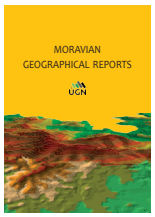

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Modal split of passenger traffic: The Polish section of EU external borders

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Abstract

Despite the ongoing processes of territorial integration, especially in Europe, there are still borders that fulfil their original function, namely that of a barrier. In some cases, this function has even been strengthened. Such is the case with Poland's eastern border, which is also the external border of the EU and of the Schengen Area. This article presents the modal split of passenger traffic under conditions of frequent changes in the functions and permeability of borders, against the background of the key drivers behind the volumes of border traffic, i.e. the geopolitical, socio-economic, and infrastructural factors, both in relation to road, rail and border infrastructure. All sections of the border display some marginalisation of railway transport. The Polish eastern border is characterised by a sustained high share of bus transport, which pertains to all sections under analysis. The long waiting times for clearance when travelling in private cars was probably one of the factors behind the creation of the market for collective transport. Private transport is most dominant on the Polish-Russian border, while the largest share of crossings by bus is recorded on the Belarusian border.

Keywords: *borders, cross-border transport, cross-border traffic, modal split, Poland*

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1. Introduction

The issues of cross-border flows are common and popular research subjects due to the constant changes in conditions and transformations of the function of borders. Several studies have addressed the methodological aspects of border traffic research (e.g. Roider et al., 2018), and the technical and organisational capacity to handle flows (e.g. border crossings under too much strain and options for improving border permeability in technical and organisational terms: Hilmola and Henttu, 2015; Miltiadou et al., 2017; von Arx et al., 2018). Many analyses concern the cross-border mobility of people. Such research is conducted both in regions where territorial cooperation has existed for a long time and the border is an area of intense contacts (e.g. Luxembourg – the Walloon Region; Carpentier, 2012) and in Central and Eastern European countries, where cross-border cooperation has been driven by accession to the European Union (Cavallaro and Dianin, 2019, 2020; Roider et al., 2018). Several other studies address specific types of cross-border mobility (e.g. tourism; Kolosov and Więckowski, 2018).

Moreover, the impact of changes in the functions and permeability of borders on cross-border passenger transport (including its modal split) remains underexplored. In East Central Europe, existing publications in this respect typically describe infrastructure and traffic volume analyses (Komornicki, 1995; Lijewski, 1996; Więckowski, 2003) and relate to historical periods (i.e. before the accession and inflow of funds for infrastructure development, and long before the emergence of increased migration flows in the second decade of the 21st century), or they investigate changes in the public transport network, but from a local or possibly regional perspective (Kołodziejczyk, 2020; Oszter, 2019). There is a lack of studies, however, covering the broader context of changes in border traffic as an element of spatial mobility by modes of transport. In particular, research is needed on the role of transport mode changes with the level of permeability of national borders.

The purposes of this article are: to analyse developments in the volumes of cross-border traffic in the medium-term (1990–2019) by types of border crossing (road, rail, airports); to create an understanding of the factors behind the volumes of cross-border traffic (geopolitical, socio-economic and infrastructural drivers, the latter including transport- and border infrastructure-related determinants); to describe

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the transformations in the functions of the Polish eastern border and the level of its permeability (by border section); and subsequently, to examine the impact of dynamic changes in the functions and permeability of the border on modal shifts in cross-border traffic. Thus, we present a description of the sources and methods employed, the characteristics of the Polish eastern border (in terms of the geopolitical, socio-economic, and infrastructural conditions behind the changes in the functions of the border), the dynamics of traffic by the various modes of transport (road, rail and air), and a synthesis showing changes in the modal split of cross-border traffic.

2. Theoretical background

The ongoing process of globalisation is reflected in human mobility, including cross-border flows (Gialis, 2011; Hannonen, 2017; Newman, 2006; Nilsson, 2018; Więckowski et al., 2014; Williams et al., 2001). Such movements can be driven by both economic factors (e.g. labour migration, differences in prices of commodities, differences in exchange rates: Bar-Kołelis and Wendt, 2018; Gerber, 2012; Nerb et al., 2009), transport-related factors (e.g. the growth of low-cost airlines: Vera Rebollo and Ivars Baidal, 2009), and political or geopolitical factors (e.g. integration within the European Union: Komornicki and Wiśniewski, 2017; Ladino, 2017). Cross-border flows also depend on the degree of permeability of a given border, as well as on conditions of the existing infrastructure (including transport and specific infrastructure: Komornicki, 2005). The development of infrastructure mirrors economic development, both of entire countries and border areas, which have their own specificities (Więckowski, 2010). The border can then become an infrastructural barrier, especially when there are additional technical differences (e.g. track gauges). In such a case, the functioning of cross-border transport and of the entire level of transboundary cooperation depends not only on the 'laws' of the market, but also on political situation and will (Haase and Wust, 2004; Wiering and Verwijmeren, 2012), including regional-level decision making (Dołzbłasz, 2018). This has been the case with the Polish eastern border, where the function of the border as a barrier has been preserved and even strengthened (Komornicki et al., 2019).

In recent decades in Europe, especially in Central Europe, two parallel processes have taken place: transformations in border permeability; and modal shifts in passenger transport. To date, these two factors have been described and analysed independently, but it seems vital that the interrelations between the two processes be addressed. The Polish eastern border is a good case study for this type of analysis. Over the last 25 years, the permeability of Poland's eastern border has changed several times (known as the border operation cycle referred to by Więckowski, 2019): from a complete barrier to people and vehicle traffic (before 1989); a period of high permeability in the 1990s; the re-emergence of the border as a barrier to the movement of people (first decade of the 21st century); to the latest phase of a gradual liberalisation of border traffic.

With such dynamic economic developments and changes in the functions of borders, the operation of cross-border connections by public transport has become a huge challenge, which has been mirrored by the modal shifts in border traffic.

Furthermore, cross-border flows, including their underlying structural characteristics, have been well researched for open borders, such as the ones between the internal borders of the Schengen Area (Carpentier, 2012; Mathä and Wintr, 2009; Medeiros, 2019). The lack of formal obstacles (i.e. those imposed at a national level) to movement creates greater opportunities for the growth of border traffic, both when it comes to public transport (i.e. in organisational terms) and travel by private means of transport. Even in border regions with a high degree of territorial integration, however, a number of obstacles to the provision of common public services emerge (Dühr, 2021). The situation is different in the case of formalised boundaries where the legal and administrative conditions come to the fore. Given their nature, such restrictions mean that population flows and public transport develop in a different way, which affects the accessibility of border areas and accessibility to public services (c.f. Rosik et al., 2020). This article fills a research gap with respect to understanding the relationships between the volume of border traffic, border permeability and modal shifts in trans-boundary traffic. Furthermore, the longer period adopted for this analysis allows the role of various types of policies (regional, transport, etc.) on modal change to be evaluated.

3. Data and methods

This study relies on complete data on the border traffic between Poland and Russia (Kaliningrad Oblast), Belarus and Ukraine in the period 1994–2019 (see Tab. 1), i.e. before the COVID-19 pandemic. This extensive database consists of over 5.8 million records. In addition, some more limited characteristics for the years 1990–1993 are used, as well as some values for 1980 as a reference point. The information has been made available by the Polish Border Guard Headquarters. On this basis, changes in the ranks of the individual means of transport in cross-border traffic are examined using descriptive methods, which have provided an in-depth insight into the development of trends and the differences in cross-border processes.

Type of data	Purpose of use
Data of the Border Guard 1990–1993 and 1994–2019 (passenger traffic and traffic by modes of transport)	To identify the volumes and direction of flows, the breakdown of flows into modes and modal shifts
Railway timetables, 1985–2019 (selected editions, printed and digital versions)	To identify organisational changes in rail transport (types and directions of rail connections)
Air carriers, 2019 (scattered sources)	To identify the directions of air connections between Poland and Russia, Belarus and Ukraine in order to supplement the information retrieved from the Border Guard database; data complementary to that of the Border Guard
Permeability of the Polish eastern border in 1990–2019	To assess the relationship between the permeability of individual border sections and changes in border traffic volumes by modes

Tab. 1: Types of data and purpose of use
Source: authors' conceptualisation

The study includes three modes of land transport, namely rail, bus and individual transport, as well as air transport, the data for which come from statistics on the origins of foreigners crossing the border by air. Contrary to the data on volumes available for the land border, this is the only source of information about the direction of air travel. The vast majority of traffic on the Polish sections of the EU border is generated by foreigners, with their greatest share recorded on the border with Ukraine (91.9% in 2019), followed by Belarus (88.3%), and Russia (66.0%)[1]. Citizens of the countries neighbouring Poland dominate on the individual sections of the eastern border, with Ukrainians prevailing on the Polish-Ukrainian border (96.8%, 2019), Belarusians on the Polish-Belarusian border (87.3%; Russians 8.8%), and Russians on the Polish-Russian border (88.0%). Given the above structural distribution of border traffic and the limitations of the air traffic database, the overall assessment of modal shifts in border traffic is based on the arrivals of citizens of Russia, Belarus and Ukraine in Poland. For Russians, the analysis covers two groups – those crossing the border with the Kaliningrad Oblast and those transiting Belarus.

The analysis of traffic by private means of transport and by rail relies on the raw data of the Border Guard, while that for buses, on an estimate of the number of crossings by persons (the database contains only the number of vehicles) based on our own research[2]. The estimate assumes the average bus contains 25 people (only data from the Polish-Lithuanian border, which is part of the Polish eastern border, have been used for this estimate). In order to estimate the number of entries by buses of the three groups of foreigners, use was made – by analogy – of the proportion of a given group of nationals to the total number of entries (foreigners + Poles) at railway border crossings (except for the Polish-Russian border[3]). Meanwhile, the number and share of crossings (entries) made by individual means of transport were determined as the difference between the volumes recorded cumulatively at road crossings and the estimates made for bus transport. Almost all individual (private) crossings were made in passenger vehicles (with up to nine passengers), because there is practically no pedestrian traffic on the Polish eastern border (it is forbidden by law at most crossing points). These data sources also assign drivers of heavy goods vehicles, special vehicles and motorcyclists into the category of individual crossings.

As supplementary material, use was also made of selected railway timetables from 1985 to 2019 (PKP, 1985, 1990, 1991, 1992a,b, 1993, 1995, 2000, 2004, 2009, 2011, 2014, 2018a,b), which include information on international passenger trains. They were useful in identifying the organisational changes in rail transport, including those in the types and destinations of direct cross-border connections. The offer of air carriers was mainly analysed for 2019, due to limited access to archival flight schedules, since they are not retrievable from online flight search engines[4]. Performing a similar analysis for bus connections turned out to be impossible due to the much larger scale of the phenomenon and the lack of integration and archiving of timetables. The research was limited to general information on the number of direct cross-border connections for 2002 (Komornicki, 2003b).

This article also relies on data on the assessment of the degree of permeability of the Polish eastern border in the period 1990–2019, based on a survey conducted among 20 experts in the functions of borders and cross-border mobility. Their assessment comprised the level of permeability, understood as the physical possibility of crossing the state border in passenger cars. The permeability of the borders was assessed by each expert on a scale from 0 to 10, where 0 meant no permeability and 10 no barriers to crossing the border whatsoever. Then, the results were averaged (for each year) to obtain the value of permeability of the individual border sections in successive years.

The Polish eastern border is a typical subsequent boundary (created secondarily to forms of spatial development: Hartshorne, 1936). The Polish-Belarusian and Polish-Ukrainian border crosses an area which belonged entirely to Poland before World War II, while the Polish-Russian border was at that time part of Germany. The length of Poland's land border is 3,071 km, 1,163 km of which form the external EU border analysed in this article. The border consists of three sections: with Russia (Kaliningrad Oblast): 210 km, with Belarus: 418 km, and with Ukraine: 535 km. The Polish-Lithuanian border (104 km) is not included in the study since it constitutes an internal border of the Schengen area. Almost 40% of the Polish segment of the EU external border runs along natural hydrological barriers (mainly along the Bug and San rivers for some 417 km, which form sections of the borders with Ukraine and Belarus), which also contributes to its permeability. In most instances, people cross this border through road checkpoints (96.5%), chiefly by individual (private) means of transport – 81% in 2019. The main underlying motivation is shopping (80.2% of those people crossing) which is undertaken with high frequency (on average several times a month: 41.9%, several times a week: 40.1%) (Statistics Poland, 2020a), which may be the determinant behind the choice of means of transport.

4. Results and discussion

4.1 Polish section of the EU external border: Determinants of border traffic and permeability

The main factors, i.e. geopolitical, socio-economic and infrastructural conditions (road, rail, border infrastructure), behind the volumes of border traffic across the eastern border of Poland can now be discussed. Changes in the permeability of the Polish section of the EU external border are the element that binds these factors together.

[1] The shares of the individual sections of the eastern border in border traffic display a similar sequence (2019 data): Ukraine – 66.5%, Belarus – 25.9%, Russia – 7.6%.

[2] The survey was carried out in 2018 on a quarterly basis on the Polish sections of the internal border of the Schengen area and was co-funded by a research grant (see Acknowledgement).

[3] Due to periodic absence of passenger train connections between Poland and the Kaliningrad Oblast in some years, the share of Russians in the number of entries at road border crossings was taken into account when calculating the number of bus passengers.

[4] Scattered sources on past traffic were applied here, including research studies (Komornicki, 2003b; Palmowski, 2015), portals publishing advice for people travelling to Poland (Shoppingpl.com, 2019; Vsetutpl.com, 2019) or reports from industry portals (Avianews.com, 2019; Latamy.pl, 2010; Wirtualnemedia.pl, 2017).

4.1.1 Geopolitical determinants of border traffic

Before the disintegration of the Eastern Bloc, the Polish-Soviet border was distinguished by a very low degree of permeability. It was a kind of 'second Iron Curtain' separating the socialist states of Central Europe from the Soviet Union (Komornicki and Miszczuk, 2010). The rules for crossing the eastern border changed fundamentally in the late 1980s, along with perestroika in the USSR.

After 1989, during the Polish political and economic transformation, the volume of border traffic with Poland's eastern neighbours increased considerably. This not only resulted from the relaxation of the formal procedures, but also from infrastructural developments (opening of new border crossings) and organisational factors (creation of new public transport connections: Komornicki and Wiśniewski, 2017; Komornicki and Kowalczyk, 2018). This was the period of the greatest freedom of movement of people across the eastern border of Poland.

The later changes in volumes of border traffic reflect two overriding factors: global and political (bilateral) ones. The former influence the overall functioning of the economy, including enterprises, while the latter are related to historical conditions (especially Poland's relations with Russia and Ukraine). The latter led to the authorities taking certain decisions, such as introducing embargoes on various types of products, leading to transformations in trade between the countries concerned. At the individual level, the greatest changes in border traffic were triggered by Poland introducing visas for citizens of Russia, Belarus and Ukraine in 2003. This initiated a strong growth of disparities in the situation from one border section to another, which was then modified by Poland's accession into the Schengen area (2007). The greatest variations in the volume and structure of traffic were perceivable on the border with Ukraine, which did not introduce a visa requirement for Polish residents at the time.

Further changes were initiated by the entry into force of local border traffic agreements with Ukraine (2009) and with the Kaliningrad Oblast of the Russian Federation (2012). The Polish-Russian agreement, however, was suspended in 2016 and has not been renewed since then. Meanwhile, the local border traffic agreement with Belarus, signed in 2010, has never entered into force. Instead, eight years later, a unilateral facilitation was put in place whereby EU citizens were allowed to stay on a visa-free basis in Belarusian tourist and recreational zones in Brest and Grodno. The volume of traffic was also influenced by the geopolitical situation in Ukraine (the annexation of Crimea in 2014) and by the lifting of visa requirements for Ukrainian citizens by the Schengen area (2017).

4.1.2 Socio-economic determinants of border traffic

During the post-1989 transformation, Poland plunged into an economic decline with a growing budget deficit, skyrocketing inflation, and the country unable to service its foreign debt (Przybyciński, 2009). Both the economy and society had to face a completely unknown reality and problems related to the functioning of a free market economy. The early years of the transformation were marked by high inflation, which followed the liberalisation of prices and a decline in the level of national income. This was caused by the collapse of internal demand, the loss of 'eastern' outlets (Kołodko, 1992; Skodlarski and Pieczewski, 2011), and the associated decline in industrial production, as well as by the emergence and rapid growth of unemployment, which had been unknown in the times of the Polish People's Republic (PRL)[5]. The following years were characterised by a slow consolidation of growth processes, manifested by a dynamic increase in GDP and sold production of industry.

The consequences of the transformation had a strong impact on volumes of border traffic. Large differences in the prices of goods between Poland and its eastern neighbours incentivised many residents into taking up cross-border trade, not always legal (Komornicki, 2010). An increase in the number of crossings was mainly recorded for the citizens of Russia, Belarus and Ukraine, whose economies were also struggling with the impacts of political and economic transformation.

The 1998 crisis in Russia gave rise to a collapse in flows across the Polish-Russian and Polish-Belarusian border and to some extent also across the Polish-Ukrainian border. Small-scale trade and consequently cross-border traffic at the borders with Belarus and Ukraine saw a short-lived revival in the years 1999–2001, to be interrupted by restrictions in the internal customs policies of both countries and the global situation after September 2001. Further material decline in the volume of border traffic across all three border sections was caused by two factors: the introduction of Schengen visas for citizens of Russia, Belarus and Ukraine, and the global financial crisis (2008). The succeeding years observed a gradual increase in the volume of traffic. This trend did not last long for the Russian and Belarusian borders, however, which can be attributed to a shrinkage in trade with both countries (Russian and Belarusian embargoes on Polish and EU food products, and EU sanctions in connection with the annexation of Crimea), and the suspension of local border traffic with Russia by Poland. On the Polish-Ukrainian border, the upward trend continued and was also observed in 2019 because of a large supply of jobs in the Polish economy. In the period 2010–2018, there was an 18.5-fold increase in the number of work permits issued for Ukrainian citizens (MRPiPS, 2021). It is estimated that at the end of 2019, there were approximately 1.35 million Ukrainians in Poland (Statistics Poland, 2020b).

4.1.3 Infrastructural and organisational determinants of border traffic

Rail transport

The current state of development of the Polish railway infrastructure should be seen in the context of the 19th and the early 20th centuries, when the three powers which ruled Poland because of the late 18th century Partitions, pursued different development policies in the areas they occupied. From the 1840s, the Prussian, and to a much lesser extent, the Austrian authorities, were developing the railway network for economic reasons, while Russians were doing this for strategic and defence reasons, with their efforts limited to the construction of several lines that connected Warsaw with Saint Petersburg, Moscow and some cities within the territory they occupied (Taylor, 2007).

Rail transport has characteristics which make it difficult for carriers in cross-border connections. Contrary to road transport, crossing the border by train requires, *inter alia*,

[5] The Polish People's Republic observed hidden unemployment, which resulted from low productivity and a mismatch between supply and demand. It is estimated that in the 1980s, the actual unemployment rate could have reached 20% (Glikman, 1992).

the rolling stock to be adapted to the infrastructure on both sides of the border (differences in track gauge, power supply systems, signalling or safety standards). The process of approving new rolling stock for service is lengthy and involves the need to obtain formal permits issued by the relevant authorities of both states. As regards passenger transport, a huge challenge is also posed by the preparation of common timetables and the integration of tariffs. As a consequence, the organisation of cross-border rail transport is a more difficult undertaking than operating international bus service, for example.

For many years, until the Central and Eastern European countries embarked on political and economic transformation, it had been more convenient for passengers to cross Poland's borders by train than by car. The growing popularisation of private automobiles resulted in public transport, including the railways, losing their leading roles in handling border traffic. Even in the 1990s, however, border trade played an important role in supporting rail transport. At the time, passenger traffic was reactivated at several crossings on the eastern border previously closed or used only for freight transportation. The first decade of the 21st century saw a nation-wide decline in the network of passenger lines (Komusiński, 2010), which also affected cross-border connections (the reduction concerned the number of local trains which handled cross-border trade, and to a lesser extent long-distance connections). In addition, the technical condition of most of the railway lines which crossed the Polish segment of the EU external border was still unsatisfactory. The growth in investment expenditures on transport infrastructure as a result of the large supply of EU funds only slightly improved the quality of these sections (PLK, 2021).

Road transport

On the eve of the transformation, the development of the Polish road infrastructure corresponded to the transportation structure at that time. In eastern Poland, many local roads were paved to ensure bus transport to remote rural towns. There were hardly any expressways or motorways. Nor were the other main routes adapted to the mass motorisation that had started even before 1989. After 1990, this went hand-in-hand with the rapid decentralisation of the economy and jobs, as well as with difficulties for many public carriers. Additionally, the road infrastructure was deteriorating rapidly since it was being used by increasing flows of heavy goods vehicles, which were gradually taking over freight transport, including bulk shipments. Roads to the eastern border (see Tab. 2), including those which led to existing or planned border crossings, were often in a very poor technical condition.

Generally, the opening of a new crossing merely meant the upgrade of very short sections of road close to the crossing itself, many of which had decayed due to them having been closed to traffic for many years. Deeper in the interior of both Poland and of the neighbouring countries, roads remained unsuitable for transit traffic, especially for trucks. Practically no new routes crossing the border had been built. The situation began to improve, as a result, inter alia, of the inflow of, first-of-all, pre-accession and then, post-accession EU funds. The road accessibility of eastern Poland, and thus also of the border crossings with Russia, Belarus and Ukraine, improved significantly (Komornicki, 2011a). Investments in other parts of Poland, which made it easier for citizens of Eastern Europe to transit Poland to Germany and other European countries, also played a role in the structure of transboundary traffic (Wiśniewski and Komornicki, 2021). For the first time, a modern road infrastructure was brought to Poland's eastern border in 2013 – the A4 motorway, which runs from the German border across Wrocław and Kraków to the border with Ukraine near Lviv (the full-length motorway has been operational since 2016). In the study area it remains the only route in this category. The S22 expressway connects Gdańsk and Elbląg with Kaliningrad Oblast of the Russian Federation (since 2008), but it is a single carriageway. Nevertheless, what was important for cross-border accessibility was the fact that some expressways integrated with the European road system, moved closer to the checkpoints on the eastern border. This was the case with the roads from Warsaw to Lublin (towards Ukraine) and from Warsaw to Białystok (towards Belarus).

The main purpose of the road investments, however, aimed at improving access to the Polish eastern border, was to respond to growing traffic (Komornicki, 2014), and those projects cannot be considered as a driver of modal changes in border traffic. Instead, these changes were driven by an intense growth in the number of motor vehicles, first in Poland, and later also in the neighbouring countries of Eastern Europe (see Fig. 1). The car ownership levels were also triggered by the prestige and social position associated, especially in countries with lower average incomes, with driving your own car, as well as by the potential for a car to communicate the identity of the vehicle owner (Hagman, 2006; Komornicki, 2003a, 2011b; Rosik et al., 2018). In 2010, the share of passenger cars in Poland reached 87.2% of the total transport performance in passenger transport (in the EU 27, only Lithuania had a higher ratio: Rosik et al., 2018). In absolute terms, the most spectacular increase in the number of cars in Poland took place in the 1990s. The car stock was increasing by several hundred thousand vehicles year on year. Moreover,

Border of	Length of the land border (km)	Number of paved roads crossing the border	Number of rail lines crossing the border	Number of border crossings available for regular passenger traffic (and overall number of crossings)				Length of border section per one border crossing available for regular passenger traffic (km)			
				Road		Rail		Road		Rail	
				1991	2019	1991	2019	1991	2019	1991	2019
Russia	210	17	3	1 (2)	4 (4)	1 (2)	0 (3)	210	52.5	105	-
Belarus	418	14	6	2 (3)	5 (7)	2 (5)	2 (5)	209	83.6	209	209
Ukraine	535	11	7	3 (3)	8 (8)	3 (5)	2 (6)	178.3	66.9	178	267.5
TOTAL	**1,163**	**42**	**16**	**6 (8)**	**17 (19)**	**6 (12)**	**4 (14)**	**193.8**	**68.4**	**193.8**	**290.8**

Tab. 2: Transport infrastructure on the Polish eastern border in 1991 and 2019
Source: authors' analysis based on MSW (1991, 2015)

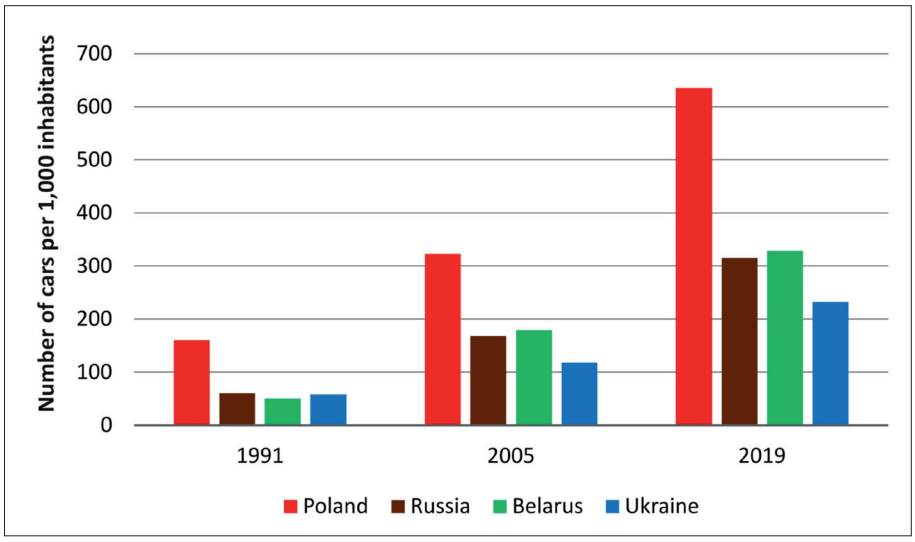

Fig. 1: Motorisation rate in Poland and in selected neighbouring countries
Sources: authors' analysis based on data from: Menes (2018), Auto.24tv.ua (2021), AVTOSTAT (2021), BELSTAT (2021), ROSSTAT (2021), Statistics Poland (2021)

motorisation rates were growing faster during that period in eastern Poland, near the border with the states of the former USSR. This partly resulted from the lower baseline figure (low car saturation in the earlier period), but the fast growth of border trade could have contributed as well (Komornicki, 2011b). A more important role for the modal split, however, was played by the growth of car numbers in the neighbouring countries since, from the start, it was their citizens that constituted the majority of people who crossed the border. In the early 1990s, the motorisation rate in the entire USSR was low and amounted to 59 cars/1,000 inhabitants (in the Russian SSR: 60, in the Ukrainian SSR: 58, in the Belarusian SSR: 50), while in Poland, this was 160 cars/1000 inhabitants (Fig. 1) (Menes, 2018). Along with the transformation of the system and socio-economic development, the rate was growing at the fastest pace in Poland and Belarus.

Border infrastructure

As late as the mid-1980s, there were only three publicly accessible border crossings on the entire eastern border, including that with Lithuania (Kuźnica /railway/, Terespol / rail & road/ – border with Belarusian SSR, and Medyka /rail & road/ – border with the Ukrainian SRR). The remaining railway crossings which existed at the time handled solely freight transport. In addition, there were several road and railway crossings of local importance, available only for exchanging political, social, sport, and other delegations from the border regions of the Polish People's Republic and the USSR (MSW, 1979, 1988).

During the transformation period (especially in the 1990s), the number of border crossings grew rapidly, but at a slower pace on the eastern border than on the western one (cf. Furmankiewicz et al., 2020). After the throughput of the main routes was ensured, subsequent crossings were built at an ever slower pace. The borders are still intersected by a number of paved roads closed to traffic on which no customs and passport clearance is carried out. In 2019, there were 19 publicly accessible road border points on the Polish section of the external border of the EU, 17 of which handled passenger traffic (including one for Polish and Belarusian citizens only) (Fig. 2). Out of the 14 official railway crossings, passenger traffic was handled by eight points, but regular scheduled passenger trains used only four of them (two on the Belarusian section and two on the Ukrainian section). Traffic on the other five crossings, three of which still handle freight traffic, was suspended gradually over the years 1999–2013 (one each on the Polish-Russian and Polish-Belarusian borders, and three on the Polish-Ukrainian border). The activities carried out from 2016 to develop the services available on the Poland-Ukraine routes were the sole exception to the general decline of railway connections (Komornicki and Kowalczyk, 2018). Thus, looking back from the perspective of 2019, changes in the modal split of cross-border traffic were driven by two opposing processes with regard to the infrastructure of the Polish segment of the external EU border. One was the development of border crossing points for road vehicles, and the other was the reduction in the number of railway crossings, which is best evidenced by the indicator of the length of the eastern border section per crossing. Between 1991 and 2019, this value decreased almost threefold for road crossings, and in parallel it increased one and a half times for railway crossings serving regular passenger traffic (see Tab. 1).

Conditions related to transport and regional policies

In addition to the cross-border transport infrastructure, the infrastructure within the neighbouring countries has also changed, especially in Poland where a number of large infrastructure investments supported by the EU's Structural Funds have been completed since 2004. The most noteworthy projects at the national level comprise those built along the TEN-T corridors, including routes leading to the eastern border of the country (inter alia the new A4 motorway to the border with Ukraine, the S20 expressway to the border with the Kaliningrad Oblast, modernisation of the E20 and E30 railway lines from Warsaw to the border with Belarus and from Kraków to the border with Ukraine, respectively). Over time, voivodeship governments have also come to play an important role in delivering transport policy, pursuing Regional Operational Programmes – EU Cohesion Policy investments designed for a lower territorial level. The objectives of transport policies (both at the European and national levels) have gradually shifted towards: a) regional investments to improve accessibility and quality of life; and b) modes of transport that are more climate and environment

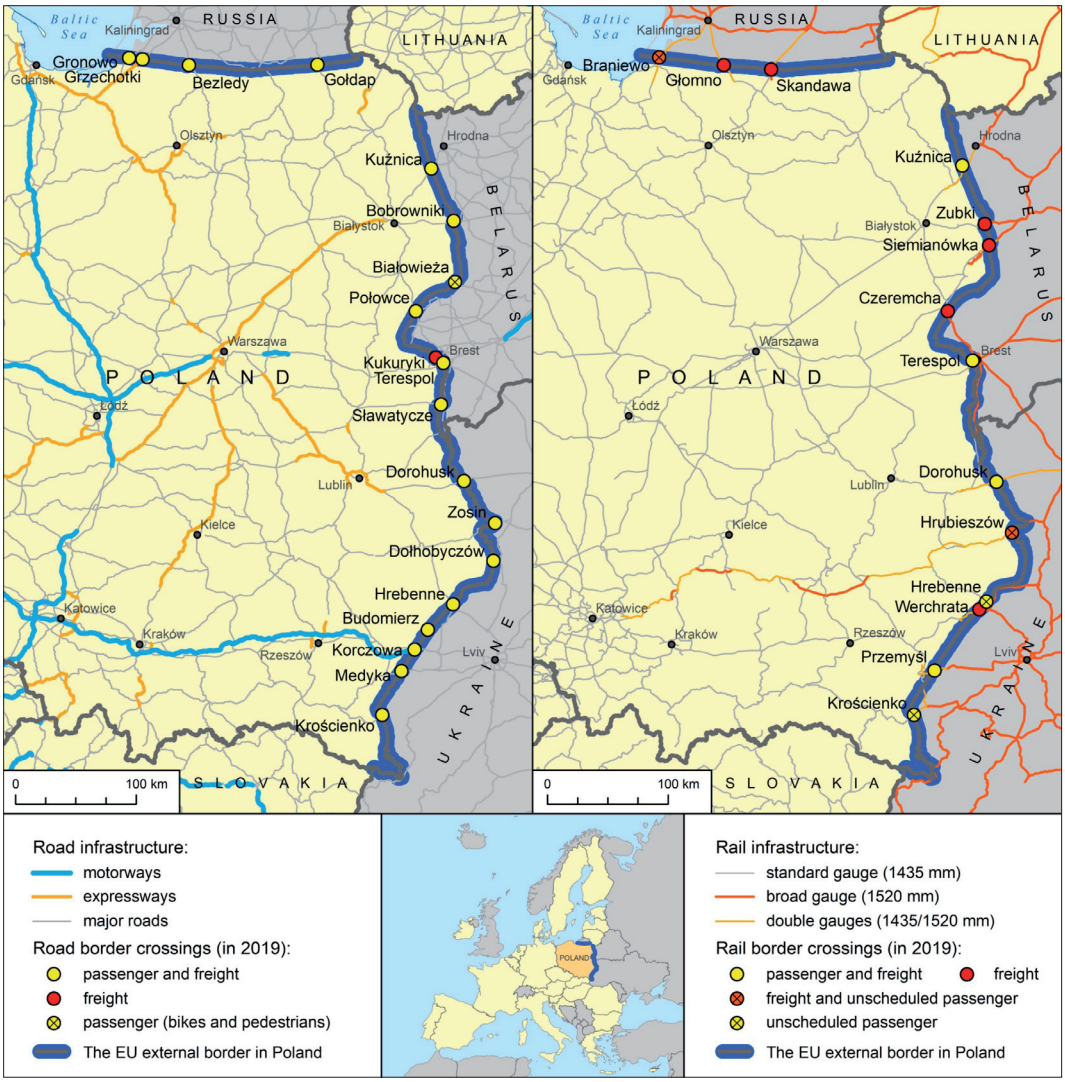

Fig. 2: Transport corridors, border crossings and the Polish section of the EU external border
Sources: authors' analysis based on: MSW (2015), Natural Earth (2021), OpenStreetMap (2021) and PKP (2018a,b)

friendly (Komornicki and Szejgiec-Kolenda, 2020). In border areas, however, this has mainly translated into an improved condition of some regional roads or at best the development of intermodal terminals beside rail routes. Cross-border railways have not benefitted from this policy. After 2015, Poland initiated a program to support public bus transport, which has, however, been oriented to the internal market and has not comprised cross-border connections. Thus, Poland's post-accession transport policy has rather been conducive to the concentration of border passenger traffic in the modal sense (in road transport) and in spatial terms (on the main routes). The scale of investments undertaken in neighbouring countries has been much smaller, with the projects concentrated almost exclusively on the main routes. This has meant, *inter alia*, that, on the Ukrainian side, no new roads have been built to some of the new border crossings (e.g. in Budomierz), with the terminal sections remaining dirt roads.

4.1.4 Permeability

In the period under study (1994–2019), changes in the permeability of the Polish eastern border to passenger traffic varied from one border section to another (see Tab. 3). In the case of the Polish-Belarusian border, these changes were so negligible that they can be considered non-existent, with a relatively low level of permeability of this section of the border (an average of 4.1 on a scale of 0–10). There are noticeable decreases in permeability levels in the years 2004–2009, which were mainly attributable to Poland's accession to the EU and the introduction of a visa regime. Towards the end of the period, there was a noticeable increase in the level of permeability associated with the launch of visa-free travel to so-called 'tourist areas' in Belarus. The entire period saw a relatively low level of permeability of the Polish-Russian border (an average of 4.2), with a marked, but only several-year, increase related to the entry into force of a local border traffic agreement (later suspended by Poland in 2016). The greatest permeability was seen on the Polish-Ukrainian border (5.4 on average). A large increase in the permeability in 2009 stemmed from the introduction of a local border traffic program and then the lifting of visas to the Schengen area (2017).

4.2 Border traffic and modal split

In the period under study, there was a general upward trend in the movement of people across the land sections of the Polish eastern border, currently forming part of the external border of the European Union (Fig. 3). This trend largely resulted from the growing rank of road transport.

Years	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Ukraine	4.4	4.5	4.5	5.4	5.4	5.4	5.4	5.4	5.4	4.5	4.5	4.6	4.6
Belarus	4.1	4.1	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.1	3.9	3.9	3.9
Russia	3.9	3.9	4.1	4.2	4.2	4.1	4.1	4.2	4.2	4.0	3.9	3.9	3.9
Years	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Ukraine	4.4	4.4	6.0	6.1	6.1	6.0	6.1	6.1	6.1	6.1	6.4	6.4	6.4
Belarus	3.8	3.8	3.9	4.0	4.1	4.1	4.1	4.1	4.1	4.1	4.2	4.6	4.6
Russia	3.7	3.7	3.8	3.8	3.8	5.8	5.8	5.8	5.8	3.9	3.9	4.0	4.0

Tab. 3: Permeability of the Polish section of the external border of the EU
Source: authors' analysis based on a survey

In the 1980s, when the total volume of passenger traffic remained very low, the railway was the leading mode. Socio-economic developments at the beginning of the 1990s enhanced cross-border mobility. Until 1992, there was a fairly steady increase in the number of crossings of the border by both types of transport. The years that followed were characterised by a rise in road transport and a declining rank of railways. Both contradictory tendencies were discontinuous. There were short-term reversals of the trend. The episodic increases of rail traffic, the last of which occurred during the period 2017–2019, were not enough to overcome the marginalisation of this mode.

Road border traffic between the People's Republic of Poland and the Soviet Union was very limited, which was due, inter alia, to formal and organisational constraints. From the beginning of the 1990s, however, its intensity started to grow dynamically on all three sections of the state border (see Fig. 4). For the most part, the fluctuations in overall traffic which were observed at the turn of the century stemmed from the situation at road crossings, and primarily reflected economic activity across the border (favourable conditions for small-scale trade), and, after that, the formal restrictions associated with Poland's accession to the European Union. The first downturn occurred during the Russian financial crisis in 1998 and another occurred after the introduction of visas for citizens of Eastern Europe in 2003. Later increases are associated with a rise in the share of Polish citizens in the traffic, which had ceased to be subject to the visa requirement when travelling to Ukraine. Poles crossed the border, inter alia, to purchase liquid fuels, which artificially increased road traffic statistics. Following the introduction of a limit on the repeated use of reliefs from customs duties, this traffic decreased again. The upward trend in the second decade of the 21st century once again resulted from the travel of citizens of neighbouring countries, mainly Ukrainians, which was stimulated by a local border traffic agreement and the opening of the Polish labour market (Komornicki and Wiśniewski, 2021). This gave rise to shuttle trips by car, often on a weekly basis.

By contrast, coach services play an invariably important role, as far as citizens of neighbouring countries are concerned. They began to take over the transport of small-scale traders from the railways at the beginning of the period under investigation. Later, they also became the means of transport of choice for many foreigners going to work in Poland. The 1990s saw a very rapid growth of international bus connections (Komornicki, 1996). According to 2002 data, 497 return trips to Ukraine, 259 to Belarus, 51 to Russia and 3 to Moldova were operated every week (Komornicki, 2003b). They reached the entire territories of Ukraine and Belarus. In addition to scheduled connections, however, the number of buses recorded on the eastern border (Fig. 5) also includes trips of tourist coaches or coaches rented by groups of small-scale traders. When it comes to bus traffic, the moment Poland joined the Schengen area is reflected by a pronounced decrease in the number of vehicles which crossed the border. From 2009 until the end of the period under study, there was a gradual increase in bus

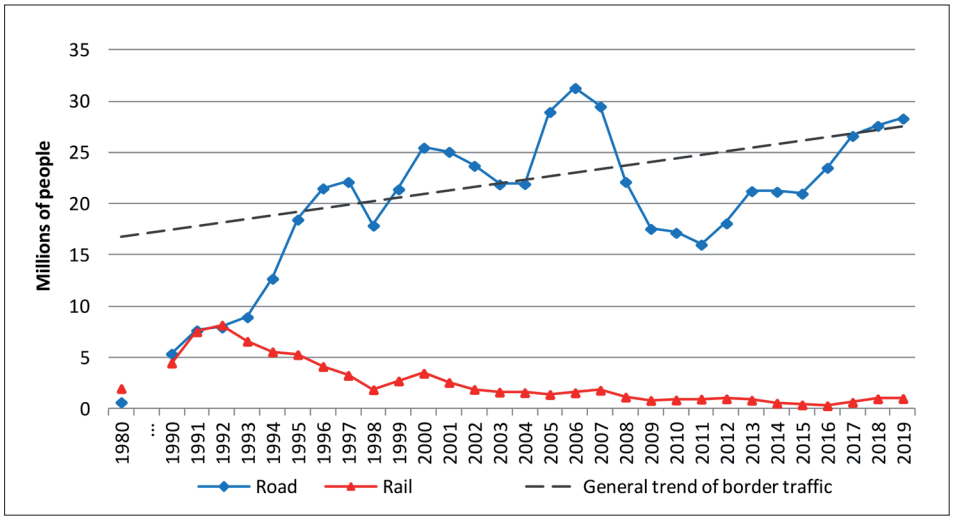

Fig. 3: Passenger traffic at road and rail border crossings on the land segments of the Polish external border of the EU (passport traffic, both directions)
Source: authors' analysis based on data of the Polish Border Guard Headquarters

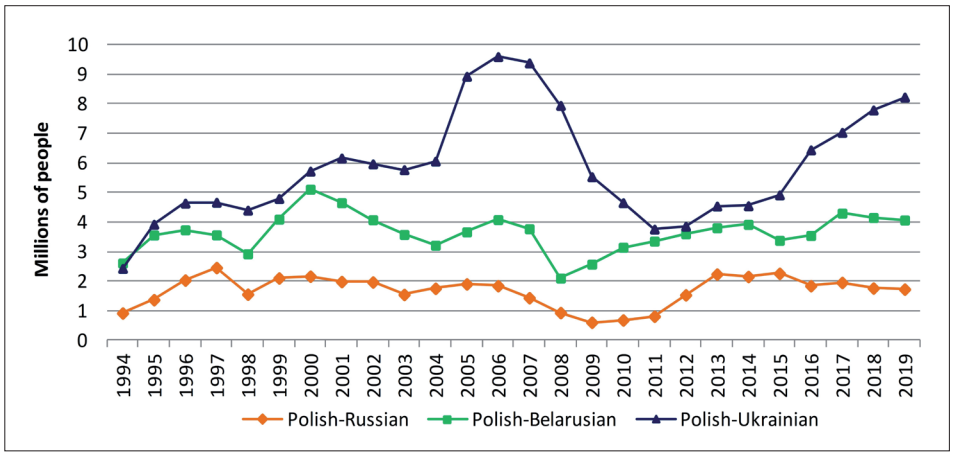

Fig. 4: Passenger traffic at road border crossings on the land segments of the Polish external border of the EU (passport traffic, arrivals to Poland)
Source: authors' analysis based on data of the Polish Border Guard Headquarters

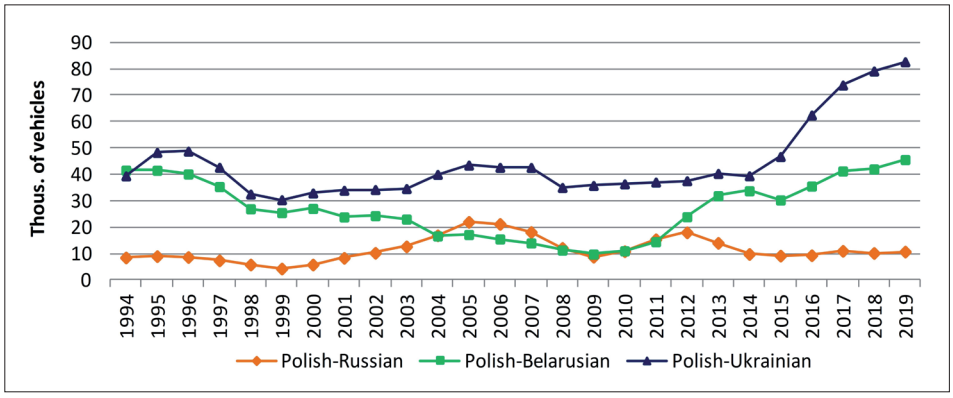

Fig. 5: Number of buses crossing the land segments of the Polish external border of the EU (arrivals to Poland)
Source: authors' analysis based on data of the Polish Border Guard Headquarters

traffic across the Polish-Belarusian and Polish-Ukrainian sections of the border, with a steep increase in 2014 caused by mass labour immigration of Ukrainians into Poland.

In the 1980s, most passenger crossings of the eastern border were made by rail transport (Fig. 6). There were mainly long-distance trains which consisted exclusively of sleeping cars. Their routes linked several Polish cities and six urban centres of the USSR: Moscow, Leningrad (Saint Petersburg), Minsk, Kyiv, Lviv and Vilnius. A separate group was formed by trains which transitted across Poland from many Western European cities towards Moscow. There were also direct connections between Poland and Romania and Bulgaria, which ran across the Ukrainian SSR and served holiday trips (PKP, 1985). Shortly before the collapse of the USSR, the percentage of crossings of the eastern border by rail decreased to approximately 45%. This actually meant a temporary growth in the number of train passengers, as overall land border traffic increased rapidly at the beginning of the 1990s. It was progressively driven by small-scale border trade, fostered by the opening of new local rail connections, first with Belarus and Ukraine, and from 1992 also with Kaliningrad. In contrast, the network of transit connections from Western Europe decreased considerably in favour of air transport (PKP, 1990–1995). In just a dozen or so years, there was a huge decline in the importance of railways in passenger transport, which deepened in the following years. Attempts to activate rail transport by launching long-distance connections (e.g. to Simferopol, Kishinev, Irkutsk, and Astana) were not able to stop the process of marginalisation (PKP, 2000–2014). A slight revival started to be observed from the end of the second decade of the 21st century, mainly as a result of the development of connections with Ukraine (PKP, 2018a,b).

The volume of rail passenger transport expressed in absolute values varied from one segment of the eastern border to another. The Belarusian section (Fig. 7), which served local and long-distance trains (including transit connections) to Moscow and other Russian cities, and initially also to Vilnius (PKP, 1990–2000), ranked first almost over the entire study period. The Ukrainian section ranked second in terms of the values recorded. A similar sequence was observable in the 1980s. For both sections, the volume of passengers peaked at the beginning of the 1990s. In addition, both showed a general downward trend, except that the railways were being marginalised more rapidly on the border with Ukraine. The lowest numbers were seen for traffic between Poland and the Kaliningrad Oblast. Before 1992, passenger transport by rail was nearly non-existent[6] and was not based on public timetables. The opening of a local train route to Braniewo (extended to Gdynia since 1993) and a long-distance connection with Berlin (since 1995) changed little. Shrinking demand for rail

[6] By the time the civilian connections were launched, only soldiers and railway workers could cross the border by rail (Maciążek, 2018). Statistics on border traffic include entries of people belonging to the crews of freight trains.

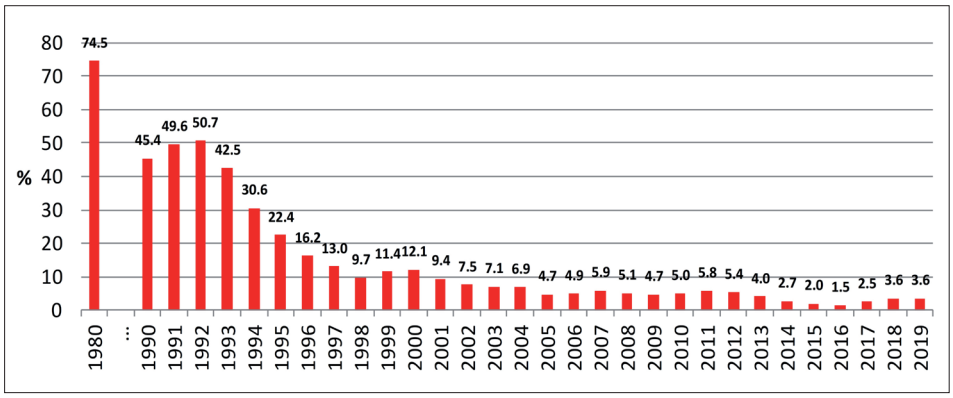

Fig. 6: Role of rail transport in passenger traffic across the land segments of the Polish external border of the EU
Source: authors' analysis based on data of the Polish Border Guard Headquarters

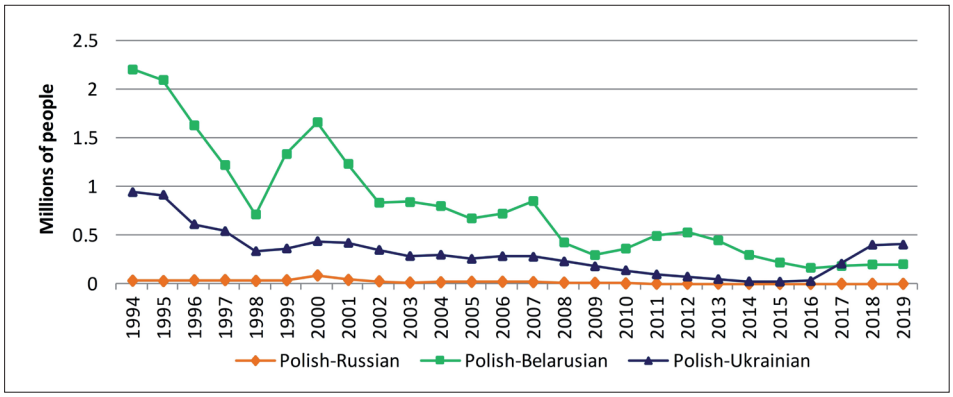

Fig. 7: Passenger traffic at rail border crossings on the land segments of the Polish external border of the EU (passport traffic, arrivals in Poland)
Source: authors' analysis based on data of the Polish Border Guard Headquarters

services resulted in suspension of the local trains at the end of 2012. The irregular connections to the German capital finally ended in 2009 (Anisiewicz, 2007; Maciążek, 2018; PKP, 1992–2011).

Starting from 2017, an increase in flows was recorded on the Ukrainian section of the border, overtaking the volumes observed on the Belarusian border in the next two years. This was brought about, inter alia, by the improvement of the transport offer through the launch of daytime express services from Przemyśl to Lviv and Kyiv and the restoration of a local connection that had not been available since its suspension in the 1990s. The latter activity established links between the Polish city of Chełm and cities of north-western Ukraine (Kovel, Rivne, Zdolbuniv). The above efforts involved bringing in new rolling stock that could travel within Polish territory on broad-gauge sections of track near the border. The absence of the need to replace the bogies and the handling of the customs and passport clearance on board the trains, considerably shortened travel times (PKP, 2014, 2018a,b). These positive signs of the rising rank of railways in cross-border traffic, however, are still incomparable to the rapid growth of car and air transport noticeable in the last decade (cf. von Arx et al., 2018).

The availability of air transport for travel between Poland and the USSR was clearly poorer than that offered by long-distance rail connections. In the 1990s, after the disintegration of the Eastern bloc, international flights were still a luxury good for the average inhabitants of Poland and of the newly created states behind its eastern border. It was somewhat different in the case of Western Europe, where long-distance railway connections to Moscow and Kyiv were largely replaced by air services in the mid-1990s (PKP, 1990–1995). In 2001 there were 19 regular return flights from Poland to Ukraine, 19 to Russia, 8 to Belarus and 2 to Moldova per week (Komornicki, 2003b).

Until the end of the 1990s, of the three groups of foreigners involved, Russians used flight connections to Poland most often. This did not apply, however, to the Warsaw-Kaliningrad route which only appeared in 2002 (Palmowski, 2015). Until 2019, this connection functioned intermittently, showing the smallest flows of people compared to the other three directions (see Fig. 8). Given the relatively short distance, a marginal role of air transport throughout the period is also observable for Belarus, where a slight rebound only occurred in 2013. Flights to Russia (Moscow, Saint Petersburg, Kaliningrad) and to Belarus (Minsk) were and continue to be handled in 2019 only by national carriers (Aeroflot, Belavia, LOT Polish Airlines). These markets continue to be affected by large barriers hindering non-state carriers from entering the market with competitive flights, as a result of which the offer was limited to connections with Warsaw. In 2019, there were 48 such connections per week for Russia, and only 7 for Belarus (Tab. 4).

The dynamic development of low-cost airlines in the first decades of the 21st century revolutionised the market for passenger transport, not only for distant but also for close destinations. Episodically from 2001, and permanently from 2009, Ukrainians had the greatest share in the number of crossings of the eastern air border (Fig. 8). This figure began to climb rapidly in 2016 corresponding to

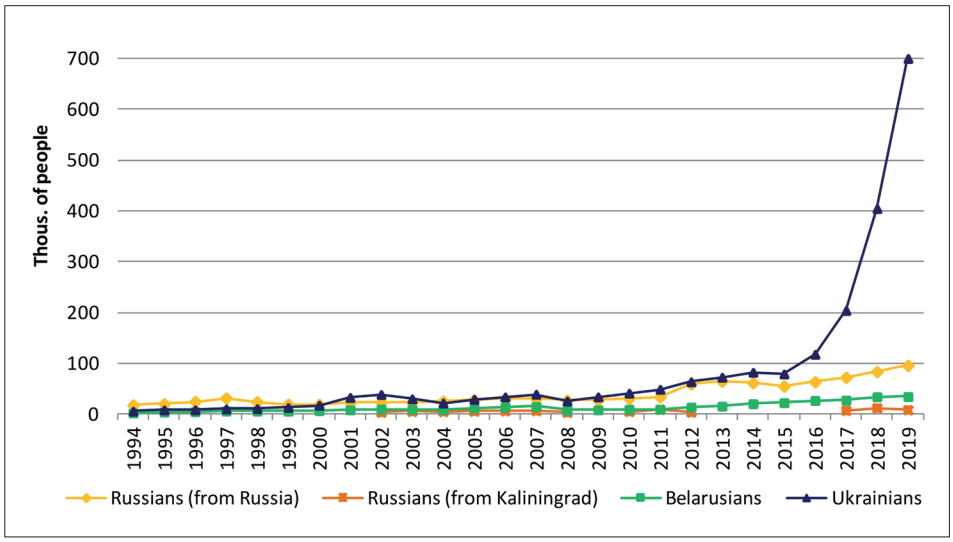

Fig. 8: Arrivals of Russians, Belarusians and Ukrainians at air border crossings in Poland
Source: authors' analysis based on data of the Polish Border Guard Headquarters

demand generated by labour migration to Poland and the subsequent visa waiver. In response to this demand there was a radical extension of the range of destinations on both sides of the border, which was coupled with attractive low-price offers (Shoppingpl.com, 2019; Vsetutpl.com, 2019). Several years before this, the network of connections had still been limited to the capitals of both countries and Krakow, with the flights operated by LOT Polish Airlines and the national airline of Ukraine (Aerosvit, later Ukraine International Airlines).

In 2019 as many as 10 Polish airports offered 189 direct flights to Ukraine per week (Tab. 4). The number of connections served by low-cost carriers (Ryanair, Wizzair) was 83, of which only 11 were operated along the Kyiv-Warsaw route. Out of the 106 connections provided by the national operators, as many as 93 went to Chopin airport in Warsaw. Among Ukrainian cities, four other destinations were available in addition to Kyiv: Lviv, Kharkiv, Odesa and Zaporizhia. The first three of these urban centres were served by both types of carriers, with Lviv in a leading position (45 connections, including 18 low-cost ones).

In the period 1994–2019, the modal split of cross-border traffic evolved differently depending on the section of the border and the group of foreigners – Russians, Belarusians, and Ukrainians. Notwithstanding the general trend characteristic of the entire Polish eastern border, namely the growing share of road transport (and in recent years also of air transport) at the expense of railways, the various modes

		Russia				Belarus
	Airport (IATA code)	Moscow (SVO)	St. Petersburg (LED)	Kaliningrad (KGD)	All airports	Minsk (MSQ)
	Warsaw (WAW)	35/0	7/0	6/0	48/0	14/0
		Ukraine				
	Airport (IATA code)	Kyiv (KBP)	Kyiv (IEV)	Lviv (LWO)	Kharkiv (HRK)	Odesa (ODS)	Zaporizhia (OZH)	All airports
Poland	Warsaw (WAW)	28/0	13/7	21/0	11/0	14/0	6/0	93/7
	Warsaw (WMI)	0/4	–	0/3	–	–	–	0/7
	Kraków (KRK)	7/4	0/4	0/3	0/4	0/2	–	7/17
	Katowice (KTW)	–	0/4	0/3	0/2	0/3	–	0/12
	Wrocław (WRO)	0/3	0/3	0/3	0/2	0/2	–	0/13
	Poznań (POZ)	0/2	0/2	2/0	0/2	0/2	–	2/8
	Gdańsk (GDN)	0/2	0/3	0/4	0/2	0/2	–	0/13
	Bydgoszcz (BZG)	0/2	–	2/0	–	–	–	2/2
	Lublin (LUZ)	–	0/2	–	–	–	–	0/2
	Olsztyn (SZY)	–	–	2/0	–	–	–	2/0
	All airports	35/17	13/25	27/16	11/12	14/11	6/0	106/81

Tab. 4: Direct air connections from Poland to Russia, Belarus and Ukraine with the maximum number of flights per week in 2019 (first value – traditional airlines, second value – low-cost airlines)
Source: Own analysis based on Avianews.com (2019); Latamy.pl (2010); Shoppingpl.com (2019); Vsetutpl.com (2019); Wirtualnemedia.pl (2017); ZOPOT (2020)

of transport on the three sections of border analysed showed different shares over the same time periods. The pace of observed modal shifts was also different (see Fig. 9).

Throughout the period under analysis, road transport, in particular by private means, invariably played the greatest role in the movement of Russians across the Polish-Russian border. The share of buses gradually decreased up to 1999. Subsequently, this trend reversed to exceed, between 2007 and 2011, the level from the first half of the 1990s. This was accompanied by a decline in the overall volume of border traffic, however, caused by the economic crisis and restrictions put in place following Poland's accession to the EU and the Schengen area. Individual transport regained its former position as a result of the operation of local border traffic on this section in 2012–2016. Meanwhile, in the case of Russians who travelled to Poland across Belarus, one characteristic feature, compared to the other sections of the border and groups of foreigners, was the relatively small percentage of crossings by road transport, even towards the end of the study period. Another one was the recurrent prevalence of public transport over private transport (in the periods 1994–1998 and 2007–2019). This resulted, inter alia, from greater distances to travel, thus making travellers opt for the train, bus or plane. The 1990s were a time of a growing share of individual transport, with a fairly stable role of bus transport. Like the border with the Kaliningrad Oblast, private transport began to lose importance after 2004, to become permanently dominated by buses over the ten years that followed. Drivers of passenger cars and trucks would increasingly prefer the Russian-Latvian border of Schengen, giving up transit across Belarus.

More spectacular modal shifts in favour of road transport, and in particular private automobile transport, were observable for the cross-border traffic of Belarusians and Ukrainians. In the initial phase, the development of small-scale border trade and smuggling was one of the driving forces. In both cases, the total share of public transport exceeded 50% only in 1994. Modal changes were proceeding at different rates however. On the Polish-Belarusian border, it was a fairly constant trend, with slight fluctuations and with a stable ratio of private transport to public bus transport, with a clear prevalence of the former. The position of buses only began to improve after 2010. Meanwhile on the Polish-Ukrainian border, the phase of rapid growth in the share of the road sector lasted until 1998. In the following years, the process slowed down, but continued until 2015, when new air and railway services started to be offered.

At the same time, unlike the Polish-Belarusian border, this section experienced a more marked decline in the share of bus transport (despite an upward trend recorded in absolute values), with a simultaneous growing predominance of private transport. The clearance waiting times, as analysed in the context of the purpose of the travel, was one factor that may have had an impact on the internal breakdown of road traffic. In the case of small-scale trade (1990s) or shopping (last decade), a decisive role was played by the possibility of transporting larger amounts of goods, which meant that private cars and vans were opted for, regardless of the travel time. With the growing share of commuting to work in Poland in overall travel, crossing the border rapidly came to the fore. This was catered for by scheduled buses, which bypassed queues at the border crossings.

From the very beginning, rail transport, at the expense of which the modal shift in question took place, was of marginal importance in the movement of people across the Polish-Russian border. It was only in 1994 and 2000 that a more noticeable percentage of Russians who travelled from the Kaliningrad Oblast, chose this method of crossing the border. Aside from a slight rebound between 2007 and 2009, rail transport on this section underwent further

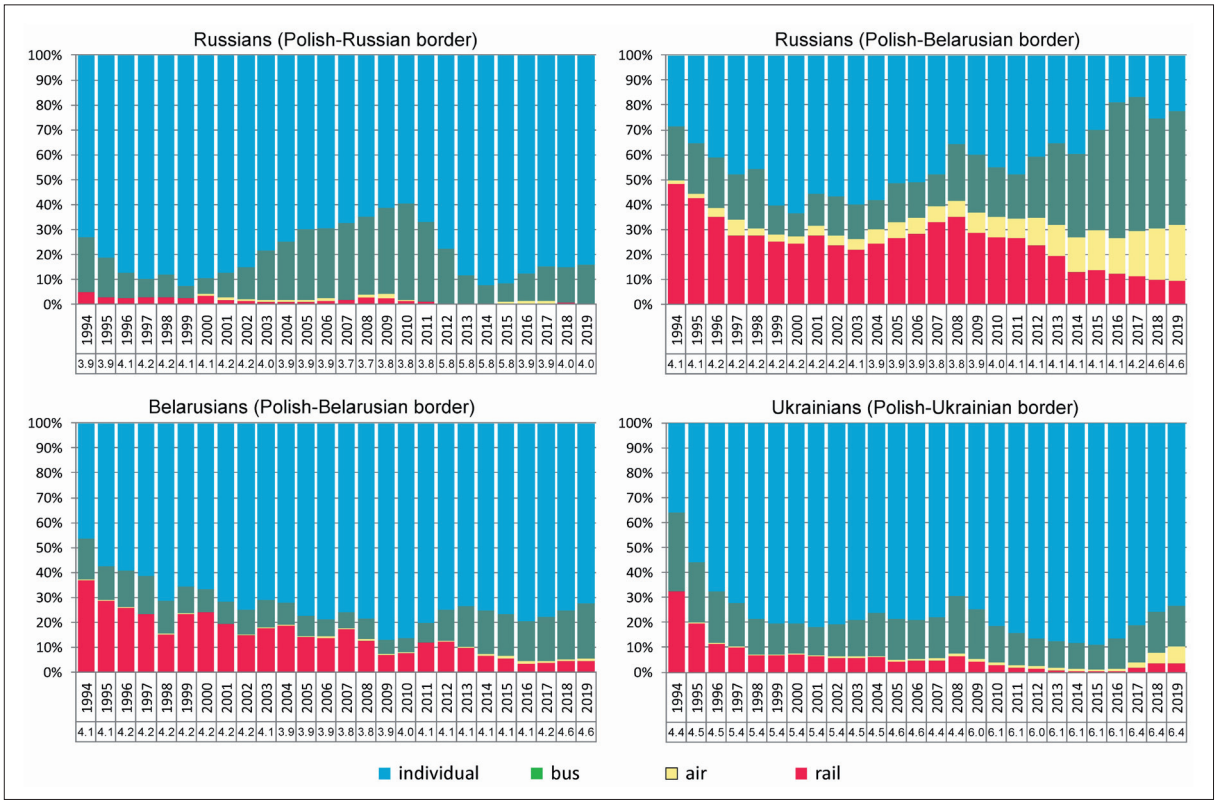

Fig. 9: Modal split changes and border permeability rate 1994–2019
Source: authors' analysis based on data of the Polish Border Guard Headquarters and our research

marginalisation, which led to the suspension of timetable-based transport in the second decade of the 21st century. Later attempts to restore them ended in 'fiasco', which was due to the lack of political will to re-establish local border traffic. Meanwhile, the railway was an important means of transport for Russians who used long-distance connections across Belarus. In the first half of the 1990s, rail's share in the modal structure here reached almost 50%. Despite the subsequent regression (excluding a five-year growth phase in 2004–2008), the percentage of crossings of the Polish-Belarusian border on trains by citizens of the Russian Federation was still much higher than in the case of the other two groups of nationals. Until as late as 2012, it was also higher than the number of entries by bus. Belarusians who travelled to Poland by public transport would also choose trains over buses for many years, but the share of railways in the modal split of cross-border traffic became lower than in the case of Russians on the same section as early as 1994, and was to decrease gradually in the years that followed. This stemmed, inter alia, from the gradual reduction in the number of local cross-border connections being offered.

The Polish-Ukrainian border is the most illustrative example of the marginalisation of rail transport. Buses very rapidly began to play a leading role in the arrivals of Ukrainians by public transport. The proportions of the shares of the two modes were similar only in 1994, with a slight advantage to the railways. The 1990s were characterised by an even faster loss of volumes to individual transport. After 2000, the share of railways saw a further decline to be marginalised totally in 2014–2016, when no local connections were in operation anymore, and the long-distance service was reduced to a minimum. It was only in 2017 that the long-term downward trend started to reverse as a result of the launch of a new, more convenient network of connections at the end of 2016. In 2018, this share continued to grow, but a year later it stalled at approximately 3.5%.

The reasons for the long-term decline of rail transport in cross-border passenger traffic are complex. They include the incompatibility of the infrastructure, its deterioration and the competitiveness of other modes of transport, the organisation of railway services, with the indirect impact of formal and customs-related restrictions. The above problems pertain not only to the eastern border, which is peculiar, but also to the other sections of the Polish border (cf. Gamon and Naranjo Gomez, 2019).

The condition of railway infrastructure in eastern Poland, including that used for cross-border traffic, had been deteriorating uninterruptedly until Poland's accession to the European Union. Reverse trends were observable only as a result of the influx of EU funds and the modernisation of some routes, mainly trunk lines. The low competitiveness of rail transport to Eastern Europe (compared to bus carriers, and later also low-cost airlines) resulted from long waiting times at border checkpoints (due to different track gauges, among other reasons), rather than from the low speed of travel. The nature of the operations of railway undertakings, notably their lower flexibility and fewer possibilities for matching the train routes to demand than in the case of bus and air transport, was another factor (Perennes, 2017). An indirect role was also played by the transport policies of the neighbouring countries. Individual countries first strive to ensure an appropriate network of domestic connections, and then of international ones (cf. von Arx et al., 2018). This study demonstrates that cross-border rail transport proved to be highly inflexible in the face of systemic changes (economic transformation), geopolitical developments (visa and customs regimes), and sectoral transitions (competition from other modes of transport; Komornicki and Kowalczyk, 2018). There are also good examples of the functioning of cross-border transport, but they mainly comprise seasonal tourist connections (e.g. between Maribor-Prevalje, Slovenia and Bleiburg-Pliberk, Austria; Interreg Central Europe, 2022, or the connection that has been announced between Kraków, Poland and Split, Croatia to be operated by the Czech carrier RegioJet; TVN24.pl, 2022).

The position of railways in the segment of international long-distance transport was also weakened by the extension of the air offer, especially in the second decade of the 21st century. This did not concern the Kaliningrad Oblast and Belarus, however, whose proximity and isolated markets resulted in the share of air traffic in these directions to be minimal over the entire period considered. It appears to be completely different for Russian travellers flying through the airspace of Belarus (mainly from Moscow and St. Petersburg) and Ukrainians, who preferred air travel on account of the distance. In the case of Russians, the role of air transport in cross-border traffic with Poland became noticeable as early as the 1990s, but the greatest upward trend in this regard was seen after 2011. In the middle of the second decade of the 21st century, the air sector began to compete with railways in real terms. In 2019, more than twice as many Russians came to Poland by air as by train. Despite the larger and growing number of arrivals by Ukrainians in absolute terms, the share of air traffic in the modal split became pronounced much later, with a much lower share than that recorded among Russians. This was due to the fast pace of development of Polish – Ukrainian road transport. The years 2013–2015 even saw a decrease in the share of air traffic, which had already overtaken rail transport by that time. The share of rail equalled that of air transport in 2017. In the last two years, however, the aviation sector strengthened its position. In 2019, almost twice as many Ukrainians arrived in Poland by air as by rail. The transformations described above are an interesting example of competition between two niche modes of transport, despite the prevalence of the road sector.

On the Belarusian section (cross-border traffic of Belarusians and Russians), the permeability of the border did not have any impact on modal change (see Fig. 9). In the absence of major changes in the level of permeability, the share of individual means of transport in the number of crossings of this border changed significantly, which was the result of general trends (increasing share of crossings made by cars) or the specificity of the Belarusian section (a high share of trains in the crossings made by Russians in long-distance travel). On the Polish-Russian border, there is a strong predominance of crossings made by passenger cars following the improvement of permeability by the signature of the local border traffic agreement. The Ukrainian section also displays a discernible growth in car traffic at times of greater permeability, *inter alia* because of the introduction of local border traffic. The higher permeability of this border coincided with a relatively large share of air crossings. This probably stems from the market's response to the demand produced by labour migration to Poland. It should not be forgotten, however, that this is concurrent with the easing of the visa regime and the associated limitation of the function of the border as a barrier, especially a formal one. Thus, the problem of permeability concerns formal issues to a greater extent than the technical possibilities of crossing the border (border checkpoints).

It follows from the outcomes of this study that increased permeability typically led to an intensification of border traffic. In parallel, longer journeys (e.g. between the large cities of Poland and of neighbouring countries, but also generally trips to work in Poland) took place during periods of greater formal restrictions too. As there is no strictly local public transport across the eastern border, changes in permeability had an indirect effect on the modal split of traffic. Better permeability is also one of the stimulants of air transport, especially by low-cost carriers. Against such a background, the role of railways is more difficult to interpret. On the one hand, for many years, cross-border travel by train would decline both at times of decreased and increased permeability, but it was mainly a secondary consequence of changes in the overall intensity of car traffic. On the other hand, in the final years of the study period, the improvement in the level of permeability on the Ukrainian border was coupled with a slow revival of rail transport. It can be anticipated that achieving a certain degree of permeability of the formal border is a condition for the formation of a modal split similar to that of internal journeys. Then, the border ceases to be a factor that shapes the breakdown of traffic. Further modal changes in passenger transport are conditioned by other factors.

6. Conclusions

The aim of this study was to identify the impact of changes in the function of the eastern border of Poland (which is also part of the EU external border) and in the level of its permeability on modal shifts in cross-border traffic over the years 1994–2019. In order to achieve this, use was made of data from the Border Guard Headquarters and our own research activities to allow the volumes of border traffic for certain categories to be estimated. Three types of land transport were analysed: rail, air and road (by bus and in private cars).

All sections of the border display the marginalisation of railway transport. A relatively high contribution of railways is still being recorded on the Belarusian border on account of long-distance travel (between Moscow and European cities). Ignoring the intermodal shifts between types of public transport, the key role was played by the growing predominance of private car transport in Russia, Belarus and Ukraine. Despite this, the Polish eastern border is characterised by a sustained high share of bus transport which pertains to all the sections under analysis. Private transport is most dominant on the Polish-Russian border, while the largest share of crossings by bus is recorded on the Belarusian border (both among Russians and Belarusians). Air transport is most favoured when it comes to Russians on the Belarusian section and in the case of Ukrainians. One inherent feature of road traffic, especially of travel by car, is congestion, which occurs on sections with a lower degree of permeability due either to the degree of border formalisation or insufficiently developed transport infrastructure (see Komornicki, 2008). The long waiting times for clearance when travelling in private cars was probably one of the factors behind the creation of the market for collective transport.

This analysis made it possible to distinguish several periods of modal shifts in passenger traffic on the Polish section of the EU external border:

- the 1990s, when rapid modal shifts were driven by the liberalisation of the economy (previously, the position of the railways had been maintained artificially by regulations of the centrally planned economy), booming cross-border trade, competition from bus transport, and mass motorisation in Poland and then also in the neighbouring countries; during this period, similar modal changes took place across all the sections of the border;
- the 2000–2011 period, when the changes were due to the low competitiveness of the railways (deterioration of the network) and the closure of unprofitable connections (including cross-border ones), but also by Poland's accession to the EU and the Schengen area, as well as by customs-related conditions; during the period, the pace of modal change on the various borders began to vary;
- the 2012–2016 period in which further changes were triggered by the inadequate offer of services from railway operators and them losing out in the competitive struggle, not so much with private car transport, which had happened earlier, but rather with public bus and air transport; and
- the 2017–2019 period, when the permeability of the Polish-Ukrainian border clearly improved (inter alia because of the lifting of Schengen visas for Ukrainian citizens), and when the modal split began to be determined more by market conditions, with a growing share of air transport and the first signs of the revival of the railways; at the same time, the situation along the Belarusian and Russian sections of the border did not radically change up to 2019.

While the first two periods mentioned above mirror objective economic and political processes (the decline in cross-border rail traffic and mass motorisation were largely unavoidable), the post-2012 period was strongly influenced by an actual transport policy, especially when it comes to Polish-Ukrainian relations. The huge increase in traffic between the two countries, associated mainly with migration (and not only with cross-border trade), opened a window of opportunity for enhancing the role of both rail and air transport. This created new opportunities for observing cross-border processes in transport terms, especially in the context of ever closer Polish-Ukrainian cooperation. The aspect of the efficiency of public transport and the mechanisms of adjusting the demand and supply of transport services in response to the huge influx of economic migrants from Ukraine and, to a lesser extent, from Belarus, seems to be of particular interest. Further research into modal shifts in border traffic seems advisable. Such research, however, must go hand-in-hand with studies into the territorial system of the social ties that generate the traffic (labour migrations, students' travel, tourism, family visits, transit). This would provide an insight into the modal structure of cross-border traffic in terms of the underlying motivations.

This analysis is also useful in formulating guidance for the broad transport policies and border regimes. Research shows that the investment activities carried out to date have indirectly stimulated modal changes towards a greater share of car transport. The construction of the new TEN-T network of road routes (on the Polish side of the border) has increased the share of cross-border road transport, especially in private automobiles. The reactivation of regional cross-border railway lines (along the sections that do not require gauge change) could help to slow down this trend locally. A role is also played by the regulations that limit pedestrian traffic on most crossings, which promote the use of private cars even for very short journeys. Ultimately, however, increasing the share of rail traffic requires that East

European countries be integrated into the network of high-speed intercity connections in order to be competitive with both private car and air transport. In the case of the rail connections across the Polish eastern border, this applies in the first place to the Polish-Ukrainian connections along the Krakow-Lviv, Warsaw-Lviv, Warsaw-Kovel-Kyiv routes. The feasibility of such actions in the case of Belarus and Russia depends on future geopolitical developments.

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