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THE SOCIO-ECONOMIC TRANSFORMATIONS OF MUNICIPALITIES IN LODZ METROPOLITAN AREA IN THE CONTEXT OF THE CONSTRUCTION OF MOTORWAYS AND EXPRESSWAYS

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Abstract
As part of the programmes for the construction of national roads in Poland in the years 2004–2014, several transport investments have been made in Lodz Metropolitan Area (LMA), that significantly improved the potential availability of the municipalities located in it. The commissioning of subsequent sections of the A1, A2 motorways and S14 and S8 expressways that primarily serve transit purposes, coincided with the progressing suburbanisation processes of the municipalities located in the immediate vicinity of the largest cities of the LMA. The aim of this paper is to identify those processes of socio-economic transformations in LMA municipalities, caused to the greatest extent by the construction and operation of motorways and expressways between 2004 and 2014. The study compared the municipalities that obtained better access to motorways and expressways with other LMA municipalities. The data obtained from the Local Data Bank of the Central Statistical Office were used for the analysis. Studies have confirmed the indirect effects of motorways on population redistribution and labour market growth. This mitigated the effects of the 2008 economic crisis in the urbanising and rural communes adjacent to the motorway. It was also found that accessibility to motorway and expressway junctions can affect the location of large industrial logistics and warehousing companies in particular. This influence may precede the very process of commissioning the motorway or expressway.

Key words
Motorways, expressways, metropolitan area, suburbanisation, enterprise structure changes.

INTRODUCTION

It is widely believed that the construction of motorways and expressways positively affects economic growth and regional development, serves to equalise interregional disparities and contributes to the increase of transport accessibility to the labour market (Potrykowski and Taylor, 1982; Hanson and Giuliano, 2004; Komornicki et al. 2015). These investments thus affect the functional and spatial trans-

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formation of the surrounding area. Meanwhile, empirical research suggests that this impact is not unequivocal (Komornicki et al. 2015) and depends, inter alia, on the extent to which the investment in transport infrastructure improves the transport accessibility of the entire transport system, the availability of land for development, spatial policy at the local level, economic development at the regional level, the scale of research and other economic and social processes, influencing the spatial development of the area adjacent to the investment and time of research (Giuliano, 2017, GREEN PAPER, 1992; Koźlak, 2011). Due to the dynamically occurring processes of spatial, social, demographic and economic suburbanisation, suburban zones of large cities require special attention in terms of the impact of new road investments on socio-economic changes (Komornicki et al. 2015).

One of the largest beneficiaries of the construction of the motorway and expressway network in Poland was the Lodz Metropolitan Area (LMA), where between 2004–2014, the length of roads with the highest parameters grew steadily. In the LMA, successive sections of expressways and motorways were commissioned in 2006, 2012 and 2014. At the end of the analysed period, earthworks related to the construction of the A1 motorway were underway in the study area. This motorway was supposed to connect the expressways opened for use in the southern part with the A2 motorway located in the northern part, thus eliminating the bottlenecks of the supra-regional road transport network (Fig. 1).

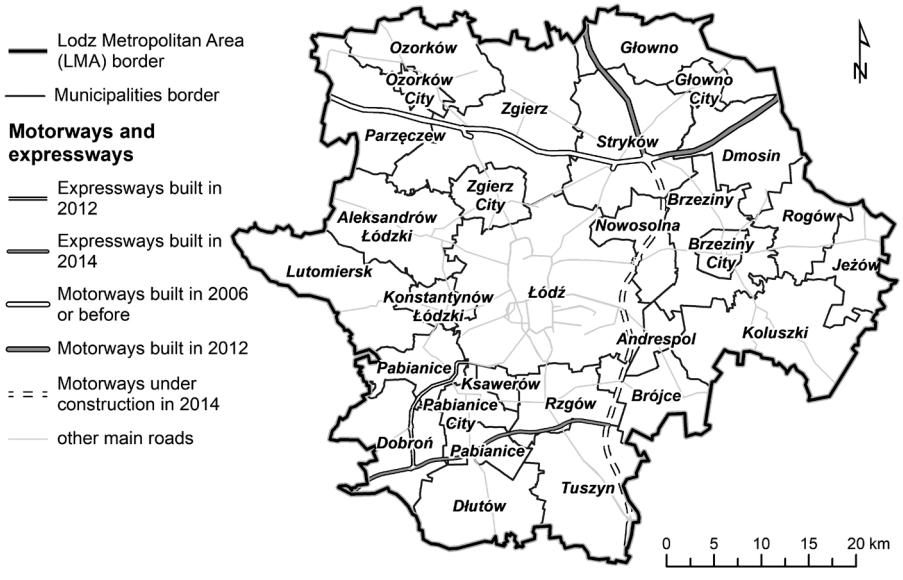

Fig. 1
Communication location of the Lodz Metropolitan Area (MLA) as of 2014
Source: adapted from General Directorate for National Roads and Highways

Taking into consideration the years 2004–2014, it was possible to capture the transformations caused both by the effects of road construction, as well as their operation. Research shows that an eight-year period from the construction of an investment is sufficient to capture changes in employment and business activity, which may imply spatial changes visible in the area, while at the same time it is short enough to avoid some of the problems related to the dynamic nature of the phenomenon, e.g., the influence of other factors such as subsequent investments, changing local economic or political conditions (Louw et al. 2013). Similar temporal assumptions, but for the ten-year period from the commencement of motorway construction were adopted by Komornicki et al. (2013), Banister and Berechman (2003) in their research to capture short- and mid-term changes.

The Lodz Metropolitan Area (LMA) is in line with the delimitation applied in the Development Strategy for the Lodz Region 2020 (Strategia 2012) and consists of 28 municipalities, including 7 urban municipalities, 5 urban-rural ones and 16 rural ones.

Its central part is Łódź with a population 774,000 in 2004 and 706,000 in 2014 respectively. Like all metropolitan areas in Poland, it is subjected to spontaneous spatial urbanisation processes but, unlike others, it was experiencing a population decline. This decline resulted from the fact that the total decrease in the number of people resulting from natural movement and migration in Łódź was not compensated by the increase in the number of inhabitants in suburban areas (Jakóbczyk-Gryszkiewicz et al. 2010).

OBJECTIVES

The aim of this paper is to identify processes of socio-economic transformations in LMA municipalities, caused by the construction and operation of motorways and expressways between 2004 and 2014. The implementation of this task required answering the following research questions:

- Has the construction of expressways and motorways changed the population density and the migration of LMA municipalities?
- Has the construction of expressways and motorways affected the social structure in individual municipalities in the LMA?
- Has the construction of expressways and motorways contributed to changes in the number, size and industry structure of enterprises in individual LMA municipalities?

The research period covers the years 2004–2014.

THEORETICAL FRAMEWORK

The first publications that started paying attention to the spatial and social consequences of the construction and functioning of motorways appeared at the end of the 1950s (e.g. Hansen, 1959). In subsequent years, referring to the economic effects of construction and operation of highways, attention was paid to the return on investment, its impact on growth and economic development on a local, regional and national scale, as well as its impact on the functional and spatial structure, entrepreneurship, real estate market and investment traffic (see Banister and Berechman, 2003; Rosik and Szuster, 2008; Koźlak, 2012; Pawłowska, 2013; Śleszyński, 2015; Kasraian et al. 2016; Giuliano, 2017). Research on the impact of highways on the spatial development of metropolitan areas was of particular interest (Boarnet and Chalermpong, 2001).

Research to date shows that there is a relationship between the construction of highways and the migration of population from the city centre to the peripheries adjacent to the motorway (e.g., Kasraian et al. 2016). Demographic changes, however, vary spatially depending on spatial development and the level of transport accessibility of a given area existing before the construction of the road (Axhausen, 2008; Funderburg et al. 2010; Kasraian et al. 2016). The size of the settlement unit and the completeness of the investment are also significant (see Kim and Han, 2016). Garcia Lopez (2012), based on census lists noted that spatial urbanisation occurs the fastest in metropolitan areas with low population density, directly adjacent to the nodes.

Numerous empirical studies, though not all, confirm the positive impact of highway construction on the labour market (Kasraian et al. 2016). Undoubtedly, this is due to the easier access to the employee market at the regional level (Giuliano et al. 2011). However, some investments may only lead to a redistribution of workplaces from central areas to places with better intra-regional and local accessibility and they do not contribute to the creation of many new jobs (Stephanedes, 1990). Such redistribution may play an important role in counteracting unemployment (Bruinsma et al. 1989, Viturka et al., 2012).

The relationship between road investments and employment growth may also depend on the scale of research and the nature of the spatial unit under study (Funderburg et al. 2010). Some research showed that the impact was positive and led to an increased number of jobs only in urban units, while in the case of rural areas there was no clear increase in employment (Iacono and Levinson, 2012) or even its declines were registered (Funderburg et al. 2010). The others states that the construction of a highway to stimulate employment growth is only meaningful in the smallest municipalities. Larger municipalities have a certain critical mass of previously existing jobs, which will attract further entrepreneurship even without the presence of the highway (Padeiro, 2013).

In Polish conditions, a smaller than expected effect of demand effects of road infrastructure investments on economic growth was observed (Komornicki et al. 2013). Infrastructural investments did not significantly contribute to the activation of the local community, nor have they led to significant development of service enterprises in the municipalities through which the investment runs (Komornicki et al. 2015). On the other hand, however, the construction of motorways and expressways has contributed to a significant improvement in the population's access to voivodship labour markets. The greatest one was noted in Upper Silesia and in the Łódź Voivodeship (Komornicki et al. 2013).

One of the basic features analysed in the context of the impact of highways on regional development is entrepreneurship. The surveys carried out in the Netherlands in the mid-1990s proved the importance of the highway (Bruinsma et al. 1997). They also showed that some companies may move their headquarters closer to the highway, reducing the average distance to the nearest node (Bruinsma et al. 1997, Martin et. al., 2010). The highway itself did not affect the decision to relocate the company. However, if the company's authorities decided to change its headquarters or create a new facility, then the availability of the highway was considered when choosing the location (Bruinsma et al. 1997).

As a general it was noticed that industrial and service areas tend to locate in places with the best transport accessibility at the regional level, i.e., in the closest vicinity of the nodes (Antrop, 2000, Villarroya and Puig, 2012, Filčák et al. 2021). Proximity of highway junctions is also particularly attractive for transport and storage services, trade and repair of motor vehicles and other services related to passenger service - e.g., hotel and catering facilities (Polyzos et al. 2008, Ziobrowski, and Korecki 2009). The surroundings of inner-city nodes are intensely built-up. Nodes on the edges of cities are characterised by larger open areas. Their level of development depends on the spatial policy of local authorities and the distance between the node and the city (Ziobrowski and Korecki 2009, Komornicki et al. 2015, Filčák et. Al. 2021).

To date, studies carried out in Poland have shown that expressways and motorways did not affect redistributive processes within the surrounding municipalities (Komornicki et al. 2015). Logistics industry in Poland was one of the largest beneficiaries of improving transport accessibility. Enterprises of this type were clearly visible and focused mainly on metropolitan centres and the largest highway junctions in Poland (Komornicki et al. 2013; Komornicki et al. 2015). It was also found that the strength of a highway's impact depends on its course in relation to metropolitan cities. When the motorway is too far from the city border, its impact is similar to the national road running parallel to it Komornicki et al. (2015). Research has also proven that, although the lack of adequate transport infrastructure can slow down or even stop economic development, the development of transport

infrastructure is not a sufficient factor for sustainable growth and economic development (Ważna, 2013).

As noted by Burnewicz (2013), Poland still experiences a lack of thorough empirical research showing relations between transport and the economy. This article is meant to partially complete the knowledge in this area.

DATA AND METHODS

The Lodz Metropolitan Area (LMA) discussed in the paper was specified in the document entitled The National Spatial Development Concept 2030 (KPZK, 2012), in which voivodship centres with population over 300,000 in the core were adopted as metropolitan areas. Therefore, it is not a metropolitan area according to the criteria adopted for the purposes of spatial development research under the ESPON project - e.g. Spatial dynamics and strategic planning in metropolitan areas (SPIMA, 2017).

This research was performed based on data collected by the Central Statistical Office (CSO) and made available through the Local Data Bank (Table 1).

Table 1 Data used in the study.

Name	Years	Aggregation level	Comments
Population	2004-2014	Municipality	Change in the compilation of balance of population between 2009 and 2010
Net migration per 1000 population	2004-2014	Municipality	Change in the compilation of balance of population between 2009 and 2010
Share of registered unemployed persons in the population	2004-2014	Municipality	Conversion of index since 2010 based on census 2011
Entities by size classes per 10,000 population at working age	2004-2014	Municipality	Methodological changes in 2014
Average monthly gross wages and salaries	2004-2014	Powiat	-

In the case of indices based on population, attention should be paid to the quality of source data. The change of the method for calculating the population balance by the CSO in 2010 slightly affects all underlying indices and may lead to an apparent sudden difference in values between 2009 and 2010. Another concern affecting the results of the analysis may be the method, used to estimate the population permanently residing in the municipality. The measure in the in-

ter-census period relies mainly on vital statistics and migration of the population. Any change of residence should be recorded in a registration book. This obligation, in turn, is often not fulfilled in Poland, which may lead to an overestimation of population in peripheral municipalities, and to its underestimation in suburban ones (see Śleszyński, 2011). As no other data on population from the inter-census periods are available in such a detail, a general direction of changes in the analysed characteristics is analysed, it may be assumed that the discussed problems do not significantly affect the final conclusions regarding the analysed variables.

Some attention should also be paid to the data on entities of the national economy. CSO statistics based on National Business Registry Number (REGON) data take into account the address of the registered office of the company, not the actual place of business. This may lead to an overestimation of the actual number of enterprises, especially in case of the smallest businesses employing up to 9 people. This needs to be considered when interpreting the results of the analysis.

Based on a distance of geometric centres of individual municipalities to the nearest motorway junction or expressway junction enabling connection with local routes, the examined municipalities were divided into four groups: A, B, C, D (Table 2). This distance was calculated based on a transport network built in ArcGIS using the shortest distance principle. The road layer from OpenStreetMap was used to build the network.

Table 2 Groups of municipalities according to the accessibility of expressways and motorways as well as functional structure of municipality

Groups	1 (urban)	2 (urbanising)	3 (rural)
A	Zgierz City, Ozorków City, Głowno City	Zgierz, Stryków	Ozorków, Parzęczew
B	Pabianice City, Konstantynów Łódzki	Brójce, Dłutów, Dobroń, Ksawerów, Pabianice, Rzgów, Tuszyn	
C	Brzeziny City , Aleksandrów Łódzki	Andrespol, Nowosolna, Lutomiersk, Brzeziny, Dmosin, Rogów, Koluszki	Głowno, Jeżów
D	Łódź		

The group A included units at a distance of up to 15 km from nodes commissioned in 2006. The group B included municipalities not included in the group A, located up to 15 km from the motorway or expressway node opened in 2012–2014. The group C included the remaining administrative units of the studied area apart from Łódź. Łódź, as the metropolis and largest city, was assigned separately to the group D. Therefore, this division also considers the different lifetime of the motorways and highways in the LMA. The distance of 15 km was chosen based on the assumption that with an average speed of moving around 60 km/h in suburban

areas, most of the municipality's area should be able to reach the node within 15 minutes.

Data included in individual groups were considered separately depending on the type of functional structure of municipalities (Bański, 2010). This approach makes it possible to identify and compare administrative units with a similar socio-economic structure. To simplify the analysis and increase the number of municipalities which could belong to the same class, urbanised municipalities were combined with multifunctional transitional ones (2) and overwhelmingly agricultural municipalities with units with predominantly agricultural functions (3).

As Aleksandrów Łódzki comprises a town with a population exceeding 20,000, which cannot be distinguished in part of statistics, and is characterised by a high degree of spatial urbanization, a decision was made to place it in the group with urban municipalities. This way, a total of 10 subgroups were distinguished (Table 2).

The work uses cross tables, analysis of the average rate of change, cartograms, and clock diagrams. To assess changes in remuneration, the pace of change ratio was used, which is expressed by the formula:

where:

$$z_g = \sqrt[n-1]{\prod_{i=2}^{n} \frac{Z_i}{Z_{i-1}}}$$

Z_i – value of characteristic in unit of time i (Jażdżewska 2013). The formula made it possible to capture the average year-on-year change in wages during the period under review.

RESULTS

In the years 2004-2014, the area under study was subject to demographic and spatial suburbanisation processes typical of metropolitan areas (see Wójcik, 2008; Jakóbczyk-Gryszkiewicz et al. 2010; Burchard-Dziubińska et al. 2014). In Lodz Metropolitan Area (LMA) municipalities in 2004-2014 the largest depopulation processes occurred in cities, towns and in rural municipalities located peripherally in relation to Łódź (Fig. 2). On the other hand, population increases were observed mainly in urbanizing municipalities directly adjacent to the largest cities in the analysed area, i.e., Łódź, Pabianice and Zgierz.

At the end of 2014, LMA was inhabited by 1.09 million people. The studied unit was characterised by a high level of spatial urbanisation. The share of the population living in the cities of LMA amounted to 87%.

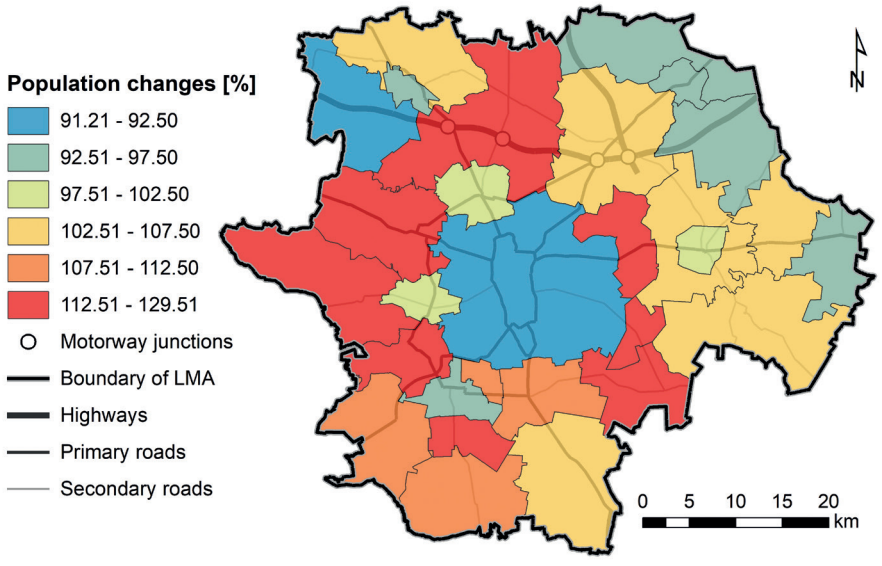

Fig. 2
Population changes in LMA municipalities in the years 2004-2014

With regard to the construction of expressways and motorways, it seems extremely interesting to analyse migratory movements in the groups of LMA municipalities under study (Fig. 3). Łódź and cities from group A were usually, especially after 2010 characterised by a negative net migration per 1,000 population, while the adjacent urbanizing ones experienced high positive balance. It can be assumed that some part of the population moved to the suburban areas of the cities they previously inhabited. These migrations, however, did not take place evenly in the urbanising municipalities. Slightly higher values of positive net migration were observed in groups A2, B2, compared to units more distant from motorways and expressways in group C2. This may suggest that these roads may have contributed somewhat to the redistribution of the population as Baum Snow showed (2007), by increasing the transport accessibility of these municipalities at the supra-regional and regional level.

For rural municipalities belonging to groups A3 and C3, no relationship could be identified between the distance to the motorway or expressway and the net migration. This is mainly due to the lack of internal homogeneity of entities in those groups. In group A3, for example, Ozorków municipality was characterised by a stable positive net migration oscillating between 5-15 per 1,000 population, while this value in Parzęczew municipality fluctuated between -45 and 9 persons. These changes in Parzęczew were largely due to the downsizing of the military unit

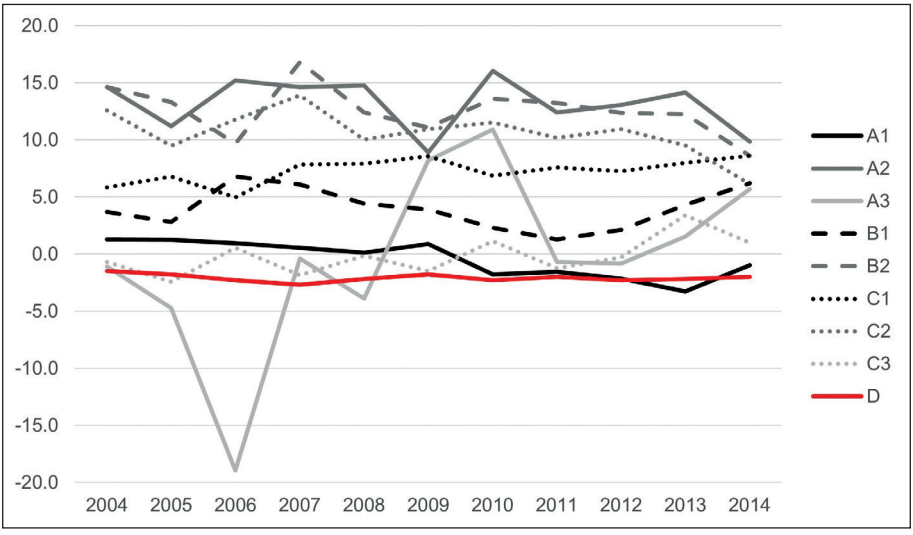

Fig. 3
Net migration per 1,000 population (averaged) in individual subgroups of LMA municipalities in the years 2004-2014

in 2006 and the sale of housing units by Military Property Agency, in subsequent years. The obtained data did not give grounds either for averaging the results per group or for searching for relations between the impact of motorways and expressways and changes in the migration balance.

One economic factor that could have diversified under the influence of improved transport accessibility in LMA municipalities was the variability in average monthly gross wages and salaries. In the years 2004-2014, all LMA counties experienced an increase in the average monthly gross wages with the highest increase recorded in the Zgierz county (where the pace of changes amounted to 5.81%). In the case of the Zgierz county, the increase in earnings in 2006-2008 was comparable only to the metropolitan city – Łódź. This period coincided with the commissioning of the Stryków-Konin section on the A2 motorway and the good economic situation conducive to the development of new investments. The increase in the number of new investments near the motorway with declining labour resources could have contributed to the proportionally higher salary increases (Table 3). Similar relationships were not observed after the remaining sections of motorways and expressways were put into service.

It seems that the motorway could have influenced the registered unemployment rate in urbanized and rural LMA municipalities located in the vicinity of the A2 motorway (Fig. 4).

Table 3 The average dynamics of changes in mean monthly gross wages and salaries in individual subgroups of LMA municipalities in 2004-2014

County name	Average wage growth rate
East Lodz county	5.12
Pabianice county	5.24
Zgierz county	5.81
Brzeziny county	4.78
Łódź city county	5.28

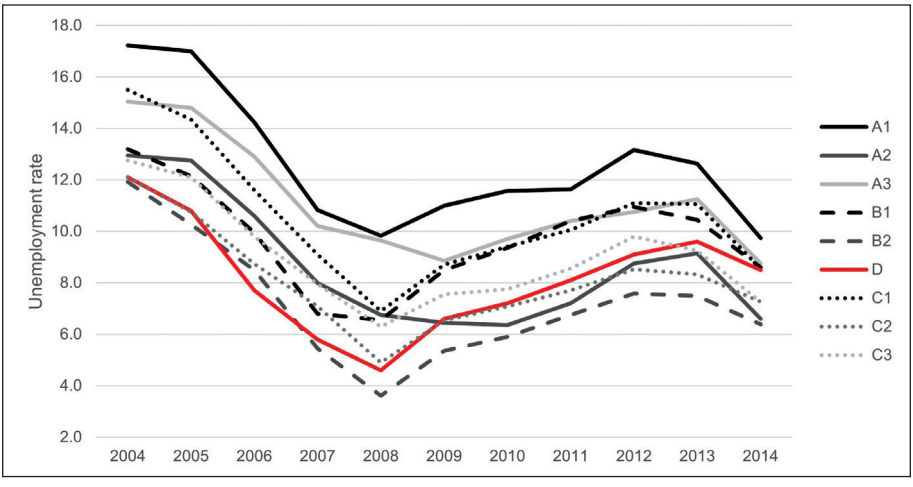

Fig. 4
Unemployment rate (averaged) in individual subgroups of LMA municipalities in the years 2004-2014

The deteriorating economic situation in 2008-2010 led to an increase in unemployment in all municipalities. In the analysed urbanizing and rural municipalities situated in the vicinity of the A2 motorway commissioned in 2006 (from the A2 and A3 groups), the increase was smaller and shifted in time, i.e., it did not occur as in other units already in 2008. In the case of urban municipalities, no impact of the motorway on the decline in unemployment (groups A1, B1, C1, D) was observed. The commissioning of the A2 motorway could, therefore, reduce the consequences of the economic slowdown among small municipalities located near the motorway (from groups A2 and A3), characterised by lower population density in two ways. Firstly, thanks to motorways, their residents had easier access to neighbouring labour markets, and secondly, they contributed to the creation of new jobs in the vicinity of the motorway**.** These results are consistent with previous studies conducted, among others, by Kasraian et al. (2016). Without in-depth studies covering

other metropolises, through which a motorway or expressway ran before 2008, it is impossible to infer whether such impact was local or noticeable in other metropolitan areas of Poland.

In economic terms, the analysis of the impact of the construction of motorways and expressways on the number, size and industry structure of enterprises in individual subgroups of LMA municipalities in the years 2004-2014 leads to interesting conclusions. For cities belonging to the group A, whose transport accessibility improved in 2006, the economic slowdown was particularly hard. The situation in Głowno and Ozorków, where the number of registered enterprises dropped significantly between 2008 and 2009, disproportionately to other LMA municipalities, was particularly negative (Fig. 5).

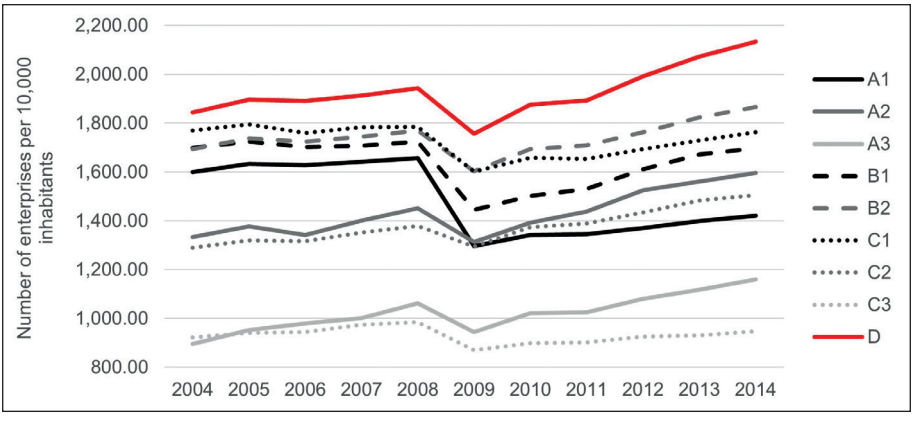

Fig. 5
Number of enterprises per 10,000 inhabitants in the analysed municipalities as compared to LMA municipalities in 2004-2014

Apart from Łódź the largest number of enterprises per 10,000 population at working age in 2004-2014 were registered in urbanized municipalities of the B2 group in which some units like Ksawerów, Rzgów, Tuszyn specialised in the manufacture and distribution of textile products. Marketplaces located in Rzgów and Tuszyn were among the largest clothing distribution centres in Poland. The urbanising communes in groups A2 and B2 were characterised by a higher increase in the number of enterprises per 10,000 inhabitants as compared to group C2**.** However, this is not a sufficient premise to conclude that better accessibility to motorway and expressway junctions already built or under construction may be a factor stimulating location of new enterprises.

It should be also noted that rural municipalities located near the motorway opened in 2006 (group A3) were characterised by faster growth of entrepreneurship in comparison to other rural municipalities in LMA (Fig. 5). However, they did

not contribute to a significant dissipation of economic activity at the expense of central areas, which was mentioned, among others, by Stephanedes (1990). In terms of entrepreneurship, the studies therefore coincide with the results of the evaluation of the impact of motorways and expressways on the socio-economic development of Poland developed by the Komornicki et al. (2013).

Taking into consideration the size structure of enterprises located in particular groups of LMA municipalities, it can be noted that in 2004 and 2014, micro and small enterprises employing up to 9 people dominated in the LMA, constituting, depending on the municipality, from 93.3% to 95.41% of all registered economic activities (Table 4). Calculated per 10,000 inhabitants, they were, like enterprises with 10-49 employees, mainly concentrated in urban and urbanizing municipalities (from groups A1, A2, B1, B2, C1, C2, D1).

Table 4 The number of enterprises per 10,000 population at working age of a municipality by the size of employment in individual groups of LMA municipalities in 2004 and 2014

Municipality group and type	Size of employment [people]							
	0-9		10-49		50-249		above 250	
Year	2004	2014	2004	2014	2004	2014	2004	2014
A1	1,523.8	1,348.9	61.3	56.3	13.1	15.1	1.4	0.9
A2	1,251.9	1,519.1	75.2	63.3	4.9	10.7	1.3	2.6
A3	833.5	1,102.4	56.7	52.6	4.1	3.9	1.5	0.0
B1	1,610.3	1,609.8	71.6	67.4	15.0	17.9	1.7	1.2
B2	1,595.8	1,765.7	87.2	87.0	9.5	12.0	1.3	0.0
C1	1,683.8	1,680.9	74.1	72.5	9.8	8.6	0.9	0.9
C2	1,218.0	1,440.8	64.7	58.3	5.7	5.9	0.2	0.3
C3	872.7	917.3	42.5	26.9	5.7	2.4	0.0	0.0
D	1,748.5	2,033.1	77.3	82.2	15.0	15.2	2.8	2.9

In 2004, enterprises employing more than 50 persons prevailed in Łódź and in cities of groups A1 and B1, although in the case of the largest enterprises their values varied within the group (for example, in group B1, Pabianice had 2.4, whereas Konstantynów Łódzki had 0.9 enterprises per 10,000 population at working age). The largest companies employing over 250 employees, in turn were located mainly in cities (groups A1, B1, C2, D1). Significant internal variation in the number of enterprises employing over 250 persons per 1000 population at working age was observed in municipalities with urbanizing and rural functions. For instance, in the A2 group, no such company existed in Zgierz municipality, while in Stryków tree such companies were present. One of them, Corning Optical Communications

Poland decided to move near Stryków when deciding to relocate the company. At that time, the design works on the construction of the A2 motorway were already underway.

Another important aspect of economic transformations are changes in the size structure of enterprises (Fig. 6).

Considering them dynamically, new micro and small enterprises were located primarily in Łódź (group D1), in rural municipalities located adjacent to the A2 motorway commissioned for use in 2006 (group A3). Major changes also took place in urbanising municipalities located both in the immediate vicinity of the motorway existing since 2006 (A2) and beyond (C2). While in all municipalities from the group A2 the increases exceeded 150 entities per 10,000 inhabitants at working age, the C2 group was much more diverse, with values ranging from -37.4 for Koluszki to 813.5 for Nowosolna, a municipality undergoing heavy urbanisation process.

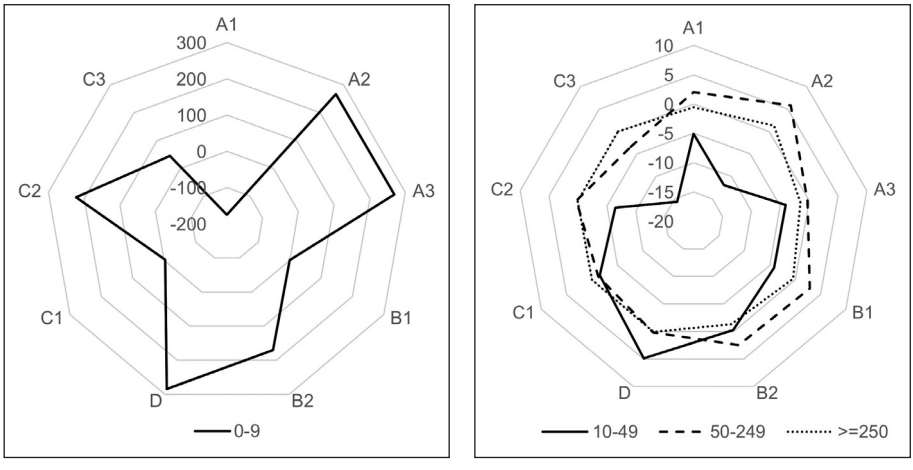

Fig. 6
The number of enterprises per 10,000 inhabitants of a municipality by the size of employment in individual groups of LMA municipalities in 2004-2014

Apart from Łódź, which performs metropolitan functions, the cities generally lost the number of micro and small enterprises, while their greatest increases were observed in municipalities already strongly urbanised, such as Nowosolna, Rzgów, or in areas with improving transport accessibility in connection with the construction of motorways and expressways, such as Zgierz, Parzęczew, Dłutów. The commissioning of new motorways and expressways could, therefore, locally imply an increase in the number of small enterprises. The factor that could have

influenced the growth of micro and small enterprises in the discussed group of municipalities could be the relocation of companies associated with the change of residence of their owners. However, without social research, this thesis cannot be confirmed with certainty.

Despite the higher increase in the number of large companies per 10,000 population at working age in cities from groups A1 and B1, it cannot be said that it is due to the impact of motorways and expressways put into use. In each of the groups, the cities had completely different characteristics. Despite high average values, group B2 was also heterogeneous. On the one hand, high increases in the number of enterprises were found in the communes of Brójce, Rzgów and Dobroń; on the other hand, the number of such businesses decreased in the communes of Tuszyn and Pabianice. It seems that a longer time of influence of the motorways might have contributed to a slightly higher and stable increase in the number of enterprises located in urbanising municipalities, situated in the vicinity of the earliest completed motorways (A2 group). Similar relationships were observed for the increase in the number of enterprises employing 250 persons and more, per 10,000 inhabitants. In the case of the municipality of Stryków, the development of its logistic and industrial functions has been the subject of many scientific studies (e.g. Bartosiewicz and Wiśniewski, 2009). Their authors drew their attention to, inter alia, location benefits, which resulted from a convenient transport location. Owing to it, in the analysed period, this municipality became one of the most important logistics centres in Poland (Bartosiewicz and Pielesiak, 2014, Burchard-Dziubińska et al. 2014).

Verification of the motorways and expressway's impact on the industry structure of enterprises was based on sections of the Classification of Business Activities in Poland PKD 2007 (CBA) in accordance with the *Nomenclature statistique des Activités économiques dans la Communauté Europenne* (NACE). Only private enterprises were considered and calculated per 10,000 inhabitants at working age. In order to better present the data, sections of CBA were aggregated into the following groups: forestry and fishery (section A), industry (sections B, C, D, E), construction (section F), wholesale and retail (section G), transport and warehouse management services (section H), specialised services and business services (sections I, J, K, L, M, N) and other services (sections O, P, Q, R, S, T, U).

In 2009-2014, the largest number of new enterprises was created in the financial and business services sector, as well as in wholesale and retail trade, along with the repair of vehicles and motorcycles (Fig. 7).

As can be seen in the chart above almost all groups recorded a decrease in the number of agricultural, forestry and fishing enterprises per 10,000 population of working age, with the greatest impact on rural municipalities (A3 and C3). In the case of units located near the A2 motorway, it may have resulted from the

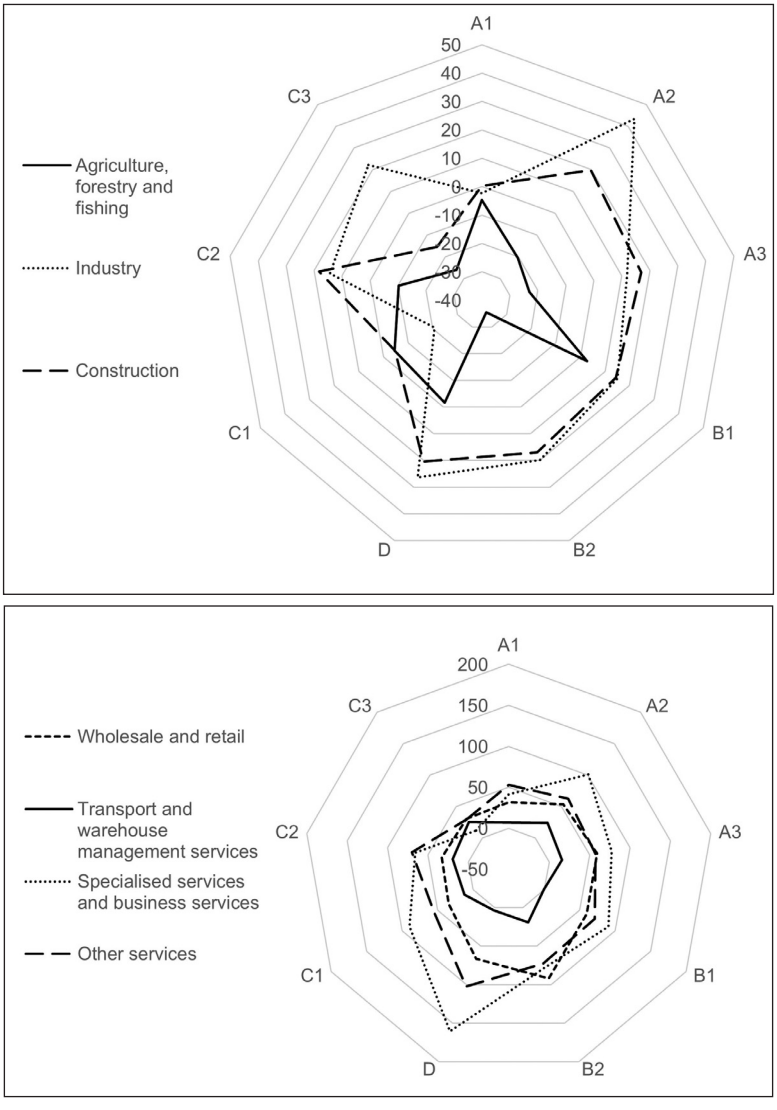

Fig. 7
The change in the industry structure of enterprises per 10,000 inhabitants according to the groups of accessibility to the highway in LMA municipalities in 2009-2014

increased attractiveness of rural areas more distant from the metropolitan core, due to their improved transport accessibility at the supra-regional level. The same factor may explain the higher decrease in the number of agricultural, forestry and fishing enterprises per 10,000 people of working age in urbanising municipalities located near the commissioned motorways and expressways (A2, B2) compared

to peripherally located municipalities. As far as Głowno is concerned (group C3), it could additionally be a consequence of the A1 motorway running through the municipality, put into service in 2012.

In the case of rural and urbanizing municipalities, a significant increase in the intensity of industrial companies in group A2, C2 and C3 was observed. Based on the subject literature (see Tesařova and Halounová 2006; Martin et al. 2010), it can be assumed that spatial accessibility is also primarily important for space-intensive companies, such as industrial enterprises that require additional good transport accessibility on regional and national level. An increase in the number of area-intensive industrial enterprises in the vicinity of motorway interchanges was visible in all A2 municipalities, while in the case of the C2 municipalities, it occurred mainly in Nowosolna and Koluszki. Since a motorway interchange had been planned in Nowosolna municipality for many years, and the A1 motorway itself was nearing completion in 2014, location decisions of enterprises could have been taken before the motorway itself was put into use. In the case of the Koluszki commune it is difficult to find a correlation between the construction of motorways, expressways and the location of enterprises. The same groups of communes, together with the communes in group B2 were characterized by a slightly higher increase in the number of enterprises dealing with transport and storage, however value for A2 group did not differ significantly from other rural and urbanizing municipalities in the LMA.

Taking into consideration construction industry, the increase in the number of construction companies could, in turn, have been endogenous and resulted from the growth of construction traffic at the local level. Thus, these companies could have responded to local needs related to the construction or renovation of homes or enterprises.

Research on changes in the industry structure of enterprises also showed that in rural municipalities located adjacent to the A2 highway (group A2) the number of companies related to professional services-grew rapidly and only the city of Łódź had higher growth figures for this type of business.

This knowledge, however, does not give grounds to state the impact of motorways and expressways on the development of new companies dealing with services. Lower results for municipalities from groups B2 or C2 resulted only from a much greater diversity of values in those groups. On the other hand, in each group there were municipalities characterized by similar amounts of increase in the number of specialised companies as in the case of Zgierz municipality from the A2 group. Similar conclusions can be drawn from the analysis of the growth of the number of trade services per 10,000 population at working age.

CONCLUSIONS AND DISCUSSION

Responding to the objectives of this article, it was found that:

1. The changes in the demographic structure in the municipalities of ŁOM in the years 2004-2014 were mainly due to the ongoing suburbanisation processes affecting almost all towns in ŁOM, including Łódź. Slightly higher values of the migration balance in the case of urbanizing municipalities located near motorways and expressways may suggest a slight influence of transport investments on the redistribution of population within the LMA, which is consistent with the observations of Baum Snow (2007). However, based on the available data for the period under review, it is difficult to determine the strength of this impact. The data do not provide possibility to capture significant changes in the development of residential areas especially for municipalities in the B group. Time lag between deciding to change the place to live and moving into a newly built house **may last at least two years.** Also, many people do not register at their place of residence for many years after moving. Thus, indices based on population, like migration balance may be significantly underestimated, especially in suburban areas (see Śleszyński, 2011).
2. The average rate of wage growth observed in the Zgierz county could have resulted from the construction of the A2 motorway, whose commissioning coincided with the good economic situation on the global market. This may be proved by a high decrease in unemployment and a large increase in investments in rural and urban-rural LMA municipalities located near the motorway in 2006-2008. The availability of labour resources is, however, one of many factors affecting wages. For example, a worse economic situation on the market could have resulted in the lack of effects of wage increase in municipalities whose transport accessibility improved in 2012-2014. In-depth research is needed to identify the transport accessibility factor in shaping wages in Poland.
3. Data on the unemployment rate in 2004-2014 suggest that the increase in transport accessibility to the labour market resulting from the construction of the A2 motorway in the years 2004-2006 at the regional level could have contributed to the local weakening of the economic slowdown in neighbouring rural and urban-rural municipalities. These results are in line with research by Bruinsma et al. (1989), who suggested that highways can play an important role in counteracting unemployment. In the case of the analysed area of the LMA, a similar impact was not observed for rural municipalities.
4. An analysis of the change in the number of enterprises in the analysed LMA municipalities in 2004-2014 does not allow to clearly answer the question whether the motorway or expressway contributed to the increase/decrease in the number of enterprises. These studies partly overlap with the results of the evaluation of the impact of motorways and expressways on the socio-eco-

nomic development of Poland developed by Komornicki et al. (2013). A slightly faster change in the number of enterprises among urbanizing and rural municipalities located in the vicinity of the motorways and expressways commissioned for use till 2014 may suggest that they had an impact on the growth of entrepreneurship. However, the growth rate in the number of companies in the discussed rural and urbanizing municipalities was not so clear that it could be attributed to the influence of completed motorways and expressways. Especially that some municipalities were subject to the rapid process of spatial urbanisation. It was also not observed that the construction of highways significantly contributed to the dispersion of economic activity at the expense of central areas, which was suggested, among others, by Stephanedes (1990).

5. Research on changes in the size structure of enterprises in LMA municipalities has shown that in 2004-2014, the A2 motorway could locally imply an increase in the number of small enterprises. The factor that could have influenced the growth of micro and small enterprises in the discussed group of municipalities could be the relocation of companies associated with the change of residence of their owners. However, without social research, this thesis cannot be confirmed with certainty.

   In the case of medium-sized, large enterprises, this impact of motorways appears to be more direct, as reflected in the more even and slightly higher growth in the number of enterprises per 10000 people of working age. In 2004, most of industries that employed over 250 people were located either in cities or in the urban-rural municipality of Stryków, characterised by improved transport accessibility since 2006. In the case of Stryków some companies admitted that when deciding on the relocation of a branch, the distance to motorway had been considered, which confirms the conclusions of Bruinsma et al. (1997). In that case, decisions were taken at the preparatory stage of the highway construction. Considering this case, it seems that the road construction project itself is sufficient for the development changes to take place (see Banister and Berechman 2003; Giuliano 2017). In 2004-2014, a further concentration of large and very large enterprises employing more than 50 people was observed above all in the Stryków municipalities, thus contributing to the creation of one of the largest logistics centres in Poland in this municipality (see Bartosiewicz and Wiśniewski 2009; Bartosiewicz and Pielesiak 2014; Burchard-Dziubińska et al. 2014). Large companies were also often located in the cities with good transport accessibility since 2006 and in rural municipalities located near expressways and motorways built in 2012-2014.
6. The presence of highways and expressways affected the industry structure of enterprises in the LMA municipalities in 2009-2014. A clear impact of highways was noted in the case of investments in industry, less in transport and warehouse management services. An increase in their number per 10,000 popula-

tion at working age was observed in urbanizing municipalities located both in the vicinity of the A2 motorway completed in 2006 and expressways and motorways commissioned between 2012-2014. In the case of municipalities in the group C2, a much greater heterogeneity in number of industry, transport and warehouse management services per 10,000 population at working age was found. The very high values of indicators for the sectors discussed in Nowosolna municipality (C3) suggest that in places with very good transit accessibility at the local level, and planned access to roads at the intraregional level, the development of enterprises is ahead of the process of commissioning motorways and expressways itself. These results are in line with evaluation studies carried out by Komornicki et al. (2013). They are also congruent with the global study of developmental changes around highways and expressways (e.g. Antrop 2000; Polyzos et al. 2008; Villarroya and Puig 2012).

This paper does not fully exhaust the problem in question. The classification of units based on the functional type of the municipality following Bański (2010) did not work well in the case of the analysis of the impact of motorways and expressways on changes in the number of service enterprises, especially those related to trade and specialist services. The specific groups featured too much internal variation of the examined characteristics. This fact, combined with the quality of data (e.g. uncertainty as to whether the declared address of a service is also the place of its provision or perhaps only the place of residence of its owner), made it impossible to draw correct conclusions. In addition to the research directions outlined in the summary, there is still a lack in Polish literature of studies conducted at the local level that would lead to a more rational spatial policy. These studies should primarily take into account the impact of motorways and expressways on functional and spatial transformations within municipalities, changes in mobility of residents and local changes in property price.

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