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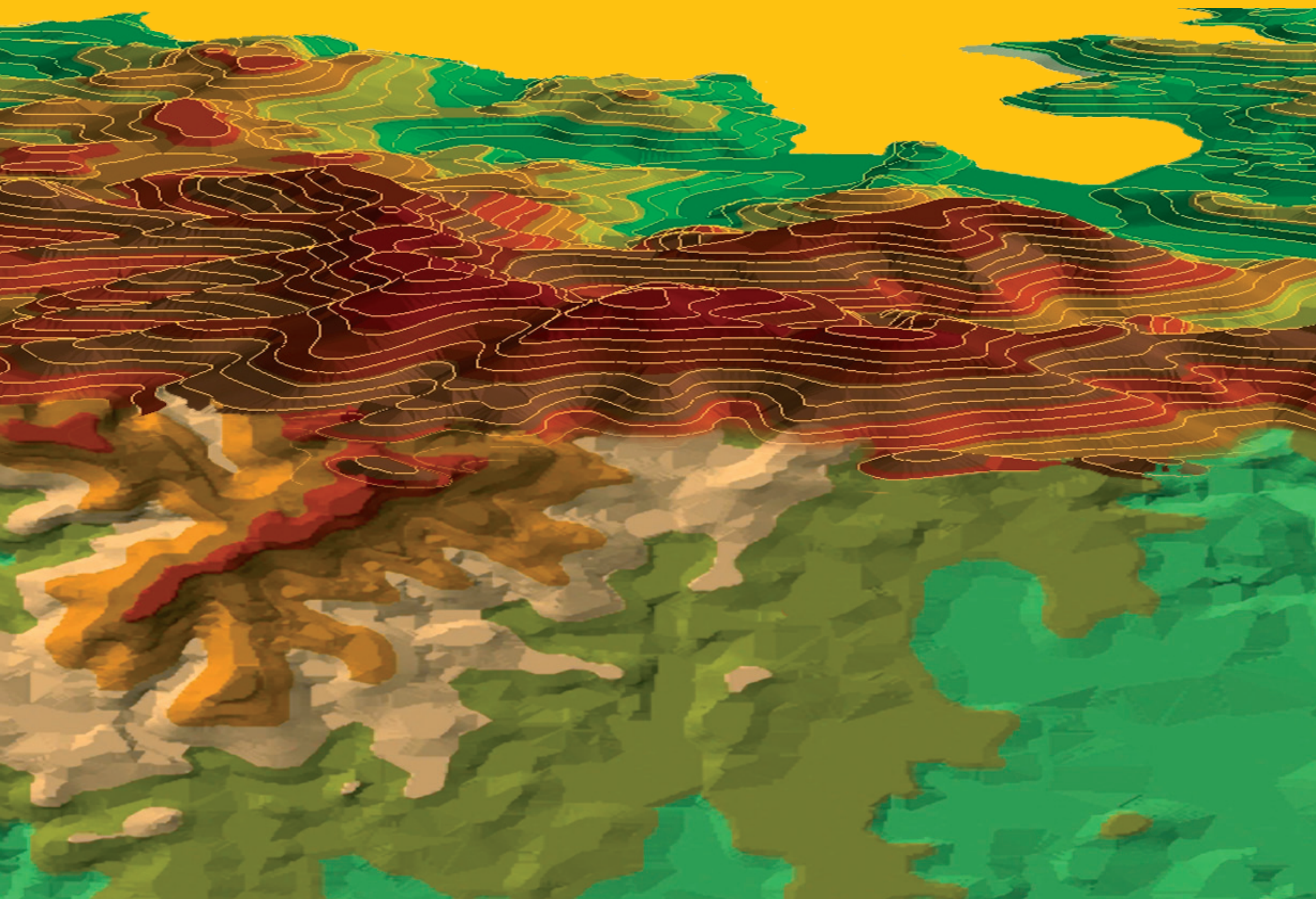

Fig. 6: Kroměříž, Rybalkova barracks (today Výstaviště Kroměříž and Dětský svět Kroměříž): 45th Anti-Aircraft Missile Regiment (technical repair bulding) (Photo: B. Pernica)

Fig. 7: Kroměříž, Žižkova barracks (today Hanácké Square): 7th Reconnaissance Battalion of the 7th Mechanized Brigade (concsripts' quarters) (Photo: B. Pernica)

Illustrations related to the paper by J. Ženka et al.

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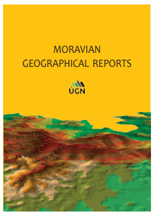

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The geography of demilitarisation: Do regional economic disparities affect the spatial distribution of military base closures?

Jan ŽENKA [a]*, Bohuslav PERNICA [b], Jan KOFROŇ [c]

Abstract

Very few researchers have focused on the question of: if and to what extent, regional economic disparities affect military base closures. In this paper, we aim to explain regional patterns of military base closures in the Czech Republic, a country that has experienced a sharp decline in military employment and expenditures since the beginning of 1990s. Three groups of predictors of closure were considered: local (size, age, location and hierarchical position of the military base); regional (wages, unemployment, city size, the initial level of militarisation of the district); and national-level predictors (geostrategic priorities and restructuring of the Czech Armed Forces). Our research is informed by the theory of public choice and its application to the decision-making processes concerning military base closures and realignments. We employed a combination of regression models to determine which group of the above-mentioned factors affected the spatial distribution of military bases in the period 1994–2005. While geostrategic factors (such as distance from the border with West Germany) and restructuring of the army (type of a military base) were the most important, regional economic disparities showed no significant correlation with the intensity of military base closures/downsizing. We did not demonstrate that military bases in economically lagging regions had been systematically protected in the Czech Republic.

Keywords: *defense, demilitarisation, military base closure, peace dividend, regional disparities, Czech Republic*

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1. Introduction

In many European countries, the end of the Cold war resulted in a widespread process of demilitarisation due to two primary reasons. First, signatories to the Treaty on Conventional Armed Forces in Europe (CFE Treaty) were obliged to reduce the strength of their military to ceilings agreed to in Paris on November 19, 1990, until 1995. Secondly, many post-socialist countries continued their demilitarisation beyond 1995, in a response to radically changed geopolitical conditions and their integration into NATO and the European Union. Finally, this trend resulted in a shift from conscripted armed forces to All-Volunteer Forces in the 2000s, leading to further reduction of the armed forces.

Considering that the "frontline" of the Cold War cut Central Europe (CE) in half, it comes as no surprise that Central European states experienced an extensive demilitarisation in the 1990s and early 2000s. The countries reduced their military strength in terms of personnel and equipment to such an extent that they went considerably below the CFE ceilings, and their military underwent substantial structural changes. In response to the NATO-related obligations (participation in out-of-region military operations) and the emerging threat of international terrorism, the countries prioritised lighter, strategically more mobile, forces. Simply, CE countries radically changed the size and structure, as well as geographical distribution of their armies.

There are several reasons to focus on the Czech Republic as a case study of this process. Firstly, the military in the Czech Republic was downsized at an unprecedented pace (see Section 2). Secondly, as Czechoslovakia was

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at the very frontline of the Cold War, the geographical distribution of its troops was extremely west-skewed (Štaigl and Turza, 2013a, b; Pernica, 2020). With the end of the Cold War and the disappearance of foes endangering the sovereignty of the Czech Republic, the existing geographical pattern of troop distribution had to change profoundly. The end of the Cold War was quickly followed by a sequence of transformative geopolitical events and processes in the region (the implementation of the CFE treaty, the break-up of Czechoslovakia in 1993, the NATO enlargement in 1999, and the EU enlargement in 2004). Finally, these changes took place within the context of profound socio-economic transformation and an economic slowdown in the early to mid-1990s.

The transformation – even if successful on a broader plane – resulted in an increase of regional disparities in employment and economic performance (Blažek and Csank, 2007; Ženka et al., 2015), and the financially challenged government struggled to directly support the lagging regions. In such a situation the government may opt for indirect support. This may include keeping military bases in struggling regions. Thus, one could hypothesise (along with Huck, 1994) that the governments should have been less willing to close the military bases in the struggling regions because their presence could be beneficial for local employment and buying power. While regional economic disparities in the Czech Republic were not considered to be a vital problem until the late 1990s, the situation has changed since the mid-1990s. Therefore, regional policy might have had certain effects on the process of military base closures and realignments, especially between 1998 and 2005 when social democrats were in power. From this perspective, the Czech Republic offers an interesting testing ground for an empirical investigation of the various structural factors – strategic, organisational, as well as economic – influencing regional differences in demilitarisation.

In summary, the main goal of our study is to explain spatial differences in the demilitarisation of the Czech Republic between 1994 (when there still lingered a network of military installations originally intended for the operations of the Czechoslovak front in the context of the Cold War) and 2005 (the year after the abandonment of conscription and the concentration of troops in a few, so-called, prospective municipalities). We focus on an estimation of the impact of several potentially important structural factors determining the governmental decisions on the distribution of forces over the territory by military bases (MBs) closures: military (geostrategic), operational factors and non-military factors, focusing on the potential effect of regional economic disparities.

More specifically, in this paper, we aim to answer three research questions. Firstly, we ask if and to what extent did regional policy affect the spatial pattern of demilitarisation: can we observe any systematic tendency to keep a military presence in economically lagging regions? In other words, is there any association between regional economic performance/employment in 1994 and the pace of demilitarisation between 1994 and 2005, controlling for the effects of geographical distance from the border with Bavaria? Did economically lagging districts experience a lower intensity of demilitarisation than their better-performing counterparts, ceteris paribus? Secondly, was there any observable effect of the MBs hierarchy on the intensity of demilitarisation at the district level? Were districts with a higher share of colonels and generals more resistant to military personnel reductions? Thirdly, was there any systematic tendency to concentrate military personnel (military bases) into larger cities to improve the possibilities of recruitment?

To answer these questions, our analysis employs OLS multivariate regression methods conducted at the district level.

2. A geography of demilitarisation – theoretical background

When considering the geographical or regional aspects of demilitarisation, three major avenues of researching this topic can be distinguished:

i. The spatial division of labour and tasks in the defence industry;
ii. Regional economic, social, or environmental effects of the MBs closures or reintegration of the former military training areas into a regional system; and
iii. Geographical and other relevant factors of the MBs closures.

Focusing more on the manufacturing of armaments than on MBs *per se* (see Tab. 1), the first group of studies deals with the changing (post)Cold-War geographies of the defence sector. These authors document a relatively sharp North-South polarity in the United Kingdom, characterised by the concentration of high-tech production, R&D and other strategic functions in the South and West of England. Atkinson (1993) and Warf (1997) document a similar spatial division of labour and tasks in the United States, showing high militarisation of the coastal high-tech metropolitan regions of California and New England. Therefore, a large share of the military employment cuts during the 1980s and 1990s occurred in economically developed metropolitan regions that were able to recover quickly from the economic shock.

The most widespread studies are those that focus on regional economic, social, and environmental impacts of the MBs closures. Scholars dealing with these issues often agree that the negative effects of the MBs closures on regional employment and income were rather limited, which was documented for example in the U.S. (Atkinson, 1993; Bradshaw, 1997; Hooker and Knetter, 1999; Poppert and Herzog, 2003; Lee, 2018), Germany (Paloyo et al., 2010), Sweden (Andersson et al., 2005), and in Central and Eastern Europe (Myrttinen, 2003). Marginal regions of the former military training areas are analysed relatively frequently. Several papers focus on their prospects of development (Seidl and Chromý, 2010), ecological value and land-use patterns (Havlíček et al., 2018), or local community perception (Frantál et al., 2020).

While papers dealing with the geographical or regional aspects of demilitarisation are relatively numerous, there are very few studies focusing directly on the geographical (or even regional economic) factors leading to the MBs closures. Beaulier et al. (2011) is a notable exception, documenting that the MBs in high unemployment U.S. states were less likely to be put on the list of MBs considered for closure. On the other hand, MBs in high unemployment counties were more likely to be closed. While there are several research contributions dealing with the factors of MBs closures in the USA, empirical evidence from Central and Eastern Europe (CEE) is rare (with some exceptions, such as Hercik, 2016). Therefore, we aimed to fill this gap and focused not on regional economic effects of MB

Title	Topic	Country	Period	Findings
Atkinson 1993	regional economic effects of MB closures	USA	1988–1991	Defence spending is spatially highly concentrated. Defence cuts occurred mostly in metropolitan/high-tech regions and did not harm local economies significantly.
Lovering 1991; Bishop and Wiseman 1999	geography of the defence industry	UK	1979–1992	North-South division of labour; strategic functions, hi-tech and RandD mostly in the South.
Warf 1997	geopolitics/geoeconomics of MB closures	USA	1988–1993	Employment multipliers of civilian activities are likely to be higher than MB-related expenditures. Communities resist MB closures. Rural regions are more vulnerable to MB closures.
Hooker and Knettter 1999	local employment and income effects of MB closures	USA	1971–1994	Multipliers were mostly lower than 1; in the short-term direct job losses prevail; per capita income were little affected.
Myrttinen 2003	regional economic, social and environmental impacts of MB closures	CEE	1989–2003	Direct negative socio-economic effects of MBs closure in CEE were weaker compared to WE due to higher self-sufficiency of MBs in CEE. Job losses were less important for the decision about the MBs closure compared to WE.
Andersson et al. 2005	local economic effects of MB closures	Sweden	1983-1998	MBs closure had no significant impact on the income growth/migration rate in the affected municipalities.
Bernauer et al. 2009	regional economic effects of the defence spending	Switzerland	1975–2003	The military keeps the cantonal unemployment low and stable.
Seidl and Chromý 2010	integration of a military training area into the regional system	Czech Republic	1991–2008	The former military training areas require a specific approach to stimulate their economic growth.
Paloyo et al. 2010	regional economic effects of MB closures	Germany	2003–2007	No significant negative socio-economic effects of the MBs closures on surrounding communities; centralised provision of German MBs reduces their local integration.
Beaulier et al. 2011	factors of MBs closures	USA	2005 BRAC round	No significant political effects; MBs in high unemployment states were less likely considered for the closure; but MBs in counties with high unemployment were more likely; size and type of MBs mattered; large MBs were more protected.
Hultquist and Petras 2012	local economic effects of MB closures	USA	1977–2005	A significant positive association between the MB and county employment, not significant in neighbouring countries.
Hercik et al. 2016	geographical aspects of the demilitarisation in the Czech Republic	Czech Republic	1989–2015	Spatial concentration of MBs into large cities; more equal spatial distribution compared to early 1990s.
Lee 2018	regional economic effects of MB closures	USA	2005–2011	Employment/income spillover effects from the military sector to the local economy are relatively small.
Deng and Sun 2017	domestic political determinants of military spending	95 countries	1989–2011	Local elections affect negatively military spending at the national level.
Zullo and Liu 2017	regional economic recovery after the defence industry reallocation	USA	1988–2005	Large defence firms are more protected than smaller firms; urban, economically growing and diverse regions recover more successfully.
Havlíček et al. 2018	land-use development in a military training area	Czech Republic	1837–2014	Military areas are characterised by a higher share of forest/grassland cover; after the withdrawal of the military, the land-use patterns converge to the non-military areas.
Nickelsburg 2019	factors of MBs closures; regional economic recovery	USA	1991–1999	Population, economic structure, accessibility and type of the base did not affect MBs closure.
Frantál et al. 2020	transformation of the military training area	Czech Republic	2016	Problems with the transformation are perceived more by older, highly educated people, those living in small municipalities or municipalities located close to the military training area.

Tab. 1: Selected papers dealing with the geography of demilitarisation. Source: authors' survey and conceptualisation

closures, but on the reverse relationship: regional economic disparities and policies as a predictor of MB closures in the Czech Republic.

In general, decisions to close or not to close an MB are determined by factors operating at three different geographical scales: (i) local (individual MBs); (ii) regional (district) level; and at the (iii) national level (Beaulier, Hall and Lynch, 2011).

All three factors are naturally shaped by prospects of developments in the international situation (geopolitics). Decisions taken at the local level may be determined more by (inter)national factors than by the condition of individual military bases. Hereinafter, we describe briefly crucial factors that are characteristic for different scales. We consider only variables that might be relevant for the demilitarisation of the Czech territory; also, not all issues discussed in the theories framing the papers presented in Table 1 are included (e.g. prospects of naval or nuclear bases).

At the national level, two principal factors shaping regional patterns of demilitarisation also at lower hierarchical levels, can be distinguished: geostrategic priorities and the restructuring of the military. Changing geostrategic priorities (often resulting from geopolitical changes at the international level) should be theoretically the most significant factor of MB closures and downsizing, because they reflect military interests embodied in operational planning, in fact. The end of the Cold War in the early 1990s was so potent that it resulted not only in a reduction of defence spending but to some extent reduction and reallocation of MBs in the U.S. (Atkinson, 1993), in Western Europe (Lovering, 1991), in the UK (Bishop and Gripaios, 1995), in the CEE (Hercik, Szcyrba and Fňukal, 2011; Hercik, 2016; Kiss, 1993; 2000; Smith, 1994) and in the Community of Independent States (the former Soviet Union). From the Czech point of view, the concentration of troops close to the border with the Federal Republic of Germany was neither necessary nor sustainable after the collapse of socialism. Therefore, the initial level of militarisation can be an important predictor of MB closures.

Changes in geostrategic orientation were usually followed by the restructuring of the military. Fundamental changes are evident, such as the reduction of offensive military capabilities, e.g. supersonic bombers, tank divisions, heavy artillery, etc., development of expeditionary military capabilities needed for peacekeeping, a curb on conscription, and a shift to AVF (All-Volunteer Force) made some military bases redundant or too costly (Warf, 1997; Paloyo, Vance and Vorell, 2010). The type of a military base affects the probability of its closure or downsizing (Beaulier, Hall and Lynch, 2011). According to this paradigm – in the context of the Czech Republic – heavily mechanised (and their support) units, (i.e. artillery, tanks, heavy infantry, etc.) should be closed or downsized more likely than other types of MBs, because they were over-represented in the Cold-war Czechoslovak People's Army due to the tasks given to Czechoslovakia in the Warsaw Treaty Organization (Dvorak and Pernica, 2021).

At the regional (district) level, demographic and socio-economic variables come into play: urban size, regional economic performance, unemployment, and the initial level of militarisation. The MBs tend to concentrate in large cities (Atkinson, 1993) due to the residential preferences of their employees and to capitalise on urbanisation economies related to urban size/density, such as the availability of a skilled labour force and a dense network of suppliers. Atkinson (1993) documented a shift of defence spending in the U.S.: from the industrial Midwest towards New England and California. This shift was to large extent technologically driven: an increasing share of electronics and other high-tech instruments and components in the weapon systems supported concentration of defence spending in economically growing metropolitan regions, where those high-tech suppliers were located. Similar trends (North-South shift) were documented in the United Kingdom (Bishop and Wiseman, 1999). On the other hand, military bases in or close to large cities may be less protected, because larger cities are more able to absorb unemployment resulting from closures and productively reuse former military land and buildings (Zullo and Lu, 2017).

To some extent, regional patterns of demilitarisation may be shaped significantly by regional policies. Districts with high unemployment rates and low wage levels should be protected from a large-scale military base closure or downsizing to avoid social and political tensions. Another reason for the protection of military bases in high unemployment districts is the local labour market: possibilities for military recruitment are better than in economically well-performing areas (Bäckström, 2019). Also, the operation of military installations in peripheral or economically stagnating regions with low per capita incomes and low costs of living can be cheaper than in higher cost locations (Wheeler, 2016).

On the other hand, in economically well-performing regions with expanding real estate markets, there is a better chance to sell the military property and a higher probability of a successful revitalisation of military brownfields. Last but not least, the quality of life associated with urban amenities and environmental attributes is also important for the successful operation of military installations, and is one of the selection criteria for military base closure or realignment (Rašek, 2002; Wheeler, 2016). Therefore, some peripheral, rural or old industrial regions may be threatened by a military base closure more than economically well-performing (urban, metropolitan) regions promising higher standards of living (Bradshaw, 1999; Fortuna, Teixeira and Silva, 2021).

Districts with a high initial level of militarisation at the beginning of the restructuring period may have excessive military capacities that need to be downsized. On the other hand, political representatives of the districts most dependent on military bases may support military spending at the national level (suggested by the Military-Industrial Complex Theory: Cobb, 1969, 1976; Lindsay, 1991) and prevent military bases closures in their electoral districts (Frawley, 2006).

At the local level, four basic factors related to the characteristics of a military base may be distinguished: size, age, location (at the local level), and position of the military base in the hierarchy of the Czech Armed Forces (see Tab. 2).

Size should negatively affect the probability of a military base closure (Beaulier, Hall and Lynch, 2011) for two reasons: (i) scale economies associated with the operation of larger military bases, smaller bases may not be able to operate efficiently; and (ii) higher exit sunk costs that make the closure of large bases too expensive (see Clark and Wrigley, 1997; Melachroinos and Spence, 2001 for the conceptualisation of sunk costs).

The latter is related not only to the size but also to the age and location of the military base (Wheeler, 2016). Older military bases in worse technical conditions with obsolete

Level	Factors	Mechanisms	Hypothesised relationship
National	Geostrategic priorities	The concentration of military forces close to the border with Western Germany is no longer necessary and sustainable after the end of the Cold War.	Proximity to Western Germany positively affects the intensity of demilitarisation.
	Restructuring of the Army	Restructuring of the Army (focus on military missions in developing countries, professionalization) makes some military bases strategically redundant or fiscally burdensome.[5,10] Type of a military base affects the probability of its closure or downsizing.[2]	Artillery/tanks/armoured units are more likely to be disbanded or downsized than other types of military units.
Regional (district)	Unemployment/wages	Districts with high unemployment rates and low wage levels should be protected from large-scale military base closures or downsizing to avoid social and political tensions. In districts with higher unemployment, there are also better possibilities for military recruitment.[9] In economically well-performing regions with expanding real estate markets there is a better chance to sell the military property and a higher probability of a successful revitalisation of military brownfields.	The regional unemployment rate negatively affects demilitarisation.
			Regional wage level positively affects demilitarisation.
	The initial level of militarisation	Districts with a high initial level of militarisation at the beginning of the restructuring period may have excessive military capacities that need to be downsized. On the other hand, political representatives of the districts most dependent on military bases may support military spending at the national level[7] and impede military bases closure in their electoral districts.[4,5,8]	The initial level of militarisation affects the intensity of demilitarisation either positively (reduction of excessive capacities) or negatively (parochialism of political representatives).
	Urban size	Military bases tend to concentrate on large cities[11] due to residential preferences of their employees and/or to capitalise on urbanisation economies related to urban size/density such as the availability of skilled labour force and dense network of suppliers.	City size negatively affects the intensity of demilitarisation.
Local/military base	Size	Higher exit sunk-costs1 and scale economies associated with the operation of large military bases lower their probability of closure.[2]	The size of military bases negatively affects the probability of the military base closure.
	Age	Older military bases with obsolete equipment can be closed more easily than modern military bases (lower exit sunk-costs), they also may have higher maintenance costs[5] and require substantial resources (entry sunk-costs) for adapting to new technologies, standards, and legislation.[6]	The age of the military bases positively affects the probability of their closure.
	Location (at the local level)	The government may protect isolated bases located in sparsely populated areas because their potential conversion, revitalisation, and civil reuse are difficult. OR Government may protect military bases located in the built-up areas of municipalities[3] to prevent negative socio-economic consequences of their closures.	Military bases outside the built-up area are more likely to be closed or downsized.
	Hierarchy	Lack of command-and-control functions makes closure easier: the military base has very limited competencies to influence the decision-making process.	Military bases with a lower share of colonels are more likely to be closed or downsized.

Tab. 2: Factors and mechanisms of military base closure at various geographical scales
Sources: authors' survey and conceptualisation: [1]see Clark and Wrigley, 1997; Melachroinos and Spence, 2001, for conceptualisation of sunk-costs; [2]Beaulier, Hall and Lynch, 2011; [3]Rašek, 2002; [4]Whicker and Giannatasio, 1996; [5]Warf, 1997; [6]Camerin and Gastaldi, 2018; [7]Cobb, 1969, 1976; [8]Lindsay, 1991; [9]Frawley, 2006; [10]Bäckström, 2019; [11]Paloyo, Vance and Vorell, 2010; [12]Atkinson, 1993

equipment can be closed more easily than modern military bases, without incurring high exit sunk costs. They also may have higher maintenance costs (Warf, 1997; Wheeler, 2016) and may require substantial resources (entry sunk costs) for adapting to new technologies, standards, and legislation (Camerin and Gastaldi, 2018). Bases located in the built-up areas of cities or municipalities can be protected from closure (Rašek, 2002) to prevent negative social and economic phenomena associated with potential brownfield formation to occur. On the other hand, military bases located in isolated areas are more difficult to sell and convert for civilian purposes. The effect of location is thus not straightforward. The position of a military base (or a unit) in the hierarchy of the Czech Armed Forces matters for its prospects of survival. Bases concentrating command and control functions should be less susceptible to closure or downsizing, while bases lacking these functions can hardly control their fate.

Considering a more general approach, public choice theory (Olson, 1971) offers a theoretical framework that might be useful for an explanation of general patterns and individual decisions whether to close a military base or not. His classical argument, as applied to the issue of MB closures, says that a reform aiming to change a system of dispersed (military) costs and concentrated benefits (local employment, multiplier effects of an MB) will fail (Beaulier et al., 2011). Parochialism and/or rent-seeking behaviour (Kehl, 2003) of the interest groups at local, regional or national level (municipalities, deputies, corporations in the defence sector, etc.) benefitting from the local MB, will resist any reform of the military complex at a national level that would at the end lead to more dispersed benefits and (spatially) concentrated costs. Our research is thus informed by public choice theory, but we are unable to operationalise and test this theory. To do so, an inquiry into the decision-making process would be necessary to validate the findings and assumptions based on the spatial analysis.

3. Context, data, and methods

In this prospect, demilitarisation in the CEE region can be divided into three periods. The first one, the early post-Cold War period, was associated with a peacetime dividend defined as a reduction of manpower and equipment to meet the CFE ceilings by 1995 (Sadykiewicz, 1987). The second period was driven by relief of the geopolitical situation in response to a reduction of Russian influence over the CEE region in the 1990s and NATO enlargement in 1999 (McCausland, 1999). The third period was characterised by an unfailing demand for military volunteers deployable in UN peacekeeping in the 1990s. The demand grows stronger after the 9/11 attack and the NATO deployment in Iraq and Afghanistan (Edmunds, 2006). So, many NATO countries opted for small AVFs. If compared with the Cold War situation, since 2001 the military has shifted towards forces composed of professional soldiers sourced by light equipment and integrated with the military that induce almost no reserves for a case of conventional war (Edmunds, 2006). Simply, the ‘Global War on Terror’ has boosted the transition from the high intensity conventional combat-oriented armies based on mass conscription – to light, small and professional AVFs.

As highly militarised frontline states, the Czech Republic (as part of the former Czechoslovakia) and East (and West) Germany enjoyed a unique position in this transition. Yet, the situation of the Czech Republic was more specific. Three major features characterised the Czech military in the first half of the 1990s, after the peaceful split of Czechoslovakia and the withdrawal of roughly 85,000 Soviet troops in 1991:

i. Excessive military capacities in terms of military employment, bases, infrastructure, weapons and arms manufacturing capacities;
ii. An unsuitable structure of the army – a high share of tanks, artillery and heavily mechanised units, and
iii. The high spatial concentration of the military bases and troops along the border with the former West Germany (see Fig. 1).

The changing geopolitical and geo-economic nexus required a significant reduction, restructuring and reallocation of the army and the military complex. Military downsizing was driven also by the discarding of obsolete Soviet weaponry and partly by a general unwillingness of the Czech government to spend more on defence. As Figure 2 illustrates, the investigated period (1994–2005) covers the years of intensive demilitarisation. The reason why we prefer to start our investigation in 1994 is that the rather abrupt dissolution of Czechoslovakia (1993) led to a dramatic process of the relocations of military units (and equipment) during late 1992 and early 1993.

Apart from the geostrategic and operational factors, the decisions about the MB closures were also driven by domestic political and economic developments. Although the economic situation in the early transformation period was rather favourable (despite the downturn in 1990–1992) and absolute regional disparities in wages and unemployment remained low (Blažek, 1996; Tomeš, 1996), the situation started to deteriorate in the second half of the decade. In the period 1996–2000, the national unemployment rate increased from 3.5 to 8.8% and regional economic disparities grew rapidly (Blažek and Csank, 2007). In 2002 (when the plan to end conscription and to adopt an AVF was announced), there was a sharp polarity between the “successful” regions (metropolitan regions: see (Smetkowski, 2013), regional capitals and several non-metropolitan industrial regions that obtained a high amount of foreign direct investment (Ženka et al., 2015) and laggards with a high unemployment rate, represented by structurally affected old industrial regions and rural regions (Hampl and Müller, 2011; Baštová, Hubáčková and Frantál, 2011; Blažek and Csank, 2007).

Coincidentally, while the previous right-wing government did not see present or future regional economic (and social) disparities as a principal problem, the new social-democratic government ruling since 1998 had at least an ideologically different attitude. Thus, one wonders if this change in attitude has affected decisions, given the geographical aspect of army reform in the late 1990s and the early 2000s. In addition, the fact that the Czech Republic has not faced any serious security threat between 1993 and 2005 (Kříž, 2021) means that the economic factors should be more easily identified.

Apart from the theoretical arguments mentioned in the previous section, we considered several factors that might explain regional patterns of the 1994–2005 demilitarisation: (i) the initial level of militarisation in 1994; (ii) the geostrategic location of a military base; (iii) regional economic performance; (iv) position of the military bases in the organisational hierarchy of the Czech Armed Forces; (v) urban size; and (vi) type of region. Each factor was represented by just one quantitative indicator (regional economic performance by two indicators): all were calculated at the level of districts (former LAU2: local administrative units), not at the level of individual military bases.

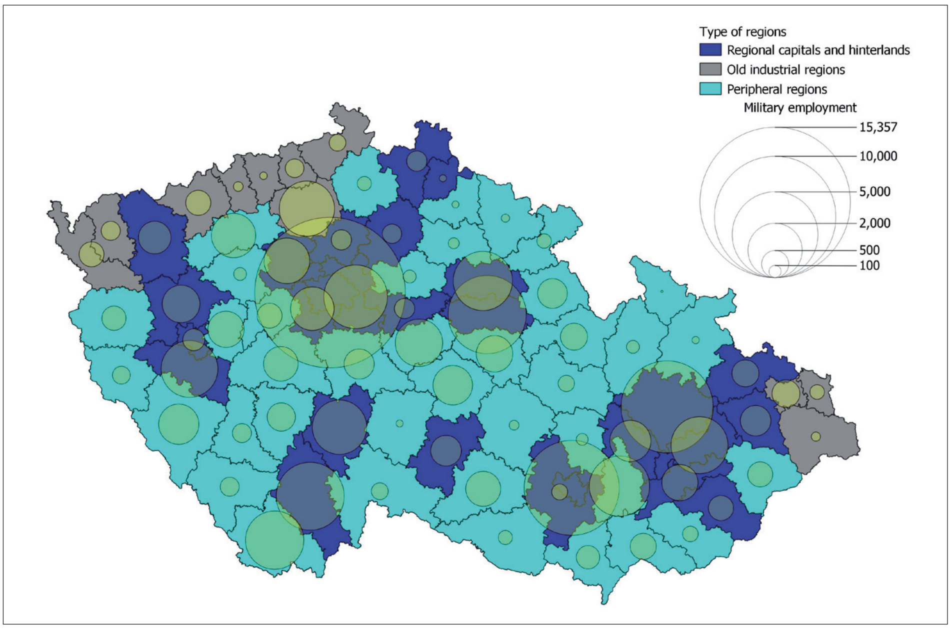

Fig. 1: Regional distribution of military employment in 1994
Source: Data: Ministry of Defence 2020; authors' elaboration

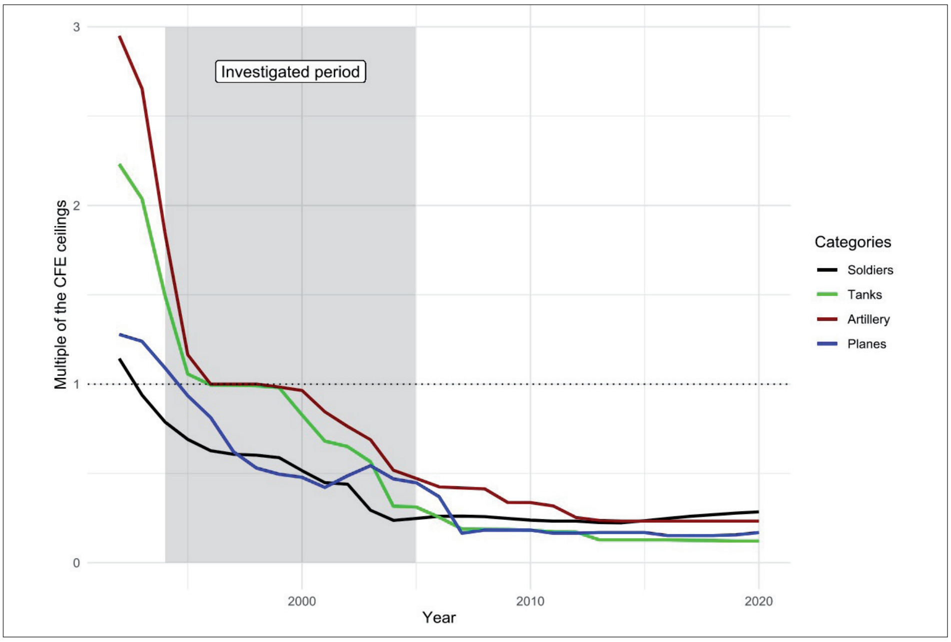

Fig. 2: Restructuring of the Czech army: military equipment as a multiple of the CFE ceilings and defence expenditures (CZK m.) on ground force and air force, 1992–2019 (Jan 1)
Source: Statistical Yearbook of the Czech Republic (1993–2020); Prague, Czech Statistical Office; Ministry of Defence, 2020; authors' compilation

The dependent variable: "Change in militarisation", was measured as the number of professional soldiers and civil employees in 2005 minus the number of professional soldiers and civil employees in 1994 in a district. The position of a military base in the hierarchy of the Czech Armed Forces is expressed as the number of generals and colonels. We also included the share of tanks, artillery, and/or armoured vehicle units in total military base staff to test the assumption that these military units were more likely downsized due to their excessive capacities in the 1990s.

The initial level of militarisation was measured by the number of professional soldiers and civil employees per capita in 1994 (see Tab. 3). This indicator is generally higher in sparsely populated peripheral regions than in large cities, ceteris paribus. Geo-strategic location can be operationalised by the distance of the military base from the border with former Western Germany. We used a simple proxy – the distance between the district town and the city of Nuremberg/Nürnberg in Bavaria.

Regional economic data (wages, unemployment) were obtained from the Appendix of (Hampl, 2005, p. 122–127). We tested not only the effects of regional wage and unemployment levels but also the type of region. A military base closure in peripheral, old industrial, and other economically lagging regions might have had severe socio-economic impacts on the local economy and social affairs. If regional policy was considered in the reorganisation of the Czech Armed Forces, wages should have had a positive and unemployment

Variable	Indicator	Abbrev.	Period	Data source
Change in militarisation	1994–2005 change in the number of professional soldiers and civil employees	Percapdif	1994–2005	MOD1, 1994; MOD2, 2005
Geostrategic location	Distance between the district town and Nuremberg[1]	DistNur	2018	The Time Now
Initial level of militarisation	Number of professional soldiers and civil employees per capita	X94percap	1994	MOD1, 1994; MOD2, 2005
Regional economic performance	Average monthly wages per employee (CZK)	Wages	1994	Hampl, 2005
	Unemployment rate (%)	Unemp	1994	Hampl, 2005
	Total annual wages per capita (CZK)	Econ_perform	1994	Hampl, 2005
Heavy units	Share of the tank, artillery, and armored vehicles units in the military base staff	Heavy units	1994	MOD1, 1994; MOD2, 2005
Organisational hierarchy	Share of generals and colonels in the military base staff	Colonels	1994	MOD1, 1994; MOD2, 2005
	Share of military officers in the military base staff	Officers	1994	MOD1, 1994; MOD2, 2005
Urban size	1 = metropolitan region; 0 = non-metropolitan region (binary variable)	Metro region	1991	Hampl, 2005
Type of region	1 = regional capital; 2 = old industrial region; 3 = peripheral region (nominal variable)	Type-region	1991–2005	Hampl, 2005; Ženka, Pavlík and Slach, 2017

Tab. 3: Indicators employed in the analysis of demilitarisation at the district level (Note: [1]Simplified proxy for the distance between the military bases and the Czech-West German border)
Source: authors' compilation

a negative statistical effect on the dependent variable. While peripheral regions were characterised by low wages and high unemployment, old industrial regions (specialised in mining, metallurgy, and chemistry, for example) exhibited high unemployment rates, but also relatively high wage levels that were inherited from the socialist era (reflecting a strategic and ideological preference of mining and heavy manufacturing), For this reason we tested the effects of both wages and unemployment. In addition, peripheral and old industrial regions provide generally lower quality of life, amenities, and the potential of realignment. Therefore, it makes sense to focus not only on economic indicators but also on regional contexts.

The variable "urban size" may affect the regional level of militarisation in several ways. Firstly, military bases in large cities benefit from various mechanisms related to urbanisation economies (see Parr, 2002 for conceptualisation): large diversified labour markets and universities providing a plethora of skills relevant for the military, access to developed technical and transport infrastructure, or a broad variety of suppliers. Secondly, the residential attractiveness of large cities providing urban amenities for (potential) professional soldiers and civil employees may protect local military bases from closure. While these first two factors favour the survival of military bases in metropolitan regions, the third – the real estate market – may work against it. High property values and demand in large cities lower sunk costs associated with the military base closure and increase the probability of successful military brownfield regeneration. The variable 'urban size' is represented by a simple binary indicator that distinguishes between metropolitan and non-metropolitan regions (based on the regionalisation by Hampl, 2005).

The end of the Cold War, the collapse of the Soviet Union and the peaceful dissolution of the Warsaw Treaty Organisation resulted in radical changes in global geopolitics. These disruptions were most pronounced in the CEE theatre, which should have become a hot zone in a hypothetical total war between the democratic West and the communist East. During the Cold War, both communist and democratic nations in the CEE stood at the very frontline and thus they fielded large armies and accumulated substantial stockpiles of military hardware (TMB, 1989). Their mass militaries became a burden, in particular, with the end of socialism and the start of economic transformation (Roaf et al., 2014). Thus, the post-cold war demilitarisation was driven both by the force of the CFE treaty (see McCausland, 1995) and by the transition cost of economic transformation of the communist polity.

4. Empirical results: the regression models

In the previous sections, we have identified four sets of factors possibly influencing regionally unequal demilitarisation of the Czech Republic (strategic, organisational, regional development, and urban factors). There are good reasons to think that these factors could have affected the process of demilitarisation and relocation of the Czech Armed Forces within the Czech territory. To test these hypotheses, we have employed OLS regression in univariate and multivariate settings.

Univariate analysis revealed that only a few of the tested factors correlate with demilitarisation (Tab. 3). Unsurprisingly the initial level of militarisation correlated most with our dependent variable. This variable alone explained roughly half of the variance on the dependent variable. Some other factors correlated too (distance to Nuremberg, share of officers, unemployment, metropolitan region), but their explanatory power was limited (see Tab. 4). In addition, heteroscedasticity was an issue among some of these variables.

In the next step, we ran several multivariate models, where the previous level of militarisation played the role of the central variable to which other potentially relevant variables were added (Tab. 5). The previous level of militarisation showed a very robust association with the dependent variable. Inclusion of any other variables does not significantly alter the slope, range of Robust Standard Errors (RSE) or p values. On the other hand, most of the other previously statistically significant variables changed their slope quite a lot and their RSE became wider. In addition, p-values rose well above 0.1. Only two variables – Metropol region and distance to Nuremberg showed some significance (above strict 0.05 thresholds but below the 0.1 – more benevolent – threshold). Even more importantly, the change in their slopes was only modest. This indicates that these variables might play a role, albeit modestly.

What is interesting is that several potentially relevant variables displayed either no or inconsistent effects. Specifically, neither wages nor unemployment played a role in more complex additive models. Another interesting null finding is that organisational factors did not play a role. One would expect, that either the share of officers or top-echelon officers (generals and colonels) could predict the level of demilitarisation. Finally, it is remarkable that demilitarisation was not more pronounced in districts with a higher share of tank, heavy mechanised, artillery or anti-aircraft units. These units were the cornerstone of the Cold War Czechoslovak Army. Nevertheless, the military utility of these units decreased with new security challenges. A focus on extra-regional operation after 2001 further reduced the need for heavy forces best suited for territorial defence. This is a paradox we will try to explain in a subsequent section, along with other key findings.

Given that 'Distance to Nuremberg' remained statistically significant even in more complex models and given its strong heteroscedasticity, we hypothesised that there might be an interaction effect between this variable and the initial level of militarisation. In such a setting, the initial level of militarisation would have been a conditioning variable affecting the effect of distance to Nuremberg (which sounds very plausible). Specifically, the interaction effect here would mean that the slope (magnitude of the effect) of the initial militarisation was stronger for regions closer to the ex-West-German border (see the red line in the Fig. 3) and weaker for regions far away from the border (see the blue line in Fig. 3).

The OLS regression with this interaction effect (see Tab. 6 and Fig. 3) provides support for this hypothesis. While there is a significant positive effect of the initial

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**	**Model 10**
(Intercept)	0.42***	0.42***	0.42***	0.42***	0.42***	0.42***	0.42***	0.42***	0.29**	0.42***
	(0.06)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.09)	(0.10)	(0.09)
X94percap	0.60***									
	(0.11)									
DistNur00		− 0.21**								
		(0.08)								
Heavy units			− 0.08							
			(0.08)							
Colonels.				− 0.04						
				(0.06)						
Officers					− 0.24*					
					(0.12)					
Econ. perform						0.08				
						(0.07)				
Unemp							− 0.18*			
							(0.08)			
Wages								0.19		
								(0.13)		
Metro_region									0.43*	
									(0.21)	
Type_region										− 0.20*
										(0.10)
Observations	77	77	77	77	77	77	77	77	77	77
R squared	0.58	0.07	0.01	0.00	0.09	0.01	0.05	0.06	0.06	0.07

Tab. 4: Univariate regression models (dependent variable: Change in militarisation)
*Notes: All continuous predictors are mean-centered and scaled by 1 standard deviation. Standard errors are heteroscedasticity robust; *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$*
Source: authors' computations

level of militarisation on the subsequent demilitarisation, the effect was stronger among west Bohemian regions and substantially weaker in the case of regions located further away from the former "line of East-West military competition". Firstly, the interaction effect is statistically significant, and it has better explanatory power than additive OLS regression models. RSE's and confidence intervals are quite narrow, further increasing our belief in the interaction effect. Second, when the interaction effect is used, then the variable "Metropol region" remains statistically significant. In sum, it seems that the interaction effect model captures quite well the structural factors affecting Czech demilitarisation between 1994 and 2005. The initial level of militarisation interacting with the east-west gradient and the (metropolitan) character of a region provides a relatively good explanation (Fig. 3).

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9
(Intercept)	0.42***	0.42***	0.42***	0.42***	0.34***	0.42***	0.35***	0.35 **	0.34***
	(0.06)	(0.06)	(0.06)	(0.06)	(0.09)	(0.06)	(0.09)	(0.09)	(0.09)
X94percap	0.56***	0.58***	0.59***	0.59***	0.59***	0.59***	0.57***	0.56***	0.56***
	(0.12)	(0.11)	(0.12)	(0.11)	(0.11)	(0.12)	(0.11)	(0.12)	(0.12)
DistNur00	− 0.11	− 0.10					− 0.10	− 0.10	− 0.08
	(0.06)	(0.06)					(0.05)	(0.06)	(0.05)
Officers	− 0.05		− 0,03					− 0.03	
	(0.07)		(0.06)					(0.06)	
Unemp				− 0.06					− 0.05
				(0.06)					(0.06)
Metro region					0.24		0.23	0.22	0.25
					(0.12)		(0.12)	(0.12)	(0.13)
Type region						− 0.06			
						(0.08)			
Observations	77	77	77	77	77	77	77	77	77
R squared	0.59	0.59	0.58	0.58	0.60	0.58	0.61	0.61	0.61

Tab. 5: Multivariate regression models (dependent variable: Change in militarisation)
*Notes: All continuous predictors are mean-centered and scaled by 1 standard deviation. Standard errors are heteroscedasticity robust; *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. Standard errors are in parentheses*
Source: authors' computations

	Model 1	Model 2	Model 3	Model 4	Model 5
(Intercept)	0.36***	0.30***	0.36***	0.36***	0.30***
	(0.06)	(0.08)	(0.06)	(0.06)	(0.08)
X94percap	0.54***	0.52***	0.54***	0.53***	0.52***
	(0.08)	(0.08)	(0.08)	(0.09)	(0.08)
DistNur00	− 0.14**	− 0.14**	− 0.14*	− 0.14**	− 0.14**
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
X94percap:Dist-Nur00	− 0.29***	− 0.28***	− 0.29***	− 0.28***	− 0.28***
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Metro_region		0.22*			0.22*
		(0.10)			(0.10)
Unemp			− 0.02		
			(0.06)		
Officers				− 0.03	− 0.01
				(0.05)	(0.05)
Observations	77	77	77	77	77
R squared	0.69	0.71	0.69	0.69	0.71

Tab. 6: Multivariate regression models with interactions (dependent variable: Change in militarisation)
*Notes: Standard errors are in parentheses. All continuous predictors are mean-centered and scaled by 1 standard deviation. Standard errors are heteroscedasticity robust; *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$*
Source: authors' computations

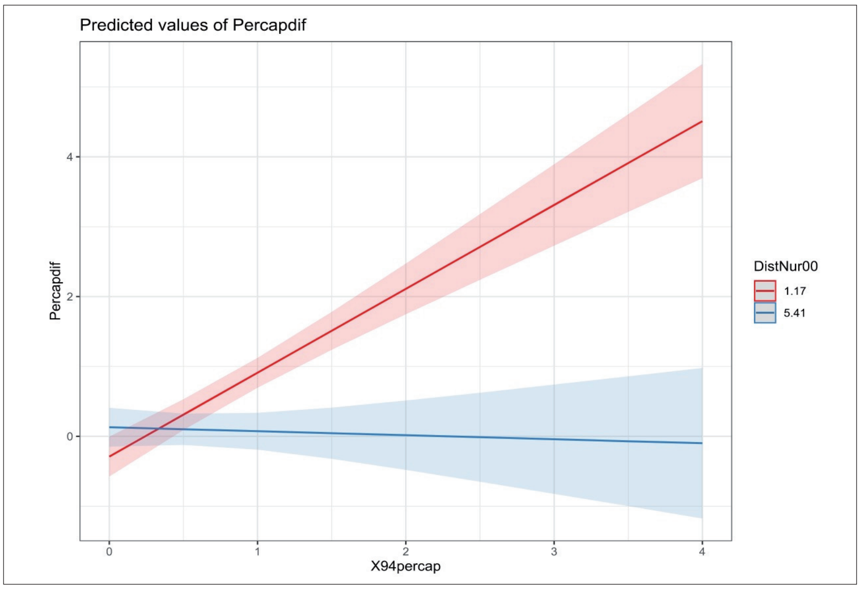

Fig. 3: Interaction effect of the Initial level of militarisation and the Distance from Nuremberg on the Change in militarisation. Notes: Percapdif = 1994–2005 change in military employment; X94percap = military employment in 1994 per capita (district); SD indicates the standard deviation of a district´s distance to Nuremberg (DistNur00)
Source: authors' computations

While this model performs well in the sense of R^2, p values and other model fit statistics, we understand that we are dealing with the population, not with a sample. Therefore, we decided to run bootstrapping (an iterated random selection of subsamples). Bootstrapping confirmed the robustness of our interaction model. Thus, we can conclude that our model is not driven by a few outliers. Speaking about specific cases, we focused on the cases deviating from the model: cases with high residuals. We also present basic changes in regional patterns of demilitarisation in the period 1994–2005.

Several high residual cases can be split into two groups. The first one includes cases that experienced rather a militarisation than demilitarisation or where the demilitarisation was surprisingly small. The other group comprises cases with unexpectedly high demilitarisation. The first group is to a large extent a by-product of its rarity. Only very few districts experienced militarisation between 1994 and 2005 (Fig. 4).

Thus, our OLS model (unsurprisingly) struggles with cases running counter the general tendency. Kutná Hora (the most deviant case) is an example here. During the Cold War, it was rather an unimportant district with a military airfield (Čáslav). Čáslav airport, however, has after several reforms become the location of one of the two major airbases of the Czech Air Force. It seems that the decision to locate a significant part of the air force at Čáslav was driven by its central location and advantageous weather conditions.

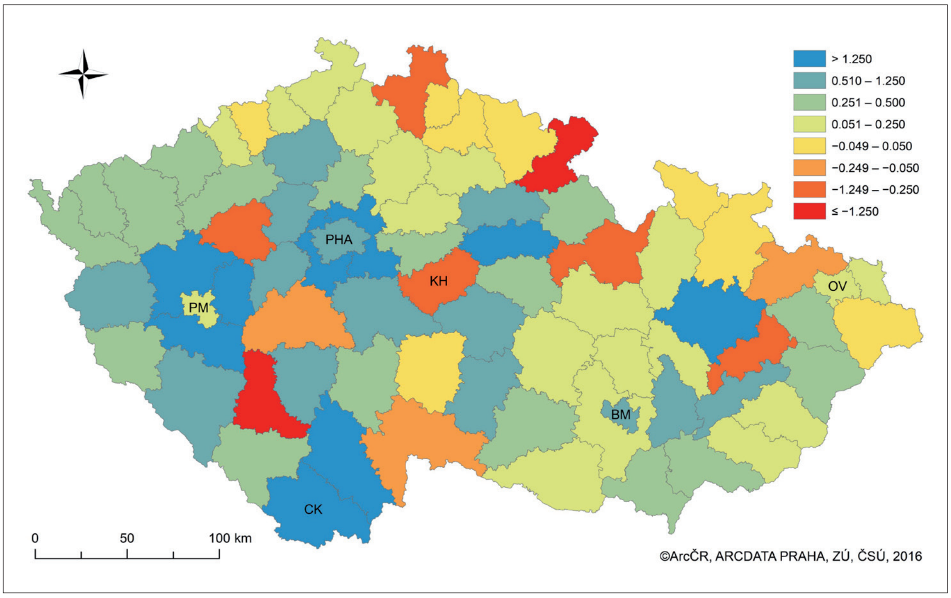

Fig. 4: Regional patterns of military employment reduction (1994–2005): relative changes. Notes: The map shows 1994 military employment divided by 2005 military employment. Blue districts showed the most rapid reduction of military employment, while in red districts military employment increased; PHA = Praha/Prague; BM = Brno; OV = Ostrava; PM = Plzeň/Pilsen; CK = Český Krumlov; KH = Kutná Hora.
Source: authors' compilation

From the perspective of validity of our model, the second group of deviant cases is even more interesting. The most substantial positive residual pertains to Český Krumlov (peripheral district close to the Austrian border). This district had several hundred DoD employees in 1994, but in 2004 it had almost none (Fig. 5). Such a large demilitarisation is unique. The case has, however, a prosaic explanation. Due its vicinity to the military training area Boletice, Český Krumlov served as a place for the training of units for international UN missions in the 1990s. Furthermore, this ad hoc arrangement created units that were formally located in Český Krumlov. While most other battalions were built around the conscripts (officially not employees of the Ministry of Defence), units for UN missions were fully manned with professional soldiers or paid volunteers. Thus, in the mid-1990s, this district was nominally among the most militarised regions in the Czech Republic. With the accession to NATO and the shift to an All-Volunteer Force, the need for ad hoc solutions and the Český Krumlov base withered away; only the military training area remained. From this perspective, the unique role of Český Krumlov in the 1990s logically led to the closure of the local military base.

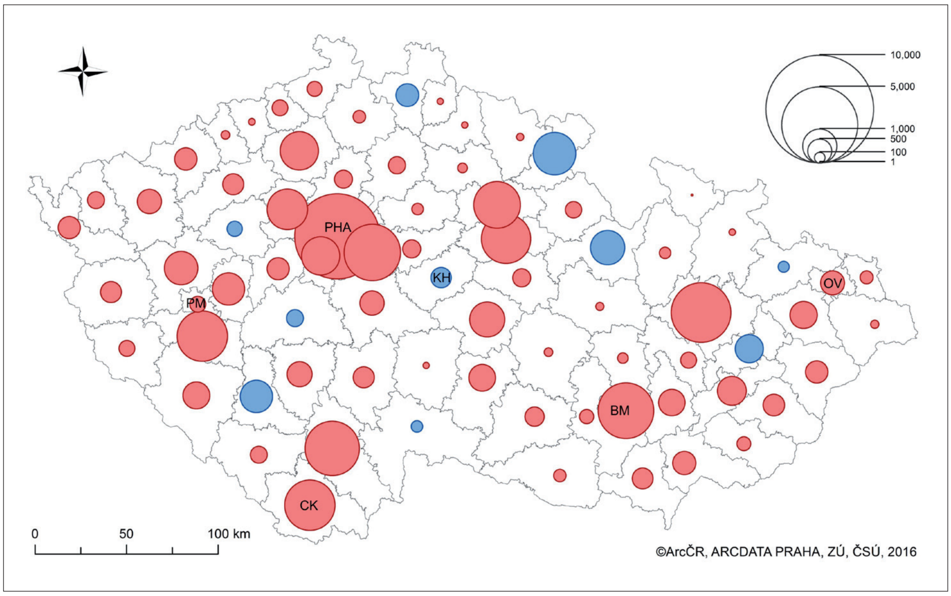

Fig. 5: Regional patterns of military employment reduction (1994–2005): absolute numbers. Notes: The map shows the difference between the cancelled military jobs and newly created jobs. Red figures mark districts with an overall decrease of military jobs between 1994 and 2005, blue districts experienced an overall increase of military jobs. PHA = Praha/Prague; BM = Brno; OV = Ostrava; PM = Plzeň/Pilsen; CK = Český Krumlov; KH = Kutná Hora
Source: authors' compilation

Deviant cases can thus be mostly explained by contextual and contingent factors, such that they do not contest the validity of the model. On a general plane, it seems that while there was a clear pattern in reducing certain bases and units, it is less clear why certain units and bases have survived until today.

5. Discussion

Our basic empirical results are consistent with the comprehensive study of geographical aspects of demilitarisation in the Czech Republic provided by Hercik (2016). Hercik documented a gradual significant spatial concentration of military bases into the largest cities, an overall reduction of military functions in space, but also the growth of military employment in municipalities with less than 1,000 inhabitants in the military training areas located in highly peripheral areas (Frantál et al., 2020). As he stated:

> "Between 1993 and 2015, the number of military bases decreased from 158 to 25. A total of 105 crews were completely abandoned, which represents 79% of all military bases affected by relocation changes and 66% of all military bases in which the Czech Army was deployed at the time of its establishment. Approximately half of them were concentrated in the western third of the Czech Republic. In terms of the size structure of municipalities, more than 50% of closed military bases were located in municipalities with less than 10,000 inhabitants" (Hercik, 2016, p. 82).

He also documented the increasing median population size of municipalities with military bases, the increasing average size of military bases, and the concentration of command-and-control functions in the capital city of Prague.

> "If in 1990 there were a total of 9 divisions and 27 brigades within the ground forces, in 2014 the Army of the Czech Republic no longer had any divisions. Only two brigades operated in the organisation of the ground troops (Hranice and Žatec)" (Hercik, 2016, p. 83).

Our empirical results suggest that the military base closure/downsizing between 1994 and 2005 was highly erratic. It was not uncommon that relatively new or modernised military bases were closed, while the obsolete/inconvenient military bases were maintained. This explanation might be valid for the lack of an association between the hierarchy and demilitarisation.

More surprisingly, although the tanks, artillery, and armoured vehicles were reduced more than other units, the share of mechanised units of soldiers within districts showed no statistical effect on demilitarisation at the level of districts. This paradox can be explained by the relatively small number (19) of districts, where these heavy units were located in 1994. Only in six districts was the share of heavy units in total military personnel higher than 50%. Also, heavily mechanised units (mostly tanks) are less "labour-intensive" and were based on conscripts rather than professional soldiers. Therefore, net employment loss resulting from closing military bases with mechanised units was limited. Finally, except for a few airborne and special forces battalions, almost all combat units were heavily mechanised. Instead of disbanding these units as a bloc, only part of them was disbanded, some were transformed into lighter units and a few continued as heavily mechanised units.

If we turn to the regional level, 'urban size' showed a positive effect on the intensity of demilitarisation in the Czech Republic. Nevertheless, there was probably no systematic regional policy behind it. The concentration of military bases into the largest cities (see Atkinson, 1993, for a similar trend in the USA) was rather driven by the strategic reorientation of the Czech Armed Forces associated with entry to NATO, by economic reasons favouring the spatial concentration of the defence sector in general (see Droff, Baumont and Barra, 2019 for the theory), and perhaps also by residential preferences (quality of life) of the commanders and soldiers (Rašek, 2002; Wheeler, 2016). On the other hand, many military bases were closed in large metropolitan areas to gain economic profits from the sale of lucrative real estate. Thus, regional aspects probably affected the military base closures primarily through ad-hoc lobbying of the deputies, mayors, or local commanders (these aspects are beyond the scope of this paper, however).

Maybe the most significant finding is that of no statistical relationship between regional economic performance (wages, unemployment) and demilitarisation. Correspondingly, the type of region (regional capital, old industrial, peripheral) played no role either. Military bases in economically lagging regions were protected neither to avoid social tensions nor to lower operating costs. While there were several isolated attempts to protect selected military bases in lagging regions, we failed to find any conclusive empirical evidence of regional policies preventing the demilitarisation in districts with low wages and high unemployment. This contrasts with the findings from the USA (Beaulier, Hall and Lynch, 2011) that military bases in high unemployment states were protected, while military bases in high unemployment (probably mostly rural) counties were more likely to be placed on the BRAC (Base Realignment and Closure) list.

While our aim was not to test specifically the effect of military base closure on regional (un)employment, no significant stabilisation effect of military presence on regional unemployment has been recorded: in contrast with the findings of Bernauer, Koubi and Ernst (2009) from Switzerland. Rather, our observations are closer to the findings of Paloyo, Vance and Vorell (2010) from Germany or Andersson et al. (2005) from Sweden, who both failed to find significant negative regional economic effects of military bases closures in their countries. In the Czech Republic, relatively low unemployment until the second half of the 1990s and a spatial mismatch between the 1990s regional unemployment growth and military base closure, may be other reasons as to why regional disparities did not affect the process of demilitarisation significantly.

By far the most important factor of demilitarisation was the combination of the initial level of militarisation (1994) and the distance from Nuremberg. Therefore, geostrategic reorientation and professionalisation of the military affected regional patterns of military base closure more than other processes. The reduction of excessive military bases mostly in the western part of the state and in metropolitan regions eclipsed the effects of other factors. We did not identify any systematic longer-term spatial change of defence prioritisation towards economically rapidly growing regions with high-tech industries that would be comparable to the Frostbelt-Sunbelt shift in the USA (Warf, 1997) or to the north-south shift in the UK (Lovering, 1991; Bishop and Gripaios, 1995; Bishop and Wiseman, 1999). In the Czech Republic, the shift from the Western part of the country to a dispersed pattern of military bases was geopolitically driven.

Finally, there are significant limitations relating to such kind of research in the post-socialist environment. In comparison with western scholars, Czech researchers are dealing with a lack of well-structured open data. Czech political and military institutions do not usually provide more detailed data. Our research could employ the data covering the spatial distribution of MBs for 1994 and 2005 only. Although the decline of military employment in the period 1994–2005 was certainly not linear, we were unable to obtain the yearly data necessary for proper panel data regressions (see Popert and Herzog, 2003). Instead, we had to rely on the basic OLS models capturing only the 1994–2005 change in militarisation as the dependent variable.

Besides, we were also unable to estimate several important factors of the MBs closure/downsizing. Most importantly, no systematic data covering the financial value of military buildings and equipment are available. Therefore, it is possible neither to calculate precisely potential exit sunk costs associated with the MBs closure, nor to quantify exactly the share of modern or obsolete tangible assets/equipment and their usability for current or future military purposes. In addition, the aggregation of the military data at the district level may obscure any potential differences between the MBs inside the district.

These limitations notwithstanding, an equally important issue deals with the generalisability of our main findings. In this respect, our study deals with a rather unique period marked by profound geopolitical changes and extreme demilitarisation. Current European trends in demilitarisation or militarisation, however, cannot be compared to the scale of changes we have investigated. As such our study may be generalisable to other CE countries in the 1990s and early 2000s but we warn against generalisations to the current decade or other world regions. The point is not to say that our findings have no bearing outside of the early post-cold war context, rather the point is to highlight that we have investigated an extreme case. Future studies should focus on current cases to provide a more nuanced picture of the key factors of demilitarisation (or remilitarisation) and their contextual significance.

6. Conclusions

While the studies dealing with regional economic impacts of military base closures are numerous, few authors focused on the question of to what extent regional economic disparities affect the process of military base closure and realignment. Drawing on a case study of demilitarisation in the Czech Republic (a country that has experienced in the last three decades probably the sharpest decline in military staff in the world), we tried to capture the geographies of demilitarisation in this post-socialist country. More specifically, we aimed to explain changes (1994–2005) in the spatial distribution of military bases, reflecting the geostrategic reorientation (entry to the NATO), restructuring, and professionalisation of the Czech Armed Forces.

Three groups of factors were tested through the regression models: (i) local (military base) characteristics; (ii) regional (economic disparities, the initial level of militarisation in the district); and (iii) national-level factors (geostrategic priorities, restructuring of the Czech Armed Forces). National-level factors played a key role. When combined with the existing spatial distribution of excessive military bases inherited from the socialist era and disproportionately concentrated in the western part of the country close to the borders with Germany, they explained more than half of the variability of 1994–2005 military staff reduction.

Regional wage and unemployment disparities, on the other hand, showed no significant correlation with the intensity of military base closures/downsizing. We did not find sufficient empirical evidence that military bases in economically lagging peripheral and old industrial regions had been systematically protected. This does not mean that regional/municipal interests had no significance. Nevertheless, they affected the fate of several military bases probably through individual actions, lobbying of politicians and mayors, or through the connection of the restitution of land. Besides, the highly erratic character of military base closure and realignment in the Czech Republic can be another explanation for this missing association. The large-scale restructuring of the Czech Armed Forces together with fundamental changes in geostrategic orientation eclipsed the effects of regional economic factors and the position of the military bases in the organisational hierarchy of the Army.

'Urban size' was related to demilitarisation in two ways: (i) several military bases in large cities (especially in the capital city) were closed as a result of the rent-seeking behaviour of the politicians that profited from the sale and conversion of lucrative land; (ii) military staff, command, and control functions have been gradually concentrated into larger cities. Therefore, potential reuse was among the key factors of the military base closure, but individuals – not the Czech Armed Forces – profited from the sales of land.

While political factors significantly affected the military base closure, we found no systematic difference between the economically lagging old industrial and peripheral regions and the metropolitan and other economically growing regions at the pace of demilitarisation. This contrasts with the situation in the USA, where the lobbying of individual congressmen was partly reduced by the establishment of an independent committee that proposed a list of military bases suggested for closure, the congressmen voted for/against the entire list, with no possibility to add or delete any bases from it (Mayer, 1995; Whicker and Giannatasio, 1996). The absence of this mechanism in the Czech Republic together with an immature institutional environment and legislative framework in the 1990s provided too much space for individual rent-seeking behaviour and incompetent decisions. In contrast to the USA, the military in the Czech Republic plays a not so important role in politics. So, it is not worth lobbying for/against their presence in a particular region when there is not a hidden agenda, for instance, utilisation of real-estate left/run by the military.

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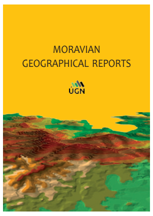

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The contribution of spatial interaction modelling to spatial history: The case of central places and their hinterlands in the territory of the Austro-Hungarian Empire

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Abstract

Research on spatial history can be enriched by using approaches from quantitative geography. We analyse an historical regional system and highlight three basic assumptions, building upon Christaller's central place theory: cities do not stand alone in space, they interact with their hinterlands, and they are hierarchically organised. We investigate the relative position of central places in space and define their hinterlands using a spatial interaction modelling approach. We present the example of functional regional taxonomy in past environments, which therefore has a higher degree of uncertainty in the results and in their interpretation. We use a variant of Reilly's model to define the functional regions in Austria-Hungary at the beginning and at the end of the 20th century. We present a possible interpretation of the model results based on the identification of the major factors responsible for developments in the urban and regional systems of Austria-Hungary over 100 years. We conclude that the development of urban and regional systems in the territory of the former Austria-Hungary was not considerably affected by the role of political-economic systems, the administrative organisation of states, nor by the different stages in economic development of its formerly constituent territories.

Keywords: *spatial interaction modelling, spatial history, central place theory, functional regional taxonomy, Austria-Hungary*

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1. Introduction

Research in spatial history includes a variety of issues, approaches, techniques and debates (Baker, 2003; Campbell, 2018; Ethington, 2007; Gregory and Geddes, 2014; Gregory et al., 2018; Jackle, 1971; Kingston, 2010; Rankin, 2020). Most authors agree that spatial history is at the intersection of history and geography, and that it highlights the role of geographic (recently, computer-based) information processing and visualisation. It is used to investigate the historical construction of space and relationships in space, in order to reveal new and more diverse meanings of historical events.

History *per se* and most of its research questions and problems cannot be separated from their spatial contexts, just as geography cannot be separated from its temporal context. In this paper, we address in general terms: (i) the past organisation of space in an historical study of urban and regional systems; (ii) the evolution of space over time; and (iii) the use of a specific methodology to accomplish our aim. The method of spatial interaction modelling, widely applied in the field of quantitative geography, enables us, apart from other things, to visualise the results in the form of a map. Spatial representations and temporal transformations of historical urban and regional systems may reveal further ways to interpret historical events and to complement standard forms of historical enquiry. Thus, the study of spatial issues can provide historians with a different view of the history of territories in general and enrich their perspectives on historical events.

In this paper we are concerned with cities and towns in a spatial and temporal context and with their roles in the organisation of space. To specify our general aim, we analyse central places and hinterlands which were part of the former Austro-Hungarian Empire. In fact, this is a study

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of functional regional taxonomy in the past environment. The analysis reveals the changes in the urban and regional systems of this territory through the 20th century, a period which saw rapid development in virtually every aspect of human life, and the organisation of space was no exception. The territory of (the former) Austria-Hungary is interesting in two primary aspects. First, it perfectly represents the relatively unstable and varied space and the turbulent history of what is widely accepted as Central Europe – the territory in between the large traditionally western European nation states and Russia. In this respect, Austria-Hungary can be seen as a conglomerate of various cultures, nationalities, and religions, all with quite different levels of economic development, social achievement and historically conditioned organisations of urban and regional systems. The Habsburg monarchy had managed to integrate and unite, relatively successfully, these varied states for almost 400 hundred years until its collapse at the end of World War I (Beller, 2018; Evans, 2004, 2020; Judson, 2016; Kann, 1974; Rumpler and Urbanitsch, 2010; Sked, 2013; Taylor, 1976). Second, no matter which paths of socio-economic and political development were taken by the successor states of the former Austro-Hungarian Empire, and regardless of the events and crises that have occurred over the last one hundred or more years, there are issues concerning the legacy of the Habsburg Monarchy, both in a positive and a negative sense (Abdelal, 2002; Cole, 2018; Judson, 2016, 2017; Kożuchowski, 2013; Miller and Moleron, 2018; Moos, 2016; Wheatly, 2019). Thus, overall, the territory of the former Austria-Hungary has remained a sensitive and diverse part of Europe up to now, even though its considerable area is now part of the European Union.

The remainder of the paper is organised as follows: The next section provides a reader with a basic theoretical background and explanation of our effort. The next section contains a general discussion concerning the issue of spatial interaction modelling and its uses, particularly in relation to tasks like ours. It is purposely conceived as a very concise introduction to the issue of spatial interaction modelling for non-geographers, and historians, in the form of the history of the approach. The methodological section specifies the data and the model used in this paper in the context of the territory and the time we are interested in. The penultimate section presents the results and illustrates how they can be assessed and interpreted. The concluding section returns to the question of the use of spatial interaction modelling in historical geographical problems, and some of the methodological advantages and limits of the specific model applied in our study are also outlined.

2. Theoretical background

While urban history is an extensive field of study in historiography (Buisseret, 1998; Ewen, 2016; Kenny and Madgin, 2015; Klautke, 2010; Rodger, 1992), it is mostly concerned with the history and development of cities and towns, including their spatial patterns and aspects (e.g. Rae, 2003). In terms of the contribution of quantitative geography to the field of spatial history, however, we emphasise three points not to be overlooked in this respect:

i. Each city does not stand alone – it is part of an urban system;
ii. Each city interacts not only with other cities, but also with its surroundings – cities serve as cores for regional systems; and
iii. Each city has a different absolute and relative importance in space – there is a hierarchy of cities.

These points are partially acknowledged for instance in the historiographical work of Careless (1979) on pre-1914 Canada, of Bácskai et al. (1980) on 1828 Hungary, of Cronon (1991), concerned with the mutual relationship between Chicago and the Great West region, of Lee (2005), who studied different hinterlands of the port-city of Bremen, of Krausmann (2013), who analysed Vienna's hinterland from the energy consumption point of view, and of Bernhardt (2019), who discussed the transformation of the urban hinterland of Berlin. More general views of cities and their surroundings are presented by Mohl (1998), Fields (1999), and Barles and Knoll (2019).

All three points, mutually constitutive, made in the preceding paragraph are, to a large extent, included in Christaller's Central Place Theory (Christaller, 1933). In brief, according to this theory, settlements (i.e. cities and towns) are so-called central places which provide services to their respective surrounding areas, their hinterlands. Actually, this is also the case of so-called functional regions (for details: see Klapka and Halás, 2016). Central places are hierarchically organised according to their size and functions, and the spatial extent of their hinterlands reflects the sizes of central places. Going beyond this traditional theory, we point out that while the 'absolute' importance of a central place can be easily expressed by its population, its 'relative' importance can provide us with much more information on the organisation of urban and regional systems. In order to assess the 'relative' position of central places and their role in space, we need information on the functional relationships in space that are at our disposal. The functional relationships between central places and between a central place and its hinterland are usually assessed through the analysis of spatial interactions (i.e. quantifiable movements of people, goods, etc.). In quantitative geography, spatial interactions are understood as vector data, with their origins and destinations in space (see e.g. Klapka and Halás, 2016).

This type of vector information has rarely or never been available concerning past environments and situations. Fortunately, geography has at its disposal a set of techniques that could be used for the objectives of the current paper: spatial interaction modelling (see next section). We consider whether and how spatial interaction modelling can provide us with some special insights into, and knowledge of, past geographical environments and their development, particularly with regard to the organisation of space. Thus, we present and highlight the possibility of employing a spatial interaction model which assesses the relative importance of central places within an urban system, and which defines the hinterlands of central places in order to construct a regional system. This approach also enables us to compare spatial patterns from different periods and to capture their evolution over time.

3. Spatial interaction modelling

Spatial interaction modelling has quite a long and rich tradition in the quantitative avenues of geographical research, and it can be used for many purposes of very different character (see for example: Clarke and Birkin, 2018; Fotheringham et al., 2000; Fotheringham and O'Kelly, 1989; Roy and Thill, 2004; Sen and Smith, 1995; Wilson, 2010). Spatial interaction modelling and central places are explicitly discussed by Batty, 1978, Fik and Mulligan, 1990, and

Openshaw and Veneris, 2003. In general, the most frequent applications attempt to explain and predict current and future spatial interactions (Fotheringham and O'Kelly, 1989), when 'real' (i.e. statistical) information on movements and contacts among places is not available for any reason (such as it is not recorded at all, or it does not cover the whole territory under consideration) and when the quality of the information is insufficient. This facet of such research can be related easily to the focus of this paper as defined in the introduction, when the analysis of past urban and regional systems is burdened with the lack of statistical information on spatial interactions.[1] Spatial interaction modelling is also a suitable tool for assessing the historical development of phenomena where real information is available only for some points in time.

3.1 Foundations

Spatial interactions are a consequence of the polarity of the Earth's surface and its distinct heterogeneity. Horizontal spatial interactions (also movements, flows, contacts), as the phenomena balancing the polarity, can be conditioned environmentally (atmospheric circulation, slope processes, etc.) based on natural laws, and socio-economically based on aggregated human behaviours in time-space. It is the latter case that encouraged extensive research into spatial interactions and their modelling in Human Geography. Behaviourally conditioned spatial interactions include various aggregations of individual, personal, material, product, financial and information movements, and contacts. Spatial interactions occur at various scales between various sections of the Earth's surface and a range of places (localities).

Several theoretical frameworks for spatial interaction modelling have been developed since its beginnings in the 19th century (Fotheringham et al., 2000). The first attempts built on simple Newtonian physical analogies (Carey, 1858; Ravenstein, 1885), which were later called demographic gravitation (Stewart, 1948). Human interaction behaviour was thought to follow the analogy of physical laws (hence also the term 'social physics') expressed for instance in the principle of the least effort (Zipf, 1949). Since the end of the 1960s, other physical analogies, based on the second law of thermodynamics (Wilson, 1967, 1970, 1974), the theory of movement (Alonso, 1978) and information theory (Plane, 1982; Snickars and Weibull, 1977), have formed the theoretical background for spatial interaction modelling. Wilson's approach using entropy maximisation, employing probability, and defining a so-called family of spatial interaction models (Wilson, 1971), is still one of the most important conceptual bases for spatial interaction modelling. More recent overviews include those by Wilson, 2010, 2018; Fotheringham and O'Kelly, 1989; Gordon, 2010; Pooler, 1994; Roy and Thill, 2004; Senior, 1979; Sheppard, 1978. Later criticism arose during the 1980s and pointed to the physicalist basis of the models, which was deemed to have no support in relation to the real behaviour of individuals. Therefore, new behaviourally conditioned concepts evolved based for instance on spatial information processing, spatial choice, and spatial decisions (Fotheringham, 1983, 1986; Hu and Pooler, 2002). These behavioural probabilistic models require difficult-to-gain information on how individuals make their decisions, and this is usually tackled by the employment of hierarchical choice and by finding suitable attributes of destinations (Fotheringham et al., 2000).

3.2 Modelling hinterlands

Spatial interaction models can be used and adjusted to analyse movements and contacts in three main ways: (i) as flows along lines; (ii) as the accessibility of points; and (iii) as hinterlands of places. All models require knowledge of the size of places (also masses) and the distances between them. It is assumed that spatial interactions increase with size and decrease with distance. The crucial question is how the interaction decreases with distance, and several so-called distance-decay functions are applied to express this decrease (see for example: Fotheringham, 1981; Halás and Klapka, 2015; Sheppard, 1978; Wilson, 1974). Each model includes one or several parameters which calibrate the model to produce reasonable results. This is the basic principle, and it is applied and developed in many and varied ways, based on the research task, information quality, geographical context, distance-decay function used, etc.

The current paper pursues the third form of analysis mentioned above, and its development will be detailed further. The first attempts to define the hinterlands of places are related to the work of William J. Reilly (1929, 1931). He proposed the law of retail gravitation based on empirical observations of 'retail trade influence', originally carried out in Texas, where retailers and housewives were interviewed. He noticed that the attraction forces of two centres in the intermediate place are approximately directly proportional to the population of centres and inversely proportional to the squared distance between the centres and the intermediate place. Square distance is in fact the value for the model parameter equal to 2 (see below). He introduced the notion of the breaking point, where the influence of both centres is equal.

Converse (1949) expressed mathematically, and determined precisely, the location of the breaking point between two shopping centres. He also tested his assumptions through a consumer survey and paid careful attention to the value of the model parameter – cubic distance instead of square distance. Huff (1963, 1964) discusses how to delineate intra-urban retail trade areas and considers all competing centres in a system. He observes that the breaking point does not mean a sharp boundary between two facilities. Rather, it shows where the influence of one centre fades and the other starts to prevail. As for the model parameter, Huff suggests that it varies between 1.5 and 3 based on the type of movement and the geographic context. He points out that the variety of goods and the travel time can be employed to express the probability of a customer making a shopping trip. This probability can be graphically expressed by isopleths. Thompson (1966) assesses the early variants of retail area models and suggests their application in other research directions. The validity of the law of retail gravitation was challenged for instance by Jung (1959) and Berry (1967).

Wilson (1970), who defined a family of interaction models based on the principle of entropy maximising, showed that the law of retail gravitation was in fact a special

[1] There are, however, some rare exceptions when there is a statistical record of past movements for some territory, such as migration in southern Sweden (Hägerstrand, 1957). In the territory of Austria-Hungary, Bálint (2016) attempts to capture historical migration between Austrian and Hungary. Deméter and Bagdi (2018) present several approaches to reveal real migration patterns in Hungary. These latter works represent a macro-view of the migration patterns, however.

case of the unconstrained gravity model; this put the law of retail gravitation within a theoretically well-defined general scheme of spatial interaction models. The original formulation of the law of retail gravitation was critically discussed by Batty (1978), who also suggests its mathematical reformulation based on contemporary knowledge and in the context of Central Place Theory. After 1980, the original Reilly model and its extensions have been only marginally used and developed. Ianoş (1987) applied the model in the regionalisation of Romania. Parr (1997) compared the law of retail gravitation to the law of market areas and found a number of common characteristics. Lee and Pace (2005) modelled the spatial distribution of retail sales between shopping malls. Řehák et al. (2009) and Halás and Klapka (2010, 2012) modified Reilly's original model, proposed its three variants (geometric, topographic, oscillatory) and applied them to the territories of the Czech Republic and Slovakia.

3.3 Spatial interaction modelling in historical and archaeological research

The current use of spatial interaction modelling in historical and archaeological research is exceptional, which is particularly true when speaking of the Modern Age as approximately to the end of the 19th century. Doorn (1985) applied a simple gravity model to early modern-day Greece. Rihll and Wilson (1987) were concerned with Ancient Greece and the grouping of settlements into regions based on the entropy-maximising gravity model. A similar task was dealt with by Klapka and Niedźwiedźová (2010), who used Reilly's model to define the hinterland of a smaller industrial centre in the present-day Czech Republic during the Industrial Revolution, and used a simple gravity formula to analyse its inner structure. Řehák et al. (2009) used Reilly's model to compare, besides others, the hinterlands of Czech central places in 1900 and 2001. They acknowledged the role of spatial interaction modelling in the analysis of the past spatial organisation of territories. Wilson (2012) returned to the study of Ancient Greece and analysed the development of the urban system in the USA in the context of railway development. More attention was paid to ancient history and archaeology. Bevan and Wilson (2013) modelled settlement hierarchies in Bronze Age Crete. Davies et al. (2014), Altaweel (2015) and Altaweel et al. (2015) analysed settlement structure, change and hierarchy in various parts of present-day Iraq and Syria during the Bronze and Iron Age. Filet (2017) modelled Latenian cultural trade interactions in non-Mediterranean Europe using the same model as Rihll and Wilson (1987). Györi (2000) modelled trade gravitation areas in the Little Hungarian Plain for the year of 1925. Demeter and Radics (2009) used the gravity principle and Central Place Theory to examine cores and peripheries after the demise of Austria-Hungary. Györi and Jankó (2009) defined gravity-based hinterlands in Burgenland and Western Hungary for 1910 and 2001. Szilágyi (2017) used a gravity potential model to visualise areas lacking cites in the Great Hungarian Plain.

4. Data and model specification

Concise, sufficient, and clear mathematical derivations and formulations of general spatial interaction models are given for instance by Rihll and Wilson (1987) and Wilson (2010). In this paper, we use an adjusted and improved Reilly's model, which is detailed below. From three versions defined by Řehák et al. (2009), the geometric variant was chosen for our purpose; the topographic variant uses real distances along transport networks and is determined to assign basic spatial units (such as municipalities) to competing central places; a similarly constructed oscillatory variant is designed to identify the overlapping hinterlands of central places. Although we will return to the assessment of the geometric variant in the concluding section, some of its properties are now due to be presented about our specific research task.

Apart from the distances between central places, the model requires us to express their sizes (masses), which can also be seen as their centrality functions. The specification of size needs to reflect the research task, data availability and comparability. In this paper we use the population of central places to express their centrality function. The population is suitable for general definitions of hinterlands. It is simple but also the most universal and comparable expression of size, and information concerning population is readily available for central places in the past. Other expressions can be distorted by the functional specialisations of some central places.

We took the populations of central places from the 1900 census,[2] carried out by the Austro-Hungarian Empire, and the later censuses from most of its successor states over 100 years later. These were carried out in 2001 in Austria, Croatia, the Czech Republic, Hungary, Italy, Slovakia, and the Ukraine; in 2002 in Poland, Romania, Serbia (i.e. Yugoslavia) and Slovenia.[3] Numbers for Bosnia and Hercegovina were acquired from Internet estimates from 2002.[4] The population of Gorizia is the sum of numbers in the Italian (for Gorizia) and the Slovenian censuses (for Nova Gorica). Cities with more than 100,000 inhabitants at the beginning of the 21st century, and the capitals of the internal division units of Austria-Hungary which were smaller than 100,000, were taken as the central places. The latter category only included the cities of Bolzano, Klagenfurt and Opava in Cisleithania. Where possible the populations of central places were related to the administrative boundaries of cities from the beginning of the 21st century so that spatial comparability is secured.

The original Reilly's law is mathematically formulated as:

$$(p_{ki}/p_{kj}) = (M_i/M_j)^{\alpha} \times (d_{ki}/d_{kj})^{\beta}, \quad [1]$$

where p_{ki} and p_{kj} are the probabilities of expected shopping travel from a place k to central places i and j, M_i and M_j are the sizes of central places i and j (usually $M_i \geq M_j$), d_{ki} and d_{kj} are the distance from a place k to central places i and j, α and β are the parameters to be estimated (α is assumed to be unity). Now we can proceed further to the identification of the breaking point between the spatial influences of central places i and j. This is based on the assumption that

[2] K. K. Statistischen Zentralkommission ed. (1903–1908): Gemeindelexikon der im Reichsrate vertretenen Königsreiche und Länder I-XIV. Hölder, Vienna. Kön Ungarischen Statistischen Zentralamt ed. (1902): Volkszählung in der Länder der Ungarischen Krone vom Jahre 1900, erster Teil. Pester Buchdruckerei, Budapest. Numbers for Bosnia and Herzegovina are retrieved from the 1895 census – Zemaljska vlada za Bosnu i Hercegovinu ed. (1896): Glavni rezultati popisa žiteljstva u Bosni i Hercegovini od 22. aprila 1895 sa podacima o teritorijalnom razdjeljenju, javnim zavodima i rudnim vrelima. Sarajevo.

[3] Data were retrieved from respective national statistical offices.

[4] https://en.wikipedia.org/wiki/Demographics_of_Sarajevo; https://en.wikipedia.org/wiki/Historical_population_of_Banja_Luka

[2] $$\left(p_{ki}/p_{kj}\right)=1.$$

Thus, if [1] is equal to unity according to [2], then

[3] $$\sqrt[\beta]{\frac{M_i}{M_j}}=\frac{d_{ij}-d_{kj}}{d_{kj}}.$$

Thus

[4] $$d_{kj}=d_{ij}\Big/\sqrt[\beta]{\frac{M_i}{M_j}}+1,$$

which is the distance from a smaller central place to the breaking point. Now we can derive the whole set of breaking points in the form of a circle on condition that we identify its centre. The equation [4] can also be expressed as:

[5] $$d_{ij}=\sqrt[\beta]{\frac{M_i}{M_j}}\times d_{kj}+d_{kj},$$

which divides d_{ij} into two parts. It enables us to construct a circle (Parr, 1997; Řehák et al., 2009) with its radius:

[6] $$r=d_{kj}\times\sqrt[\beta]{\frac{M_i}{M_j}}\Big/\sqrt[\beta]{\frac{M_i}{M_j}}-1,$$

when $r > d_{kj}$ and r is plotted from the breaking point towards (and in fact always behind) a smaller central place along the axis connecting i and j, where the centre of the circle is located. This circle circumscribes the hinterland of a smaller central place against larger central place.

In practice, the largest and the second largest central places are the first to be considered, and the territory under study is divided between their respective hinterlands. Then the third largest central place is taken and dealt with the larger place to whose hinterland it belongs. This procedure is repeated until all central places have their hinterlands defined. If a circle intersects another circle(s), then any respective pair of central places must be taken into consideration. This in fact ensures that the regional system is taken as a whole and that selected pairs of central places are not dealt with out of context. Therefore, in practice the final shape of a central place's hinterland can consist of a system of arcs related to various relevant pairs of central places and their respective hinterlands. Likewise, it means that some arcs of circles are rendered redundant and must be deleted from the graphical expression of the results.

The last issue to be addressed is that of the β parameter value. In Newtonian physics this value equals 2. But leaving celestial bodies aside, questions concerning the parameter value in socio-spatial research remain open. In historical tasks it can become rather complicated. This value is usually estimated during the calibration of a spatial interaction model, but in this case at least some and sufficient preliminary knowledge of the real interaction patterns is required. The calibration is basically done through the approximation of modelled interactions onto real interactions, while adjusting the parameter value.[5] For the territory of Austria-Hungary, we have no knowledge of sufficient, applicable and comparable real interactions (such as travel-to-work flows) until the second half of the 20th century. Although some local studies exist (see e.g. Györi, 2000), if the model is calibrated based on these quite unique data, its performance in different parts of the Empire with various levels of socio-economic development could be seriously compromised. Moreover, the parameter value estimates can tend to be spatially non-stationary, but the discussion on non-stationarity is well out of the scope of the paper (see e.g. Fotheringham et al. (1996) for clear explanation of the concept of non-stationarity).

As an acceptable calibration of the 'historically oriented' model is almost impossible, another means of setting the parameter value must be used. In his original empirical study, Reilly (1929) found that the parameter value most frequently ranges between 1.5 and 2.5, the closest whole number being 2. These values are also retained by Parr (1997). Converse (1949) uses $\beta = 2$ and if there is a distinct difference in the sizes of towns then $\beta = 3$. In this study we follow these traditional suggestions and use the parameter value $\beta = 2$.

5. Results and their interpretation

The hinterlands of central places in the territory of the (former) Austro-Hungarian Empire defined by the model application are shown in Figure 1. The map itself requires a short commentary. For the modelled situation of 1900, the territorial units of the inner division of the Dual Monarchy are shown for easier and more comprehensible interpretation. Cisleithania (officially the Kingdoms and Lands represented in the Imperial Council) is divided into crown lands – historical political units with various former statuses. In contrast, Transleithania (officially the Lands of the Holy Hungarian Crown of St Stephen) is divided into the Kingdom of Croatia-Slavonia and Hungary proper. The latter territory consists of so-called comitatuses, which are too small to be compared to the Cisleithanian crown lands. Therefore, seven statistical regions (so-called 'circles'), consisting of these comitatuses, are shown on the map. Finally, there is the Condominium of Bosnia and Herzegovina, which was governed jointly by both parts of the Empire. One hundred years later the situation had changed completely because of several major events (both World Wars, the fall of the Iron Curtain). The boundaries of independent states are shown on the map. The territory of the former Dual Monarchy is currently under the governance of thirteen independent states (see above the section on statistical data, the thirteenth state being Monte Negro). It is symptomatic that even the administrative boundaries point to the complex histories of this part of Europe.

The main features of the initial situation and the pattern of the hinterlands in 1900 will be outlined before we proceed to the assessment of the most apparent aspects of spatial developments that occurred in the 20th century. The distinct aspect of the organisation of space is the significant dominance of the capitals of both parts of the Dual Monarchy – Vienna and Budapest. The dominance is quite noticeable in the case of Vienna, the largest city in the Empire, whose hinterland includes substantial parts of such distant areas as Bosnia and Hercegovina and Dalmatia and, less surprisingly, parts of Moravia. The influence of Vienna reaches parts of Vorarlberg, Tyrol and Silesia and extends

[5] Rihhl and Wilson (1987) suggest that models can be calibrated based on the knowledge of some other aspects of spatial structures if real flows are not known, such as the importance of places.

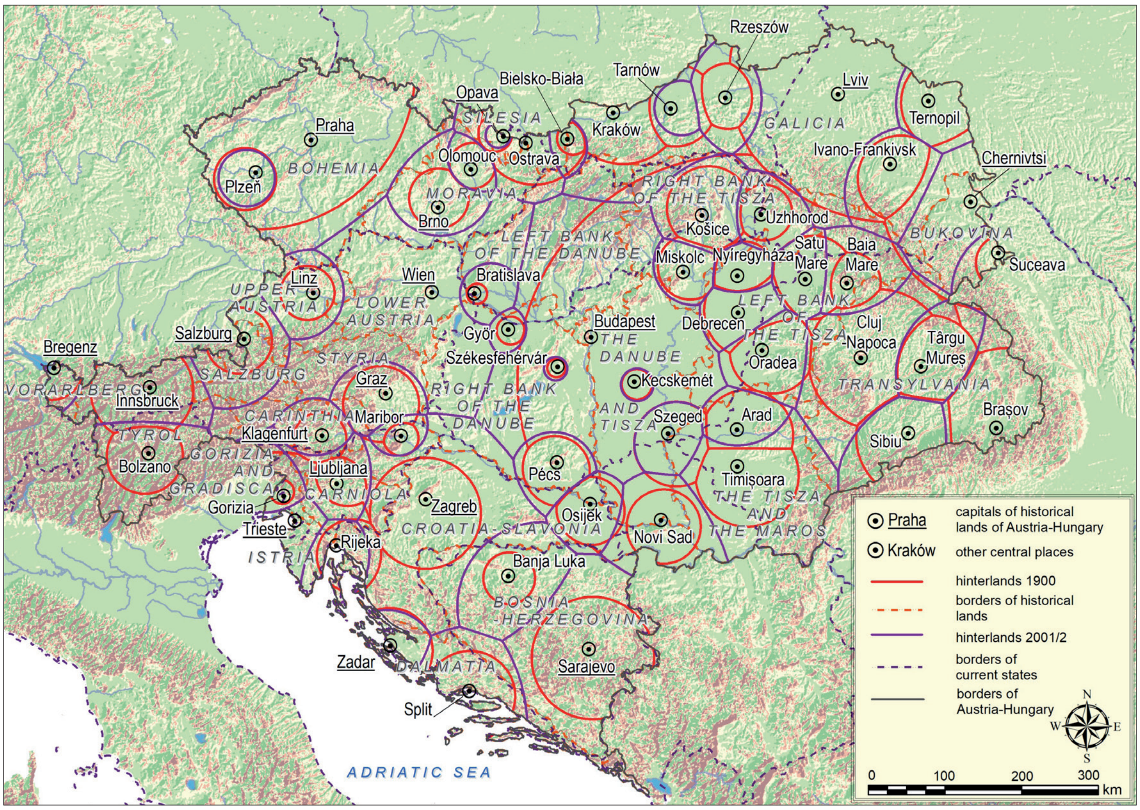

Fig. 1: Central places and their hinterlands in Austria-Hungary in 1900 and 2001
Source: Author's elaboration

along a strip dividing the western part of Galicia from northern Hungary. Seemingly illogical, the hinterland of Vienna includes the north-eastern part of Transylvania, but this is how the model deals with the largest city in the system. The dominance of both capitals, Vienna, in particular, can be documented in the hinterland of the third largest city in the Empire, Prague, which does not even include the whole territory of Bohemia. Except for Lviv (Galicia), the hinterlands of other central places are only small.

To interpret developments over time correctly, the relativizing effect of spatial interaction models needs to be considered. This means that the population of a central place itself is not as crucial as the mutual ('relativized') relations among central places in space. Distance plays the most significant role in this respect. For instance, the hinterland of Kecskemét changed very little over the hundred years, but that does not mean its population stayed the same. It means that its population changed (increased) in almost the same relative number (proportion) as did the population of Budapest, against which the hinterland of Kecskemét is defined.

The development of society during the 20th century is reflected in the organisation of space in several respects. This can be shown through the changes that occurred in the hinterlands of central places. First, the hinterlands of both capitals of the Dual Monarchy were reduced significantly, particularly in favour of the hinterlands of 'new capitals'. There are several types of these 'new' central places:

i. Federal capitals in the new multi-national states of the former Yugoslavia (Zagreb, Sarajevo, Ljubljana, Novi Sad) and Czechoslovakia (Prague[6], Bratislava), formed in 1918 and dissolved shortly after 1989, virtually completing the demise of Austria-Hungary and the establishment of nation states;

ii. Federal capitals in Austria (Salzburg, Linz, Klagenfurt, Graz); and

iii. 'Capitals' based solely on cultural and economic attributes[7] (e.g. Kraków, Brno, Timişoara, Banja Luka, Split).

In the case of cities (Brno, Bratislava, Linz) located relatively near to Vienna, the relative increase in their influence was further driven by the decrease in the influence of Vienna, which was one of the steepest falls in the territory of the former Empire. Also deserving of our attention is the fact that the increase in the spatial extent of the hinterlands of the new capitals was not affected by the existence of the Iron Curtain which split the former Empire after 1945, or by the differences in economic levels. The political-economic system seems to have played a smaller role than general economic, cultural, and social development in this respect.

Second, apart from both capitals of the Dual Monarchy, there are other cases where the hinterlands of central places have shrunk. The shrinkage is most distinct in the case of Trieste, which is, together with Vienna, the only

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[6] Prague can be seen as a special case. It is the third largest city in the system, it is by far the oldest of the 'new' capitals (1918) and it is an historical capital. This makes Prague more similar to Vienna and Budapest; also the expansion of Prague's hinterland is modest in comparison to Zagreb and Bratislava but also to Salzburg and, Innsbruck.

[7] Of course, culture and economy also contributed to the increased influence of the first two types of capitals, together with political and administrative reasons.

central place that had less population at the end of the 20th century than it did at the beginning. Trieste was the main commercial seaport of Austria-Hungary. The city lost its importance considerably in this respect during the 20th century because Italy has several more suitable ports and Trieste was in the immediate vicinity of the Iron Curtain, and its political status was not resolved until 1954. The remaining cases are the cities of Lviv and Chernivtsi (former capitals of Galicia and Bukovina respectively), which lost their importance due to extreme peripherality during Soviet times, and the city of Tarnów, whose significance faded as it was in the vicinity of Kraków which, after 1918, rapidly grew in size and importance, and in part because of its own migration-related population decrease at the end of the 20th century.

Third, stable spatial relations during the 20th century are visible in the territories of present-day Hungary, the eastern part of Transylvania and Bohemia. Interesting situations can be found in territories with a mix of stable and unstable relations. Bohemia and Moravia (today's Czech Republic) show internal stability in the hinterlands of their central places, which, in contrast, increased their importance in relation to Vienna. Central places near the borders of today's Hungary have stable relations with Budapest but lost their importance to central places in Serbia and Romania (typical examples are Szeged and Novi Sad, Timişoara, Arad). Today's Romania shows stable relations in Transylvania (Braşov, Tărgu Mureş, Sibiu, Cluj-Napoca), while in its northwestern territory, which has a Hungarian minority, the hinterlands of such places as Timişoara, Oradea and Baia Mare have expanded.[8]

In most cases referred to above, the mixed situations are conditioned by the emergence of new state borders, and this can be interpreted as a source of instability for urban and regional systems as they were in the Habsburg Monarchy. Although some sections of newly established Hungarian borders, after the end of the World War I, respect physical geographical features (the Danube and Ipeľ/Ipoly Rivers in the case of Czechoslovakia; the Mura and Drava/Dráva Rivers in the case of Yugoslavia), the bulk of the new borders did not respect long-lasting functional relationships in the territory (and its administration), ethnic and partly also religious composition (e.g. Demeter, 2020; Hajdú, 2020; Szilágyi and Elekes, 2020), which affected negatively particularly the Hungarian areas along the Eastern-Slovakian, Ukrainian, Romanian and Croatian border sections (cf. Süli-Zakar, 1992; Papp and Pénzes, 2017; Pénzes, 2020; Szilágyi and Elekes, 2020).

In contrast, the development of central places behind the Hungarian borders might be boosted based on political reasons, when for instance larger Romanian industrial cities were fed by intensive in-migration of ethnically Romanian population.[9] Nevertheless, some cross-border relations remained stable during the 20th century: Osijek–Pécs; Oradea–Debrecen; Satu Mare–Debrecen, Nyíregyháza. In contrast, the removal of borders induced the development of Polish central places. A special instance of mixed ('converging') relations can be found in today's Ukraine, where the hinterlands of larger central places (Lviv, Chernivtsi) shrank and the hinterlands of smaller central places (Ternopil, Ivano-Frankivsk, Uzhhorod) expanded. Possible reasons can be seen in Soviet policies of levelling economic differences.

At the end of the 20th century Budapest was the largest central place in the former Austro-Hungarian Empire. Its hinterland expanded west at the expense of the hinterland of Vienna. The hinterlands of the 'new capitals' expanded considerably and more fully covered their respective territories. That is particularly so in the cases of Zagreb, Sarajevo, Ljubljana and, partly, Prague. Even Bratislava, located close to Vienna, expanded its hinterland; however, it does not yet cover a significant part of Slovakia.

6. Conclusion

We have presented the possible use of spatial interaction modelling in the field of spatial history and historical geographical research. We have applied a geometric variant of an adjusted and improved Reilly's model. This is a relatively easy way to define the hinterlands of central places for quite general purposes, such as the regionalisation of territories, and capturing the basic features of urban and regional systems. We have analysed the situation in Austria-Hungary in the 20th century and presented a very general illustration of the historical geographical interpretation of the model results.

The model has its advantages and limitations, which go hand in hand. The main advantage is that it offers a simple assessment of basic relations within the urban systems of territories, and this is quite easily attainable – we only need the sizes of central places and the orthodromic distances between them. Thus, it is not necessary to consider any units of inner divisions of the territories or transport networks. This would be rather problematic because the units and networks have different historical backgrounds and geographical logic in various parts of Austria-Hungary, despite the centralistic efforts in respective parts of the Dual Monarchy, and this is particularly true for the differences between Cisleithania and Transleithania. The model is quite independent about the availability of data, their quality, and their comparability, both in time and space. The model is not a mere mapping of the historical data, but it acknowledges the mutual relations and dependencies in space, which are relativized through the interaction approach.

In contrast, the model has its limitations. The relative ease of its construction is at the expense of more detailed results and a more thorough interpretation. It works with an isotropic space and ignores real features of the environment, particularly the physical geography. In some parts of the territory, however, the model can approximate physical geographical borders, for instance the mountain ranges between Innsbruck and Bolzano, Ljubljana and Klagenfurt, Rijeka and Trieste, and the orographic barrier of central Slovakia and the north-eastern Carpathians. The model also does not take into consideration the effects of any areas outside the former Austria-Hungary.

The concrete application of the model on the territory of Austria-Hungary has revealed some more general aspects of the development of its urban and regional systems. Four

[8] An interesting interpretation of the changing roles and functions of centres along wider Hungarian-Romanian border zone is put forth by Szilágyi and Elekes (2020). Some of their findings in this respect corroborate those reported here (regarding for example: Cluj-Napoca, Timişoara, Baia Mare).

[9] See Kocsis and Tátrai (2021, p. 71). Szilágyi and Elekes (2020, p. 104) mention for instance Baia Mare.

types of situations regarding the hinterlands of the central places have been identified: (i) stability; (ii) a trend towards expansion; (iii) a trend towards shrinkage; and (iv) mixed development. We suggest that the situations are mostly related to political (state) and administrative (intra-state) borders which are the products of major geopolitical and socio-economic changes that took place during the 20th century. Such changes start with the dissolution of Austria-Hungary, then the rise and fall of the Iron Curtain, followed by the dissolution of the Soviet Union, Yugoslavia, and Czechoslovakia.

As the result, the 'monocentric' or better still 'duocentric' urban and regional model of the Austro-Hungarian Empire has been replaced by polycentric (Bosnia and Hercegovina, Slovenia, Croatia, relevant parts of Poland, Romania, the Ukraine) or semi-polycentric (Austria, the Czech Republic) models over the whole territory of the former Empire, and within its successor states. One exception is present-day Hungary, see further, which has remained extremely monocentric) at a lower hierarchical level of the transformation process.

The prevailing tendencies we have identified are quite irrespective of:

i. The historical role of a political-economic system: it does not matter whether market economy (Austria), planned economy (Czechoslovakia, Poland, Romania, the Soviet Union) or the mixed system of Yugoslavia, which was effective in that territory for some time, prevailed;
ii. The administrative system: it does not matter whether it is a national federal state (Austria), a multi-national federation (Czechoslovakia, Yugoslavia, the Soviet Union) or a 'centralised' national (Poland) or multi-national (Romania) state; and
iii. The economic level: it does not matter whether it is a traditionally developed state (Austria), a successfully transformed state (the Czech Republic) or a transforming state (Romania).

In this respect the traditions and legacy of Austria-Hungary appear to be surprisingly clear. The tendencies seem to build on the trajectory set during the period of Austria-Hungary and to reflect a global or at least a Euro-Atlantic socio-economic development based on the theories of regional development supporting decentralisation and deconcentration in the organisation of space.[10]

As mentioned earlier, the exception to the identified three prevailing tendencies is present-day Hungary. It is partly the tale of its modern state borders, which differs much from more traditional and stable boundaries (both international and intra-state) in many other parts of the former Empire. The borders of present-day Hungary were based on political and military-strategic reasons favouring, quite logically, the needs of newly established victorious states, and they were confirmed by the Treaty of Trianon. The non-existence of traditional borders brought a huge disruption of existing human geographical relationships in the Great Hungarian Plain, which has brought economic and social problems along some sections of new state borders and affected the development paths of border regions.[11]

We have presented the way in which the model can be interpreted, and we have put forth some basic historical causes for the changes in the organisation of space. In contrast, the spatial development of urban and regional systems can be used as a referential framework and a context for more specific historiographical studies (such as Makaš and Conley, 2009), which could hopefully enrich historiography with further knowledge of the spatial aspects.

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[10] For this extremely wide and complex issue, see for instance the basic overview in Capello and Nijkamp (2019), Stimson et al. (2006); for the transformation of settlement system and polycentricity, see Davoudi (2003), Hall and Pain (2006), Rozenblat and Pumain (2018). See also Demeter (2020) for a historian's view related to the territory of Austria-Hungary.

[11] Presenting the Hungarian point of view, there is a suitable historical-geographical outline in English published by Demeter (2020).

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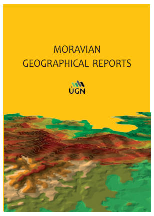

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Central European tourist flows: Intraregional patterns and their implications

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Abstract

Understanding tourist spatial behaviours is essential for strategic planning and sustainable development. Especially at the city-level, data provide implications for spatial planning and transport governance. Intraregional tourist flows to cities contributed significantly to the total volume of tourists within the Central European region before the COVID-19 pandemic outbreak. Given the challenges that urban tourism is currently facing, intraregional tourist flows could be a strategic opportunity for future growth. As a comprehensive assessment of the tourist flows at this spatial level is lacking, the paper aims to evaluate the structure of these flows and discuss the factors that influence their spatial distribution. Statistical data analysis of tourist flows to selected cities in Central Europe is evaluated by multiple linear regression. The results show that the main factors affecting the distribution of tourist flows are air connection, the attractiveness of the destination, and the size of the source market. Tourist flows within Central Europe are fundamentally affected by Germany. This market can be considered the most important source of demand for inbound tourism. Germany's national ties with Austria and Switzerland generated 47% of all trips examined. In this case, the influences of historical ties and the broader socio-economic context are evident.

Keywords: *mobility, urban tourism, tourism development, intraregional flows, spatial analysis, Central Europe*

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1. Introduction

The essence of tourism is the movement of people in time and space. Tourists leave their home environment and head to destinations to have experiences, discover places, carry out business or search for themselves. The understanding of tourist movements is important for the development of tourist and transport infrastructure, for the development of tourism products, for the commercial viability of the tourism industry, and for managing the social and environmental impacts of tourism (McKercher and Lew, 2004).

Tourist flows reflect tourists' preferences and the result of choices they have made. In addition to the traditional demand (push) factors that explain the need to travel, we should pay attention to the supply side of tourism to explain the motives to travel (pull factors). Marrocu and Paci (2013) emphasise the fact that tourism destinations are very different in terms of travel motives. Therefore, the various features of leisure products play a crucial role in determining the flows of different tourists to different destinations.

Understanding the context of the spatial distribution of tourist flows and thus the manifestations of tourism, are prerequisites for assessing the potential for further tourism development. The knowledge of the factors that influence these flows allows stakeholders in local and regional governance and destination management to make more informed political and economic decisions (see Beritelli et al., 2020). Moreover, public policy today must respond to the challenges facing tourism. Climate change and the effects of the COVID-19 pandemic require public interventions that affect the intraregional movements of tourists. The emphasis on short journeys, environmentally friendly forms of transport, and tourists' sustainable behaviours, is becoming the new reality.

In this respect, the Central European region is a useful case study area where the development of intraregional tourist flows can be a strategic opportunity for future growth. The region's size primarily creates preconditions for revising the transport systems, and the start-up of processes associated with the shift from air transport to rail.

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Therefore, we focus on the intraregional tourist flows within the Central European region, i.e. internal sources of demand that the region generates itself, and analyse the most important tourist flows from Central European countries to the most important Central European cities. The paper aims to evaluate the structure of these tourist flows and to discuss the factors that influence their spatial distribution. In other words, we are interested in answering the following questions:

1. How important are the tourist flows to cities within Central Europe, and what is their spatial structure?
2. What factors influence the character and spatial distribution of intraregional tourist flows, and what is the significance of the individual factors?

The contribution of the research is twofold. First, tourism in the Central European region from spatial perspectives has not been addressed at this time. Quantifying the importance of the region in European tourism and knowing the structure and volume of intraregional tourist flows, provides new insights potentially affecting tourism policy, and an opportunity for growth in the post-pandemic tourism period.

A second contribution lies in the choice of the spatial level of analysis. In our evaluations, we concentrate on a spatial nexus at the city level. Typically, regional studies are focused on higher spatial levels, mainly NUTS 2 areas. In contrast, city-level data allow us to take a more detailed view of tourist flows and set aside the heterogeneity of higher territorial units (see Yang and Wong, 2013). At the same time, urban tourism was one of the most dynamically growing segments of the industry until being hit by the COVID-19 crisis.

2. Theoretical framework

2.1 Investigating tourist flows at different territorial levels

Contemporary literature analysing tourist flows is particularly extensive (Ferrante et al., 2017). In this respect, the investigation of patterns of tourist mobility has a dominant position in scientific outputs (Šauer and Bobková, 2018). Tourist flows are usually researched among a select group of countries that dominate the international tourist market on a world scale (e.g. Williams and Zelinsky, 1970; Chung et al., 2020; Shao et al., 2020). Based on the political economy approach, tourist flows relate closely to the economic circumstances of the generating regions (Li et al., 2008). The functional approach indicates that the flows are derived from the nature of demand and supply interactions (Mansfeld, 1990).

Few studies have focused on the different geographic scales of tourist flows. From a macro-regional perspective, they investigated tourist flows among the Asia-Pacific countries (e.g. Kulendran and King, 1997; Li et al., 2008; Liu et al., 2010), or identified the structure of tourist flows within Europe (Jansen-Verbeke and Spee, 1995). A major part of the tourist flows was accounted for by tourists coming from regions within a range of 500 km. Jansen-Verbeke and Spee (1995) confirmed that tourists were predominantly oriented towards destinations within a short distance range.

It is suggested that the extent of intraregional tourist flows can make significant tourism growth (Oppermann, 1993; Li et al., 2008). Therefore, more narrowly focused regional analyses also appeared in addition to the macro-regional analyses. Analysis of tourist flows at the regional level allows identifying relevant markets for the region (Jansen-Verbeke and Spee, 1995). Therefore, knowledge of the spatial structure of tourist flows in smaller geographical areas leads to more competitive tourism destination planning, the formulation of tourism policies, and management strategies (Liu et al., 2010; Kang et al.,2018).

From this regional point of view, the authors dealt mainly with the spatial distribution of cross-boundary tourist flows within specific countries (e.g. Oppermann, 1993; Liu et al.,2010; Peng et al., 2016) or specific regions (e.g. Hall, 1991; Hall, 2000; Williams and Baláž, 2002). On the other hand, research on tourist flows within the specific market conditions of Central and Eastern European regions was fragmented and atheoretical (Williams and Baláž, 2002). The socialist ideology, difficulties in obtaining visas, a forbidding image, and inadequate tourism infrastructure represented the main constraints on tourism growth (Hall, 1991). The organisation of tourist flows in these transition countries changed over time, mainly in scale and motivation. On the contrary, the pattern of nearest-neighbour tourist flows has changed very little since 1989 (Williams and Baláž, 2002). In 1997, almost 50% of tourist flows in Central and Eastern Europe were from other countries within the region (Hall, 2000). Before embarking on their transition, the share of intraregional tourist flows was 61%. In the former Czechoslovakia in 1989, as much as 83% of tourists came from just three neighbouring countries (Williams and Baláž, 2002).

The importance of cities in Central and Eastern Europe was highlighted, as tourists remained concentrated in the capital cities due to their greater ties to the global economic system (Ivy and Copp, 1999; Baláž and Williams, 2005). The patterns of tourists overwhelmingly concentrated in the capital cities were similar to those in Third World nations (Oppermann, 1993). In contrast to the more extensive analysis of tourist flows on the international or regional level, contemporary statistics are not able to capture tourist flows at the level of individual cities (Šauer and Bobková, 2018). At the same time, urban tourism is considered by UNWTO/WTCF (2018) to be an important segment of international tourism. According to the World Travel Monitor (IPK International, 2020), trips to cities made up close to 30% of all holiday flows in 2019. The importance of urban tourism is reflected as well in the role of tourism within the urban economy (Dumbrovská and Fialová, 2014).

Urban tourism can be a driving force for the economic, social, and spatial transformation of cities in the sense of revitalisation of public spaces, the development of public infrastructure, or interconnections of their residential and recreational functions (UNWTO/WTCF, 2018). Given the structuring of the urban environment and dynamic processes in cities (Šveda et al., 2020), it is necessary to investigate the flows to cities and find a method that would be able to estimate such flows (Šauer and Bobková, 2018). This need is amplified by the COVID-19 pandemic outbreak, which drastically affected the tourism industry in urban destinations (Novotná et al., 2021; Seyfi et al., 2021).

2.2 Determinants of tourist flows

Researchers are interested in tourist flows not only in terms of their patterns and intensity but also in their nature. The nature of tourist flows to regions, countries, or cities needs to be analysed further in terms of the determinants that are leading to their volumes. The existing literature has taken various factors into account, e.g. the traffic links between regions and the tourist attraction potential (Jansen-Verbeke and Spee, 1995). The nature of tourist flows may also include factors such as the socio-economic, psychographic characteristics of tourists, destination attributes, promotion, or marketing effectiveness, etc. (Mansfeld, 1990). Insights into tourist flows in such detail contributes to an understanding of the geographic dimension of tourism. At the city level, there are profound implications for infrastructure planning, transportation improvement, and economic growth (Xing-zhu and Qun, 2014).

To determine the nature of tourist flows, researchers have investigated variables that account for various characteristics of destination areas (supply side), as well as the characteristics of the tourists (demand side). The tourist characteristics that could shape the flows include motivation, time budgets, interests, and emotional value (Lew and McKercher, 2006). Motives that drive tourists to travel (the so-called push factors) can be divided into four groups: social gathering, education, self-reflection, and relaxation. On the other hand, the specific characteristics of a destination (the so-called pull factors) encourage tourists to visit it (Lesjak et al., 2015). Push motivations are conceived as useful for explaining the desire for travel; pull motivations are useful for explaining a tourist's destination choice (Bozic et al., 2017).

Different pull factors influencing tourist flows are considered to understand the tourist attractiveness of a destination. For destination variables, historical attractions and monuments are the most important motivators (Bozic et al., 2017). In this respect, UNESCO sites have a significant and persistent role in attracting foreign tourists and enhancing international tourism (De Simone et al., 2019). According to Reitsamer et al. (2016), infrastructure, scenery, accessibility, and local community are among the key factors of destination attractiveness. The factors generating tourist flow to a destination are other tourist attractions such as museums and galleries. Their absence can dissuade tourists from visiting a particular location (Das et al., 2007). Similarly, Krešić and Prebežac (2011) highlighted the importance of tourism superstructure, which refers to the variety of tourism facilities in which different destination activities take place (e.g. accommodations and capacities). Activities in a destination were identified as influential pull factors. In addition to recreational activities and cultural attractions, business motives including meetings, incentive travels, congresses, conventions, and exhibitions are also associated with urban tourism (Bozic et al., 2017).

Factors influencing tourist flows do not only include natural and cultural resources, infrastructure, or services in the destination. According to Jansen-Verbeke and Spee (1995), the volume of tourist flows is related directly to the major population concentrations and the economic situation in the visited destinations. As cities are places with high population density, one of the most important motives associated with their travel is visiting friends and relatives (Bozic et al., 2017). The tourism industry considers this type of tourism as a low-value market due to the personal motivations and use of unpaid accommodations (Aslan and Dinçer, 2018). The position of cities within the urban and economic structure can be measured not only by the city population but also by their gross domestic product. The income level in a destination represents an indicator of the economic development and thus may be interpreted as a proxy for the quality of the public services available for the incoming tourist flows (Marrocu and Paci, 2013).

In the case of tourist flows, the factors related to the originating country, i.e. the source market, should be investigated. The most important explanatory variables of flows to the destination are income in the originating country, the population in the market, cost of living, and other price factors such as exchange rates (Zhang and Jensen, 2007). In other words, the mechanisms that facilitate the tourist flows can be related to the origin area variables, such as the country's population size, national GDP levels, and issues related to destination competitiveness (Prideaux, 2005). According to Zhang and Jensen (2007), the variable capturing the relative price competitiveness of the individual destination is not statistically significant; on the other hand, better local purchasing power attracts tourists.

Origin-destination variables are also important factors in explaining tourist flows between pairs of countries. Marrocu and Paci (2013) mentioned the geographical distance in the kilometres between each origin and each destination area. These authors also considered accessibility based on flights and transport infrastructure. The number of direct flights between countries also contributes to increases in international tourist flows (Lohmann et al., 2009; Khan et al., 2017). From this point of view, transport infrastructure is a key element in moving the tourists efficiently nearer to the tourism product (Page, 2005). Connectivity of transport can influence the mobility of tourists and enhance the destination´s accessibility. Similarly, accessibility to the destination may enhance spatial competition. Improvements in accessibility are expected to boost urban and business tourism due to a reduction of the generalised cost of transportation (Albalate et al., 2017). Moreover, the interconnection of cities is a significant factor which stimulates horizontal and vertical cooperation of cities and enhances their competitiveness (Viturka et al., 2017).

In summary, international tourist flows can be explained by the supply-side as well as demand-side variables (Zhang and Jensen, 2007). In a broader context, there is also an influence of historical ties, linguistic proximity, and other institutional perspectives that are not negligible determinants of tourist demand (Khalid et al., 2021).

3. Data and methods

3.1 Study area

The subject of this evaluation is the spatial differentiation of tourist flows within the Central European region. This region is defined by the territory of eight countries, namely the Czech Republic, Poland, Slovakia, Hungary, Austria, Germany, Switzerland, and Slovenia. The essential starting point for defining this space was the World Factbook, Encyclopedia Britannica, and others (e.g. Nováček, 2012; Šauer et al., 2019). The political and historical settings of the selected countries were also considered.

We specifically focus on urban tourism as one of the most dynamically developing and currently also one of the most affected forms of tourism. At the same time, urban tourism has contributed to the growing importance of cities in the regional economy and has been part of general processes of urbanisation. Therefore, the selection of cities for analysis was conditioned on the one hand by their attractiveness supported by supply and demand factors, and on the other hand by their complex functional size and importance in the settlement system. Certainly, a no less important aspect of the selection was the availability of statistical data on the geographical structure of inbound tourism. Based on this methodological basis for the city's evaluation (Viturka et al., 2017), some 34 most important cities in Central Europe were selected for a detailed spatial analysis at the city level. The cities that are further analysed are listed in Table 1. The International Standard ISO 3166 for country codes is used when referring to individual countries.

According to official statistics (UNWTO, 2021), Central Europe is, in terms of international tourist flows, the third most important region in Europe (after the Southern Mediterranean Europe and Western Europe, but ahead of Northern Europe). It is visited annually by more than 110 million foreign tourists, which represents about 21% of total foreign arrivals in Europe. Central Europe is, however, a region very open to external sources of demand. The Central European region itself (i.e. the intraregional tourist flows) generates only 35% of the total volume of tourists. The number of tourists from other parts of Europe is thus greater than the intraregional movement of tourists within the region.

The above-identified cities made up more than 70% of the tourist flows of all cities in Central Europe. From Table 2, it is theoretically possible to determine 34 × 7 = 238 tourist flows from the Central European countries to selected cities (with Slovenia having none). The most important tourist flows to cities were taken for representative evaluation, namely the flows above 50,000 arrivals in 2018. A total of 51 such flows were analysed. The following Table 2 indicates where and in what intensity these flows were headed.

A general view of the spatial arrangement of tourist flows within the Central European region is shown in the following Figure 1.

3.2 Study design and data analyses

To evaluate and discuss the factors that influence the spatial distribution of tourist flows within the Central European region, we process the gathered information on the number of tourists to selected Central European cities and determine their geographical origin at the level of individual countries. The data is compared with the outputs obtained from a model created based on the Guirao and Campa (2014) ranking methodology. Differences in the order of tourist flows according to the model and actual measured outputs represent the source for discussion on

Country	City	Country	City
Austria (AT)	Vienna	Germany (DE)	Leipzig
Austria (AT)	Graz	Germany (DE)	Bremen
Austria (AT)	Linz	Germany (DE)	Dresden
Austria (AT)	Salzburg	Germany (DE)	Nuremberg
Austria (AT)	Innsbruck	Hungary (HU)	Budapest
Czech Republic (CZ)	Prague	Poland (PL)	Warsaw
Czech Republic (CZ)	Brno	Poland (PL)	Krakow
Czech Republic (CZ)	Ostrava	Poland (PL)	Wroclaw
Czech Republic (CZ)	Pilsen	Poland (PL)	Poznań
Czech Republic (CZ)	Karlovy Vary	Poland (PL)	Gdansk
Germany (DE)	Berlin	Poland (PL)	Szczecin
Germany (DE)	Hamburg	Slovakia (SK)	Bratislava
Germany (DE)	Munich	Slovenia (SI)	Ljubljana
Germany (DE)	Cologne	Switzerland (CH)	Zurich
Germany (DE)	Frankfurt	Switzerland (CH)	Geneva
Germany (DE)	Stuttgart	Switzerland (CH)	Basel
Germany (DE)	Düsseldorf	Switzerland (CH)	Bern

Tab. 1: Selected cities of Central Europe

Intensity of flows from:	Number of arrivals in thousands				
	Above 50 in total	50–100	100–200	200–500	over 500
Austria (AT)	7	3	3	1	0
Czech Republic (CZ)	4	2	2	0	0
Germany (DE)	20	8	7	3	2
Hungary (HU)	2	0	2	0	0
Poland (PL)	6	2	3	1	0
Slovakia (SK)	2	1	0	1	0
Slovenia (SI)	0	0	0	0	0
Switzerland (CH)	10	6	2	2	0
Total flows	**51**	**22**	**19**	**8**	**2**

Tab. 2: Intensity of tourist flows from eight Central European countries to selected cities (2018)
Source: authors' compilation

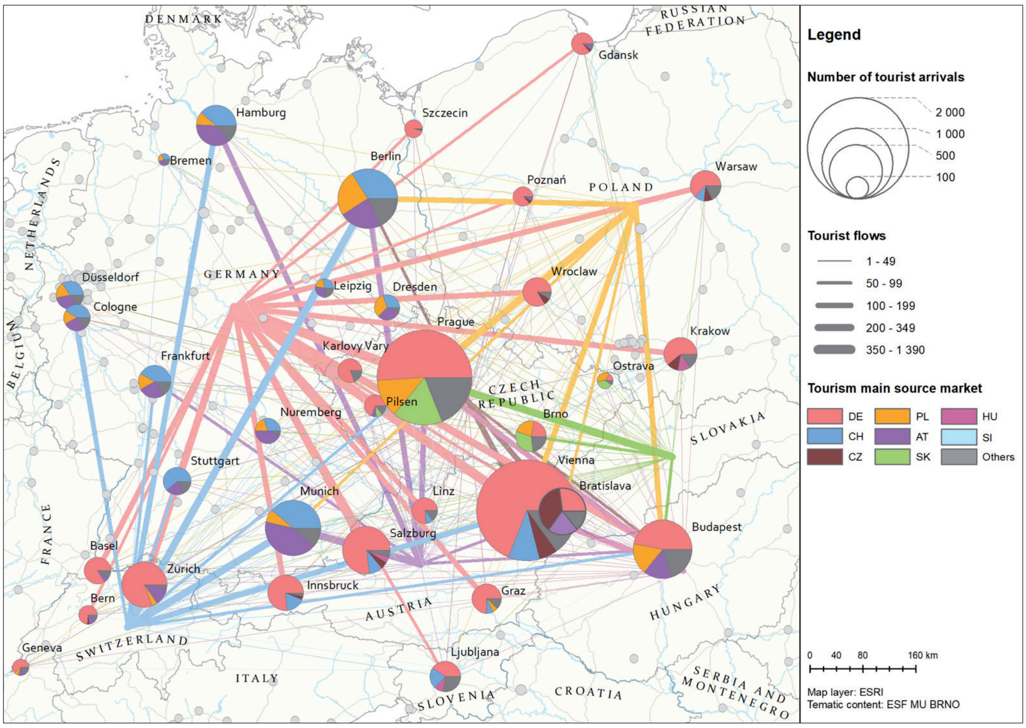

Fig. 1: Tourist flows to the most important cities of Central Europe

the impact of individual analysed variables. Furthermore, the interpretation of the obtained results is supported by the application of a multiple linear regression model, which quantifies the potential importance of the assumed factors. The whole process involves several follow-up steps.

3.2.1 Spatial analysis of tourist flows to selected cities

The following Central European countries are selected for the analysis of the inbound/outbound origin-destination (O-D) matrices: Czech Republic (CZ), Germany (DE), Poland (PL), Austria (AT) and Hungary (HU), Slovakia (SK), Slovenia (SI) and Switzerland (CH). With respect to the applied statistical methodology, the number of foreign arrivals to selected countries is measured using the UNWTO category "TCE: arrivals of non-resident tourists to all types of collective accommodation establishments". The basic source of these comparative analyses is the TourMIS (2019, data for 2018) and the UNWTO (2019) Yearbook of Tourism Statistics (selected data for 2017), supplemented by other statistical and information sources and portals of national and regional or municipal statistical offices, and tourist organisations, namely: Slovenian Tourist Board (STB, 2019), the Statistical Office of the Slovak Republic (SOSR, 2019), the Federal Statistical Office of Germany (Destatis, 2019) and annual reports of selected federal states, the Czech Statistical Office (CZSO, 2019), the Hungarian Central Statistical Office (HCSO, 2019), Statistics Austria (2019), Statistics Poland (2019), and the Swiss Federal Statistical Office (FSO, 2019).

3.2.2 Identification of the factors influencing tourist flows and their operationalisation via selected variables

In connection with the spatial distribution of tourist flows, we assume four main areas that might have an impact on the flows. As outlined in the literature review, they are: (1) the tourist attractiveness of a destination and its surroundings; (2) the importance of the source market; (3) accessibility; and (4) the economic importance of the visited city.

1. Tourist attractiveness of the destination and its surrounding

To better interpret the results of our spatial analysis, we supplement the analysis with an assessment of the level of attractiveness for tourists of the most important Central European cities. For this purpose, we define two variables. The first variable is a point evaluation of the city attractiveness. The city attractiveness is based on a composite indicator, which consists of four sub-indicators of the tourism supply mentioned in the scientific literature: the presence of cultural and historical monuments on the UNESCO list, the presence of important galleries and museums, the evaluation of the MICE (Meetings, Incentives, Conference/Conventions and Exhibitions) tourism segment, and the capacity of collective accommodation establishments. All sub-indicators are standardised on a three-point scale: significantly above-average, average, and below-average significance. The evaluation of the galleries and museums is based on the collection of statistics on museums in Europe (Eurostat, 2019). The MICE rating is based on the number of congresses in the city and their attendance (ICCA, 2019). When evaluating the significance of UNESCO World Heritage Site (UNESCO, 2021), the extent of territorial protection is considered (e.g. the difference between a free-standing monument and the historical centre). The last sub-indicator is evaluated according to the number of bed capacities in collective accommodation establishments in the city (Eurostat, 2021a). The composite indicator is a weighted average of these four sub-indicators: the presence of UNESCO (40%), museums and galleries (20%), MICE (20%), and number of bed capacities (20%).

The second variable is the evaluation of city surrounding's attractiveness. In this case, we work on the number of visits to the NUTS 2 region, in which a particular city belongs (the exception is the Czech Republic, where the number of visits to NUTS 3 regions is evaluated). The variable is designed as several overnight stays per km^2 (*nights_region*) and does not include the impact of the city itself. The data were obtained from the Eurostat (2021b) dataset on the number of overnight stays in NUTS 2 regions. In the case of the Czech Republic, the data comes from the Czech Statistical Office (CZSO, 2019).

2. The importance of the source market

The capacity of demand is observed based on a traditional variable, which is the adult population of the source country of demand. We assume the population over 20 years of age (the variable is *pop20+*) is sufficient. The data were obtained from the Eurostat statistics on population (Eurostat, 2021c; Eurostat, 2021d). Another variable in this category is the index GDP per capita (*gdp_index*). It is compiled as a ratio of the Destination GDP per capita (PPP) and Origin GDP per capita (PPP). In both cases, numerator and denominator include the values for the whole country. The data were obtained from Eurostat (2021e), specifically, the data on GDP per capita in the purchase power parity. The aim of the variable is to take into consideration the purchasing power of individual source countries.

3. Accessibility

The accessibility is also evaluated by means of two variables. The first is the distance between the source and target destinations (*distance*). We used the Mayer and Zignago's (2011) approach to determine the distance between various spatial units (country, city), and modified their general formula to fit the relation country – city. The core is the calculation of the average distance between city i and functional urban areas k in the country j and their weighted amount of population (Eurostat, 2021f).

$$d_{ij} = \sum_{k=1}^{n} \frac{p_{kj} \cdot d_{ik}}{\sum_{k=1}^{n} p_{kj}}$$

where d_{ij} is an average distance between the city i and the country j, p_{kj} is the amount of population of the functional urban area k in the country j, and d_{ik} is a distance between city i and the functional urban area k. Individual distances were modelled based on network analysis in a geographical information system.

Another variable that characterises the importance of the availability of the evaluated city is the number of flights (*flights*) that the local airport handled in 2018, both arrivals and departures (Eurostat, 2021g). This parameter characterises the connectivity of the studied cities to the countries of the Central European region. The flights have been included in the model because the distance itself in the present developed transport network does not have to play just one role. The importance of air transport within tourism is growing, and in several instances, it is the driver of the development of urban tourism.

4. Economic importance of destination (city)

The last category of factors includes the variables that operationalise the position of cities within the urban and economic structure of Central Europe. We work on the assumption that the more extensive and more advanced the destination is, the better quality and more diverse spectra of services it offers – it includes a higher number of urban functions. Naturally, various functions attract various types of mobilities and are also reflected in the differentiation of demand segments. We measure the economic importance by means of GDP per capita variable in the purchase power parity (*gdp_city*). The data were obtained from the Eurostat (2021h) and its METROREG dataset published by GDP on behalf of metropolitan regions. Furthermore, as a proxy of the economic importance of a destination, the variable 'city population' (*pop_city*) was used. Data on European cities were collected in the Urban Audit project and is integral to the city statistics from the Eurostat (2021i). Table 3 presents data sources for each independent variable.

3.2.3 Creating the ranking model

The methodology of the model assumes that the eight above-mentioned independent variables determine the value of the ranking index (RI), which evaluates the importance of tourist flows. The ranking index is usually calculated as a weighted average of standardised values of individual variables (Guirao and Campa, 2014). The general formula for this rule is as follows:

$$RI_{ij} = \beta_1 v1_{ij} + \beta_2 v2_{ij} + \beta_3 v3_{ij} + \cdots + \beta_n vn_{ij}$$

where $\beta_{(1-n)}$ are the values for individual variables, whereas $\sum_{i=1}^{n} \beta_n = 1$; and vn_{ij} is n variable for a target destination i and a source country j.

In our case, we decided to determine the same value for each variable, or, not to assume the values in the model. For example, Guirao and Campa (2014) determine the values randomly, without explaining the values. The values determined randomly make the model rather doubtful, with a certain level of subjectivity.

(1) Multiple linear regression

Only variables that are statistically significant are included in the final model. We use the method of multiple linear regression to determine the importance of individual variables and analyses of relations between them. The identified number of arrivals is the dependent variable, and the set of independent variables includes the eight above-mentioned factors that influence the spatial distribution of tourist flows. The general expression of multiple linear regression is as follows:

$$Y_{ij} = b_0 + b_1 v1_{ij} + b_2 v2_{ij} + b_3 v3_{ij} + \cdots + b_8 v8_{ij}$$

where Y_{ij} is the dependent variable of arrivals to destination i from the source country j, b_0 is a constant, the values b_1, b_2, b_3, … b_8 are partial regression coefficients, and $v1_{ij}$, $v2_{ij}$, $v3_{ij}$, … $v8_{ij}$ are the values of independent variables.

To find the most appropriate model, we used the backward method, where all independent variables are first inserted into the model and the calculation algorithm then eliminates those variables that are not statistically significant.

3.2.4 Comparison of results obtained from the model with the spatial distribution of tourist flows to selected cities

In the last step, we compared the results of the model and actual arrivals. We evaluate the correlation at the level of categories determined according to the importance of the tourist flows. The significance categories sort out tourist flows according to their amount based on the Jenks natural breaks classification method. In total, five significance categories were created. To measure the correlation, we applied Spearman Rank Correlation analysis.

The following evaluation is based on the determination of such relations, either overvaluing or undervaluing the model (change is ≥ 2 levels), or they shift the given relation by one category higher or lower. In such cases, the distribution of tourist flows is probably affected by other factors than those used in the analysis.

Area	Variable	Data sources
(1) Tourist attractiveness	*attractivity*	Eurostat (2021a): Urban Audit – Culture and tourism – cities and greater cities – Number of bed-places in tourist accommodation establishments (https://ec.europa.eu/eurostat/databrowser/view/URB_CTOUR__custom_1237092/default/table?lang=en)
		UNESCO (2021): World Heritage List (https://whc.unesco.org/en/list/)
		ICCA (2019): 2018 ICCA Statistics Report: Country & City Rankings (http://www.iccaworld.org/dcps/doc.cfm?docid=2321)
		Eurostat (2019): Culture statistics (https://ec.europa.eu/eurostat/documents/3217494/10177894/KS-01-19-712-EN-N.pdf/915f828b-daae-1cca-ba54-a87e90d6b68b?t=1571393532000)
	nights_region	Eurostat (2021b): Tourism statistics – Nights spent at tourist accommodation establishments by NUTS 2 regions (https://ec.europa.eu/eurostat/databrowser/view/tour_occ_nin2/default/table?lang=en)
		CZSO (2019): Public Database – Collective accommodation establishments by NUTS 3 regions (https://vdb.czso.cz/vdbvo2/faces/en/index.jsf?page=statistiky#katalog=31739)
(2) Importance of source market	*pop20+*	Eurostat (2021c): Main population – Population by age group (tps00010) (https://ec.europa.eu/eurostat/databrowser/view/tps00010/default/table?lang=en)
		Eurostat (2021d): Main population – Population on 1 January (tps0000) (https://ec.europa.eu/eurostat/databrowser/view/tps00001/default/table?lang=en)
	gdp_index	Eurostat (2021e): Economy and finance – GDP per capita in PPS (tec00114) (https://ec.europa.eu/eurostat/databrowser/view/tec00114/default/table?lang=en)
(3) Accessibility	*distance*	ArcGIS Network Analyst
		Eurostat (2021f): Urban Audit – City Statistics: Population on 1 January by age groups and sex - functional urban areas (urb_lpop1) (https://ec.europa.eu/eurostat/databrowser/view/urb_lpop1/default/table?lang=en)
	flights	Eurostat (2021g): Air Transport – Airline traffic data by main airport (https://ec.europa.eu/eurostat/databrowser/view/AVIA_PAOAC__custom_1251681/default/table?lang=en)
(4) Economic importance	*gdp_city*	Eurostat (2021h): METROREG – Economic Accounts by metropolitan regions (https://ec.europa.eu/eurostat/databrowser/view/MET_10R_3GDP__custom_1236660/default/table?lang=en)
	pop_city	Eurostat (2021i): Urban Audit – City Statistics: Population on 1 January by age groups and sex – cities and greater cities (https://ec.europa.eu/eurostat/web/cities/data/database)

Tab. 3: Data sources for independent variables
Source: authors' processing

4. Results of spatial analysis of tourist flows to cities and their determinants

The role of cities in intraregional tourism performance is significant. If we consider the selected cities (34), the tourist flows into them represent 17% of Central Europe's tourism performance. If we assess urban tourism, however, then we estimate that trips to cities account for about 40% of all Central European tourist flows. For example, 2.42 million tourists from the above-mentioned Central European countries came to regional cities in the Czech Republic in 2018, which accounted for 60% of all arrivals in the Czech Republic. Similarly, in the case of voivodship cities in Poland, this share was 40%. In 2018, this share reached 35% in the 14 largest German cities (over 500,000 inhabitants).

Tourist flows to cities in the area reflect the form and structure of tourist flows to regions. Germany's strong dominance as a source country is confirmed, which fundamentally affects the character of internal Central European tourism. Germany accounts for 40% of the monitored flows, representing 45% of the visits of the cities surveyed. Switzerland has a 20% share of the total number of flows, but it generates only 15% of arrivals. This suggests that, although these are more numerous flows mainly to Germany, they are mostly low in volume. Austria ranks third in departures to cities (14% share of flows and 12% of visits) and Poland (10% share of visits) is fourth. A total of 10.6 million foreign tourists from Central European countries went to the 34 Central European cities, i.e. more than 27% of all 38.9 million foreign tourists from eight Central European countries. If we added the available data from other regional cities (regional, voivodship, federal and cantonal), we would approach the border of 14–15 million foreign tourists to administrative centres.

Destinations are dominated by capitals (see Fig. 2). The first four positions are held by the capitals of Austria, the Czech Republic, Germany, and Hungary. Next in line are cities that represent culturally social and commercially important centres in German-speaking regions in western Austria, as well as Switzerland and Germany (Munich, Salzburg, Zurich, Innsbruck, etc.). Second-ranked cities (Camagni et al., 2015), also appear in the foreground, attracting the attention of tourists as secondary centres of commerce (Hamburg, Brno, Graz) or with strong cultural and historical potential (Krakow).

The strongest tourist flow within Central Europe is the departure of Germans to Vienna. There were 1.4 million such trips in 2019. The second strongest flow also comes from Germany, but this time to Prague, with a strength of 65% of the strongest Central European flow. Other strong tourist flows also have a source in Germany and head to Salzburg and Zurich. The strength of these flows approaches the first "non-German" flow from Slovakia to Prague. German departures to Budapest and Swiss to German cities (Berlin, Munich) are also important. The connection of the Austrians to Munich and the Poles to Prague is similar. The volume of journeys above 150,000 arrivals is recorded at Innsbruck (Germans), Berlin (Poles, Austrians), Vienna (Swiss) and Hamburg (Swiss). The strongest tourist flow from the Czech Republic is to Vienna, closely followed by Bratislava.

Overall, Vienna (2 million arrivals) and Prague (1.8 arrivals) are the most popular urban destinations for Central European travellers. Other cities lag significantly. Berlin attracts one million fewer tourists from Central Europe than Prague, with a similar situation for Budapest (1.1 million arrivals compared to Prague). Munich is still in the top five. Salzburg, Zurich, Bratislava, and Hamburg also account for four to three percent of the total number of tourists to the surveyed cities from Central Europe. The Polish and Slovenian capitals are in the middle of the rankings. In general, Polish cities lag the tourism performance of cities from the Czech Republic (influence of Prague), Germany or Austria.

4.1 Factors determining spatial behaviours

To interpret the factors determining the spatial behaviour of cross-border tourists within the Central European region, we have created a basic ranking model. In accordance with the methodology, we first evaluate the suitability of using eight selected variables. Through multiple regression, we identify those variables that enter the final model. The number of Central European arrivals in cities forms the dependent variable, and individual factors (*pop_city*, *gdp_city*, *pop20+*, *nights_region*, *distance*, *attractivity*, *flights_person*, *gdp_index*) form the independent variables.

The backward method identified three statistically significant variables (see Tab. 4). They are the flights variable (0.54), the attractivity and pop20+ variables. These are therefore the three most important factors which, according to the regression analysis, result in the distribution of inbound trips to cities.

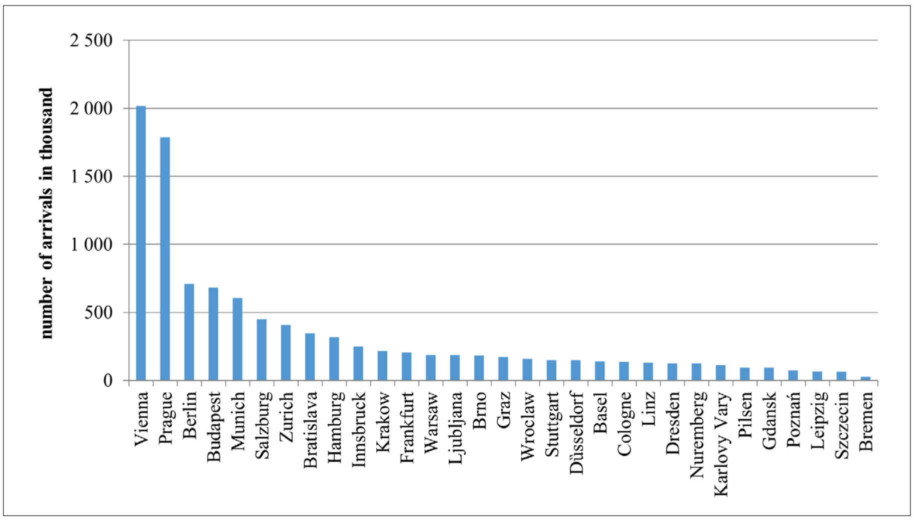

Fig. 2: The most important tourist flows to Central European cities (2018)
Source: authors' processing based on TourMIS (2019), CZSO (2019)

N = 238	Regression Summary for Dependent Variable: arrivals (dataset_flow_v2) R = 0.76; R^2 = 0.57; Adjusted R^2 = 0.56 F(3.227) = 100.36 p					
	b*	Std.Err. of b*	b	Std.Err. of b	t(227)	p-value
Intercept			– 53.214	11.025	– 4.827	0.000
Attractivity	0.276	0.046	47.435	8.630	5.811	0.000
pop20+	0.201	0.049	0.000	0.000	4.141	0.001
Flights	0.536	0.051	0.011	0.001	10.605	0.000

Tab. 4: Regression summary for dependent variable: arrivals
Source: authors' processing

Basically, these results correspond to the general idea of factors influencing the number of city visits. The development of air transport (low-cost transport) is an important predictor of tourist arrivals in cities (see Albalate and Fageda, 2016). Less important, yet still fundamental, is the impact of city attractiveness. Tourist attractiveness based on tourism supply is the main factor that attracts the attention of potential tourists (so-called pull factor). Likewise, the size of the source market proved to be very important here, and so is Germany as a source of demand.

The impact of other variables is very limited, which is surprising, particularly for the variable "distance". It has a negative value (therefore, an indirect relation between the amount of demand and distance of a source market applies here); however, it does not have any fundamental impact on the number of visits. In this context, we can speak about two main factors. The first is material, linked with the importance of air transport for urban tourism, i.e. the impact of distance is declining owing to development and accessibility. The second is methodological, connected with measuring the distance between various space levels (in our case, it is the relation city – country). The weighted average can significantly distort the real accessibility of destinations, particularly in large cities, since the capacity of demand is influenced by the significance of ties (mainly, close border agglomerations which are, on average, disappearing).

The adequacy of the whole model is evaluated based on R Square (R^2) and Adjusted R^2. In our case, R^2 equals 0.57. It implies that 57% of the variance of the dependent variable is explained by the variables selected by us. Considering the size of the dataset, the Adjusted R^2 is similar, and it does not change the interpretation. The results show that there is still relatively large space for the inclusion of other factors. Such factors are very difficult to be quantified and operationalised, however. They include the impact of historical and cultural ties, travels with the aim to visit friends and relatives, or a destination image factor.

Based on the results of the regression analysis, we compiled a simple ranking model that considers only the three most important variables (*pop20+*; *attractivity*; *flights*). The results are presented in Table 5. The table shows the thirty most significant identified flows. Besides the score obtained from the model, the table also includes the values of all arrivals from the Central European countries and their categorisation according to their significance (based on Jenks natural breaks classification method).

The general informative quality of the model, as well as the factors, is quite good. If we compare the ranking of visits to the cities obtained from the statistics on tourism and the model, then the Spearman Rank Order Correlations reach the value of 0.74. Naturally, the order of individual tourist flows differs; however, the basic patterns of the spatial behaviour of Central European travellers becomes evident here. Primarily, it is the importance of Germany as a source market vital for both nearby destinations in Austria and Switzerland and all capitals of the surveyed countries. A very close relation between Switzerland and Austria also shown to exist here. The model assigns higher importance to Poland as a source country, which may, to a certain extent, cause the insufficiently used capacity of the Polish market.

Rank	Flow	Score	Arrivals	Category
1	DE – Vienna	2.94	1,390	1
2	DE – Prague	2.27	913	1
3	DE – Zurich	2.27	317	2
4	DE – Budapest	2.05	289	2
5	DE – Warsaw	1.92	118	3
6	DE – Salzburg	1.85	346	2
7	DE – Krakow	1.67	118	3
8	DE – Wroclaw	1.58	134	3
9	PL – Vienna	1.54	132	3
10	PL – Prague	1.54	232	2
11	DE – Basel	1.52	118	3
12	DE – Geneva	1.49	33	5
13	DE – Graz	1.48	129	3
14	CH – Vienna	1.37	193	3
15	DE – Ljubljana	1.35	76	4
16	DE – Brno	1.33	40	5
17	PL – Munich	1.29	50	4
18	DE – Bratislava	1.28	80	4
19	DE – Bern	1.26	50	4
20	DE – Gdansk	1.26	82	4
21	PL – Berlin	1.26	181	3
22	PL – Budapest	1.25	100	3
23	PL – Frankfurt	1.22	33	5
24	DE – Poznań	1.20	65	4
25	CH – Berlin	1.18	242	2
26	CZ – Vienna	1.17	115	3
27	DE – Linz	1.15	102	3
28	AT – Prague	1.15	143	3
29	HU – Prague	1.15	106	3
30	CH – Prague	1.14	77	4

Tab. 5: Ranking model – Thirty most important tourist flows. Source: authors' processing

A detailed analysis of the individual tourist flows generated by the model is analysed by the comparison of individual relations into categories of significance.

From the total number of 238 relations, the model significantly overvalues or undervalues nine tourist flows (see Tab. 6). The model overvalues or undervalues, only slightly (shift by one category), the other 30 relations.

The model significantly overvalues trips from Germany to Brno and Geneva and from Poland to Frankfurt. The model significantly undervalues relations between the Czech Republic and Slovakia and the Swiss and Austrians with Hamburg. Therefore, impacts and factors other than those specified in the model will be relevant here – for example, cultural proximity and historical ties. The same hypothesis may be also applied for relations between Switzerland as a source country and German cities, such as Düsseldorf, Cologne and Stuttgart, or, between Austria and Bratislava or Slovakia and Brno.

The distance factor in the model does not exhibit the expected results. Even though the regression analysis indicates an inverse relation between distance and arrivals (negative regression coefficient b), the significance of this variable is weak. It probably appears also in the results when the model either undervalues or overvalues close relations. The reason for that might lie in the above-mentioned construction of this variable (weighted average of the distance from the main agglomerations of the given country).

5. Discussion

Although the objects of the analysis are the most important cities in the region, the results still show a high level of unevenness of tourist flows to cities. This is perhaps not surprising, as tourism is, by its nature, a significantly differentiated phenomenon. Explaining the differences and consequences for future development is the primary motivation of this paper. Tourist flows represent a kind of materialisation of the interaction between the supply and demand factors affecting tourism. Unlike Zhang and Jensen (2007), we focus on supply-side factors and on demand variables. We consider this approach to be very important.

In the case of Central Europe, it proves to be a significant influence on the size and importance of source markets, the transport accessibility of localities, and the effect of the very attractiveness of destinations. These results are broadly consistent with Jansen-Verbeke and Spee (1995), who point to the impact of the source market's population size. Another factor, the number of direct flights between the original countries and cities, also contributes to the importance of international tourist flows (Lohmann et al., 2009; Khan et al., 2017). This is mainly due to low-cost flights, which brought new segments to cities and more frequent and more varied connections (Kraft and Havlíková, 2016). The importance of air transport in the number of tourists to cities and the geographical proximity of such links has increasingly relevant consequences today. Measures in response to climate change, as well as changes in travellers' preferences, are already leading to pressure for changes in transport modes. The development of railway infrastructure, especially the implementation of high-speed transport systems in practice, is undoubtedly a challenge for the future. Both Europe's transport policies and indeed the EU's activities in the Green Deal emphasise these issues.

The last important factor is the tourist attractiveness of the destinations. Attractiveness has always been the focus of several authors (Bozic et al., 2017; Krešić and Prebežac, 2011), who evaluate the historical value of destinations or the 'equipment' of tourist sites with tourist

By at least 2 levels		**By 1 level**	
Significantly overvalues	Significantly undervalues	Overvalues	Undervalues
DE – Brno	CH – Munich	DE – Warsaw	CH – Berlin
PL – Frankfurt	AT – Munich	DE – Krakow	DE – Innsbruck
DE – Geneva	SK – Prague	DE – Wroclaw	HU – Vienna
	CH – Hamburg	PL – Vienna	AT – Berlin
	AT – Hamburg	DE – Ljubljana	SK – Budapest
	CZ – Bratislava	PL – Munich	PL – Bratislava
		DE – Bratislava	CH – Düsseldorf
		DE – Bern	AT – Bratislava
		DE – Gdansk	SK – Brno
		DE – Poznań	CH – Cologne
		PL – Salzburg	CH – Stuttgart
		SK – Vienna	
		SI – Prague	
		SI – Vienna	
		DE – Ostrava	
		HU – Berlin	
		PL – Hamburg	
		PL – Dresden	
		PL – Bremen	

Tab. 6: Relation with the change of order
Source: authors' processing

infrastructure. All these factors are applied in our analyses and significantly affect the size of tourist flows. In principle, this is a traditional factor, which was the subject of research in the first geographically oriented research in tourism (Häufler, 1955).

On the other hand, we did not demonstrate the influence of price factors (differences in price levels), nor the effect of factors of city size and their economic maturity. Zhang and Jensen (2007) reached the same results in terms of price competitiveness. Some studies do consider the relative economic position of the destination as an important factor. For example, Marrocu and Paci (2013) assume that the high elasticity of destination GDP indicates that favourable economic development and is enhanced by the availability of public services in the visited locations.

A more detailed analysis of the individual relations of cities to source markets can shed more light on the interpretation of the main factors influencing tourist flows in Central Europe. Two types of cities in the region have different market positions. By the thesis of hybrid processes and the application of path-dependent path-creation tourism development during the transition years (Baláž and Williams, 2005), we can emphasise the different involvement of the studied cities in global processes. On the one hand, there are cities (dominantly) in the western half of the examined region, well connected to the surrounding world and acting as important sources of demand (Germany, Switzerland, Austria). On the other hand, there are many cities in the region that must rely on their traditional long-term markets. The dynamics of their development depend on the situation in the immediate vicinity (the market proximity factor dominates). In this case, tourist flows are constituted around existing networks, and deep-rooted social routines and a path dependency trajectory are manifested. These are mostly second-order cities that lack strong links to a broader range of source markets within the region.

On the contrary, well-anchored cities, which often have the status of capitals (Prague, Budapest), can abandon the original models, and radically reposition themselves in global markets (path creating). The identified factors play a role in these processes. Air transport, cities' attractiveness and connections to the most important markets create benefits for already established destinations. Low sensitivity to price competitiveness or destination GDP results from barriers and limits that lock destinations in the region's traditional model of spatial position. Barriers and limits can be found both in the mentioned social routines and in the historical-political ties and differences of the monitored destinations. An equally important factor can be the level of availability, image, and other variables. An excellent example of the manifestation of such barriers and limits is the low connection of Polish cities with the rest of the region (except Germany). For example, knowledge of Wroclaw as an important economic centre of Poland is negligible in the Czech population, business contacts are not significantly exceptional, and transport connections are unsatisfactory.

6. Conclusions

An analysis of the visits between Central European countries has shown that the region is one of the important objectives of contemporary tourism but is lagging its potential. It is in third place in the ranking of the sub-regions of Europe, well behind southern and western Europe. On the other hand, there are substantial internal resources from which the region's tourism can draw. Undoubtedly, this is the territory's attractiveness due mainly to the presence of the Alpine region and the localisation of major urban destinations. Border tourism must also not be neglected, but this is not always reflected in the performance of collective accommodation establishments (excluding one-day visits). An important factor is also the region's population size, which offers an opportunity for intraregional mobility: only about one third of the share of Central European tourists is seen in the performances of Central Europe. This ratio is significantly below the similar ratio in the case of European tourists in Europe (they account for 78%). Similar results are based on a comparison of the volume of visits made to the region's population. In Europe as a whole, this indicator is 0.55 (415 million arrivals per 750 million inhabitants), and in the Central European region, this figure is less than half (0.24). These processes are even more robust in the case of urban tourism. The tendency to globalise links to the external environment is a natural feature of urban development. Cities are more strongly integrated into global value chains; they are centres of international trade and therefore destinations for business travel. Moreover, they have good accessibility and are well connected to remote source markets because of air infrastructure.

How to interpret these data? Tourism and its performance are not minor in Central Europe, but relative to the population and their purchasing power, there is the potential to activate the region's internal resources. The 160 million inhabitants of Central Europe make their journeys mainly outside their own region. In today's globalised and interconnected world, this is a natural phenomenon. The world's current problems, whether it be the short-term impact of the COVID-19 pandemic or the significantly deeper problems of climate change, however, are causing the need for changes in travel behaviours towards sustainable development. This is a departure from quantitative development, based on the continuous growth of visits to the inclusion of qualitative components of consumption and an emphasis on local and regional tourism (travel within the region and in the vicinity, elimination of carbon footprints, etc.).

When we assess the interactions between the countries monitored, there is still a clear boundary between the western parts of the region and the post-socialist countries. Germany's national ties with Austria and Switzerland generate 47% of all trips examined. Interactions between Germany and the Czech Republic (1.3 million trips between them), and Germany and Poland (1 million mutual trips), follow closely. The strongest non-German interaction is between the Czech Republic and Slovakia. Intraregional flows within the examined cities of the Czech Republic, Hungary, Poland, and Slovakia, known as the Visegrad Group (V4), are negligible, making up only 3% of the total volume of visits. This is also because the Czech Republic or Poland are more strongly connected to Germany than to their V4 neighbours and the weak position of Polish cities in intraregional interactions. The Czech Republic also benefits from its location and the attractiveness of Prague, and is a kind of bridge between the west and east of the region.

There are three main factors behind the distribution of tourist flows in Central Europe. The most important is the air connection, which is playing an increasingly important role in international tourism. An equally important factor is the actual attractiveness of the destination. Tourists to Central Europe are dominated by capital cities and selected attractive second-rank cities (Wroclaw, Krakow, Salzburg, Graz, Nuremberg, Brno, and others). The third crucial factor is the size of the source market and corresponds to Germany's above-mentioned influence on traffic and its spatial distribution.

Indirectly, we have showed the importance of factors that cannot be well quantified. It is mainly the influence of cultural and historical ties, but also broader socio-economic contexts. In our case, we are talking about relations between the Czech Republic and Slovakia, and Switzerland with selected German cities. Undoubtedly, the close distance between Bratislava and Austria, or between Slovakia and Brno, is also essential.

Global tourist systems and their interconnection by air transport are strongly reflected in the visits to cities. Therefore, the development of intraregional visits must be oriented towards the strong links of geographically close metropolises. Location, accessibility, tourist attractiveness of the destination and strength of ties, determine the potential of tourist mobility. The connection of the main sources of demand in the west of the region with attractive locations in the east is the promise of further development of tourism in the region.

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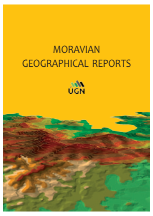

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Barriers everyone: A new method for multiscale analysis of barriers using the Barrier Index

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Abstract

The Barrier Index is presented in this contribution. The index shows the extent to which spatial units of different sizes are closed off by barriers, influencing society by the different "thickness" and "thinness" of boundaries. The article defines the Index and compares land units with barriers in various details. The calculations were made for spatial units from the scale of parcels to one-hectare areas in selected types of regions, selected geographic regions, and border barriers in selected countries. The Index is useful for cross-scale analysis and for identifying the underlying causes and relationships within different cultural, social, and geographical contexts. The example of spatially persistent family structures was used to highlight the underpinning influencing factors that connect the building of barriers at different scales.

Keywords: *Barrier Index; border; barrier; fence; urban design; human geography*

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1. Introduction

A novel index that defines barriers as a spatial structure is proposed in this article. The term "barrier" is used in the sense of an umbrella term that refers to various physical barriers, such as fences and walls, security barriers, fortifications, and even virtual walls. It also refers to natural barriers. The novelty of this study is that it allows comparing barriers at different spatial scales and barriers in one place throughout history. In this way, the article contributes to a better understanding of the modern world, where barriers are increasing at all levels, especially at the level of countries that erect border barriers.

Barriers define the property of a place which is expressed as territoriality. Territoriality can be examined at different spatial scales: from primary (people's homes and places not accessible to others) to secondary (clubs and bars), to public (parks and streets), and to the national (country) level. The design of places is within the domain of architecture, whose criteria of strength, functionality, and beauty have been known since Antiquity (Vitruvius, 2009). However, a conflict arises in this regard: the more safety and privacy a specific place offers, the lower is its mobility. This separation is reflected in Robert Frost's poem, Mending Wall: "Good fences make good neighbours". At the local scale, the territory is defined as exclusive ownership of a portion of the earth's known surface, controlled by visually or physically permeable technical elements, such as walls and fences. This simple definition has evolved to bring a more complex understanding (Elden, 2013), including local and regional effects, and sovereignty as a legitimacy of social groups to exercise their power over territory (Domínguez-Mujica, Díaz-Hernandez and Parreno-Castellano, 2016) and "to determine who belongs where and who is and who is not a member of the group" (Warf, 2010, p. 292). Introducing border barriers has long-term effects on society (Repe, 2018) – the border effect can be observed (Minondo, 2007).

The article addresses a research gap in the analysis of bordering at different spatial scales. We propose a method to analyse the relationships and possible differences between territories based on barriers at their borders. The analysis was done at the level of regions, countries, and cities (Jirón, 2010), as well as at lower spatial levels, such as parcels of land, typical examples of territories with defined ownership (Komac and Kušar, 2017; Revzina, 2018).

The main objective of the article is to define the Barrier Index and its subtypes, and to present its use in enclosed

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areas of different sizes and types, from the level of parcel to the level of regions. In the Results section, a detailed analysis of the Barrier Index is carried out at the county level, for which comparable data are available. The new index allows physical barriers to be defined regardless of their relative size. Thus, we can present the underlying geographical processes, so that in the Discussion section we relate the barriers to some fairly stable social structures and propose some policy implications.

2. Theoretical background

The topic discussed here is clearly multidisciplinary as boundaries depend on a combined understanding of human relations, history, culture, economy, perceptions, stereotypes, ethics, symbols, and constructions (Pounds, 1972; Donnan and Wilson, 1999; Newman, 2003; Vallet, 2018). They are "real or understood, visible or invisible (Jones, 2012), natural or artificial, of legal or of no legal significance" (Clark, 1998, p. 50). Barriers are built at the borders to separate the interior from the exterior, the public from the private, the private from the private, and the private from the feudal, state-owned, and common (Petek and Urbanc, 2007). Providing privacy is a dynamic process, in which individuals or groups are controlled (Altman, 1977). Most of the research on the topic has been done at the level of countries.

As spatial border markers, barriers have accompanied the built environment since prehistory. The Bible describes how it is good for a vineyard to have "a wall to the right and a wall to the left" (Sir 36: 25; Num 22: 24). The nearly 10,000 km long discontinuous Great Wall of China was built through centuries after the 7th century BC to prevent incursions of nomadic peoples from the Eurasian steppes, similar to the Japanese 20 km long Genkö Börui from the 13th century. The Romans built several limites along their borders in the 2nd century, while the Danish King Gudfred wall was built in the 7th century. Although the idea of un-crossable lines disappeared with Ancient Rome, the barriers still enforce and justify the system of territorial borders (Vallet and David, 2012).

Nijkamp and Rietveld (1989) provided the first classification of barriers, dividing them into natural and manmade. An example of the former are mountainous areas, lakes, rivers, swamps (Alm and Burkhart, 2013), and seas, such as the Mediterranean (Locchi, 2016). In the early phases of territorialisation, physical delimitations became part of the cultural and political landscape, as shown by the following statement by Herder on the foundation of the US and Canada: "Nature separated nations by mountains, seas, rivers, and deserts" (cf. Pounds, 1972, p. 61).

At first, borders marked the territory of a specific people and, later the nation, and were ultimately defined as a feature of state territory. Before the development of nation-states, territories such as those in feudal Europe were delimited by fluid barriers, and by dynamic frontiers (Brown, 2010). From the Peace of Westphalia (1648) to the twentieth century, borders were conceived as linear landscape elements (Pounds, 1972). State borders evolved as lines of demarcation, marking the dissimilarities between institutional and cultural settings (Van Geenhuizen and Rietveld, 2002).

In the second half of the 20th century, globalisation led to the opening of borders, increased mobility, and deterritorialisation (Sassen, 2008). Borders acquired the character of networks, and became more porous and loosely regulated (Dear, 2013). The term territory acquired a meaning that connects the contexts of terrain, identity, and culture (Agnew, 1994).

Nonetheless, territorial claims based on ethnic considerations have increased (Medzini, 2016). Various barriers have been erected, while the borders have been thickening and becoming less permeable due to security enhancements (Haselberger, 2014; Heiskanen, 2016). The process of bordering has created large frontiers or borderlands (Warf, 2010; Casey and Watkins, 2014). A re-emphasis on statehood and demands for greater security (Newman, 2006; Warf, 2010) resulted in a shift from borders and fences to walls (Jones, 2012; Roche, 2016).

Border linearity is now being emphasised again, but this time around it is enhanced with virtuality (Heyman, 2008) and dispersion (Kolossov, 2005) resulting in a "new border landscape" (Konrad, 2016, p. 90). Borders are increasingly marked by barriers and enhanced by social practices (Johnson, Jones, Paasi, Amoore, Mountz, Salter and Rumford, 2011), such as electronic biometric surveillance systems (Amsoore, 2006; Parker and Vaughan-Williams, 2009; Golunov, 2014). As the new technologies may exist "everywhere" (Pena, 2021) the borders became diffuse (Johnson et al., 2011). Dynamic border management works across scales, from the transnational level to the level of individuals, beyond border space (Adey, 2004; Newman, 2006; Heiskanen, 2016). We observe a trend of "examining and analysing issues beyond and below the scale of the nation-state" (Warf, 2010, p. 2224).

Paradoxically, the described border dispersion (Haselberger, 2014) is characterised by the development of thick borders with an increasing number of border separation barriers, fences, and walls (Wills, 2016). Even ordinary spaces are saturated with "borders, walls, fences, thresholds, signposted areas…" (Multiplicity, 2005). We face increasing local bordering activities (Silvey, Olson and Truelove, 2007) at increasingly lower spatial scales (Nijkamp and Rietveld, 1989), such as gated communities, "resilient" communities, and respect zones (Johnson et al., 2011). In this article we address this changing nature of border separation regardless of the spatial scale.

3. Methods and data: Comparison of barriers at different spatial scales

Spatial entities enclosed with boundaries that take the physical form of barriers are a general spatial feature. To analyse their meaning, each spatial unit, such as a parcel or state, must be ascribed a numerical value termed an index. The index shows the ratio between a barrier's length and the size, area, or other features of a selected entity.

As an index (as described by Wentz, 2000), the proposed Barrier Index is easy to understand, since similar phenomena have similar values, and the values are independent of the size of phenomena, their movements, and scale. The values are comparable across scales. We submit that the border barrier index can be a useful statistical measure, giving readings that vary widely between 0.00 and 1.00 or 0 and 100 (percent). This makes it possible to measure the status and tendencies within any given territory on one continuous scale.

Here we define the Barrier Index. To calculate the index for the selected spatial units we used the border barrier length and compared it to the land border length. Countries that, according to the data available, had built a wall or were located along a natural barrier were included. Data on border lengths, the area of countries, the population, and border barrier lengths were taken from publicly available sources, such as The World Factbook (2019).

The Barrier Index, originally based on the border barrier length, was further divided into four subtypes, with the option for additional ones. The Barrier Length Index (BLI) defines the share of an entity's perimeter in relation to the entire perimeter on which a barrier could be erected. It is expressed in absolute values as m/m (km/km) or in relative values as a percentage of a parcel's fenced perimeter. The values range between 0.00 and 1.00. The Barrier Area Index (BAI) is defined by the length of a fence per area of the spatial entity enclosed with this fence (m/m^2; km/km^2). For example, the length of border barriers of a country in km is divided by the area of the country in km^2. For combined units (e.g. parts of settlements), this index can be calculated from the average indices of smaller units (e.g. parcels) that make up the larger one. The length of barriers in the spatial unit is summed and divided by the total area of the unit. To add a social perspective, the Barrier Population Index (BPI), is proposed. It is calculated by the value of the Barrier Length Index with the population (per 10,000 people) and it is thus population-density-dependent. As the borders are not just barriers but they allow mobility of people, goods, and data through openings, checkpoints, and gates (Pallister-Wilkins, 2016), we propose the Barrier Closure Index (BCI). It shows the ratio between length of the barrier (e.g. border in case of countries) in 1,000 km divided by the number of barrier openings or crossings (Fig. 1). In the case of country borders it is based on the number of land border crossings. Its values range from 0.00 to 1.00. The low BCI defines barriers as "open" and high values as "closed".

4. Results and discussion

4.1 Analysis at the parcel level

Parcels are the smallest, precisely measured pieces of fertile or infertile land with one or several owners, belonging to a specific cadastral district, and entered in the land register under a specific number (Kladnik, Lovrenčak and Orožen Adamič, 2005). They vary in shape (Foški, 2019), land use, and size (Irwin and Bockstael, 2004). In this study, we present the example of parcels in various Slovenian regions.

We selected this example because the needed data were available (Geodetska..., 2020). The BLI for the selected parcels ranged between 0.50 and 1.00, depending on the location of the main and auxiliary buildings in the parcel. Most parcels were quadrangular, with one side usually along the road where fences are most common. This is also confirmed by the BLI for roadside fences in selected towns across Slovenia, which ranged between 0.17 and 0.90. The lowest value was recorded in Žerovnica, Southern Slovenia, where erecting fences is clearly not part of the local tradition and parcel borders are usually indicated with a curb, a road, or the edge of a lawn (Tab. 1).

4.2 Analysis at the street level

Certain differences of the BLI at the street level can be observed between the (Slovenian) regions, stemming from tradition and natural conditions. The Slovenian example was selected because its territory combines Alpine, Dinaric, Mediterranean and Pannonian landscapes and is a European landscape hotspot with high landscape diversity (Perko, Ciglič and Zorn, 2019). The calculated BLI ranges from 0.173 in the Dinaric region to 0.903 in the Pannonian region (Tab. 2). We observe that the differences are gradually disappearing due to globalisation. An example of this is the stone walls in karst regions, which were created because of piling up leftover rocks obtained by clearing farmland. Another example is the Ljubljana Marsh, where parcel borders are "marked" by ditches. Modern construction of parcel fences follows traditional patterns (Kušar and Komac, 2019).

4.3 Analysis at the one-hectare area level

One-hectare areas with detached houses in randomly selected examples of Cordoba (Argentina), Kampala (Uganda), Ljubljana (Slovenia), Nakhon Sawan (Thailand), and Uppsala (Sweden; Fig. 2) showed a BAI between 0.38 and 0.66. The index was the highest in Sweden (0.66) and

Fig. 1: The San Ysidro Port of Entry is the largest land border crossing between San Diego in the USA and Tijuana in Mexico. Source: Mimi Urbanc, with permission

Level	Unit name	Number of cadastral municipality	Number of parcel	Coordinates	Barrier Length Index	Barrier Area Index
1 Parcel (Slovenia)	Central (Ivančna Gorica)	1,820	46/1	45°56'19"N; 14°48'26"E	1.00	145.83
1 Parcel (Slovenia)	Pannonian (Nedelice)	152	1414	46°36'37"N; 16°20'22"E	0.54	53.99
1 Parcel (Slovenia)	Mediterranean (Šmarje)	2,608	889/1	45°30'07"N; 13°42'54"E	0.60	101.24
1 Parcel (Slovenia)	Dinaric (Petelinje)	2,501	1252/2	45°41'22"N; 14°11'43"E	0.84	113.57
1 Parcel (Slovenia)	Alpine (Kranj)	2,131	128/1	46°13'54"N; 14°20'29"E	0.74	120.72
Average					**0.74**	**107.07**

Tab. 1: Barrier Index at the parcel level in selected Slovenian settlements
Source: authors' calculations

Level	Unit name	Coordinates	Barrier Length Index
2 Street (Slovenia)	Central (Ivančna Gorica)	45°56'22N; 14°48'30"E	0.61
2 Street (Slovenia)	Pannonian (Beltinci)	46°36'32N; 16°13'31"E	0.90
2 Street (Slovenia)	Mediterranean (Prade, Koper)	45°32'19N; 13°46'29"E	0.59
2 Street (Slovenia)	Dinaric (Žerovnica, Cerknica)	45°45'31N; 14°25'33"E	0.17
2 Street (Slovenia)	Alpine (Radovljica)	46°20'57N; 14°10'16"E	0.70
Average			**0.59**

Tab. 2: Barrier Index at the street level
Source: authors' calculations

the lowest in Thailand (0.38; Tab. 3). The aim was not to present a comprehensive analysis but to show that the method can be applied worldwide.

The analysis of four randomly chosen settlement areas around the world showed that the borders of land are marked everywhere, but that the types of barriers depend on a series of factors. In Sweden, the fences are low, made of wood or metal, and easy to traverse, but the border can also be indicated by ground landscaped in various ways

Fig. 2: Barrier Index for the one-hectare area in Uppsala (red: borders of the area examined, yellow: barriers)
Source: Google Maps and Google Street View

(gravel, grass, or flowerbeds). In Uganda, the fences are tall, furnished with security elements (barbed wire and broken glass), and are used to prevent access to land or for security reasons. Other examples (Cordoba, Ljubljana, and Nakhon Sawan) are somewhere in between. In Sweden and partly in Slovenia, the buildings mostly stand in the centre of parcels, whereas in Argentina and Uganda the main building is part of the border. Common and public land or low-value land usually has no fences.

In Europe, most cities removed their medieval walls at the end of the nineteenth century because, as military technology improved, the walls became ineffective and hindered urban expansion. They were replaced by other security devices and their security role moved to a higher, national level and to a lower, parcel level. Such abandonment of city walls shows that on the one hand cities were becoming more externally open and, on the other, more internally closed (Foucault, 2009), if referring to the fences and barriers around individual house lots.

4.4 Analysis of countries

Enclosing countries with barriers is a common practice in both totalitarian regimes and democracies (Fig. 3; Jones, 2012). As of 2013, "the US, Israel, Greece, Spain and India had a total of 6,000 kilometres of walls" (Vallet, 2018); see Vallet for a comprehensive overview. For this study, we collected data on erected barriers for the selected countries; border barriers with a total length of 10,659 km were covered (Tab. 4). This is a conservative estimate of built walls and fences as, according to some sources, the total length of border barriers around the world (not only walls and fences) varies from 18,000 km (Foucher, 2011) to more

Level	Unit name	Coordinates	Barrier Length Index
3 Settlement/Street	Ljubljana (Slovenia)	46°02'22"N; 14°30'04"E	64.7
3 Settlement/Street	Uppsala (Sweden)	59°51'33"N; 17°39'33"E	66.0
3 Settlement/Street	Cordoba (Argentina)	31°25'20"S; 64°07'25"W	58.6
3 Settlement/Street	Kampala (Uganda)	0°22'49"N; 32°35'54"E	40.4
3 Settlement/Street	Nakhon Sawan (Thailand)	15°41'39"N; 100°06'52"E	38.0
Average			**53.54**

Tab. 3: Barrier Index at the one-hectare area level
Source: authors' calculations

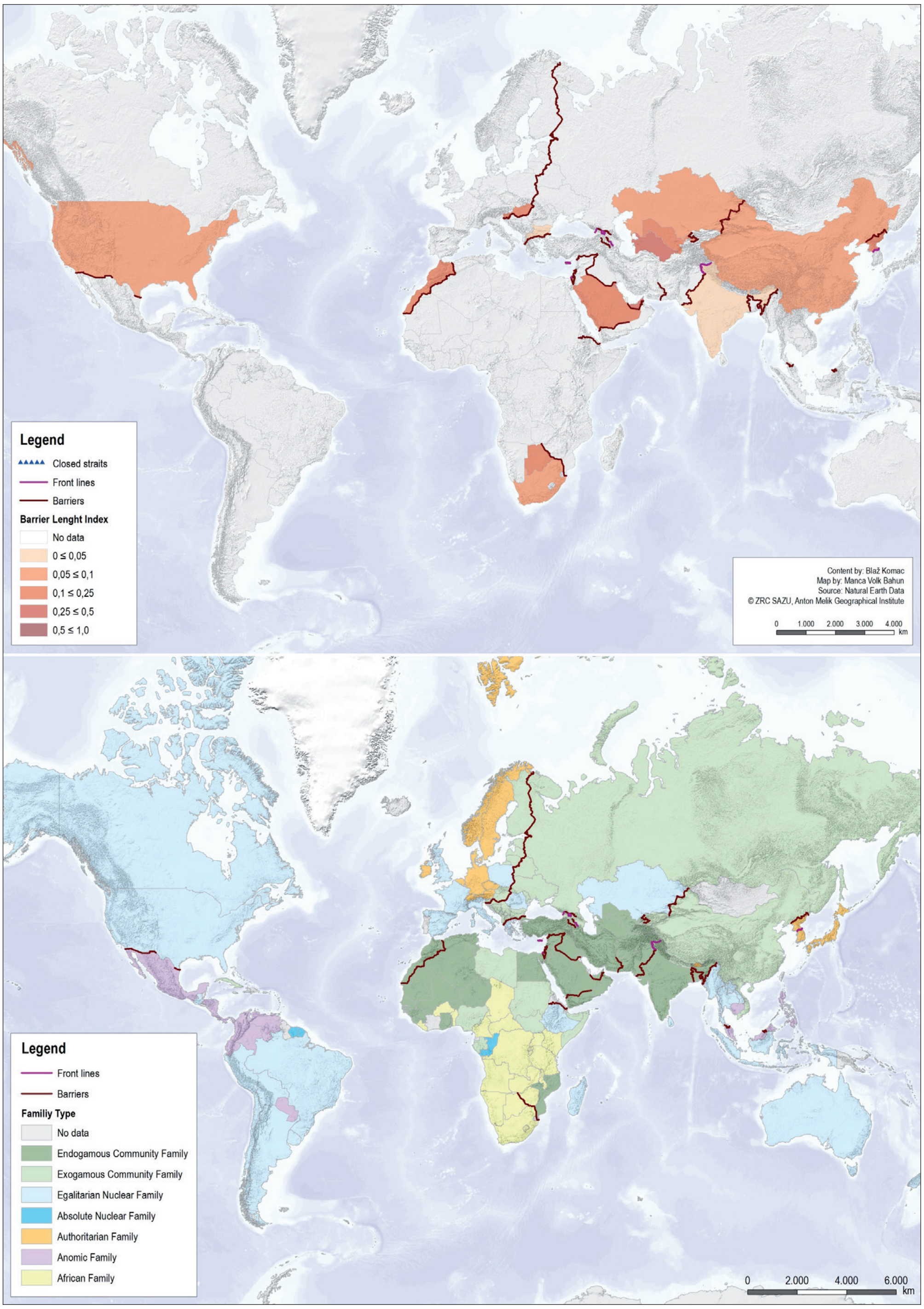

Fig. 3: Barrier Length Index in the countries with border barriers analysed (top) and the countries' predominant social structure illustrated by family systems (bottom)
Sources: Todd, 1985; data by Rijpma and Carmichael, 2016; Rosière and Jones, 2012: 219; Schengen included as a barrier; authors' compilation

Unit name	A	B	C	D	E	BLI = B / A	BAI = C / B	BPI = D / B * 10,000	BCI = E / A * 1,000
	Border length [km]	Barrier length [km]	Area [km^2]	Population [July 2017]	Number of land border crossings	Barrier Length Index	Barrier Area Index	Barrier Population Index [km per million inhabitants]	Border Closure Index [1,000 km of border per border crossing]
Botswana	4,347	813	581,730	2,294,104	26	0.19	0.001	3.54	0.17
South Africa	5,244	345	1,219,090	55,380,000	48	0.07	0.0003	0.06	0.11
USA	12,034	930	9,833,517	329,256,465	173	0.08	0.0001	0.03	0.07
China	22,147	1,416	9,596,960	1,379,302,771	116	0.06	0.0001	0.01	0.19
Hong Kong	32	32	1,108	7,213,338	14	1.00	0.029	0.04	0.00
India	13,888	550	3,287,263	1,296,834	65	0.04	0.0002	4.24	0.21
Kazakhstan	13,364	45	2,724,900	18,744,548	15	0.00	0.0000	0.02	0.89
North Korea	1,607	248	120,538	25,381,085	21	0.15	0.002	0.10	0.08
Uzbekistan	6,893	1,079	447,400	30,023,709	7	0.16	0.002	0.36	0.98
Turkmenistan	4,158	1,700	488,100	5,411,012	9	0.41	0.003	3.14	0.46
Austria	2,524	25	83,871	8,793,370	55	0.01	0.0003	0.03	0.05
Bulgaria	1,806	30	110,879	7,057,504	50	0.02	0.0003	0.04	0.04
Greece	1,228	11	131,957	10,768,477	37	0.01	0.000083	0.01	0.03
Hungary	2,106	523	93,028	9,980,000	65	0.25	0.006	0.52	0.03
N. Macedonia	838	30	25,713	2,118,945	25	0.04	0.001	0.14	0.03
Slovenia	1,322	200	20,273	2,102,126	24	0.15	0.010	0.95	0.06
Spain	1,953	19	505,370	46,080,000	39	0.01	0.00004	0.00	0.05
Brunei	266	20	5,765	450,565	6	0.08	0.003	0.44	0.04
Cyprus	152	152	9,251	1,221,549	10	1.00	0.0164	1.24	0.02
Egypt	2,612	3	1,001,450	99,413,317	13	0.00	0.000003	0.00	0.20
Israel	1,068	780	20,770	8,424,904	16	0.73	0.038	0.93	0.07
Kuwait	475	193	17,818	2,916,467	2	0.41	0.011	0.66	0.24
Morocco	2,018	443	446,550	33,986,655	4	0.22	0.001	0.13	0.50
Saudi Arabia	4,431	975	2,149,690	33,091,113	6	0.22	0.0005	0.29	0.74
United Arab Emirates	867	410	83,600	6,072,475	12	0.47	0.005	0,68	0.07

Tab. 4: Barrier Index at the country level
Source: authors' calculations

than 41,000 km of "terrestrial closed borders" (Ballif and Rosière 2009, p. 193–206), of which 87% or 35,670 km are walls and fences. According to Rosière and Jones (2012), the total length of border barriers is 27,624 km, while the total length of forty-five walls was 29,000 km in 2011 according to Vallet (2018) and Vallet and David (2012). The data vary also because they may include the planned walls.

The mean BLI for the 25 analysed countries (Austria, Botswana, Brunei, Bulgaria, China, Cyprus, Egypt, Greece, Hong Kong, Hungary, India, Israel, Kazakhstan, Kuwait, Morocco, North Korea, North Macedonia, Uzbekistan, Saudi Arabia, Slovenia, South Africa, Spain, Turkmenistan, United Arab Emirates, and the USA) is 0.25, with values ranging from 0.001 to 1.00. The above-average values were recorded for Hong Kong and Cyprus (1.00), Israel (0.73), Kuwait (0.51), United Arab Emirates (0.47), Turkmenistan (0.41), and Hungary (0.25). The average BAI for the analysed countries with border barriers is 0.01 with a minimal value of 0.000003 for Egypt and a maximal value of 0.038 for Israel. The BPI ranges from 0.03 (Egypt) to 424.11 (India), with a mean value of 68.24. The BCI ranges from zero (Hong Kong) to 0.98 (Uzbekistan), with a mean value of 0.21.

Asia has the largest number of barriers among all the continents (5,070 km), with the Middle East having the highest average BLI (0.40; Fig. 4) and second highest BCI (0.23). As regards the BLI, the Middle East is followed by Asia (0.28) with the highest BCI (0.40). The BLI is low in Africa (0.13), North America (0.08), and Europe (0.07). The BPI is the highest in Asia and Africa (1.13 and 1.12, respectively) and the lowest in North America (0.03). In terms of barrier length, the Middle East is second (2,976 km), followed by North America (930 km), Africa (845 km), and Europe (838 km).

Calculating the BLI by country (N = 25) made it possible to estimate the global index. All the world's countries combined have approximately 460,000 km of land borders and 10,659–29,000 km barriers. Hence, the global BLI is 0.02 to 0.06. However, at the global level at least twice as many border barriers are planned or under construction (30 walls, 25,000 km long), following the increasing trend in the post-WWII-period (Vallet and David, 2012). Based on the US and Israel, the average cost of barrier building about 1.7×10^6 US$ per km or 350,000 US$/km/year (Vallet, 2018), the estimated global cost of building the barriers is 16×10^9 US$, an equivalent to the GDP of Somalia, Haiti, Kosovo, South Sudan or Iceland.

4.5 Analysis of the selected regions

We present selected examples of the data on barriers for the Schengen Area (those borders that are subject to strict control), for Slovenia (Fig. 5) during various historical periods (Tab. 4), and some approximations for the selected historical and natural areas, such as China under the rule of the Ming Dynasty, the Alps, the Mississippi basin, and the continents.

The example of the Schengen Area covers four million square kilometres and is enclosed by a 6,277 km land border established in 1985, which, due to its strict controls, is here considered a border barrier (Haselberger, 2014). The BLI of this open area (BCI = 0.04) is 0.68, the BAI is 0.001 and the BPI 10.20. The BLI for historical China from the period of the Ming Dynasty – which ruled the country from the fourteenth to the seventeenth centuries (acknowledging the fact that the wall was continuously built through centuries after the 7th century BC and did not function as a continuous barrier), when China was enclosed by a roughly 11,300 km long border and of which the Great Wall of China accounted for about 8,850 km – is estimated as high, at 0.78 (the BAI is 0.001 and the BPI 59.00). As concerns historical regions, we calculated the changes of BLI for Slovenia in order to present how a turbulent modern history influenced border barriers of a European country. Its territory belonged to the Austrian-Hungarian Empire before World War 1. After the war, the west belonged to Italy and a military line was built. Its territory was divided between Germany, Italy, Hungary, and Croatia during WWII by barriered borders. The BLI increased during the socialist regime (1945–1990) and decreased after Slovenia gained independence in 1991. By the introduction of the Schengen area, the BLI increased again and is expected to fall after Croatia joins the Schengen area (Fig. 6).

The Alps are an important natural barrier (Gams, 2001) that influences social, spatial, and political development. We considered the length and the area covered by the land borders of Austria, France, Italy, Germany, Slovenia, and Switzerland, and used the length of borders between Italy and the rest of these countries as an approximation. The

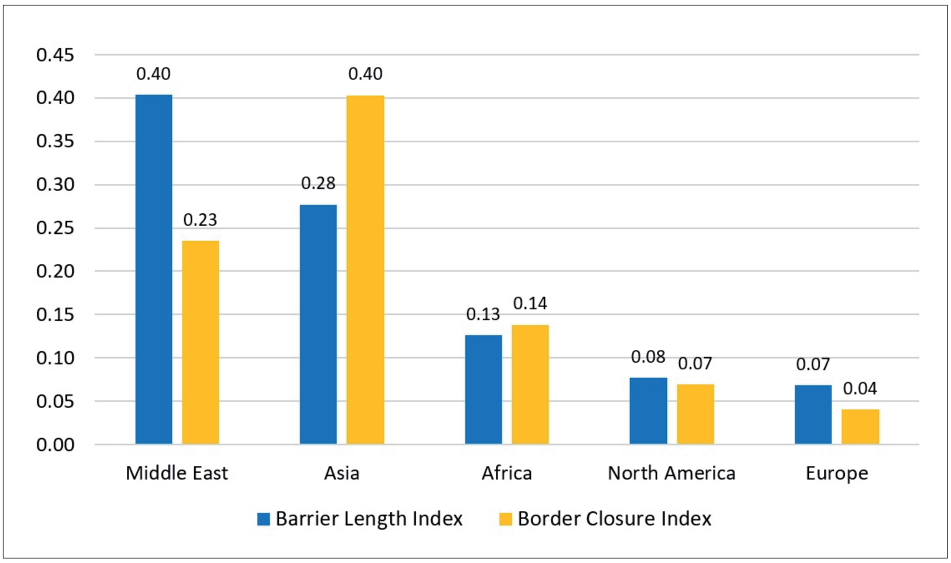

Fig. 4: The BLI and BCI by continents, based on the countries examined
Source: authors' calculations

BLI of the Alps is 0.22, the BAI 0.001, and BPI 133.00. With high number of mountain passes and some tunnels, the divide is rather an open one with the BCI at 0.15.

Large rivers, often form political borders (Pounds, 1972). We calculated the Barrier Index for the Mississippi, which separates the 2.5 million km^2 western part (North Dakota, South Dakota, Nebraska, Kansas, Minnesota, Iowa, Missouri, Oklahoma, Texas, Arkansas, and Louisiana) from the 1.3 million km^2 eastern part of the central US (Wisconsin, Michigan, Illinois, Indiana, Ohio, Kentucky, Tennessee, Missouri, and Alabama). The river is 3,778 km long, which is also the approximate length of the 'border' between the two areas. The BLI is 0.15 and 0.10 (east/west), and the natural border is of a closed type (BCI = 0.18 and 0.27). The method does not acknowledge the fact that the Mississippi River is not a meaningful political barrier as the state borders are completely open and that it can be easily crossed by many bridges and boat services.

4.6 Physical barriers as a reflection of cultural contexts

Closing borders at the level of parcels, settlements, and states is on the increase, and so is the trend of building border barriers and restricting mobility, even within uniform and closed territories, such as the European Union. At the same time, a distinction is being made between walls and more acceptable fences, which even leads to denial, such as that reported on along the Mexico – United States border (Vila, 2003, p. 217): "Mexican officials insisted that they were proposing not a border barrier fence but rather a train protection device."

The article presents a new method for interpreting barriers at different spatial levels. It proposes an indicator for analysing the closedness of borders that allows a temporal and spatial comparison of barriered borders regardless of their size. Some examples for each spatial level were presented.

Fig. 5: The Slovenia–Croatia border barrier was erected near the Kolpa/Kupa River after the migrant crisis in 2015
Source: Matej Gabrovec, with permission

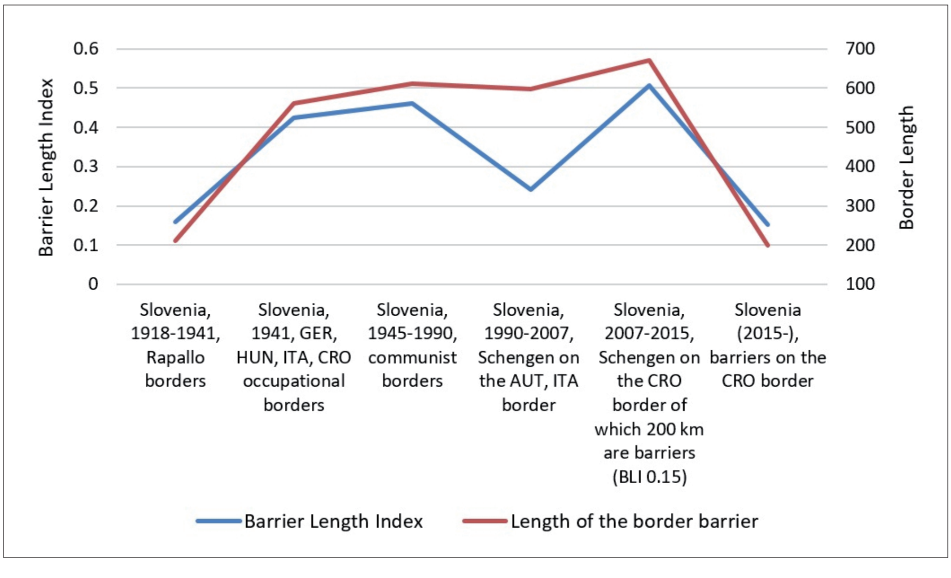

Fig. 6: Changes of the BLI due to political changes in Slovenia in the last century
Source: authors' calculations

The new method was first used to analyse barriers at the local level, focusing on privately-owned parcels. Since these are plots of land with known owners, they reflect the physical, social and historic dimensions of geographic regions. Here we have presented examples from different regions on the example of Slovenia. Slovenia makes a good example because it includes the Alps, the Mediterranean, the Pannonian and the Dinaric regions. The calculated parcel BLIs were quite high, ranging from 0.50 to 1.00, with the lowest values recorded in the Mediterranean regions.

We then extended the analysis across geographic scales to more publicly controlled neighbourhoods. We presented data for the street level and the control group at the one-hectare level. Differences between geographic regions are also evident at this level, with BLI lowest in the Dinaric region and highest in the Pannonian region. We observe the influence of globalisation, however, the modern construction of parcel fences follows traditional patterns. Analysis at the level of one-hectare plots from randomly selected areas around the world shows that plot boundaries are marked everywhere. However, their closedness differs according to historical development and perceptions of ownership; communal and public lands usually have no fences.

Further, the method has been applied to human and physical regions, states, and transnational communities. The countries was analysed more thoroughly since the most data are available at this level. It is no doubt barriers have something in common at all spatial levels. We assume that several underlying processes influence the continuous barriering of the parcels, territories and countries. Being socio-technical structures or devices (Pallister-Wilkins, 2016) that inhibit or promote human interaction and mobility, the border barriers reflect social relations. Therefore, physical structures in the landscape are influenced also by social environments and contexts.

One way to approach the complex institution of barriers (Sassen, 2008) is to understand them as social structures. A natural limitation of the index is that it does not define the absolute characteristics of the spatial entities it distinguishes. Therefore, we introduced a denominator to compare spatial units at all spatial levels according to social aspects. Since family structures with their various types are one of the basic institutions of society, they are a common basis for research in agriculture (family farms), medicine, statistics, urban planning and also for border studies. Borderlands are formed through cross-border regionalisation processes at various levels, including everyday economic, social, familial, and cultural practices (Kolossov and Scott, 2013). We use it here because it provides geographical information as a level between the individual and society (Guo et al., 2021). Family types link the parcel level, which is characterised by private property (of a group of people, e.g. a 'family'), and the regional or national level, which is characterised by shared governance and defined by shared values expressed by the predominant family type. At the same time, the term provides insight into the relationships between society and space, which are reflected in borders and border barriers.

Family structures are extremely persistent, lasting, stable (Masso et al., 2021) and they affect other socioeconomic structures, including separation between poor and wealthy neighbourhoods (Vallet and Jones, 2012). Medieval family structures even influenced European regional disparities, causing the states to become isolated by closing borders. According to Todd (1987): "Every anthropological system lives out its own political dreams, keeping interaction with its neighbours to the minimum possible" (1987, p. 25). The neighbourhoods are limited by boundaries that are established by social or political agents or agencies, to distinguish between national, ethnic, religious, linguistic, legal, or security differences (Haselberger, 2014). "[T]he oldest political borders in Europe are only a few hundred years old, and most were established more recently than that", which is linked to advances in cartography that allowed fixed borders and territories to be represented (Jones, 2012, p. 70).

Barriers are a physical representation of invisible discontinuities, where the social system reveals its underlying logic: family structures define the ideological systems (Todd, 1985) and development level (Duranton, Rodriguez-Pose and Sandall, 2007), including wealth and inequality, and they influence (self)enclosure at the regional and local scales. Therefore, many barriers are located on economic or social discontinuity lines (Ribeiro, Burnet and Torkar, 2013).

The relation between border barriers and family types confirms Reece Jones's hypothesis (2012, p. 70) that in most instances the barriers are the result of the "internal politics of the state that builds them" (see Fig. 7). Similarly, Rosière and Jones (2012) argue that, although countries try to justify building walls with smuggling, migration, and terrorism, these barriers are mostly connected with managing immigration flows. They are an internal affair and build a sense of security and identity. An example of this is the construction of the Israeli West Bank wall (Pullan, 2013), which was built for reasons of "demography", with the International Court of Justice declaring it illegal in 2004. Along similar lines, the Swiss government has rejected the idea of building a fence along its border with Italy because of no clear legal basis to authorise its construction (Cabinet…, 2016).

To illustrate this point, we use the typology of Todd (1985), who introduced two opposites – liberal/authoritarian and equal/unequal – to capture the dimensions of liberty and equality and introduced family types. These dimensions also relate to the balance between security and freedom (Heiskanen, 2016) that are reflected in border issues (Fig. 7). Because of their fundamental basis they can be related to place-based realities, such as property (parcel level) and territory (country level) as illustrated in this article. We ranked countries in terms of the average BLI and family type (modern data of Todd's 1985 typology were taken from Rijpma and Carmichael, 2016).

The highest average BLI (0.35) is typical of countries with predominantly endogamous community types. Their borders are barriered and closed: they have a high average BPI (1.06), the highest average BCI (0.34). This type is found in Asian and Middle Eastern countries. A similarly high average BLI (0.30) is typical in countries with predominantly exogamous communitarian types, which have a low BPI (0.29), and very low BCI (0.03). This type is characterised by egalitarian societies that tend to protect themselves more against the "unequal" and "others" (Duranton et al., 2007). This family type is found in European countries with border barriers. The African type with barriers predominates in Botswana and South Africa, characterised by unstable households, generally strong prohibitions on consanguinity, and polygyny. Their BLI is 0.13, their BCI 0.14, and their BPI is very high (1.12). The egalitarian nuclear type is characterised by low BLI (0.09) and BPI (0.12), and a moderate BCI (0.22). This type with liberal intergenerational relationships predominates in countries with border barriers, such as Greece, Hungary, Spain, and the

US. The authoritarian type has low BLI (0.08) and BPI (0.06), and thin borders (BCI 0.06). In these "strong bureaucratic" countries (Todd, 1987, p. 148), border barriers can be found in Austria and North Korea, while barrier-free countries include those in the Schengen Area, and naturally isolated Japan.

The fluid and liberal anomic type with a low BLI (0.08) is found in barrier-free countries, such as Burma, the Philippines, Indonesia, Laos, Madagascar, Cambodia, and Malaysia, and in South America. Barriers are not present in rare countries with an asymmetrical communitarian system (an example is southern India), and in countries with the prevailing absolute nuclear type (English-speaking countries, the Netherlands, and Denmark).

A third (9) of the analysed 25 countries has BLI and BCI above 0.25. Seven countries have BLI and BCI below 0.10. The values of BLI are upward-limited (Fig. 8). The maximal value can be estimated based on the BCI by the equation: BLI = – 0.197ln (BCI) + 0.1941 (R^2 = 0.9843).

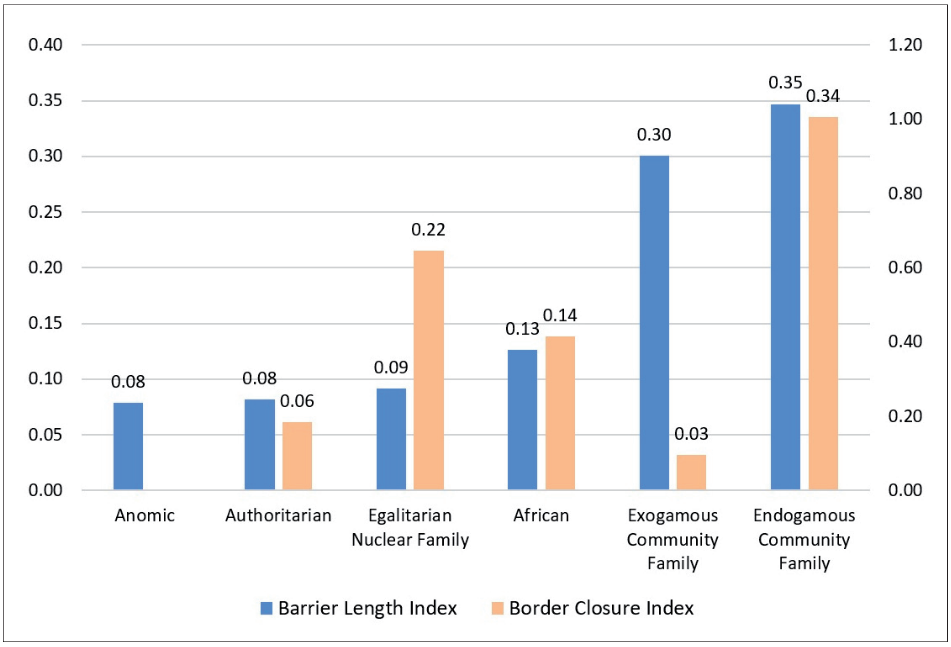

Fig. 7: The BLI and BCI by family types as defined by Todd (1985) in the countries examined
Source: authors' calculations

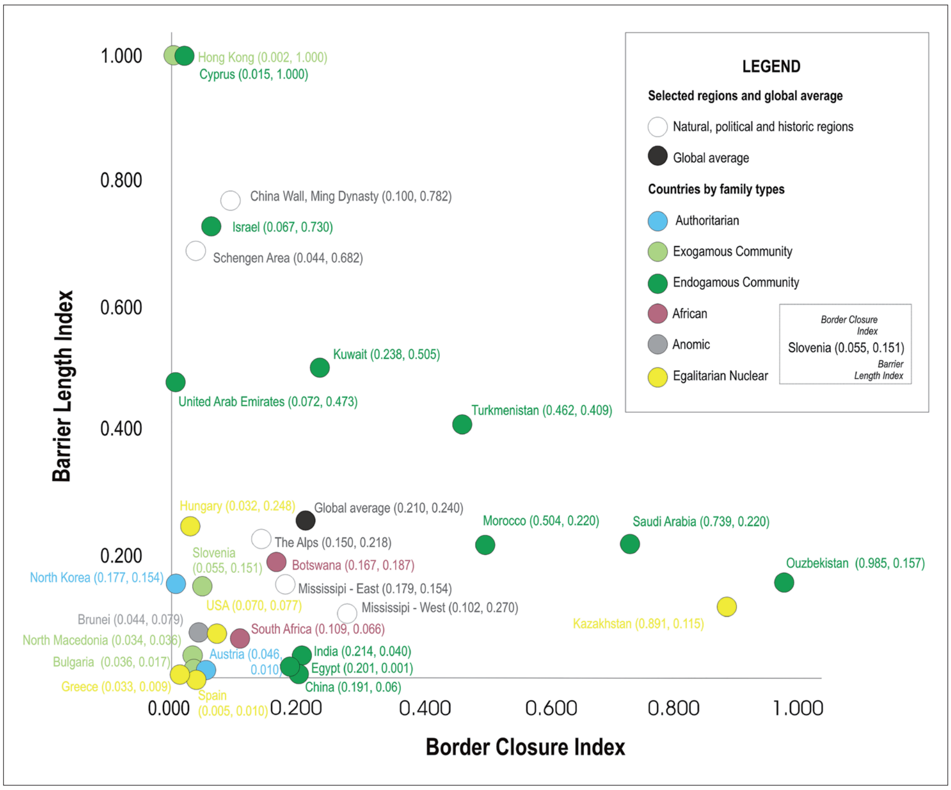

Fig. 8: Barrier Length Index (BLI) in relation to the Border Closure Index (BCI) by country and selected other areas, and the predominant family type (note: for the Ming Dynasty we used a theoretical value of BCI (0.1)
Source: authors' calculations

4.7 Some implications of the Barrier Index

The Barrier Index makes it possible to analyse entities enclosed by borders and to compare them in terms of physical spatial features, such as fences and border barriers, as shown in this paper. The data to calculate the Barrier Index and the sub-indices can be easily obtained by field work and remote sensing techniques, such as Google Street View. The data can also be extracted using remote sensing methods, which extends the applicability to areas that are not directly accessible. This also expands the possibilities to reproduce the study.

Although the presented index refers to the physical environment, it is related to the social background, as stated in the previous section. Using the examples of historical regions, we argue that the index can also be used to represent other geographical elements of the landscape, its functions, history, geography (e.g. related to land use) and culture. Its multiple uses include, for example, the analysis of 'barriers' in terms of cultural differences, such as language groups (represented by the predominant language or the number of languages spoken in a spatial unit, such as a household or a country), economic regions (and their invisible barriers, represented by economic inequalities, the origin and location of investments), and historical regions with an impact on the contemporary landscape.

All this implies that the border barriers also are related to expressing identity (Foucher, 2007). At all levels, they physically characterise an area of identity and serve as individual and social expressions or identity symbols. They are largely created to preserve or protect this identity against external influences. The reasons for the increasing trend (Vallet and David, 2012) of this type of "self-protection" are mostly internal; this is suggested by the stable differences in the social structures, reflected in the proposed relation between the Barrier Index and border openness.

We used the stable features of family types and inheritance systems to analyse if different social properties conditioned the Barrier Index. When related to the proposed Barrier Index, this feature made possible a structural and spatial analysis from the scale of an individual and family to the scale of a country. We found that the concept partially explains the general picture of current border barriers and closure. The index provides insight into the background of certain spatial processes and makes it possible to examine their past, present, and future.

Although we observe the (re)appearance of walls and barriers as instruments for the protection of state sovereignty (Vallet and Jones, 2012), the question of whether border barriers in fact increase security remains unresolved (Vallet, 2018). Yet, it is still a topical issue, especially considering migrants and the Covid-19 crisis, when many countries have been closing and reopening their borders (Böhm, 2021) (Fig. 9).

Border barriers can be considered largely ineffective and indeed destructive for the space that surrounds them, as presented by Dear (2013) for the US-Mexico border. But they are indirectly connected with the openness and peacefulness of spatial entities, from regions to countries, because in border regions cross-border conflicts are inversely proportional to the level of cross-border cooperation.

Limitation of the study might be the availability of data. The data of parcel shapes, usually extracted from the land cadaster data, are not publicly available in every country. The data for other spatial units, including countries, are scattered in different literatures.

One limitation can be seen in the fact that only the land border is considered as a basic prerequisite for ensuring comparability across scales. This can be seen in the case of North and South Korea. Because of this, the situation regarding border barriers, as reflected by the Barrier Index in North Korea looks "better" than in South Korea. Further, the analysis of the Index on the local level is limited to urban areas with urban land use. Large parcels in rural areas are usually not "locked" by fences or other barriers.

The index and its subtypes focus on the spatial characteristics of borders, defined by barriers. As the barriers are erected on land, the index does not describe the properties of the borders related to air or water. Here, only land border crossings were used to calculate border openness. The index could be updated with sea and air border crossings to better reflect the effect of barriers on island countries, for example.

A specific challenge is related to the analysis of Barrier Index between neighboring regions in a country. Since these kinds of borders are not defined by formal barriers, the index could be updated with data on transport, economic factors and the influence of other geographical factors. In this way it would add to understanding of the landscape.

Similarly, it is difficult to analyse natural and historical regions without clearly defined borders. In this regard, comparative studies of similar entities are only possible. But on the other hand, the index allows to present changes in a region through time, which is an added value to better understanding of geographical processes in modern landscapes. As barriers are a becoming an important visual element of the landscape, the Index makes it possible to identify visual differences between the landscapes by the architectural properties of barriers in different regions and countries.

Fig. 9: Several borders were physically closed during the COVID-19 pandemics
Source: B. Komac

5. Conclusions and policy implications

This article proposes an indicator for the analysis of the closedness of borders. The Barrier Index was used to analyse units enclosed by borders and to compare them in terms of spatial characteristics, function, history, geography (e.g. in relation to land use), and culture. It allows for temporal and spatial comparison of barriered borders regardless of size, from the level of parcels, settlements and to countries.

The Barrier Index has been further developed into four subtypes, namely the Barrier Length Index (BLI), which defines the proportion of the perimeter of a unit relative to the total perimeter on which a barrier could be erected. It is expressed in absolute values as m/m or in relative values as a percentage of a parcel's fenced perimeter. The Barrier Area Index (BAI) shows the length of a fence per area of the spatial unit enclosed by that fence (m/m^2). For spatial units with known population the Barrier Population Index (BPI) can be calculated, which compares the Barrier Length Index to the population (in our case, per 10,000 people). The Barrier Closure Index (BCI) shows the ratio of barrier length in 1,000 km divided by the number of barrier openings or crossings and defines barriers as "open" or "closed".

The Barrier Index was calculated for scaling spatial levels, from the level of parcel to physical-geographic units, to show its potential use, although it was developed at the country level with the most available data. We compared the values of the Barrier Index for 25 countries from different continents and with different social and physical contexts. The BLI is highest in the Middle East (average value: 0.40), followed by Asia (0.28), Africa (0.13), the Americas (0.08) and Europe (0.07), while the BCI is highest in Asian countries (0.40), and followed by the Middle East (0.23), Africa (0.14), the Americas (0.07) and Europe (0.04). It is interesting to note that the maximum values of BLI and BCI are connected by inverse relationship.

The proposed index allows spatial and temporal comparison of various barriers at the scale of parcels, settlements and their parts, regions and states, as well as other geographical units. The BLI for the Schengen area was estimated to be 0.68, for historical China 0.78, while in Slovenia it varied from a minimum of 0.15 (1918 and 2015) to a maximum of 0.50 (2007–2015). Natural regions such as the Alps (0.22) and the Mississippi region (0.15) have low values for the BLI.

The concept we present links all types and categories of borderlines across scales into a single measure. Because these are measurable values, the predominant character of the units' physical "openness" or "closedness" can be determined regardless of their size. It thus addresses the influence of the barriers on different aspects of the society. The article brings a selection of examples at different spatial units to present the method. The discussion relates the results to the societal processes to present influencing factors that work across spatial scales. We argue that the Border Index at different spatial levels can be partly explained by underlying structures of the society, expressed, for example, by family types, that are quite stable throughout history.

The index could help identify relationships and similarities between barriers at local and state levels. Policy makers can more easily assess the impact of boundary closures at the local level and feed the results into management at higher spatial levels. The Index can provide data to monitor the status of the border and its visible or invisible barriers within territorial units. Since the degree of openness/closure of spatial units at different levels is linked to underlying social mechanisms (Dołzbłasz, 2015), it is possible that countries with more closed boundaries at the parcel level are also more closed within their borders.

From a visual perspective, the Barrier Index adds value to landscape management. It provides policy makers with a comprehensive view of the openness of the landscape that could determine the future development of private and common lands.

Further work will explore the implications of boundary openness. This includes, but is not limited to the flow through the boundary through crossings such as bridges and tunnels. This would provide decision makers at various levels with a good tool for planning and advocating for appropriate land use policies.

As higher values of the index could indicate lower levels of safety in a selected area, comparing index values between settlements and regions could help policy makers to define areas where people feel more 'unsafe'. In a modern society characterised by individualisation, economic and social inequality, safety is an important factor in the quality of life. The index could contribute to a better quality of life in the future. Trust in the state, the community, the neighbours is reflected in the degree of openness of borders – defined also by their physical bordering. One such example is the open borders between Schengen countries within the EU. In case of emergencies or mistrust in the successful functioning of the neighbours (e.g. pandemic, migration), the establishment of a border regime increases the BCI. In this way, the Index can be used to observe present and predict future developments of border areas – "space and borders are closely intertwined" (Peńa, 2021).

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Fig. 10: A fence marks the mountain border crossing at the border tripoint between Slovenia, Austria and Italy in the Karavanke/Karavanken Mountains (Photo: B. Komac)

Fig. 11: Reinforced barrier of the USA Embassy parcel on Prešernova Street in Ljubljana (Photo: B. Komac)