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Differences in Slovenian NUTS 3 Regions and Functional Regions by Gender

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Abstract

Background: Regions at the level of NUTS 3, which is a system used in the EU for various analyses and statistical reports, can be defined as functional regions in terms of labour markets, education areas, and supply markets. **Objectives:** This study analyses the functional regions of Slovenia, differentiated by gender, and their correspondence with the statistical regions at the level of NUTS 3. **Methods/Approach:** Functional regions are analysed as labour market areas, which are modelled according to the CURDS method, and evaluated using the fuzzy set approach. **Results:** The analysis of functional regions resulted in ten regions for male commuters and fourteen regions for female commuters. Only four of the twelve functional regions for commuters relate to the corresponding statistical regions. Functional region Ljubljana is much larger than the corresponding statistical region, mainly at the expense of neighbouring regions. In recent decades, two new functional regions have been created which are becoming candidates for inclusion in the system of NUTS 3 regions. **Conclusions:** A detailed analysis showed that functional region Velenje is becoming an important local labour market and should be included in the system of NUTS 3 regions of Slovenia, while the Central Sava Statistical Region should be removed from it.

Introduction

The Nomenclature of Territorial Units for Statistics (NUTS) is a system for the collection, compilation and dissemination of European statistics at different territorial levels of the European Union (EU). The nomenclature NUTS divides the economic territory of the Member States hierarchically into territorial units. It divides each Member State into NUTS territorial units at level 1, each of which is subdivided into NUTS territorial units at level 2, which are in turn subdivided into NUTS territorial units at level 3 (EC, 2019). The current NUTS 2016 classification is valid from 1 January 2018 to 31 December 2020 and lists 104 regions at NUTS 1, 281 regions at NUTS 2, and 1348 regions at NUTS 3 (Eurostat, 2020a). The NUTS 2021 classification, which will be valid for data transmissions to Eurostat from 1 January 2021, lists 104 regions at NUTS 1, 283 regions at NUTS 2, and 1345 regions at NUTS 3 (Eurostat, 2020b). According to the NUTS regulation (EC, 2019), changes in the scope and number of NUTS regions are only possible every three years. The changes are usually based on changes in the territorial structure of a Member State.

For statistical purposes at local level, Eurostat maintains a system of Local Administrative Units (LAU) that is compatible with NUTS. LAU units, like municipalities and communes, are the building blocks of NUTS regions (Eurostat, 2020c).

According to the criterion for the number and size of these regions, each region at the NUTS 3 level must have between 150,000 and 800,000 inhabitants, based on the average population (EC, 2019). In practice, this means that Slovenia can have a maximum of thirteen statistical regions at this level.

Slovenia includes twelve regions at the NUTS 3 level that are mainly used for statistical reporting, which is why they are also called "statistical regions". Twelve Slovenian statistical regions are as follows (SORS, 2020a; Wikipedia, 2020): SI031 Mura Statistical Region, SI032 Drava Statistical Region, SI033 Carinthia Statistical Region, SI034 Savinja Statistical Region, SI035 Central Sava Statistical Region, SI036 Lower Sava Statistical Region, SI037 Southeast Slovenia Statistical Region, SI038 Littoral–Inner Carniola Statistical Region, SI041 Central Slovenia Statistical Region, SI042 Upper Carniola Statistical Region, SI043 Gorizia Statistical Region, SI044 Coastal–Karst Statistical Region. Figure 1 shows twelve regions at the NUTS 3 level and 212 municipalities at the LAU level in Slovenia in 2020.

Regions at the NUTS 3 level can also be defined as functionally connected areas, i.e. functional regions, in terms of labour markets, education areas, and supply markets (Drobne, 2016). In this study, we analysed functional regions, differentiated by gender, at the level of twelve statistical regions (NUTS 3) in Slovenia. We tested the hypothesis that there are differences in gender-specific functional regions of Slovenia. We discussed also the differences between NUTS 3 regions and the corresponding functional regions (FRs) and between men and women within FRs.

Figure 1
Twelve regions at the NUTS 3 level and 212 municipalities at the LAU level in Slovenia in 2020
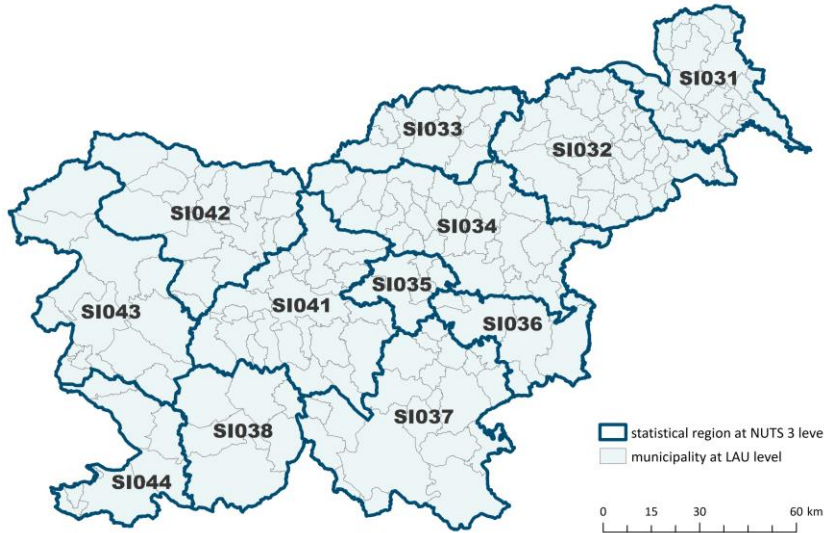
Source: Author's work, SMARS (2020)

Literature review

The first version of the classification of Slovenian statistical regions was prepared in the mid-1970s. It was based on a detailed gravity analysis of labour markets, educational areas and supply markets in twelve regional and sub-regional centres (Vrišer, 1974, 1978; Rebec, 1983, 1984; Vrišer & Rebernik, 1993). From this time onwards, statistical regions were used for regional planning and cooperation in various fields. This is why Slovenian regions at the NUTS 3 level have been very consistently stable (Drobne, 2016). However, labour and supply markets are changing all the time, especially during economic and/or financial crises, like the one that arose in 2008. For that reason, OECD (2002) and Eurostat (Coombes et al., 2012) suggested the more frequent analysis of labour market areas. However, labour market areas are good approximations of so-called functional regions (OECD, 2002) that could be the basis for regions at the NUTS 3 level in the EU.

There are many definitions of functional regions (FRs). One of the first definitions describes a FR as an area surrounding a strong economic centre that attracts residents from the near and far hinterland (Berry & Garrison, 1958), whereas the centre of FR is understood as a location as defined in Christaller's theory of central places (Christaller, 1933), the size of which depends on the supply of goods and services to the residents. Today, a FR is the most often understood as a territorial area characterised by the high frequency of intra-regional economic interaction, such as intra-regional trade in goods and services, labour commuting, and household shopping. Even though it is characterised by its agglomeration of activities and by its intra-regional transport infrastructure, according to many researchers (e.g., Vanhove & Klaassen, 1987; Karlsson & Olsson, 2006; Cörvers et al., 2009; Coombes et al., 2012), the fundamental characteristic of FR is the integrated labour market, where commuting and job search and demand are much more intense than their counterparts outside of the region. This is why FRs are most frequently analysed by flows of commuters. From this point of view, FRs are understood also as areas delimitated by generalized patterns of commuting flows (Drobne et al., 2020).

Commuting to work is not just a daily or weekly movement in space, but also a personal experience that men and women experience differently (Prashker et al., 2008). Commuting is influenced by various factors that have different effects on each gender. Studies by White (1977) and Fanning-Madden (1981) have shown that gender and occupation form the basis for differences in wages, working hours, places of work, and household duties, which also leads to differences in the distance and time spent commuting among genders. On the other hand, many authors (e.g. White, 1977; Green et al., 1986; Tkocz & Kristensen, 1994; Sang, 2008; Prashker et al., 2008; Roberts et al., 2011; Nafilyan, 2019) note that the commuting distance and time to work increases for both genders. However, men have always commuted on average longer distances to work and spent more time commuting, which the researchers cite as a consequence of cultural standards regarding restrictions on female domestic work and childcare. Roberts et al. (2011) explicitly pointed out that childcare is one of the strongest factors that significantly influence the choice of time and distance to commute among women.

A gender-specific comparison of the distance and time spent commuting by age group showed that women in almost all age groups were less inclined to commute for longer periods, except during the first years of employment (Nafilyan, 2019). The willingness to commute longer to work increases and is very similar for both sexes up to the age of 25. For women, it remains constant until the age of 35, when it begins to decline. For men, on the other hand, the willingness to commute to work for longer periods increases until the age of 35 and remains at a similar level until the age of 45, after which it begins to decrease.

The choice of place of residence is influenced by many different factors, such as socio-economic characteristics, life cycle, place of work, and other important factors such as school, family, friends, shopping centres, property value, and characteristics of the working and living environment. Some choose to live by their place of work, and some choose to work by their place of residence, or both at the same time (Prashker et al., 2008). It is also known that, as incomes and specialisation increase, so does the average distance and travel time to work (ibid.). However, Roberts et al. (2011) showed that daily commuting to work affects mental health and leads to stress and greater social isolation. With benefits such as higher income, better living environment, and more favourable working conditions, daily commuting has an impact on the mental health of women, while it has almost no effect on men (ibid.). Despite lower wages, women tend to choose to replace more remote jobs with nearby ones (Sang, 2008; Nafilyan, 2019).

However, analysis of the spatial distribution of occupations by gender in the urban environment revealed a higher proportion of male jobs in more developed urban areas, while women are employed equally throughout the urban area (Blumen, 1994).

Methodology

The basic data source for the study of functional regions (FRs) included the average annual flows of commuters between 212 municipalities in Slovenia over the three years of 2016-2018, obtained from the SI - Stat Data Portal and taken from Statistical Register of Employment (SORS, 2020b). These resources provided the place of residence and work and the gender of the worker. The flows of commuters were considered in a quadratic matrix of interactions of the dimension $n \times n$, F,

$$F = [f_{ij}], \ n \times n \text{ matrix}, \ n = 212, \tag{1}$$

where $f_{ij} \geq 0$ is the value in the i-th row and the j-th column, i.e. the flow from the municipality of origin i to the municipality of destination j.

Spatial data on municipalities and statistical regions at the NUTS 3 level in Slovenia were obtained from the "Free Access Database" of the Surveying and Mapping Authority of the Republic of Slovenia (SMARS, 2020).

We modelled FRs with the use of the CURDS method, which comes from the Centre for Urban and Regional Development Studies, from Newcastle University, UK. The method was first introduced in the mid-1980s by Coombes et al. (1986) and was later improved several times. We used the third version of the method, which was presented by Coombes and Bond (2008). The method is also called the EURO method because it has been tested by EUROSTAT and several research groups in Europe (Coombes et al., 2012).

FR was modelled according to an iterative procedure of the third version of the method CURDS (Coombes & Bond, 2008) in the R software tool with the library LabourMarketAreas 3.0 (Franconi et al., 2016a, 2016b, 2017). When modelling FR, we follow the principle of maximizing internal flows (flows within FR) and minimizing external flows (flows across the boundaries of FR). For commuter flows, we monitor these two principles with FR self-sufficiency, which is treated as supply-side self-containment ($SSSC$) and demand-side self-containment. $DSSC$). f_{hk} is the flow of commuters from the group of municipalities h to the group of municipalities k or f_{hk} is the number of workers living in origin h and working in destination k.

$$SSSC = \frac{RW_i}{R_i} \text{ is supply-side self-containment} \qquad (2)$$

and

$$DSSC = \frac{RW_i}{W_i} \text{ is demand-side self-containment,} \qquad (3)$$

where $R_i = \sum_k f_{ik}$ is the number of workers living in i, $W_i = \sum_h f_{hi}$ is the number of workers working in i, and $RW_i = f_{ii}$ is the number of workers living and working in i.

Supply-side self-sufficiency ($SSSC$) indicates the extent of employment opportunities for the local population. The high level of $SSSC$ indicates a relatively closed FR (a large part of the local population finds employment in FR). Conversely, a low $SSSC$ rate indicates a relatively open FR (a large part of the local population works in other FRs). Demand-side self-sufficiency ($DSSC$) provides a range of housing options for FR employees. The high $DSSC$ rate, therefore, means that a large proportion of FR employees have found accommodations there, and at the same time, this may also indicate a lack of jobs in FR (Drobne, 2016). Van der Laan and Schalke (2001) therefore suggest that, when assessing FRs, $SSSC$ should always be confronted with $DSSC$. In addition to self-containment, an important criterion in the evaluation or modelling of FRs according to the CURDS method is also the number of workers or employed active population (EAP). Before performing an iterative procedure of the CURDS method, we must therefore define the four parameters with which we model the FRs; these are the minimum number of EAP in FR ($minEAP$), the target number of EAP in FR ($tarEAP$), the minimum self-sufficiency of FR ($minSC$) and the target self-sufficiency of FR ($tarSC$); we consider self-sufficiency to be the smaller of the two self-sufficiencies considered:

$$SC = min(SSSC, DSSC). \qquad (4)$$

The CURDS algorithm groups the basic spatial units (BSUs), in our case municipalities, step by step into the FRs. The algorithm treats each municipality as a FR. The algorithm

checks the validity of the FR in the aggregation process using the defined parameters ($minEAP$, $tarEAP$, $minSC$, and $tarSC$) that define the criteria function f_v:

$$f_v(EAP, SC) = \left(1 - \left(1 - \frac{minSC}{tarSC}\right) max\left(\frac{tarEAP - EAP}{tarEAP - minEAP}, 0\right)\right)\frac{min(SC, tarSC)}{tarSC}. \tag{5}$$

A group of municipalities becomes an FR if the condition is met:

$$f_v(WP, SC) \geq \frac{minSC}{tarSC}. \tag{6}$$

The validity condition of FR is checked after each merge step. Namely, the algorithm merges step-by-step municipalities (groups of municipalities), between which the strongest link, L_{hk}, is defined by labour mobility flows:

$$L_{hk} = \frac{f_{hk}^2}{R_h W_k} + \frac{f_{kh}^2}{R_k W_h}, \tag{7}$$

where f_{hk} is the number of active population living in a municipality or group of municipalities h and working in a municipality or group of municipalities k; f_{kh} is the number of active population living in a municipality or group of municipalities k and working in a municipality or group of municipalities h; R_h is the number employed active population in a municipality or group of municipalities h; and W_k is the number of jobs in a municipality or group of municipalities, k. The algorithm of the third version of the method CURDS, implemented in the library LabourMarketAreas 3.0 for use in the software tool R, is described in detail in Franconi et al. (2016a).

A specific feature of the CURDS method is the possibility of disaggregating FR into BSUs, in our case municipalities, if FR does not meet the validity condition (6), and we include them on the reserve list with the possibility of reuse in the merging process. The final result of modelling FRs using the CURDS method is determined by the parameters $minEAP$, $tarEAP$, $minSC$, and $tarSC$, but they depend mainly on the size (population) of the area under consideration and the size of the labour market in that area. Recommendations for the above parameters can be found in the literature (e.g. Coombes and Bond, 2008; Franconi et al., 2016a, 2016b), but they generally apply to modelling FR at the micro and mezzo levels. However, for all levels of treatment, the target of self-sufficiency should be greater than 0.65 ($tarSC \geq 0.65$), and the minimum of self-sufficiency should be greater than 0.60 ($minSC \geq 0.60$), while the target ($tarEAP$) and the minimum number of the employed active population ($minEAP$) in FR depend on the characteristics of BSUs, in our case municipalities, the flows of labour mobility, and other characteristics of the area under consideration, especially population density. The parameter $minEAP$ has a significant impact on the size of the modelled FRs. Coombes and Bond (2008) recommend at least a generalised knowledge of FR at a selected level of an analysed area.

By changing the parameters $minEAP$, $tarEAP$, $minSC$, and $tarSC$, we initially modeled twelve FRs for all commuters in Slovenia. In the separate analyses of labour mobility flows by gender, we used the same parameters $minSC$ and $tarSC$ as in the analysis for all commuters, while $minEAP$ and $tarEAP$ were calculated concerning the number of women and men in the analysed population and rounded for hundreds, as proposed by Arnuš (2020).

Three final sets of functional regions, i.e. twelve FRs for commuters together, ten FRs for male commuters, and fourteen FRs for women, were evaluated using the Fuzzy Set Theory (FST) approach proposed by Feng (2009) and Watts (2009, 2013) and improved

by Drobne (2020) and Drobne et al. (2020). The membership function values of each municipality were calculated as the geometric mean of the membership function values of municipality i concerning fuzzy residential functional region m, $M'_{im} = \sum_{j \in (g)m} f_{ji}/f_{\cdot i}$, and to fuzzy local employment functional region m, $M''_{im} = \sum_{j \in (g)m} f_{ij}/f_{i\cdot}$:

$$M_{im} = \sqrt{M'_{im} \cdot M''_{im}} \ . \tag{8}$$

To evaluate the entire sets of FRs, geometric mean membership values were calculated for each FR and also for the whole system of FRs. The calculation of membership function values was performed in Mathematica 11.3 with the programme code developed by Drobne and Lakner (2016) and Drobne (2020).

In addition to the modelled FRs, we also calculated some interesting statistics. Of particular interest is the weighted average distance between home and work municipalities obtained by multiplying the commuter flow by the Euclidean distance between the municipal centres.

Results

Between 2016 and 2018, an average of 829,626 people was employed in Slovenia, of which 448,976 (54.1%) were men and 380,366 (45.9%) women. Of those in employment, slightly less than half (398,258; 48%) worked in the municipality of residence and the rest (431,368; 52%) in another municipality. Comparison by gender shows a slightly higher proportion of women who found a job in their home municipality (48.3%) than men (47.8%); see Table 1.

Of the 44,944 interactions between 212 municipalities, less than a third (13,915; 31%) were non-empty interactions in matrix F. A comparison between the sexes shows that employed men commuted to work in more different municipalities (11,582; 25.8% of interactions) than employed women (9,363; 20.8%). This statement is also confirmed by the fact that the non-empty interactions include interactions ii, (i.e. interactions of the municipality with itself) and that a higher proportion of women than men worked in their home municipality.

The capital of Slovenia Ljubljana (code 61 in Figures 2) is the country's most important centre of employment, providing more than a quarter (220,779; 26.6%) of jobs. Of all jobs in the country by gender, relatively more women (27.9%) than men (25.5%) found employment in the municipality of Ljubljana. Also, out of a total of 99,681 persons in employment, more women (12.9%) than men (11.3%) were employed in their home municipality of Ljubljana compared to Slovenia. The most intensive interaction in daily labour mobility is between Ljubljana and the neighbouring Domžale (code 23 in Figures 2), where just over 7,000 workers from the municipality of Domžale come to work in the municipality of Ljubljana every day. Again, this region includes relatively more women (1% of all employed women) than men (0.8% of all employed men in Slovenia).

The above data shows that, regarding the number of jobs by gender in Slovenia, relatively more women than men stay in their home municipality or commute to work mainly in neighbouring municipalities. This statement is also confirmed by the results of the analysis of the weighted average distance to work, according to which commuters travelled an average of 16 km to work every day from 2016 through 2018, 16.8 km for men and 14.9 km for women (see Table 2).

Analysis of the functional regions performed by the CURDS method and parameters listed in Table 2 revealed twelve FRs for all commuters, ten for men, and fourteen for women.

Table 1

Employed active population and labour commuting interactions for 2016-2018 in Slovenia

	Together	Men	Women
Employed active population (**EAP**)	829,626 **(100%)**	448,976 **(100%)**	380,366 **(100%)**
Work in residential municipality	398,258 (48.0%)	214,584 (47.8%)	183,673 (48.3%)
Work in another municipality	431,368 (52.0%)	234,392 (52.2%)	196,693 (51.7%)
Number of full interactions	13,915 (31%)	11,582 (25.8%)	9,363 (20.8%)
Number of empty interactions	31,029 (69%)	33,362 (74.2%)	35,581 (79.2%)
Maximum number of working places in the municipality (Ljubljana)	220,779 (26.6%)	114,484 (25.5%)	106,300 (27.9%)
Maximum number of employed active population in the residential municipality (Ljubljana)	99,681 (12%)	50,553 (11.3%)	49,129 (12.9%)
Maximum volume of interaction between municipalities (Domžale-Ljubljana)	7,083 (0.9%)	3,415 (0.8%)	3,668 (1%)

Source: Authors' work.
Note: The proportions in the table are calculated according to the starting point of the column.

Table 2

Population, weighted mean commuting distance, and parameters for modelling functional regions for 2016-2018 in Slovenia

	Together	Men	Women
Employed active population (**EAP**)	829,626 **(100%)**	448,976 **(54.1%)**	380,366 **(45.9%)**
Weighted mean commuting distance [km]	16.0	16.8	14.9
Minimum number of the employed active population in a functional region (**minEAP**)	10,000	5,400	4,600
Target number of employed active population in functional region (**tarEAP**)	50,000	27,000	23,000
Minimum self-sufficiency of a functional region (**minSC**)	0.6	0.6	0.6
Target self-sufficiency of a functional region (**tarSC**)	0.7	0.7	0.7

Source: Authors' work.
Note: The values for the employed active population in the table are calculated according to the starting point of the row.

A comparison of twelve FRs and twelve statistical regions at the NUTS 3 level (see Figure 2a) shows that only four FRs are fully consistent with the statistical regions. These are the FRs of Murska Sobota, Slovenj Gradec, Krško, and Kranj. These are naturally delimited and historically known regions and/or important employment areas in Slovenia. FR of Ljubljana is much larger than an adequate statistical region; it also contains the whole Central Sava Statistical Region and parts of three other neighbouring statistical regions (Southeast Slovenia Statistical Region, Coastal–Karst Statistical Region, and Gorizia Statistical Region). Other FRs are much smaller than adequate statistical regions. In the western part of Slovenia, FRs occur at the expense of FR Ljubljana, or they simply do not exist compared to the statistical regions. Much

smaller are the FRs of Maribor and Ptuj and the FRs of Celje and Velenje, which cover the territory of two statistical regions (two FRs for each NUTS 3 region) and FR Novo mesto and FR Nova Gorica, which are smaller at the expense of FR Ljubljana. Surprisingly, there are no FRs of Trbovlje and Postojna in Slovenia, which has been listed as statistical regions at the NUTS 3 level for 40 years. These are mainly covered by the FR in Ljubljana and that of Koper.

The modelling of gender-specific functional regions at the NUTS 3 level revealed ten male and fourteen female FRs in Slovenia (see Figures 2b and 2c). In general, this indicates that men commute longer distances and women shorter distances.

Figure 2
Functional regions at the NUTS 3 level in Slovenia in 2020: (a) twelve functional regions for common commuter flows, (b) ten functional regions for male commuting flows, and (c) fourteen functional regions for women commuting flows
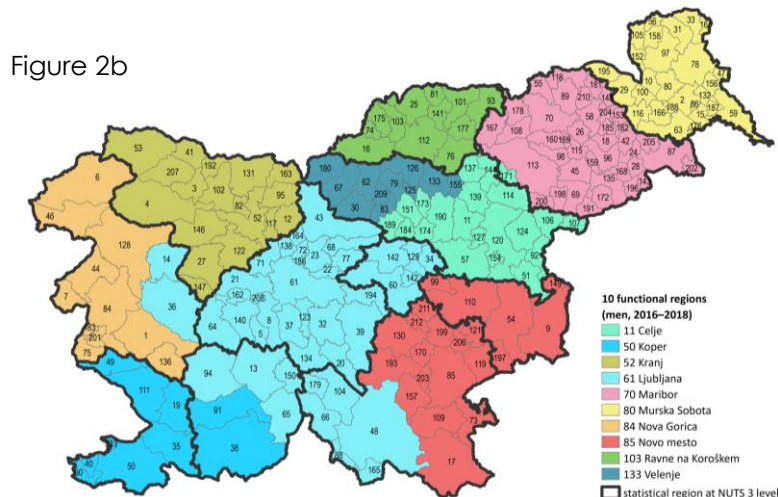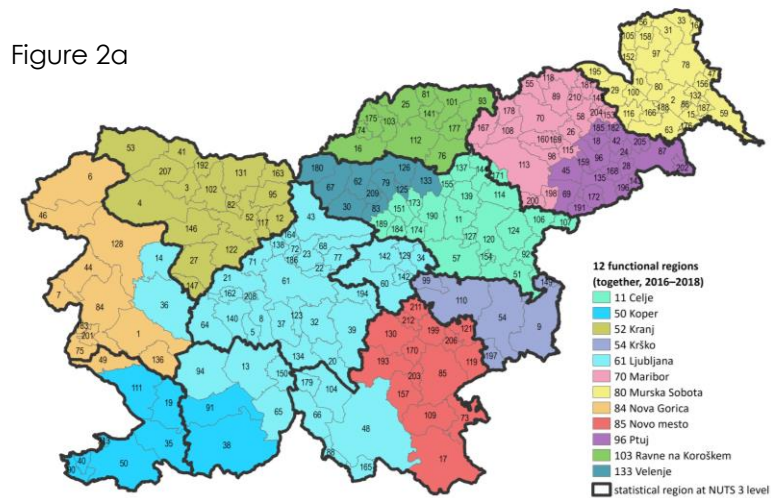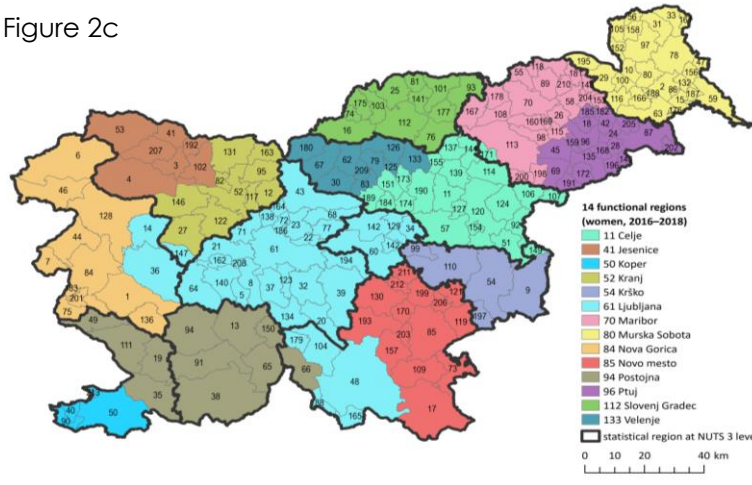

Figure 2a

Figure 2b

Figure 2c

Source: Author's work, SORS (2020a,b), SMARS (2020)

A comparison of twelve FRs for all commuters and ten FRs for men shows the specificities of labour mobility for men in the eastern part of Slovenia, while the regions in the western part correspond exactly to the general FRs. The male commuters form a single FR of Maribor (excluding FR of Ptuj for all commuters), which corresponds to a particular statistical region. Similarly, a single male FR for Novo mesto is formed, including the already-mentioned FR of Krško for all commuters. In southeastern Slovenia, more precisely in the Lower Sava Statistical and Southeast Slovenia Statistical Regions, the areas of labour mobility for men thus differ significantly from the corresponding regions at the NUTS 3 level. As with the general FR, other areas of labour mobility for male commuters are considered more important than the areas around Trbovlje and Postojna, where statistical regions have been nominally defined.

As previously mentioned, fourteen FRs for women appeared at the level of twelve NUTS 3 regions in which ten FRs for male commuters were found, which indicates that women generally commute shorter distances than men. Three FRs for women are fully aligned with the statistical regions: those of Murska Sobota, Slovenj Gradec, and Krško. However, in contrast to the general FRs, women commuters form two FRs in the Upper Carniola Statistical Region, i.e. FR of Kranj and FR of Jesenice. In addition to this specificity, another specificity for women is found in the FR of Postojna, which covers the entire territory of the adequate statistical region and most of the Coastal-Karst Statistical Region. At the expense of the FR of Postojna, two other FRs (the FR of Ljubljana and FR of Koper) are much smaller than the adequate FRs in the system of twelve FRs for all commuters together.

Functional regions should be delimited so that as only few labour mobility flows as possible cross their borders. This basic principle of delimiting FRs is already built into the method CURDS itself, which we used to model FRs. Nevertheless, in the study, we analyzed the final sets of FRs using an FST approach. We calculated the membership value of each municipality belonging to FR, and at the same time, we calculated the average membership value of all municipalities in FR (i.e. the average membership value of FR), and the average membership value of all municipalities in the system of all FRs (i.e. the average membership value of FR systems in the country). It is understood that a higher number of FRs will result in lower average fuzzy membership values and vice versa. Nevertheless, some common features can be drawn from the results in Table 3.

Of all three FRs systems, ten FRs system for men have the highest average fuzzy membership value of the municipalities belonging to FRs, i.e. 0.84, while the system for

women and the system for all commuters have the same average membership values, i.e. 0.82. In all three compositions of FRs, the FR of Ljubljana has the highest average membership value, i.e. 0.9, and the FR of Krško has the lowest. In the case of the common FR system, the average fuzzy membership value of belonging to FR of Krško is low, i.e. 0.67, and higher in the case of female FRs, i.e. 0.73. The latter indicates that many more women than men have found work in the home FR of Krško. A similar situation can be observed in the case of FR of Ptuj, where the average membership value of municipalities to FR is 0.73 for all labour commuters, while it is 0.77 for women.

Table 3
Mean membership values of the functional regionalization in 2016-2018 in Slovenia

ID	Functional region / Slovenia	Together	Men	Women
	Slovenia	*0.82*	*0.84*	*0.82*
11	Celje	0.79	0.79	0.80
41	Jesenice	N.A.	N.A.	0.78
50	Koper	0.80	0.78	0.85
52	Kranj	0.81	0.81	0.71
54	Krško	0.67	N.A.	0.73
61	Ljubljana	0.90	0.90	0.89
70	Maribor	0.82	0.87	0.84
80	Murska Sobota	0.87	0.86	0.88
84	Nova Gorica	0.87	0.88	0.89
85	Novo mesto	0.81	0.82	0.82
94	Postojna	N.A.	N.A.	0.72
96	Ptuj	0.73	N.A.	0.77
112	Slovenj Gradec	0.83	0.82	0.85
133	Velenje	0.80	0.77	0.80

Source: Authors' work.
Note: N.A. means that it does not apply to a particular case in question (there is no FR).

Discussion and conclusions

The study examined whether the statistical regions, i.e. the regions at the level NUTS 3 in Slovenia, still correspond to the gravitational zones around the more important regional centres as defined more than 40 years ago (Vrišer, 1974, 1978; Rebec, 1983, 1984; Vrišer & Rebernik, 1993). We analysed the gravitational areas of all labour commuters together and separately for men and women. Separately for both sexes, we also estimated the average distance between home and work. The results of our study are in line with the literature (White, 1977; Green et al., 1986; Tkocz & Kristensen, 1994; Sang, 2008; Prashker et al., 2008; Roberts et al., 2011; Nafilyan, 2019), since in Slovenia, the average distance between home and work is also shorter for women (14.9 km) than for men (16.8 km).

The number and extent of gravitational areas at the NUTS 3 level were analysed based on areas of functional urban regions, i.e. functional regions around the main employment centres in Slovenia. FRs were modelled using the CURDS method (Coombes & Bond, 2008), whereby generalized areas of commuter flows were identified at the level considered, which was defined by the population and self-sufficiency of the regions.

A comparison of the statistical and functional regions of all commuters showed that 2/3 of FRs do not correspond to the statistical regions, that FR Ljubljana is much larger

and FR of Novo mesto much smaller than the corresponding statistical regions, and that two new and important employment centres have emerged in eastern Slovenia, i.e. Ptuj and Velenje. At the level of twelve regions in Slovenia, these employment centres replace the previously defined centres (and their gravitational areas) of Postojna and Trbovlje.

The FRs were modelled also separately for both sexes using the corresponding parameters of employed men or women and regional self-sufficiency. Using such an FR modelling approach resulted in ten FRs for males and fourteen FRs for female commuters. The generalisation of commuter flows for men thus leads to a smaller number of larger labour market areas for men (ten male FRs), while for women, a larger number of smaller labour market areas (fourteen female FRs) are formed for Slovenia. Given the shorter commuting distances for women, such a result can be expected.

A comparison of general FRs and FRs separately for both sexes reveals some interesting facts. While the new FR Velenje is shaped by flows of labour mobility of men and women, the FR around Ptuj is mainly created because of the flows of labour mobility of women. In comparison to men, women form two additional FRs, i.e. FR Postojna and FR Kranj, which are less important if all flows are generalized at the level of NUTS 3 regions. All three maps of FRs show a decline in the importance of Trbovlje as a regional employment centre in Slovenia at the level in question. Based on this result, it would be useful to reconsider the inclusion of the Central Sava Statistical Region (SI035) in the system of NUTS 3 regions in Slovenia.

In our study, we also investigated the self-sufficiency of FRs using a fuzzy set approach. In the system of twelve FRs for all commuters together, the average value of the municipality's membership of FR is 0.82. FRs with lower values are regions from which on average relatively more workers commute to another FR than from others. These FRs are FR Celje, FR Koper, FR Kranj, FR Novo Mesto, and FR Krško. These results are consistent with the findings of Bole (2011), who found that, from 2000 through 2009, commuting flows from the municipalities of the Littoral–Inner Carniola Statistical Region (SI038) and of Coastal–Karst Statistical Region, and also from the municipalities from Southeast Slovenia Statistical Region to Ljubljana increased by more than 100%. In this period until 2009, important sections of the motorway in all directions were completed, making Ljubljana, Slovenia's main employment centre, more accessible.

The inclusion of FR in the system of statistical regions can also be based on the average membership values of Slovenia's functional regionalisation. In this case, it is useful to consider the possibility of excluding Southeast Slovenia Statistical Region from the system of NUTS 3 regions, as the average value of municipalities in FR Krško, which is fully consistent with the Southeast Slovenia Statistical Region, is relatively low (0.67). A similar consideration is offered in the case of adding a new region to the system. In this case, FR Ptuj has a low average value of municipality membership (0.73), while FR Velenje has a much higher value (0.8); this means that FR Velenje is more suitable for inclusion in the NUTS 3 system than FR Ptuj.

We consider the lack of analysis of the gravitational regions in the educational systems and the regional supply systems to be an important shortcoming of our study. Therefore, it makes sense to investigate additional FRs in the future that has a significant impact on the creation of functional urban regions around regional centres. These are mainly FRs in secondary and higher education, as primary education is usually provided in the home municipality and FRs of regional supply systems.

Functional regions, as discussed in this article, are formed based on labour mobility of the working population. Europe, and Slovenia in particular, is faced with a rapidly

ageing population. According to Eurostat population projections, the age structure of the Slovenian population is expected to change very significantly in the coming decades, but not in the structure by gender (Eurostat, 2019). Therefore, we expect that the change in the demographic composition of the population will not significantly affect the formation of FRs in the coming years, but new jobs related to the care of the elderly population will have an impact on the formation of FRs in the coming decades.

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