly adapted to the changed social, economic and political framework conditions - still serves today as a basis for spatial planning decision-making processes [1], [2] or [3]. The latter, for example, opines "Central places are not the products of chance, but the result of a long-term market economy process."

This emphasis on the market economy suggests that different degrees of economic prosperity can be held responsible for a differentiation of space into economically stronger and economically weaker regions (in a sense central and peripheral spaces). From the point of view of politics and society, the logical reaction to this process is the endeavor to compensate for recognized deficits and in this way to ensure - within the framework of the existing possibilities - an optimal development of the area and thus to effectively counteract negative tendencies such as out-migration, aging of the local population, thinning out of the infrastructure, etc. The development of the area as a whole is a matter of course.

This is also true for the Austrian province of Styria, where, in addition to the rural, peripheral areas and the former industrial areas in Upper Styria (mostly areas of out-migration in recent decades), there is also the so-called Styrian Central Area, which is growing steadily in terms of population and importance [4]. Especially the number of inhabitants is important for the Styrian municipalities for several reasons, since the number of political representatives depends on the number of inhabitants and decreases accordingly when the number of inhabitants decreases. Excessive out-migration thus also has an impact on the results in supra-regional elections, as the respective region thus loses influence in future development policy votes. However, the decrease in population also has fiscal effects, especially since this also reduces the flow of money back to the municipalities from the federal and state governments and thus also tends to reduce the municipalities' income from the so-called fiscal equalization system. In order to counteract this development and to better equip the province administratively for the future, the municipalities in Styria were reduced from 539 to 287 on Jan. 1, 2015. As a result of this reform, municipalities with fewer than 500 inhabitants have largely disappeared from the map, which should create efficient municipalities throughout Styria [5] or [6]. From the above, the need for a parameter that makes all the effects described directly or indirectly measurable or comparable and, moreover, makes these results comparable with each other over a longer period of time becomes understandable; since only a few economic statistical data are made available for Austrian municipalities on an annual basis (such as data on unemployment or on supply and demand in the tourism sector), the portfolio of methods for the spatiotemporal analysis of this phenomenon is relatively manageable. For this reason, the approach presented here attempts to use the informative value of the parameter tax power per capita ratio (STKKQ), which has been consistently reported since 1999, to assess the economic position of Styrian municipalities. This seems plausible insofar as a high STKKQ presupposes at least a certain size of municipality coupled with a high economic power. Thus, a municipality with a high STKKQ has an economically and/or politically superior position compared to the other administrative units [7]. In detail, the following questions arise from the problem just explained:

- How has the tax power per capita ratio in Styrian municipalities developed as of 2015? What impact did the COVID-19 pandemic have?
- Can development or spatial patterns of the tax power per capita ratio be identified on the basis of time series data?
- Are there clusters of municipalities with the same/similar tax power in Styria and where are they located?
- What other parameters influence the tax power per capita ratio or how do they affect the tax power per capita ratio?

BASIC CONSIDERATIONS

Characteristic and meaning of the tax power per capita ratio

In official Austrian statistics, the STKKQ is simply referred to as "tax revenue per capita" or as "taxes and revenue shares of municipalities per capita (in €)" [8]. A somewhat more detailed definition is provided by the Provincial Statistics of Styria: "The tax revenue per capita of a municipality is the sum of the exclusive municipal taxes, which are again used in the municipality's own sphere of activity, the revenue shares of the federal joint taxes, which are divided among the federal, provincial and municipal authorities according to a

certain allocation formula, divided by the population of the municipality" [9]. This definition shows that the exclusively municipal levies and the revenue shares from fiscal equalization are of particular importance for the available financial volume of the municipalities. The Fiscal equalization system essentially regulates the distribution of all taxes collected among the federal government, the provinces and the municipalities. First, a distinction must be made between own taxes (which remain with the collecting authority) and joint federal and state taxes, which are divided among the federal government, the states and the communities according to a key and are returned to the Austrian municipalities in the form of the so-called revenue shares from fiscal equalization as an extremely important source of revenue (Fig. 1).

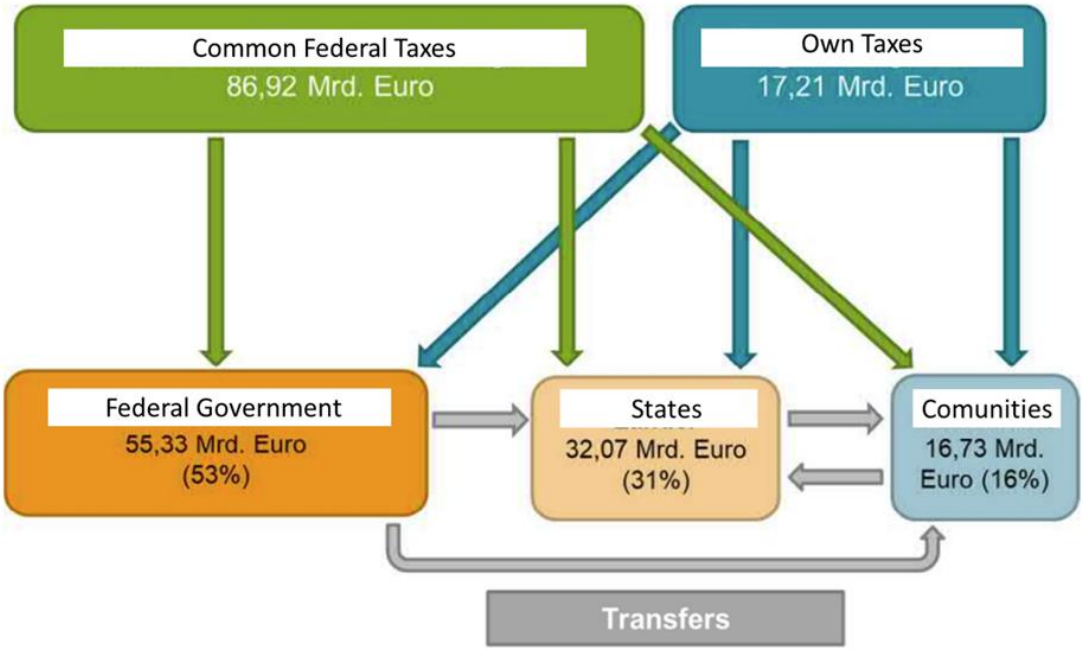

Figure 1. Cash flows under the fiscal equalization scheme for Austria 2018 [10].

In principle, the allocation of funds is based on a key that is renegotiated approximately every 6 years between representatives of the federal government, the states and the municipalities and thus adjusted to developments. From 2011 to 2014, the distribution of levies between the three regional authorities looked as follows: 67.417% was received by the federal government, 20.7% went to the states, and the municipalities received 11.883% [11]. As can be seen from Figure 1, these shares changed in 2018 to 53% (federal government), 31% (states) and 16% at the same time, which equals a significant shift towards states and municipalities. The number of inhabitants of the respective territorial units is considered to be a key control parameter for determining the key; in addition, of course, the amount of tax revenue generated by the territorial unit also influences the amount of revenue shares and thus also the returns (i.e. tax power or - in relation to the number of inhabitants - per capita tax power). It can be seen that a high number of high-quality (and thus "more tax-active") jobs in the production, service and tourism sectors also shifts the level of STKKQ upward. In very simplified terms, it can be said that municipalities with very low populations and a strong agricultural orientation are conspicuous for their particularly low STKKQ.

Concerning Styria as the spatial framework of the study, special attention must be paid to the chronology of the STKKQ coverage in two respects: First, it should be pointed out

that the population figures of the observation year are not used for the calculation, but the adjusted population figures of the respective previous year (i.e., for the STKKQ 2018, the population figures on October 31, 2016 are used; the publication takes place at the end of 2017). On the other hand, although the STKKQ has been calculated since 1957, it does not make much sense to consider the development over this period, especially since the structure of the Styrian municipalities was seriously reshaped, for example, by the structural reform of the municipalities that took effect in 2015. As a result of mergers or regroupings, the original 542 municipalities became 288 (currently 286) units, with only 157 municipalities remaining unchanged. Relevant for the present study is the increase in the average number of inhabitants of Styrian municipalities from 1747 to 3293; at the same time, the share of Styria in the number of Austrian municipalities with less than 1000 inhabitants decreased from 32% to 3.6% (with a simultaneous increase in large municipalities with more than 10000 inhabitants from 5 to 15).

COVID-19 and its possible effects

Longer-term observation - despite all the associated problems - clearly shows how much continent-wide or global events affect the development of STKKQ; for example, the economic and financial crisis of 2008/2009 was partly responsible for a marked slump in STKKQ that was not overcome until 2011. For this reason, a noticeable decline in development could also be expected with some probability for the period of the Corona pandemic, since the study area, together with the rest of Austria, was on its way into lockdown from mid-March 2020, which - apart from summer interruptions and temporary relaxations - severely restricted social and also economic life until mid-March 2021. Attempts were made to react to the effects of the pandemic (supply bottlenecks in production, absence of guests in tourism, etc.) with short-time work, compulsory leave, layoffs ,and company shutdowns, with a decline in tax revenue becoming apparent.

General methodological remarks

The research questions formulated at the outset of this study have resulted in the methodological instruments used in the investigation. Naturally, the statistical evaluation of the available data material is in the foreground, whereby particular importance was attached to the spatial frame of reference. Fortunately, the freely available software package GeoDa (version 1.20) of the development team around Luc Anselin (Center of Spatial Data Science, University of Chicago) is an analysis tool that provides both the appropriate tools for dealing with spatial statistical issues (spatial characteristics, autocorrelation, regression, clustering) and those for analyzing the spatio-temporal dimension of the problem [12]. In addition to the material provided by Statistics Austria [13], the extensive data pool and the (digital) publications of the Styrian Provincial Statistics [14] could be used as a data basis for the analyses. The results presented in this paper are based exclusively on data from the last-mentioned source.

METHODS, RESULTS AND DISCUSSION

For a superficial assessment of the temporal development of the STKKQ with respect to the central tendency and the dispersion of the distributions, a series of box-whisker plots was first created, whereby three times the interquartile range was chosen as the limit value to the extreme outliers [15]. This widening of the range between the limits of the plots allowed on the one hand an assessment of the general development trend, but at the same

time should emphasize the extreme values, so that striking outliers could be identified more easily (Fig.2).

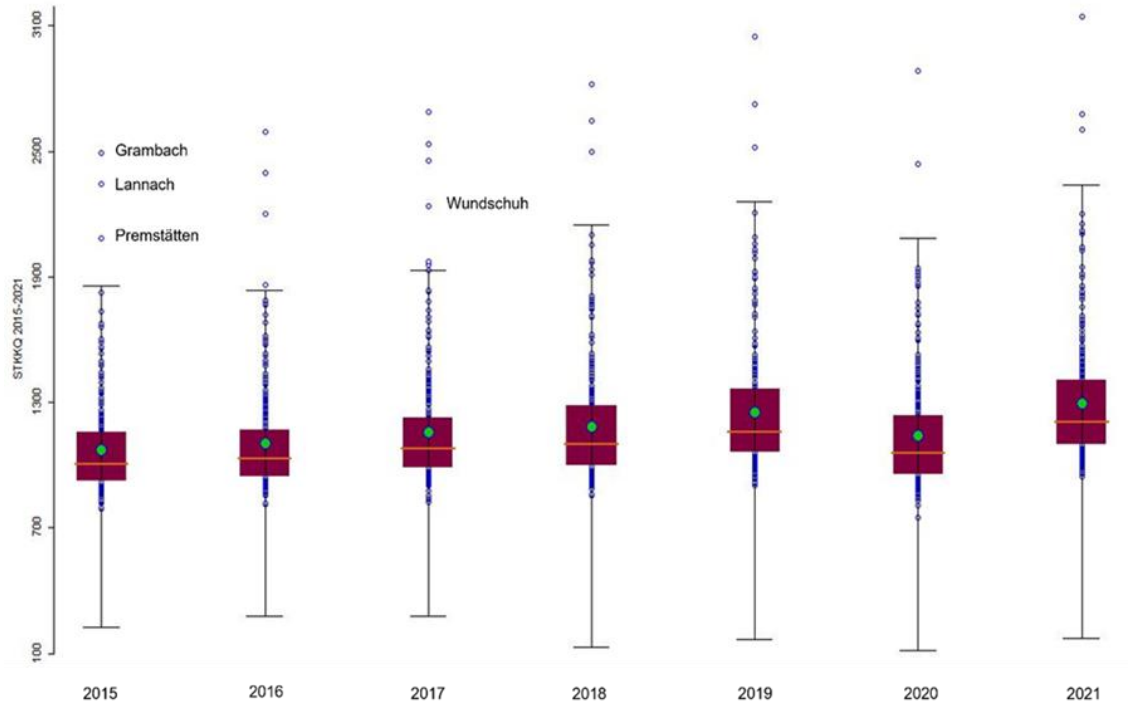

Figure 2. Development of the distribution of STKKQ over time 2015 – 2021

demonstrated. For example, both the median of the distributions and their arithmetic mean showed a slight upward trend (mean 2015: 1073 € to 2021: 1293 €) which, as expected, only experienced a dip due to the pandemic year 2020 (mean 2019: 1250 € and 2020: 1141 €, respectively). Regarding the dispersion behavior of the distributions, the interquartile range (i.e., the "middle" 50% of the values) showed an inconspicuous behavior over the entire period, but it also became clear that the higher values of the STKKQ dispersed much more than the "lower" quarter of the distribution; in other words, the group of municipalities with lower STKKQ is much more compact than those with higher STKKQ. The extremes are particularly noteworthy. During the entire observation period, the same three municipalities are at the top of the ranking: Raaba-Grambach and Premstätten in the immediate vicinity and thus under the influence of the provincial capital Graz, and finally Lannach, a municipality in the catchment area of Graz, which obviously benefits from its status as a highway or railroad junction and the associated locational advantages for industrial and commercial enterprises. Wundschuh is an exception: This municipality, which is located on the supra-regional traffic axis Graz-Maribor, recorded a one-time peak for 2017, which, however, soon leveled off again to the long-term level in the following years.

A different impression of the same facts is provided by the presentation of the numerical material by means of a parallel coordinate plot (PCP), which in principle also describes the time series, but in addition allows a detailed assessment of the chronological development of individual spatial units. The simultaneous standardization of the data material also makes the individual time periods more comparable with each other in a certain sense. Therefore, the representation in Fig. 3 shows the already known development, but in addition, it also enables the isolated consideration of individual municipalities [16].

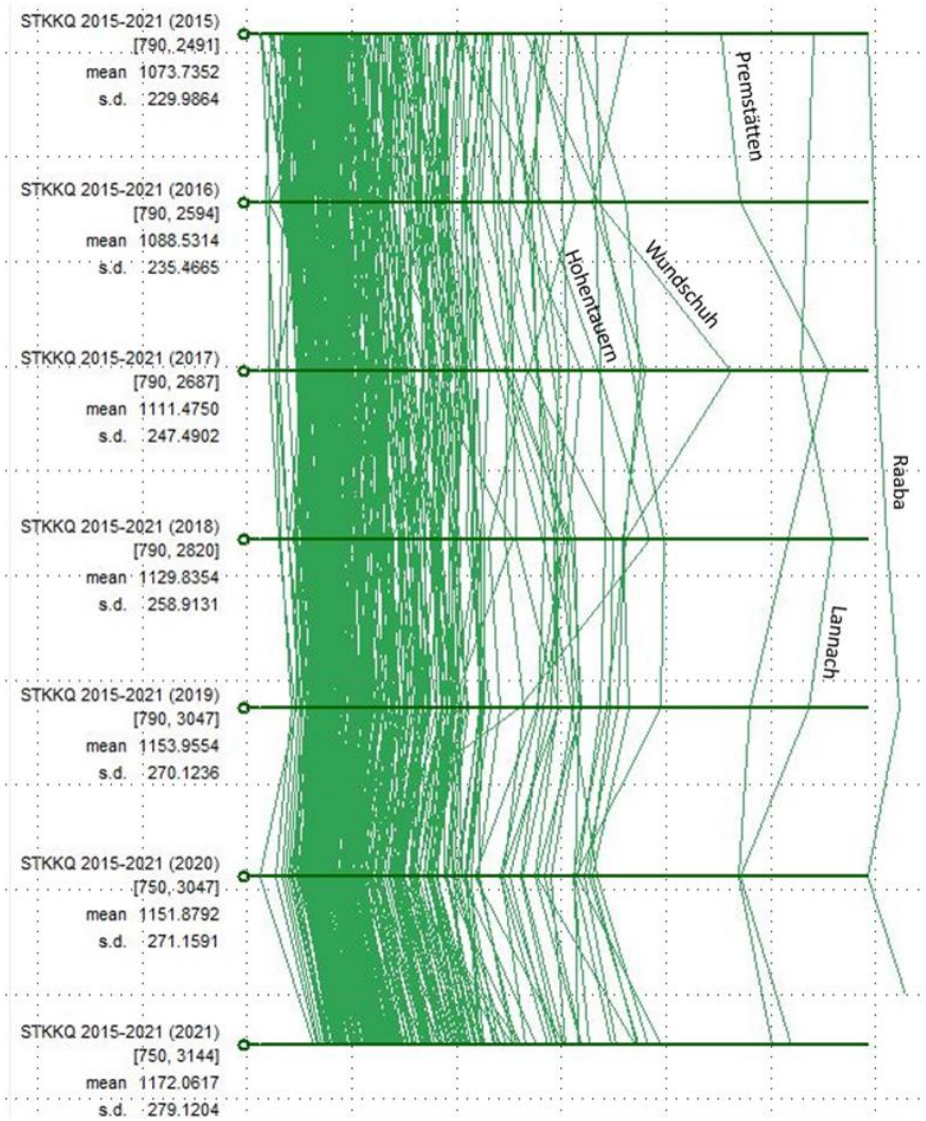

Figure 3. Development over time of STKKQ 2015 - 2021 by municipality

This is of particular interest when these communities cannot be identified in Box-Whisker Plot because this information is overlaid by the prevailing trend. For example, in the present case, in addition to the development of Wundschuh, the situation of Hohentauern, a predominantly winter tourism-oriented Upper Styrian community, during the pandemic becomes apparent.

In addition to the temporal development of the STKKQ, the current situation of the parameter in the first year after the removal of the restrictions is of particular interest, whereby a visualization using the natural breaks concept [17] would be obvious. However, this approach has a disadvantageous effect in that - although describing the actual distribution of the values quite correctly in terms of classification - it merely documents the lack of symmetry of the data set: Using 5 (unequally wide) classes, the lowest class (< 1209 €] is occupied by 146 units (which corresponds to more than half)! In addition, the arithmetic mean would be found in the next higher class, making a mean-based classification into above/below average impossible; the addition of the next higher class (1209 € - 1402 €) with 65 elements would shift this relationship even further and, moreover, mean that all "below average" elements would be considered but only a

fraction of the "above average" communities. Alternatively, quantile- or percentile-based classification methods could be used, which describe the distribution of a value series around a mean value. However, it must be kept in mind that this study is less concerned with the question of frequencies of occurrence, but primarily with the extremes and their location in space. For this reason, a symmetrical classification scheme with intervals based on the standard deviation was used to describe the STKKQ. The two middle classes mark the less prominent municipalities with STKKQ around the national mean (70 above, 177 below); the subsequent classes define municipalities with STKKQ significantly (up to two standard deviations) above (19) or below (7) the mean. The marginal classes carry - in relation to the arithmetic mean - the outliers. As far as the spatiotemporal development of the municipalities examined on this basis is concerned, only moderate dynamics can be detected, and the municipalities seem to react relatively sluggishly to quite remarkable external influences (Fig. 4).

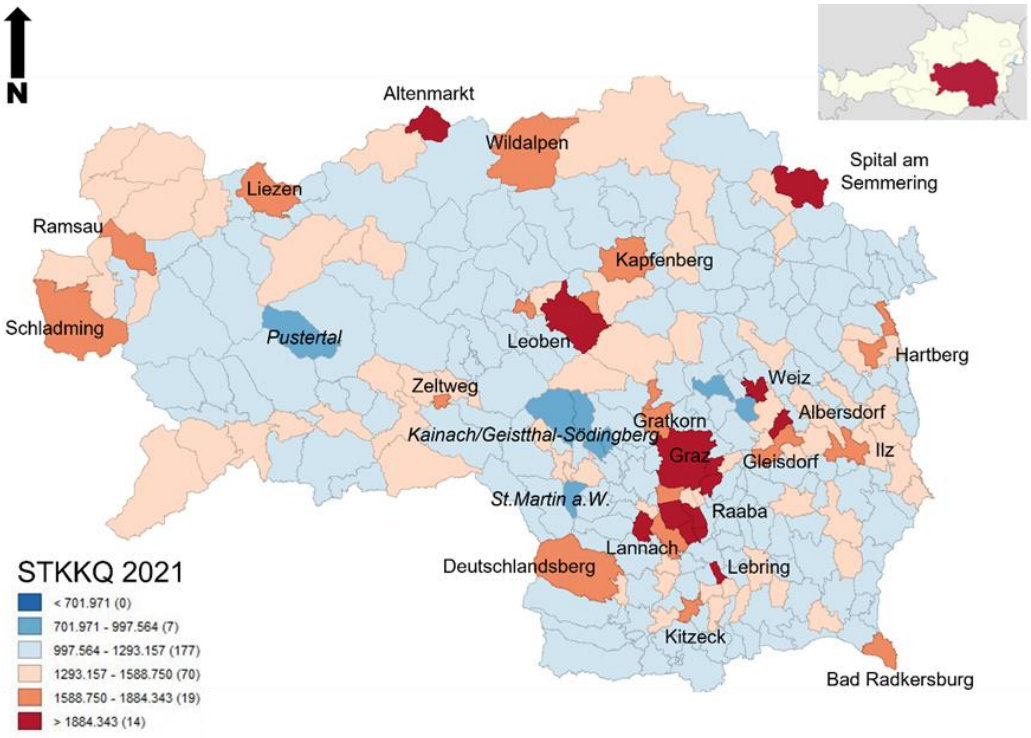

Figure 4. Maxima and Minima of the STKKQ 2021 of the Styrian Municipalities

Apart from revaluations as a result of short-term/one-time events, it was almost exclusively tourism communities that experienced a slump in STKKQ that could be paralleled with COVID-19. In most cases, this was a slip into the next lower class, a process that was already reversed in the following year (exception: the already mentioned Hohentauern, which as a positive outlier of 2017 slipped into the penultimate class and has since then only recovered very slowly. Apart from that, it can be summarized that urban centers with a pronounced share of services (Graz and its southern and eastern neighboring municipalities, Leoben and Kapfenberg as well as cities with higher centrality such as Weiz, Gleisdorf or Liezen) or tourist communities (Schladming, Altenmarkt, Spital am Semmering, Wildalpen or Bad Radkersburg) consistently occupy the top positions. A similar situation, but in the opposite sense, applies to municipalities that are mostly located in the periphery, are predominantly agricultural and structurally

weak; Kainach, Geistthal-Södingberg, Stiwoll, St. Martin am Wöllmißberg and others have been in the last class unchanged for years.
In addition to the descriptive-statistical characteristics of the study area, phenomena such as spatial autocorrelation, the tendency to clustering or the interaction of several factors in the shaping of the STKKQ are subsequently analyzed with the help of the methods of explorative analysis of spatial data (ESDA). Because in this study scenario the possible existence of an interaction between the characteristic expressions of two (indirectly or directly) neighboring spatial units is assumed, the consideration of the distance between them or the range of the interaction is of particular importance. The implementation of this parameter into the model is usually done by defining weights; this can be done in two ways - contiguity-based or distance-based. The contiguity of areas describes the extent of their connection and distinguishes between "adjacent in points" (bishop's or queen's case), "adjacent to edges" (rook's case) or "not adjacent" or the order of contiguity (directly or indirectly via 1, 2, 3, ..., n areas). From what has been said, it can be deduced that in the presence of irregularly shaped (administrative) spatial units, queen's contiguity produces a more realistic representation of reality [18]. Additionally, it has to be taken into account that the data-technically necessary limitation of the analysis to the province of Styria is associated with a reduction of potential neighbors at the state borders (edge effect; [19], which can only be counteracted by the use of higher order contiguities. Alternatively, the use of the distance-based approach which takes into account the real distances between the location points representing the areas (usually the centroids) for the calculation of the weighting factor. The distance in this process serves either as a range limit (distance band method) or as a limit on the number of centroids considered (k-nearest neighbor method). In the former case there is no possibility to control how many neighbors are considered for each centroid, in the latter case there is no possibility to influence the actual distances considered. Because of these considerations, both the queen's case (with 1st, 2nd and 3rd order neighbors) and the distance-based model (distance band with 15 km, 20 km and 25 km) or the k-nearest neighbor model with 4, 5 and 6 neighbors were tested for their suitability in the present study. Finally, the decision was made in favor of the distance-based approach with a bandwidth of 15 km, since it corresponded best to the real conditions; moreover, with a non-zero percentage of about 6 %, each study unit could be assigned an average of 16 neighbors.
On this basis, the global Moran's I was determined for the investigation of the spatial autocorrelation of the STKKQ, whose graphical representation allows basal statements about the configuration of the characteristic values in the defined neighborhood of a spatial unit. This calculation results in a value of 0.044 for Moran's I, which at first rather indicates a random distribution, whereas the significance test for I (with 999 permutations) on a probability level of 95 % suggests a weakly pronounced clustering. Nevertheless, the graphical representation of Moran's I is telling in that it allows for a basic identification of HIHI or LOLO communities. The first group includes those areas of the study area where communities with high STKKQ occur in close proximity, while in the LOLO area areas with low STKKQ are surrounded by the same. The enclosed overview maps support the assumption made at the beginning: tourist areas and economically strong municipalities (HIHI) are juxtaposed with agrarian and economically weak areas (LOLO) (Fig. 5).

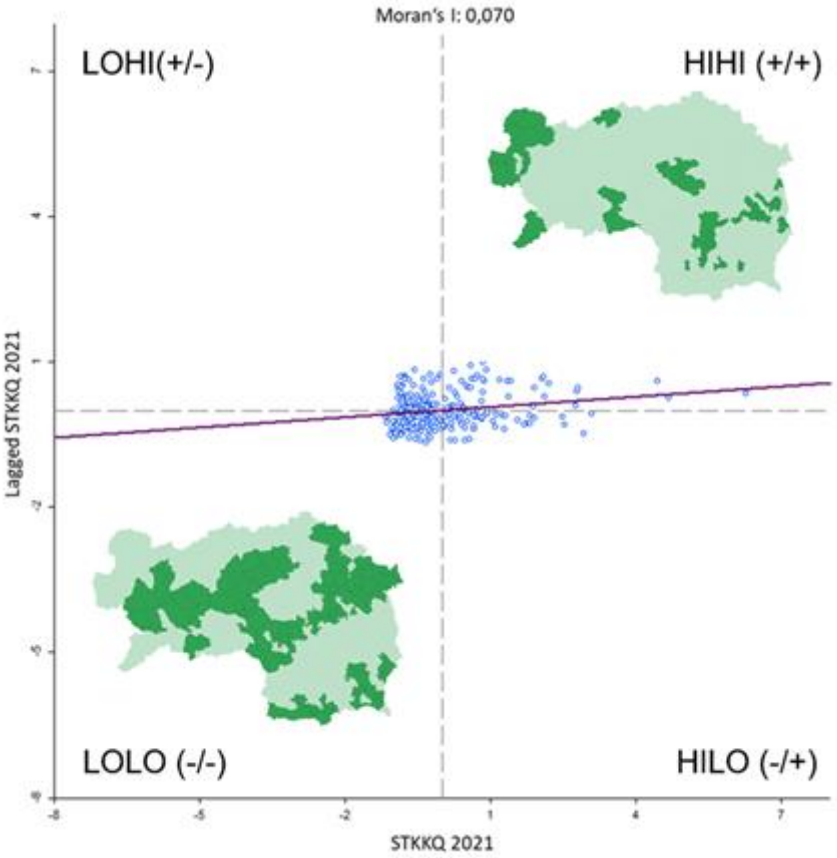

Figure.5. Global Moran‘s I of STKKQ (scatterplot and spatial distribution).

Beyond this statement, however, the global variant of Moran's I is not able to provide information on the more precise spatial distribution of the individual clusters and the associated significance level, so that "localized" I had to be determined additionally. The resulting results confirm in principle the findings derived from Moran's I. Significant results (p = 0.05 or smaller) can only be found for 53 of the 287 Styrian municipalities, whereby previous assumptions had to be corrected in part. Thus, only Graz with its eastern and southern neighbors (14 municipalities) as well as Niklasdorf in Murtal and Bad Aussee, respectively, are found in the significant HIHI range. Also, in the LOLO area the results differ from the "global" view. While the results for the western Styrian municipalities of Maria Lankowitz, Bärnbach and St. Martin am Wöllmißberg could have been expected, a cluster of 10 municipalities in northern eastern Styria and the hitherto inconspicuous municipality of Schöder, for example, are surprising. For a better understanding, however, it should be mentioned that in the described facts only the core areas were identified, that means that it can be assumed that the area characterized in this way also includes the respective neighboring municipalities, so that altogether much larger homogeneous areas are created (Fig.6).

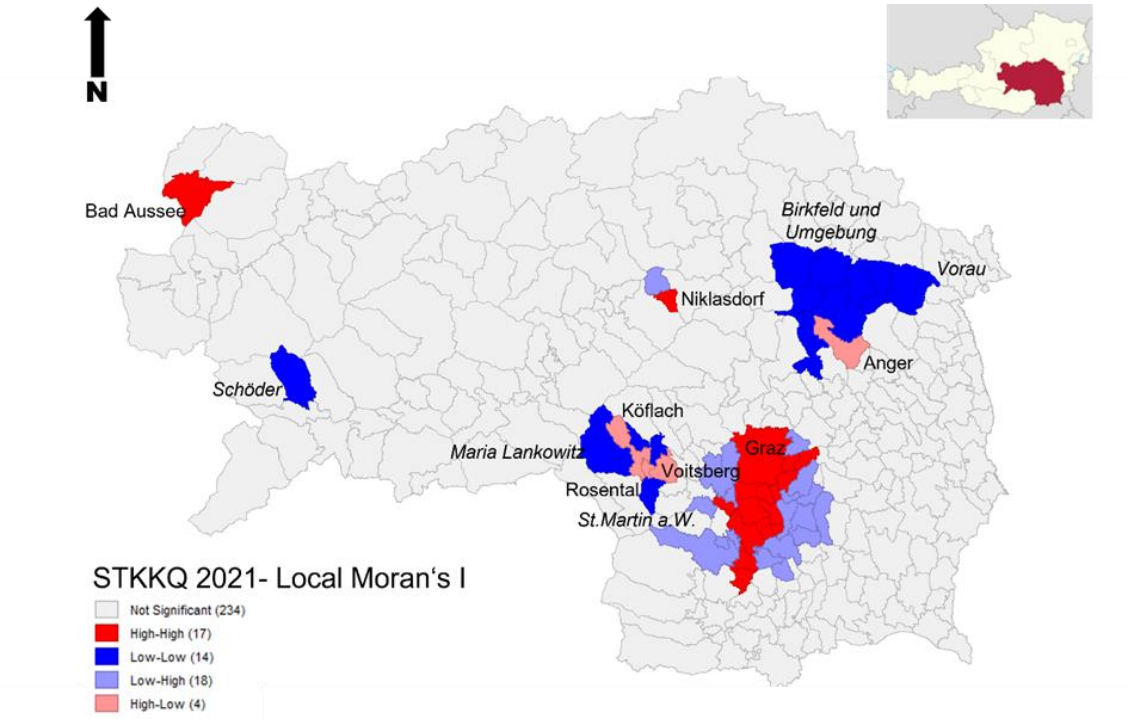

Figure 6. Spatial distribution of significant Local Moran's I (p less than or equal to 0.5).

Extending this approach to delineate STKKQ clusters, an attempt was also made to use cluster analytic methods to structure the entire study area into clusters of municipalities with approximately equal economic power. From the large number of clustering methods, hierarchical clustering was selected as the most suitable method because in this method the number of clusters does not have to be determined a priori, but the clusters can be built up step by step [20]. The size of the cluster is determined from the results of each step, a process that can be easily understood using a dendrogram. In this agglomerative process, the successive steps are performed bottom up and can be interrupted at any point in the process. For the present study, the complete linkage option was used because, unlike single linkage, this method tends to lead to the formation of a larger number of balanced, compact clusters and thus is more likely to satisfy the task as a tool for regionalization [21].

look at the results shows that the described procedure - using automatic weighting based on Euclidean distance - allows the formation of 13 clusters, which not only make sense in the given context (economic/demographic/transportation), but also roughly reflect the current administrative structure of Styria. However, the value for the within-cluster sum of squares (measure for the homogeneity of the cluster) is significantly higher in 2 clusters than in the rest of the study area, while 3 municipalities (Raaba, Premstätten and Lannach form a separate, non-contiguous cluster (Fig.7). Also noteworthy is the fact that the provincial capital Graz is assigned to a cluster in central eastern Styria, thus contributing - albeit indirectly - to the increase in variance within the cluster. Alternatively, the clustering was performed using Ward's variance-minimizing linkage method [22], which slightly decreases the between-cluster sum of squares; nevertheless, there are also massively increased similiarities in two clusters; on the one hand caused by the assignment of Graz and on the other hand by the municipality Lebring, which was assigned as exclave to a cluster south of Graz.

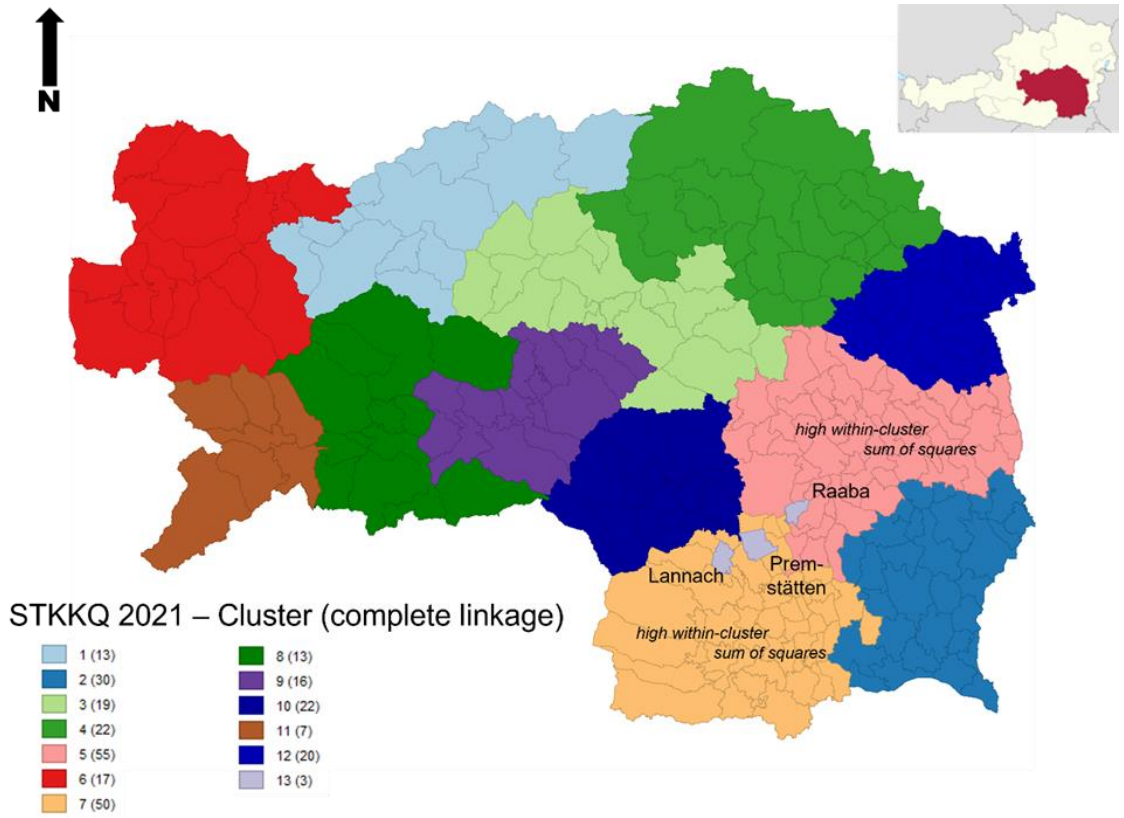

Figure 7. 13 STKKQ – Clusters of Styria (based on centroids and automatic weighting)

Finally, this paper will examine the question of possible statistical correlations between the STKKQ and the control variables of population, number of workers and overnight stays in the calendar year, which may be partly responsible for its level. Unfortunately, it was not possible to include the latter parameter because it turned out in the course of the study that the required data for all observed municipalities could not be obtained in the necessary scope or form. Instead, the factors "tax performance" (sum of all taxes and duties of a municipality, STUA) or "employed in the agricultural sector" (I) or "employed in the tertiary sector" (III) were included in the calculations. The multiple OLS regression model (OLS = Ordinary Least Square) created on this basis yielded an R^2 of 0.30 for the dependent variable STKKQ, which seems surprisingly low in view of the predictors STUA, III, inhabitants (EW) and employees (ACT) used, with only the contributions of I and III to the model being relatively high (coefficients: -24.07 and 3.48, respectively). However, the extremely high value for multicollinearity (Mulitcollinearity Condition Number: 143.06) has a far more severe effect, rendering the model unusable in this form [23]. For this reason, the variables were subsequently examined individually, showing that the variables ACT (R^2: 0.048), EW (R^2: 0.049), and STUA (R^2: 0.054) hardly contribute to the expression of the target variables. In comparison, the dependence of STKKQ on the variables III (R^2: 0.122) and I (R^2: 0.154) is somewhat stronger; in contrast to the former, however, the relationship for the latter is, as expected, in the opposite direction.

SUMMARY

Regarding to the questions formulated above, it can be summarized first of all that the parameter STKKQ has recorded a permanent increase since the municipal structural

reform in 2015, which shows a significant drop in parallel to the COVID 19 pandemic. Apart from some local outliers, the development is uniform, so that hardly any significant changes in the ranking occur. A classification based on arithmetic mean or standard deviation yielded for the year 2021 supports this thesis. The results for Moran'I (global) indicate a very weak autocorrelation, which means that there are hardly any dependencies between the municipalities regarding the expression of the STKKQ. This finding is also consistent with the results for I at the local level, which show that HIHI or LOLO are also significant in only a few cases (31 out of 287). The attempt to group communities of similar STKKQ using hierarchical clustering suggested the formation of 13 clusters, although it must be emphasized that this result represents an administratively justified compromise between spatial compactness and the similarity of the communities within the clusters. An examination of the dependence of the STKKQ on certain socioeconomic variables showed only an unexpectedly weak dependence on the factors "employed in the primary sector" (negative) and in the "tertiary sector" (positive). A significant influence of the other variables could not be detected.

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