

Industrial legacy towards modern urban environment: a comparative study of Wrocław and Brno

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Abstract. The paper examines the spatial structure of industrial production in the urban environment of two Central European cities, Wrocław and Brno, and their changes during the transformation from centrally controlled to capitalist economies. It aims to evaluate the spatial impacts of deindustrialisation on the urban environment and subsequently interpret the functional and structural changes in the cities. Mapping techniques are used to analyse the spatial distribution of industrial activities, representation of industrial sectors and major industrial enterprises in both cities. The study integrates a review of scientific literature with a range of statistical sources from national and international statistical databases and collections. The data were processed and visually presented using ArcGIS. The results revealed similarities and differences in the transformation of the two cities and indicated the substantial scale of their post-industrial transformation. Major structural changes have occurred since the 1990s. The last two decades have been directed towards creating modern post-industrial environments while retaining the significant and visible industrial heritage.

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1. Introduction

The phenomenon of systemic transformation that occurred in many countries of the former socialist bloc in the late 1980s not only manifested in changes to the political system, but also marked itself in the economic and social spheres and in changes to spatial structures. Systemic transformation is most often described as "the process of transition from a socialist economy, based on state ownership and central planning and management, to a capitalist economy, based on private ownership and free enterprise" (Sztaba, 1999). The systemic transformation was necessary due to the collapse of the socialist economy, whose results included the growth of market imbalances, inflation, inability to meet foreign debt repayment obligations, and decapitalisation of fixed assets. The protracted crisis and economic destabilisation in Poland, Czech Republic, Slovakia, Hungary and other countries led to the inevitable collapse of the socialist system and the centrally controlled economy. The political, economic and functional-spatial transformations that followed affected all sectors of the national economy (e.g., Szubert-Zarzewny, 1995; Ondoš & Korec, 2008; Kovács et al., 2013; Bański, 2017; Židek 2017).

The systemic transformation and its impact on the functioning of the city and its residents has been the subject of numerous studies (e.g., Matlović et al., 2001; Haase & Steinfuhrer, 2005; Stanilov, 2007; Sýkora, 2009; Litwińska, 2013; Węclawowicz & Wątorska-Dec, 2013; Płaziak, 2014; Lewicka & Szczepański, 2016; Ira & Boltižiar, 2022; Kunc & Tonev, 2022).

In many Central European (CE) countries after 1989, a specific category of cities emerged that began to function under the new political and economic conditions. The post-socialist cities had to face significant political, social, economic and spatial changes. The severance of economic ties with Russia and the economic and social crisis of the cities required that a new path of economic and functional development be chosen. The crisis was exacerbated in many cities by a monofunctional and traditional industrial structure (Cudny, 2011).

The Czech Republic, as well as Slovakia, Hungary and Poland, recovered quite quickly from the shock transformation therapy and achieved significant progress in both external and internal economic relations (levelling output balance, re-orienting the foreign trade to the West, considerable reduction of unemployment, regulated inflation, etc.). Basic structural changes in CE economies saw the removal of a substantive part of manufacturing activities

and employment into the service sector within less than one decade. The situation had largely stabilised by the end of the 20th century (Holman, 2000; Steinführer, 2003; Hirt, 2013; Židek, 2017).

During the first phase of the industrialisation, the spatial needs of the industry were determined by the textile and engineering industries' dependence on water, which was essential for the operation of steam engines. That is the reason why the oldest industrial compounds are concentrated linearly in the structure of the present-day city, despite their out-of-control and additive development in the 18th and 19th centuries (Kunc, 2006). This structure had not significantly changed in the days of socialist industrialisation – the post-war industrial development continued mainly via further concentration of the factory buildings in their original locations (Kuča, 2000).

What changed, however, was the immediate surroundings of industrial sites. In the 19th century, manufacturing activities were often segregated and located on the outskirts (periphery) of the city or along rivers. As a result of the continuous spatial development of cities, industrial areas gradually began to be surrounded by urban development, redefining their location from peripheral to inner city (Sikorski, 2012).

The decrease and rationalisation of manufacturing in industrial factories, elimination of overemployment or ineffective use of outsourced services (catering, cleaning, security, etc.) and the overall modernisation of manufacturing led to less intensive use of many traditional industrial operations. Structural changes connected with the flow of the workforce into the tertiary sector created unprecedented dynamics in the service and business functions of the transitioning cities (Bertaud, 2006; Muliček et al., 2016).

In addition, the observed changes were influenced by the demands emerging in the late 1990s to deconcentrate industrial activity away from the central and downtown areas of large cities, which were in line with the demands for sustainable and ecological development of the city (Słodczyk, 2001). This, combined with other socio-economic factors (e.g., land rent), resulted in the slow encroachment of new functions in industrial areas, and industrial activity began to increasingly move and concentrate in the suburban zone (Sikorski, 2012, 2019; Sikorski & Szmytkie, 2021).

The reasons for this process of industrial dispersion were not only the increasing costs of operating industry in the urban fabric, but also the appearance of development thresholds (e.g., deficit of vacant land, inefficiency of the transportation

system, deteriorating environmental conditions) in large urban agglomerations (Moriarty, 1983; Kortus, 1986). If this growth exceeds the agglomeration benefits achieved by companies, they must relocate their activities in whole or in part to areas where there are opportunities to reduce costs. Such areas include suburban zones of metropolises (Brezdeň & Szmytkie, 2019).

The polarity between the dynamic secondary sectors and the declining traditional branches made its mark onto the spatial structure of the city. Centrally located industrial compounds and premises fell behind, while the developing suburban zones attracted new investments (Mulíček & Olšová, 2002). Today the location of new investments is mostly influenced by transport accessibility, quality of workplace environment, availability of inhabitants with high levels of education, as well as the legal status of the land plot (ownership structure, conditions of the rent, etc.). Gradually, the higher added value of new industrial companies and services for companies as well as other higher services (e.g., finance and insurance, ICT, real estate) became evident in the post-socialist industrial environment; nevertheless, a large proportion of assembly factories remained in business (Birch et al., 2010; Kunc et al., 2018).

The above-mentioned facts resulted in the industrial and, gradually, the business, service and institutional functions of the inner city weakening in favour of the new economic structures localised on the outskirts of the city or within the city suburbs (Hutton, 2010; Kunc et al., 2014b). The relocation of manufacturing activities to newly established industrial zones and technology parks connected to administrative and logistic centres and the construction of vast retail premises (supermarkets, hobby markets, shopping centres) became both economic and spatial city-forming phenomena.

The growth of the industry sector from the mid-19th century had an immediate impact on the urban environment of CE cities. Similarly, deindustrialisation, which began in the 1980s and fully developed after 1990, was accompanied by significant economic, social and spatial transformations. The main objective of our paper is to identify the functional-spatial transformations of the cities of Wrocław and Brno and to compare the spatial impacts of industrial legacy and consequent deindustrialisation on the urban environment. The present research seeks to answer several fundamental research questions:

- RQ1: How did the spatial transformation and deindustrialisation after 1989 affect the development, structure, importance and

changes in distribution of industry in the post-socialist cities of Wrocław and Brno?

- RQ2: What are the contemporary trends and directions of industry transformation in the development of the modern urban environment of both cities?

2. Area under study, research methods and data

Wrocław is the third largest city in Poland, with a population of over 670,000. Combined with its suburban zone, it constitutes the largest and most important agglomeration of south-western Poland, with a population of over one million. The area has been characterised by numerous changes of a political, social and economic nature (Kulak, 2001; 2006). The key phenomena and factors determining the development of the area over the centuries included numerous changes in nationality, a convenient transportation location (Fig. 1), the huge scale of destruction after World War II (Wrocław alone was more than 70% destroyed), functioning under the socialist system in 1945–1989, and the systemic socio-economic and political transformation after 1989 (Książek & Szuszczyk, 2017).

Industrial activity has been important in the development of Wrocław for decades. Despite significant political changes, the city continues to be an important industrial centre of Poland. Wrocław's industry is represented mainly by manufacturing and light industry in metal products processing, precision manufacturing, electrical engineering or machinery and equipment manufacturing. The modernity of the city's modern manufacturing activities is evidenced by the fact that nearly 50% of the employees involved in R&D activities are employed in industrial enterprises.

In recent years, the city has been developing intensively. There are new investments in the city every year and economic activity is systematically increasing. The consequence of these successes was, among others, that Wrocław was awarded the title of European Capital of Culture (2016) and entrusted with holding the World Games (2017).

Brno is the second largest city in the Czech Republic, with almost 400,000 inhabitants. Brno metropolitan area is the third largest in the country (after Prague and Ostrava metropolitan area). Within the area, Brno is dominant and monocentric. It is possible to consider the other towns and villages as Brno satellites (the second largest town in the area does not have even 15,000 inhabitants).

For more than a hundred years, Brno's main connection has been to Prague and, in a slightly limited way, to the capital of Slovakia, Bratislava. The former significant north-south orientation (Vienna-Brno-Ostrava/Wroclaw) has been weakened in favour of a slightly more east-west orientation (Berlin-Prague-Brno-Bratislava-Budapest/Vienna) strengthened by important national and international transport corridors (see Fig. 1).

Methodically, the study is based on a review of professional literature, both domestic (Polish and Czech; e.g., Słodczyk, 2001; Szymańska & Matczak, 2002; Toušek & Muliček, 2003; Sýkora, 2009; Sikorski, 2013; Brezdeň & Szmytkie, 2019; Kunc & Tonev, 2022) and foreign (e.g., Haase & Steinfuhrer, 2005; Stanilov, 2007; Hirt, 2013; Kovács et al., 2013) reflecting the spatial but also economic and social transformation and changes in the industrial orientation of post-socialist cities. Emphasis is also placed on the industrial history and presence

of Wroclaw and Brno and their changes during the last three decades towards a modern urban environment.

The choice of both cities for the analysis is justified. Regardless of their geographic proximity in the Central European area, the cities of Wroclaw and Brno share a rich industrial history, particularly in the textile industry, which has shaped their economies and cultural identities, and during their historical development they have undergone essentially similar (yet in some respects different) industrialisation and deindustrialisation processes.

The study methodologically employs a spectrum of analytical tools, including analysis, comparison, abstraction, deduction, interpretation and synthesis. These tools are the basis for the interpretation of statistical sources extracted from national and international statistical databases and collections. The processed data are transformed into a visual narrative, communicated through illustrative maps produced using the ArcGIS platform. These



Fig. 1. Wroclaw and Brno in the settlement and transport system of CE
Source: Authors

maps portray a multifaceted visual landscape that encompasses the spatial distribution of industrial sites within both cities, including the positioning of innovative enterprises, commercial ventures, business activities, office spaces and shopping centres.

It should be noted, however, that the databases differ in availability and quality. Accordingly, the aspects of industrial transformation are covered similarly, though not completely in the same way. The primary statistical sources used in this research include:

- on the Polish side: Statistics Poland, Statistical Yearbooks, PESEL database on population, REGON database on economic activity, databases from own spatial inventory research, Cartographic Collections of the Institute of Geography and Regional Development of the University of Wrocław,
- on the Czech side: Czech Statistical Office, Municipality of Brno (data.Brno),
- authors' own databases resulting from previous research and professional studies.

3. Results

3.1. Spatial aspects of deindustrialisation: the case of Wrocław

The period of economic transformation with regard to industrial activity has not only caused quantitative changes in the number and structure of industry but has also fundamentally affected the spatial and social sphere of the city of Wrocław.

The first processes of deconcentration of industry in the city already took place in the 1970s and 1980s through the creation of branches of industrial plants mainly in satellite cities of the agglomeration such as Oleśnica, Oława, Trzebnica, Środa Śląska and Wołów. At the same time, these cities were located on the exit directions of major transit routes, along which zones of industrial concentration were formed in the city over many years. Further symptoms of change could already be observed in the early 1990s. Among the new phenomena in economic activity resulting from the transformation processes, there was the phenomenon of the breakup of large enterprises into smaller units with a high degree of production, financial and organisational-management independence. This process called "atomisation of enterprises" is also observed in many industrial plants in Wrocław (Slenczek, 1995; 1996). This peculiar division of enterprises was

associated with attempts to save large industrial plants by separating out from their structures some of the least profitable activities, isolating them for resale.

The consequences of this phenomenon included a gradual weakening of the hitherto mono-functional industrial areas and the encroachment onto their territory of business entities with other functions. This peculiar functional succession taking place in the industrial and post-industrial areas of Wrocław was determined by several factors: the emergence of the land rent mechanism; the convenient location of the city's industrial areas, which could be developed by more extensive functions; the idea of deconcentration of industrial activities from the city centre and downtown; and the idea of sustainable and ecological development of the city (Sikorski, 2012; 2013).

According to a study by Sikorski (2019), more than 50% of Wrocław's industrial areas were subject to functional and spatial changes after 1989. At the beginning of the economic transformation, industrial areas covered an area of about 19.7 km², which accounted for about 6.7% of the entire city. As a result of the functional transformation of these areas, they now cover an area of about 11.6 km² (4.0% of the city area), and 8.1 km² are brownfields. Among the 214 identified historical manufacturing areas, only 109 (50.9%) areas have retained their original predominantly industrial character, while 105 (49.1%) areas are already dominated by other functions.

Initially, the process of transformation of industrial areas was very chaotic and dynamic. In the 1990s, the city's brownfields were mainly encroached upon by commercial entities using and adapting the available building infrastructure (e.g., storage facilities) for their needs. This period also saw the destruction of many architecturally valuable industrial buildings (e.g., the City Slaughterhouse facilities). Increased awareness of the importance of industrial heritage and the idea of sustainable development resulted in the transformation of brownfield sites becoming more rational and planned after 2000. In the 21st century, the city's brownfields were increasingly developed with residential functions (mainly developer housing estates) or services (e.g., the revitalisation of the Piast Brewery) (Sikorski, 2022).

The spatial distribution of industrial and post-industrial areas in Wrocław is determined by the history of the city's industrial development, which tended to locate along the main transportation routes and the Oder River (Slenczek, 1994). Thus, the spatial distribution of industry in Wrocław takes

the form of concentration zones, underpinned by the rationale of the city's internal and external transportation network. This spatial arrangement of industry in the city allowed for relatively easy and rapid transportation of raw materials and semi-finished products, as well as the initiation of cooperative ties and technical and technological advantages that were foreseeable between individual plants and industries (Fig. 2).

Among the city's numerous examples of post-industrial sites, it is worth noting: Railway Rolling Stock Repair Company, Port Popowice, Piast Brewery and City Slaughterhouse.

The first described area of concentration of Wrocław's post-industrial areas is the former ZNTK site located on the Nadodrze estate in the city's downtown. This plant was established in 1866 and specialised in the repair and construction of rail vehicles. At the end of the 20th century, manufacturing activities gradually ceased on the site, and the available space began to be used and adopted by other functions (e.g., car repair shops,

auto-wash shops, etc.). In 2008, a decision was made to build a large complex of residential and commercial buildings on the site, called Wrocław Promenades.

The post-industrial land belonging to the Popowice Port has also been developed in a very similar way. On the former sites of the river port in 2018, construction began on a huge complex of residential and commercial buildings with a target commercial space of 135,000 m² by 2028. The investor is the Wrocław-based development company Vantage Development, and the cost of the investment is expected to close at around €200 million.

A different path of transformation has been traversed by the post-industrial site of the Piast Brewery, established in the downtown area of Ołbin in 1894. Beer production was carried out there until the beginning of the 21st century, and then the plant site went unused for a dozen years. Finally, in 2017, construction of a large complex of commercial and retail buildings began on the site. However, different from the previous two cases, this

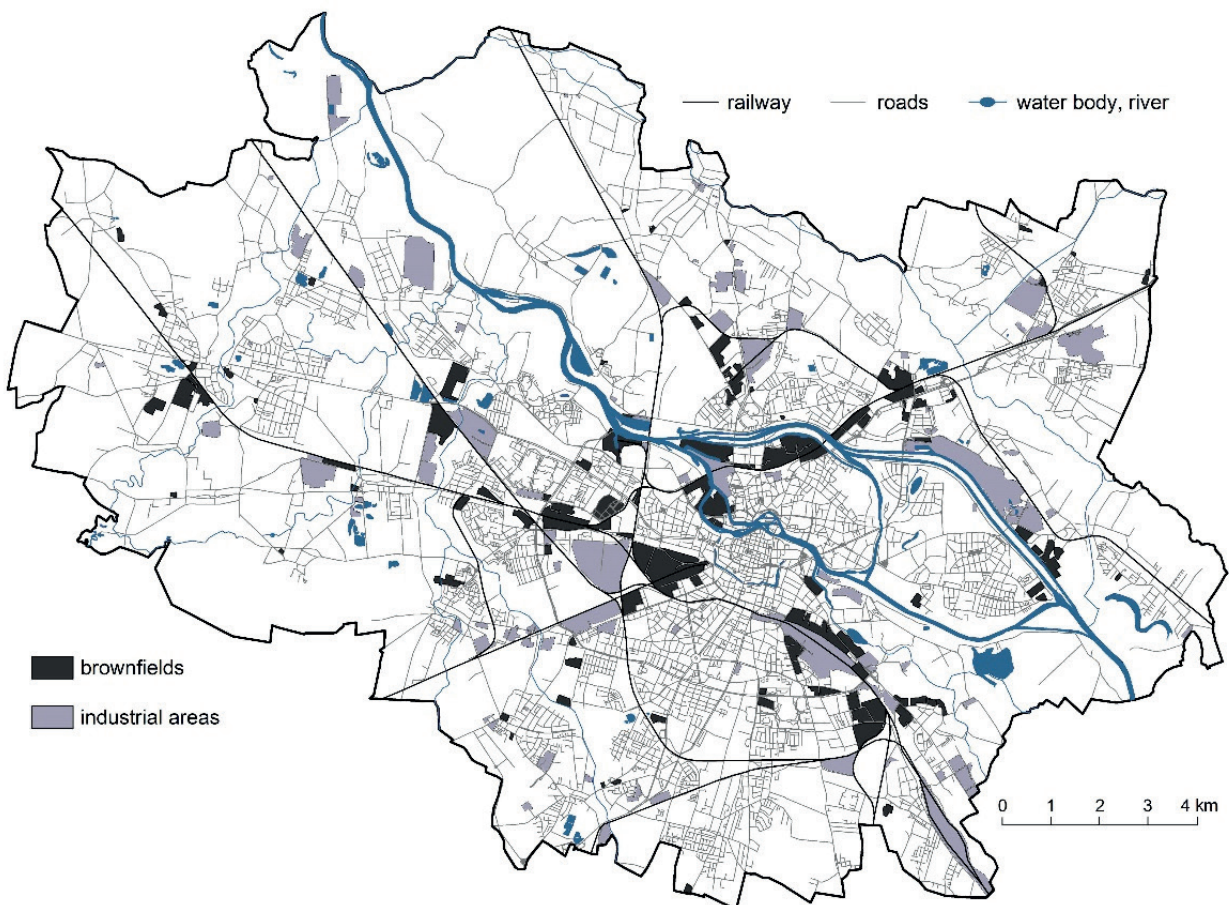


Fig. 2. Spatial location of industrial and brownfield sites in Wrocław

Source: Authors

investment is revitalisation and adaptation of post-industrial facilities to new functions. The planned time for completion of the investment is 2023 (Fig. 3).

The transformation of individual industrial areas into post-industrial areas had a huge impact on the urban estates and districts in which they were originally located. As a result, usually individual parts of the city changed their character, a very good example of which is the functional transformation of the Kleczków estate in Wrocław (Fig. 4).

The last example of the transformation of post-industrial sites in Wrocław, and the most controversial, is the story of the development of the former City Slaughterhouse located on Legnicka Street in the Fabryczna district (downtown). The plant was established in 1893–1896 on an area of more than 20 hectares and operated there for almost a century. It was finally decided in 1999 to demolish the abandoned valuable post-industrial buildings and build the Magnolia shopping centre in their place in 2007.



Fig. 3. The contemporary appearance of the Piast Brewery brownfield site
Source: Archive of Dominik Sikorski



Fig. 4. Functional transformation of the Kleczków estate in Wrocław from 1998 to 2022
Source: Authors

A common feature of the transformation of Wrocław's post-industrial sites is their very extensive nature, which is aimed at maximising profits from their redevelopment. On the one hand, brownfields are some of the last vacant spaces in the city possible to be developed for other functions. On the other hand, their contemporary development pattern (high density of buildings, lack of transportation infrastructure, lack of public institutions such as schools) may bring more disadvantages than benefits in the future (Sikorski, 2022).

Describing the transformation of industrial areas associated with the spatial, political and economic transformation, it is also worth saying a few words about other types of developing city zones today. In Wrocław and its suburban zone in recent years, there has been a noticeable dynamic growth in the number and area of logistics centres. In the entire agglomeration there are approximately 25 logistics centres with an area exceeding 1.5 million m², including eight centres with an area of more than 500,000 m² in Wrocław alone. The city is also home to ten diverse industrial and technology parks, led by the Wrocław Technology and Industrial Park. Wrocław is also a cluster of nearly 40 innovation centres and various incubators. Important and thriving zones also include large shopping centres, of which there are a large number in the city.

The distribution of these new zones of economic and social activity is characterised by several regularities. First, a significant number of these zones have been located along road and rail transportation routes. Second, the zones described have been established on numerous brownfield sites. And third, in some of the zones, correlations with the institutional environment can be seen in their location (e.g., the location of innovation centres near universities) (Fig. 5).

The business support institutions are a modern instrument of urban planning and spatial management related to industrial planning and serving to increase the attractiveness of productive areas (Curdes, 1991). The contribution of the institutions to the development of urbanised areas consists in the development of new land, wasteland and brownfield zones. A key role in this process is played by the introduction into the urban (metropolitan) landscape of urban architectural solutions, characterised by the high quality of the premises, attractive modern design, and large share of landscaped green areas. In the case of Wrocław, the mentioned institutions are increasingly taking this form and are being created as new ventures (mainly logistics centres located on the outskirts of the city that take advantage of the internal

and especially external transport system allowing for efficient and fast access to them), but also as a supplement and concentration of development in the existing tissue (Wrocław Technology Park) or revitalisation of post-industrial areas associated with traditional and degraded industry (Wrocław Industrial Park). All the forms of economic activity are a tool of spatial policy aimed at improving the quality of the environment and the sustainable development of urbanised areas (especially large cities) and metropolitan areas (Wdowiarz-Bilska, 2007). Thus, they are a manifestation of new directions in the construction of modern urban structures (including post-socialist cities) based on sustainable development. The distribution of these institutions in Wrocław confirms a new phenomenon – the sustainable development of the city in response to the requirements for the creation of urban space and the economic activities carried out, as stated by Majkowska (2021). These institutions are often characterised by their absence of negative environmental impact. Their functioning, through cooperation between the scientific and business communities, is based on the modern and innovative intellectual work of engineers and scientists and the use of advanced products and technologies in offices and laboratories. Research and development for environmentally beneficial technologies is a common profile of activity in the mentioned institutions or a leading sector of their development. The scope of research and implementation work carried out includes topics related to various aspects of environmental protection and monitoring, pollution neutralisation, disaster prevention, exploration of unconventional energy sources and development of eco-industry and eco-tourism.

The emerging institutions supporting the business environment and innovation have therefore reinforced the process not only of deeper deindustrialisation in Wrocław, but also the process of delocalising industry in the spatial structure of the entire Wrocław agglomeration. As a result, industrial activity is spilling over into peripheral areas. However, this process is selective and mainly concerns low- and medium-low-tech industries. However, the reasons for shifting production are more complex. The main motive for the relocation of manufacturing activities is, of course, the desire to reduce production costs and increase the flexibility of operations (Moriarty, 1991; Morrill, 1992; Renski, 2008). In the case of Wrocław, an additional important role is played by the high supply of vacant warehousing, manufacturing, logistics and service space located on the outskirts of the city along the

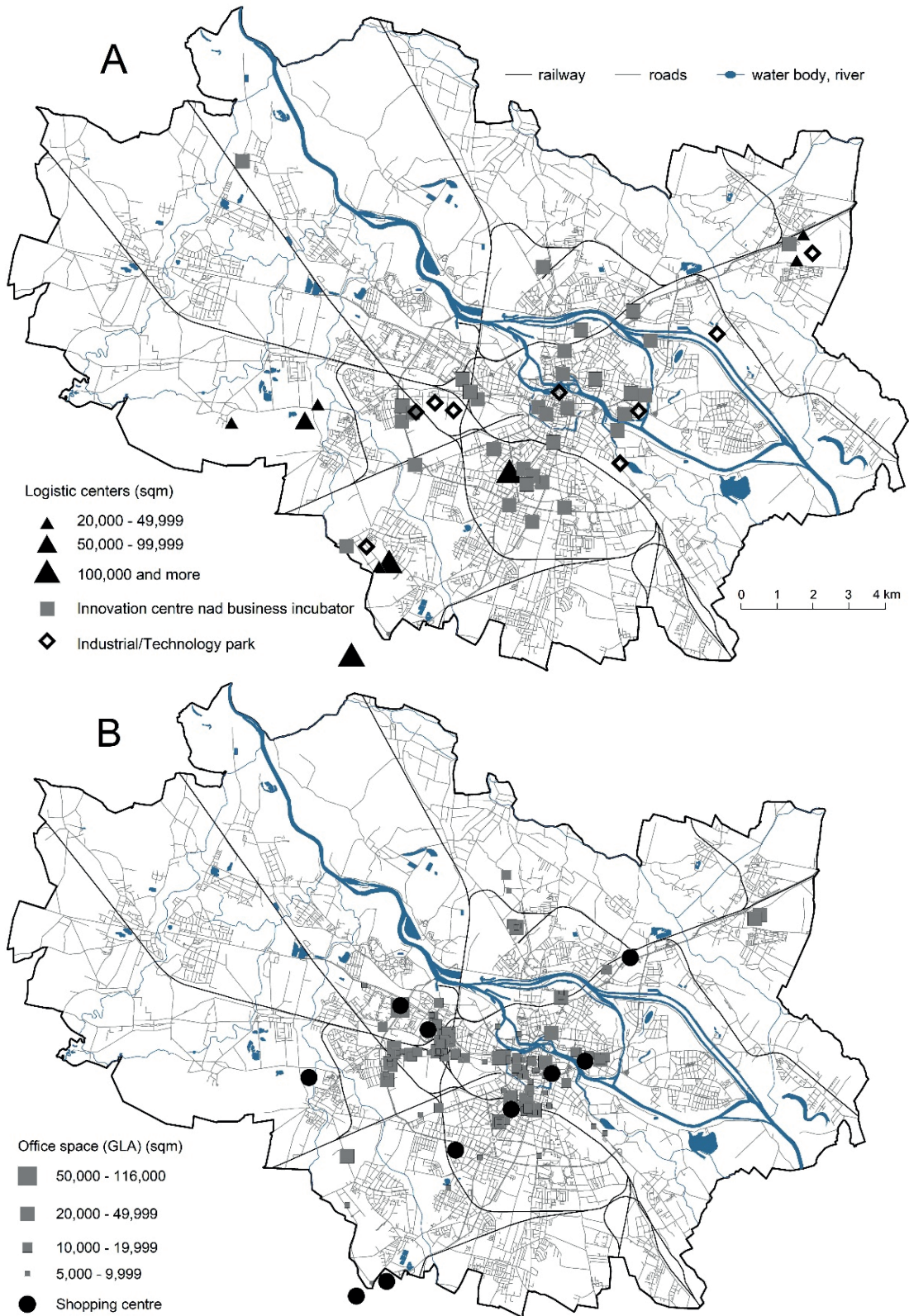


Fig. 5. Zones of innovative, business, commercial activity (A) and clustering of office space, shopping centre, (B) in Wrocław
 Source: Own elaboration based on Majkowska (2021)

main exit arteries and the existence of important transportation hubs. Multifunctional centres are being developed there in the form of parks often within subzones of special economic zones offering the possibility of investment projects of the built-to-suit type (assuming the design and construction of a building strictly according to the needs of a specific tenant) of warehouse, manufacturing, logistics and service space, thus also creating favourable conditions for industrial entities. In contrast, high-tech industries remain in the central part of the city. In the core of the agglomeration, there is usually a set of favourable conditions (a large presence of skilled young people, scientific and research and institutional facilities, numerous high-tech companies enabling cooperation). For this reason, in the central area of the city, high-tech entities are created more often than in the rest of the area although the rate of exit of these new companies is also high (Arauzo, 2005; Coll-Martínez et al., 2016). In the case of Wrocław, however, the spatial structure of high-tech industry is constantly transforming, hence the significant dispersion of institutions supporting the development of high-tech manufacturing.

3.2. Spatial aspects of deindustrialisation: the case of Brno

Industrial production was, in the case of Brno as well as other CE cities, the major decisive factor determining the city's spatial organisation and functional-spatial layout. Despite the considerable manifestation of post-socialist deindustrialisation, which culminated with the loss of the economic dominance, the industrial heritage in Brno still leaves a highly significant trace that conditions the basic form of the city. The present spatial structure still resembles the urban patterns dating back to the times of the early and little-coordinated phase of industrialisation in the second half of the 19th century (Toušek & Mulíček, 2003; Kunc et al., 2018). With respect to the number of inhabitants, size of the area, and Brno's own morphostructure, we cannot speak of the typical change in structure from monocentric to polycentric that happened in the case of many post-socialist cities (Brade et al., 2009; Malý, 2016; Mulíček & Malý, 2018).

The total area of the production areas in the middle of the first decade of this century was 15.1 km², which meant 6.6% of the city area and 19% of the built-up area. In 2006, Brno City Council initiated the first registration of brownfields in the city. A total of 118 sites larger than 0.5 hectares

were identified, which represented a total area of 5.2 km², i.e., only 2.3% of the total area of the city (Kovoprojekta Brno, 2006/2009). According to further regular monitoring surveys, which were already fully under the responsibility of the Brno City Hall, about 50% of Brno's old industrial areas (similarly to Wrocław) have undergone functional and spatial change after 1989 and have acquired new/other uses.

Besides the modern industrial zones, logistic-administrative grounds and premises, and shopping campuses, there emerged new substantial spatial elements in the city – the brownfields (Kunc et al., 2014a; Nekolová et al., 2016). Due to all kinds of transition changes and a rather critical view on the part of the magistrate and the inhabitants concerning the quality of life in the city area, brownfields became an ambivalent element of the development. On the one hand they represent the potential and the possibility to reshape abandoned areas often close to the city centre into a lively city organism: on the other hand they represent an economic, social, environmental and visual stain on the face of the city, which is due to be dealt with by the public sector, ideally in cooperation with the private sector (Litt et al., 2002; De Sousa, 2006; Kunc et al., 2014b). Brownfield developer projects are thus a rather visible activity and in some cases the city became its own developer.

In Brno, the historical development of industry and other manufacturing activities connected with the construction of the railway from the south-east and Vienna and its continuation via the city centre up northwards along the river Svitava created three important compounds of brownfield sites (see Fig. 6). The first can be found in the south and south-east area bordering the historical core. These are the compounds and premises of former textile factories and other manufacturing mills whose location near the city centre excludes the future continuation of sophisticated manufacturing activities. The usability of these locations is on the one hand limited to non-manufacturing activities, while on the other hand this location is and will be highly prominent in the context of potential company headquarters, as well as office and administrative premises (Kunc & Tonev, 2008; 2009; Kunc et al., 2014b).

An example of revitalisation is the ongoing construction of a modern administrative (and in the future also housing-and-shopping) complex, New Vlněna, by a Dutch developer company CTP Invest in the place of the former textile company Vlněna. The plan is to create 85,000 m² of office and business area for highly equipped and furnished

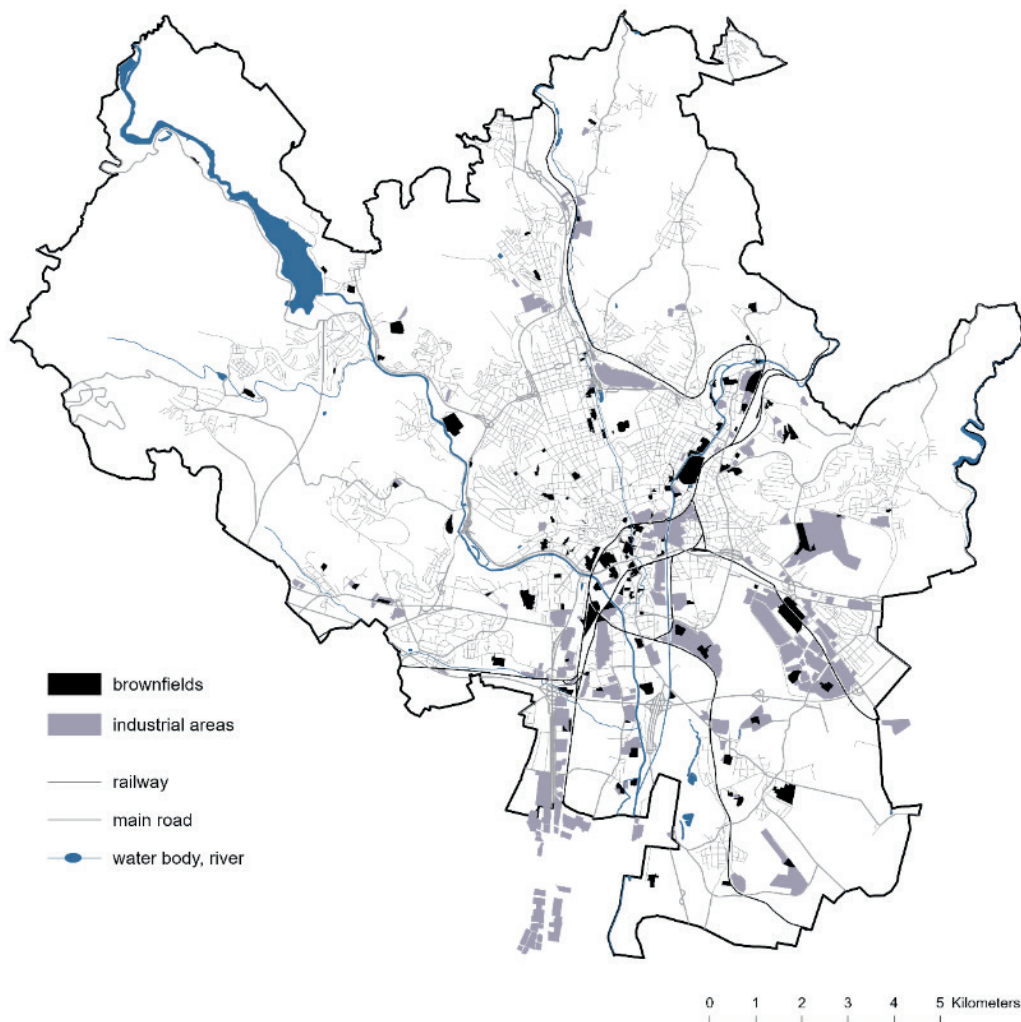


Fig. 6. Spatial location of industrial and brownfield sites in Brno
Source: Authors

classical offices as well as shared coworking premises. By 2030, the investment will rise to 160 million euros and up to 10,000 people should work here. Today, mostly IT firms and multinational companies such as Moravia IT, Avast and Oracle have their residences within the complex, which is still under construction. The basic benefit of this area is its location close to the city centre, the main railway station and the central coach station.

The second large area of brownfield sites concentration is the zone stretching along the River Svitava and reaching out from the zone of the inner city into the wider inner city. The area's dense concentration of textile mills, engineering works and chemical plants has a linear structure that follows the course of the river. This concentration is considered possibly the most problematic aspects of Brno, primarily due to the associated water and soil contamination. The area north of the historical core can be considered the third important concentration

of brownfields. This area contains both military brownfields and the Brno's largest factory by area, Královopolská Steel (37.5 hectares). Concerning transportation, this area is quite accessible due to the Large City Circle Road. Its technical infrastructure is sufficient to provide the necessary facilities for extensive industrial functions here (industrial or logistics parks). With a favourable landscape environment, the northern part of this area is also suitable for recreational purposes (Kunc & Tonev, 2008; 2009; Kunc et al., 2014b).

On the other hand, there are several industrial buildings close to the historic centre of Brno that have the potential to bring the 150-year historical legacy of the city's textile production into the present. One of the best preserved is the Mosilana factory complex. Declaring the most valuable parts of the Mosilana site a cultural monument (see Fig. 7) would help to preserve an important part of Brno's textile history. A private investor wants to demolish

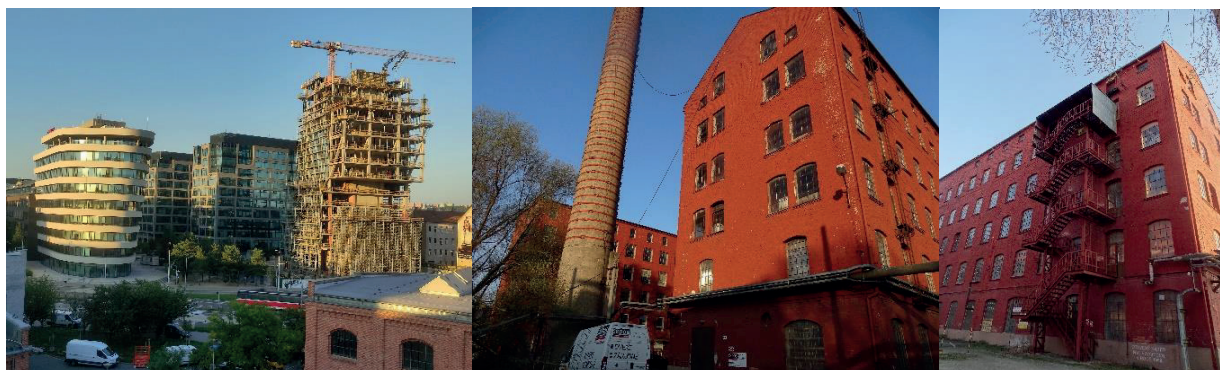


Fig. 7. Nová Vlněna and Mosilana complex

Source: Archive of Josef Kunc

the entire complex – a proposal opposed by the city administration and the public. The preservation of the genius loci of the Mosilana textile complex would combine the history of the “Moravian Manchester” with plans to build a modern residential district (Neumannová & Kunc, 2022).

Figure 8 depicts the spatial distribution of other important types of developing zones – industrial zones, science-technology parks, business incubators and shopping centres. Although the industrial zones Černovická Terrace (200 ha, the biggest zone in the Czech Republic) and Areal Slatina are located within the zone of the wider inner city (zone 3), which stretches from the city centre down to the south-east, where both these zones lie, they are considerably distant from the historical core. By contrast, the Technology Park Brno is closer to the centre, but it is located on the border of zones 4 and 5. Two more zones are located behind the administrative border of Brno city. Business incubators in Brno are concentrated (with just a few exceptions) within two locations – i) near Technology Park Brno (in the neighbourhood of Brno University of Technology) and ii) the university campus of Masaryk University. The relation of these business subjects to the academic sphere is more than obvious.

Administrative centres and office spaces are naturally located and accumulated within the inner-city zone, often in the immediate background of the historical core. This was a natural reaction to the historical location of industrial plants in the inner city, which also needed an efficient administration. Residential complexes for workers and clerical staff were also built around them, and, later (in the second half of the 19th century), entire city districts were created (Haase & Steinführer, 2005; Vyskočil, 2014).

Concerning the developing zones, the important location line features were typically earlier important transport lines, in the case of Brno specifically, the

railway tracks in the north–south (in connection with the Svitava river) and east–west directions and still never-finished Brno–Vienna motorway, which intersects the Prague–Brno–Olomouc motorway in the south of the city. As in the case of the business incubators, there is also a significant connection between certain types of office centres and existing science-technology parks and industrial zones.

Industrial activities began to move to the periphery of the city only during the 1990s, with the development of new industrial zones and parks, followed by logistics centres and warehousing facilities, or large shopping centres. The latter needed more suitable land for their business and more free space for the construction of single-storey complexes and connections to the railway and, especially, the motorway network. Despite the significant spatial shifts that took place, Brno never became a typical polycentric city or agglomeration (Sýkora et al., 2009; Muliček et al., 2016). The historical legacy of higher education and scientific institutes, human capital and concentration of highly equipped office space with tenants from hi-tech fields higher services and innovation centres together with vacant areas for further development have become a dominant aspect of the spatial and socio-economic transformation of the city (Kunc & Tonev, 2022).

4. The modern, post-industrial urban environments of Wrocław & Brno

The population of Wrocław, being 1.8 times that of Brno, is reflected in a relatively similar difference in the size of the metropolitan area, but in a more significant difference in the number of visitors and people who move daily in the cities (work, school, business, services, etc.). Regarding the

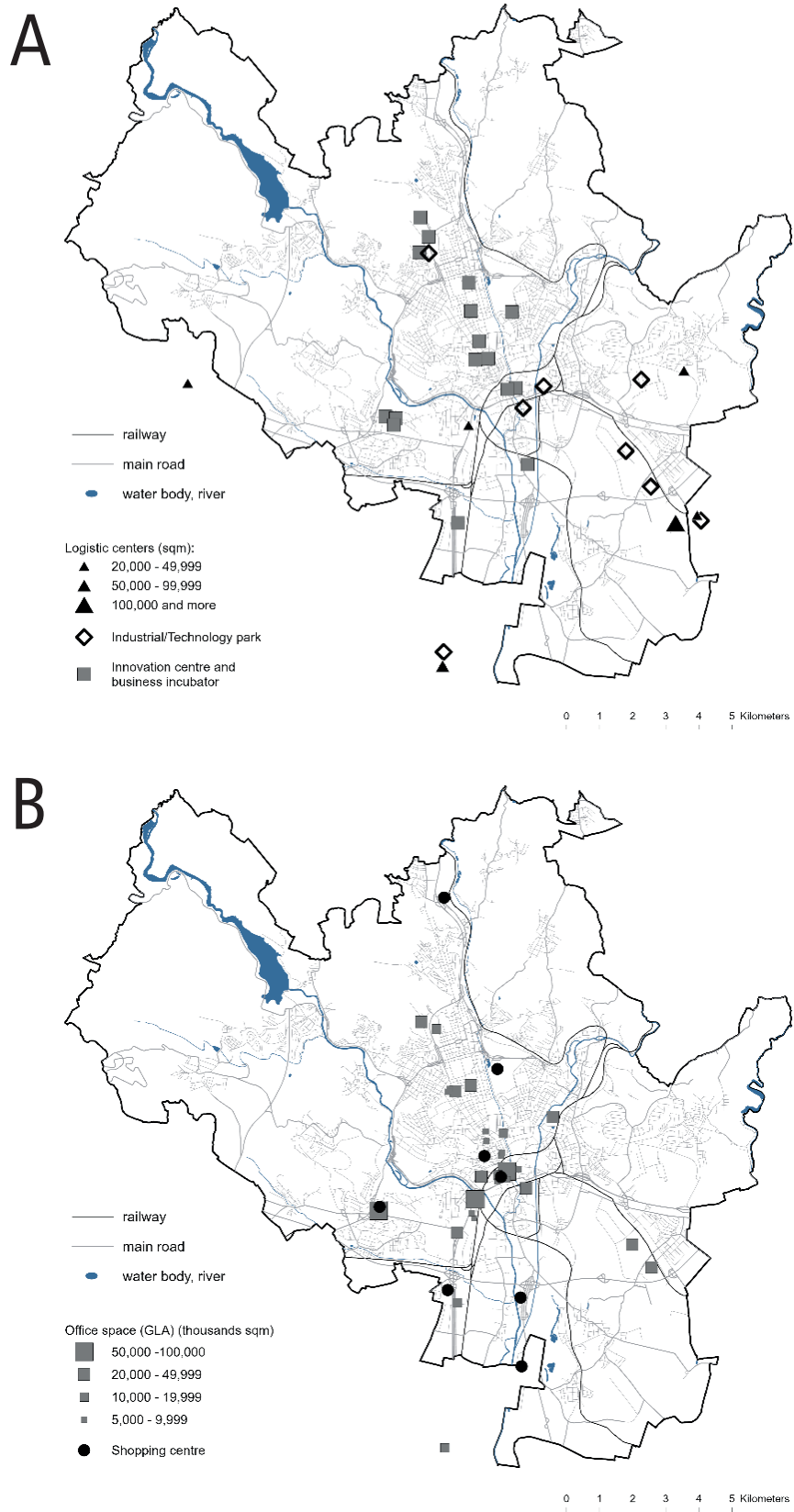


Fig. 8. Zones of innovative, business, commercial activity (A), and office space, shopping centre (B) in Brno
Source: Authors

population, Wrocław's relatively smaller cadastral area indicates a high population density compared to Brno, but this does not prevent it from having more than a third of the area of green space on its territory. Both cities belong to the smaller number of medium-sized CE cities, where there have not been strong depopulation tendencies since the fall of communism, and they can rely on the very important socio-economic and political aspect of population stability in the long term.

Both cities also have a very strong student population and can be considered university towns. The number of foreigners in Wrocław has increased dramatically due to political and labour migrants from Ukraine in a wide range of more or less qualified fields, but also from other countries, including from outside Europe. So too in the case of Brno, the number of foreign workers going into higher services, innovative technologies, ICT, etc. has increased over the past 30 years. Concentrations of higher-value-added industries may indicate a higher GDP per capita and average monthly wage in the populationally smaller Brno (Table 1).

In recent years, Wrocław's growth has brought about its own set of challenges. Along with the dynamic socio-economic development of the city, the process of modernising and expanding the existing transportation infrastructure and public transport has unfortunately not kept pace. This has resulted in significant traffic problems, especially evident during peak traffic hours. Wrocław has a very dense transport network with 30 railway stations, 125 bus routes and 21 tram routes allowing numerous long-distance bus and train connections to other cities. Due to hydrogeological conditions, the construction of a subway is not viable in this

city. Brno operates a high-quality and functional public transport system, which includes trams (12 routes), trolleybuses (13 routes), buses (50 routes) and trains (8 stations). This system enables people to get to work in an efficient and economical manner. Brno's more central location within Europe means it is very well connected to the surrounding capitals and other large CE cities; Wrocław has closer links with large cities in Poland and eastern Germany.

Wrocław has its own supra-regional airport named after Nicolaus Copernicus, with dozens of international connections, 2–3 million passengers in the run-up to the Covid-19 pandemic, and competition in nearby Katowice, whose airport also serves passengers from the Czech Republic and Slovakia. Brno is also connected internationally via the regional Brno-Tuřany airport with a growing number of regular seasonal destinations associated with trips to the Mediterranean and Black Sea and direct flights to London and Milano/Bergamo.

Wrocław and Brno are important centres of sports, culture, education and tourism. The more populous Wrocław has more than 160 sports clubs, with more than 20,000 active members. Brno has a long tradition of hosting motorbike and other motorsports racing events on the Masaryk circuit (established in 1930) including the famous MotoGP, of which the last race took place in 2020.

Both cities are characterised by their long history and many preserved historical and cultural monuments. Wrocław, the capital of Lower Silesia, is home to numerous cultural institutions (e.g., 21 museums), which are visited by nearly a million people each year. There are numerous historical monuments and tourist attractions with the Centennial Hall (listed as a UNESCO heritage site

Table 1. Basic characteristics of Wrocław and Brno

	Wrocław	Brno	
	670,000	number of inhabitants	380,000
	1,140,000	number of inhabitants in Metropolitan Area	700,000
	1,000,000	daily attenders	500,000
	100,000	number of foreigners	40,000
	250,000	people commuting to the city on a regular basis	150,000
	323,000	total workforce	250,000
	105,000	university students	65,000
	293 km ²	total area	230 km ²
	2,300 inhab./km ²	density of population	1,600 inhab./km ²
	35%	green vegetation	19%
	120%	GDP <i>per capita</i> ; EU 28=100%	155%
	1,814€	average monthly salary	1,956€

Source: Statistics Poland (2021) and Eurostat (2021); Brno City Profile (2019) and data.Brno (2023)

since 2006), the magnificent Market Square and the historic Ostrów Tumski (Old Town). Nearly 1.5 million tourists visit the city each year, of which nearly 150,000 are foreign tourists. Brno has a similar number of museums, including the UNESCO-listed Villa Tugendhat. The total number of visitors to the city is around 1.2 million a year, of which around 30% come from abroad (data.Brno, 2023).

There are 25 universities in the city of Wrocław, with more than 105,000 students. Every year, out of nearly 35,000 university graduates, as many as 40% are science graduates. The infrastructure to help realise this transformation is also being successively developed. Brno has about 80,000 students enrolled in 13 universities (8,000 students are foreigners). There are more than 16,000 new graduates each year (45% are science and technical graduates) and this figure denotes the highest density of graduates per capita in the Czech Republic.

The strength and innovation of the city's economy is evidenced by the fact that more than 323,000 people work in the Wrocław, and fewer than 8,000 are unemployed. The city has been striving for years to develop an innovative economy based on its own academic potential. The city is home to the Wrocław Research Centre EIT+, the Wrocław Technology Park, the Lower Silesia Innovation and Science Park, as well as ten other industrial and technology parks and 40 innovation centres and business incubators. The labour market in Brno is stable and has around 13,000 job seekers. The total workforce is about 250,000 people. The availability of IT, economics and business students is one of the main factors attracting investors to the city. Business services are booming in Brno, with over 30 major international centres delivering a complex range of high-end IT, finance and business support functions for the largest global players. The sector employs more than 22,000 people in the city. The research and development sector in Brno is very important (five centres of excellence are in Brno), with around 20,000 employees and more than 12,000 researchers.

Along with the transformation of the city's economic sector, the city's rapidly growing office and logistics space is increasingly visible in its space. Throughout the agglomeration, there are about 25 logistics and service centres with an area of more than 1,500,000 m², including eight centres with an area of more than 500,000 m² in Wrocław alone. Brno currently has a total modern office area of 660,000 m². Approximately 80% of the area meets the requirements for A-class office space, and more than 70% of the space is occupied by the companies in the ICT sector. In terms of office rental, Brno

is currently the most expensive among regional cities of >400,000 inhabitants in the CE region and surpasses markets almost twice its size such as Krakow and Wrocław.

There are dozens of shopping centres in Wrocław, and these function as meeting and trading places for hundreds of thousands of people every day. Brno, with almost 320,000 m² of retail space in the shopping centres, has one of the highest shopping centre densities in the Czech Republic.

The pace of transformation of Wrocław, where industrial activity was important in the city's development during the period of centrally controlled economy, is now tremendous. The city is transforming before our eyes from a grey socialist city into a modern metropolis of regional, national and increasingly international significance. One of the symbols of the transformations that have taken place in the city was the construction in 2012 of one of the tallest office buildings in Poland – the Sky Tower, which towers over the city and is a kind of symbol of the new changes in the city. Brno is in a similar qualitative transition. Modern industrial, logistics and warehouse areas are represented by about twenty industrial parks and zones, technology parks, innovation centres and business incubators. More than 40,000 people are employed there and technology giants such as IBM, Honeywell, Siemens, AVG Technologies, Acer, Cisco Systems, AT&T, SGI, Red Hat, Alstom and Motorola have headquarters or branches here (Brno City Profile, 2019; data.Brno, 2023).

5. Conclusion

Given the cultural, social and economic similarities, many of the historical contexts of heritage and transformation activities in Wrocław and Brno had similar features and manifestations but also some differences.

The industrial history of both cities is long and dates to the second half of the 18th century, with the role of the textile industry being decisive. The breaking down of the city walls in the early (Wrocław) and mid-19th century (Brno) marked the cities' inspiration to expand their built-up areas and the great expansion of industrial production in the rapidly growing suburbs. The introduction of the railway to Brno in 1839 and to Wrocław in 1842 and the nearby raw material base (within 50 km) in the form of black coal contributed to this. At the end of World War II, Wrocław was turned into a fortress by the Germans and subsequently subjected to a very strong onslaught by the Red

Army. As a result, 80,000 civilians were killed and up to 70% of the housing stock, factories and other buildings were destroyed. Brno was also attacked in 1944 and 1945 by both American and Soviet air forces, but there were hundreds of casualties and destroyed buildings. After the war, a rapid renewal of industrial production was preferred in both cities within the framework of socialist industrialisation, and completely new, large production enterprises were also established (e.g., Pafawag in Wrocław – production of locomotives and railway carriages, Zetor Brno – production of tractors). From the 1960s onwards, the production of transport equipment, engineering products and electrical engineering began to dominate in Wrocław, while in Brno general engineering and, to a lesser extent, textile production completely dominated.

Fundamental structural economic and social changes in the industry of both cities occurred in the 1990s. The processes of transformation of their spatial industrial structures were the result not only of local conditions, but also of global ones. This was reflected in both cities' strong inclusion, due to their geographical proximity to Western European markets, in the process of industrial relocation through numerous foreign direct investments. They played an important role in the shifting (on the centre–periphery line) of industrial activity, with the periphery nowadays including the countries of Central Europe (from the perspective of the “old” European Union). The processes were also superimposed on the previously initiated processes of industrial deconcentration in the 1970s and 1980s. In addition, along with the decline in the importance of industrial production, there was a significant and rapid increase in the importance of services in the economy and changes in the form of ownership of business entities. Both Wrocław and Brno became important players in the regional market of residential and, to some extent, industrial development. The extensive nature of the transformation of post-industrial sites, aimed at maximising profits from their redevelopment, has often led to the unregulated commercialisation and destruction of many architecturally valuable industrial buildings. After 2000, the transformation of brownfields became more planned and sensitive, as the interest and awareness of city representatives and residents towards the industrial heritage and sustainable development increased. The focus was on new residential functions, services, commerce, administration and mix zones.

During the past three decades, industrial employment in Wrocław has seen a marked decline of approximately 40%, while in Brno, this decline

has been even more pronounced at around 65%. There has also been a sectoral transformation of industrial employment. The publishing and printing, metal products, clothing, precision engineering, machinery and equipment manufacturing sectors have taken on a decisive role in Wrocław, while in Brno the electronics and electrical engineering, ICT, life science, telecommunications and precision-engineering sectors have taken over (Fig. 9).

The spatial distribution of industrial and post-industrial areas (often brownfields) in the city is primarily determined by the history of industrial development of the city, which tended to locate along the main transport routes and the Oder (Wrocław) and Svitava (Brno) rivers where concentration zones were created. This spatial arrangement of industry in the cities allowed for relatively easy and fast transport of raw materials and semi-finished products, as well as the initiation of cooperative links and technical and technological advantages between individual plants and industries. After 1989, deconcentration changes began to take hold, in particular the break-up of large enterprises into smaller units with a high degree of production, financial and organisational-managerial autonomy. The area of industrial estates in the city has decreased by more than 40% and industrial brownfields account for 1.5–3% of the city's area and are becoming smaller as regeneration progresses.

Over the years, there has been a dynamic increase in the number and size of modern logistics centres, industrial and technology parks, innovation centres and incubators, and large shopping centres or retail parks. The emergence of new non-industrial institutions has further accelerated the city's ongoing deindustrialisation. This transition is particularly evident as industrial activity, including zones and parks, progressively relocates to peripheral areas. However, this shift was selective and concerned mainly lower-technology sectors. The motivation for relocating manufacturing activities was to reduce production costs and increase flexibility of operations; the supply of warehousing, production, logistics and service premises located on the periphery of the city close to major transport hubs and arteries increased. High-tech industrial enterprises remain in the central part of the city, supported by a high concentration of young, educated and qualified people, scientific research and institutional facilities, or cooperation with other, industry-related high-tech enterprises (Wrocław); in the case of Brno, especially life-science and ICT industries are in the city centre. In general, the spatial structure of the high-tech industry is constantly changing in the city, which results in a

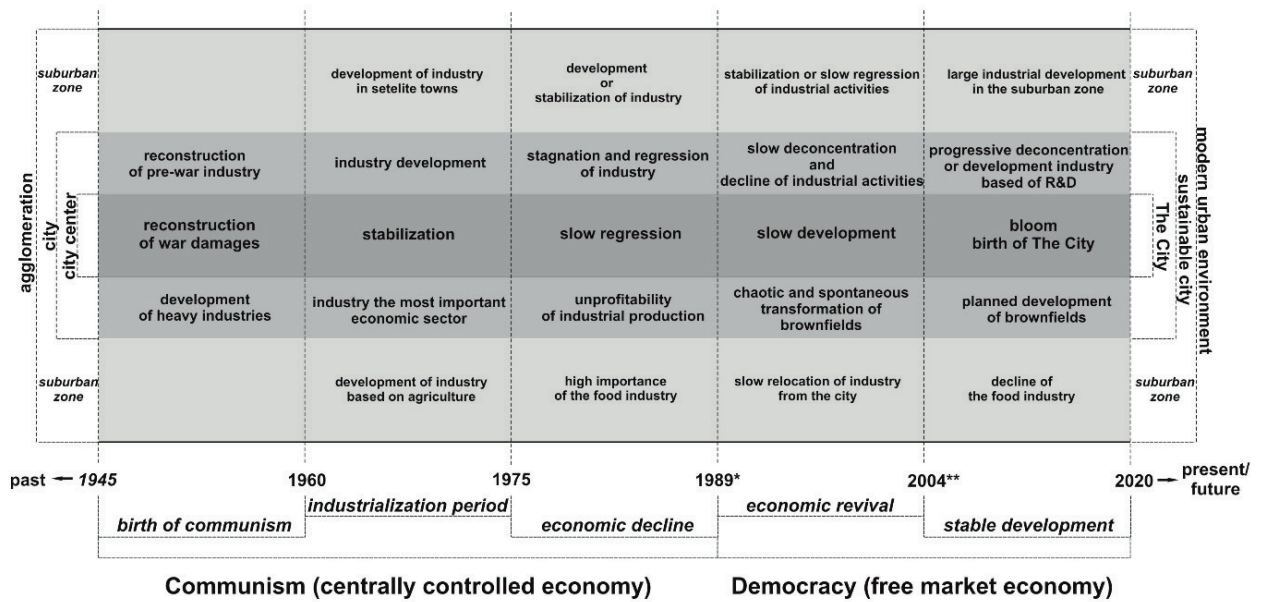


Fig. 9. Scheme of the transformation of industrial structures of CE cities

* beginning of economic transformation;

** accession to the European Union

Source: Authors

considerable dispersion of institutions supporting the development of high-tech production.

After 2000, Wrocław and Brno began to establish themselves as modern metropolises with dynamically developing innovations, hi-tech industry, trade, life science, information technology, research and innovation, business incubators and scientific centres of excellence. These cities have established themselves as appealing destinations for both national and international students, as well as hubs for the workforce and investors. Wrocław is a leading centre of social and economic development in the region, as well as in Poland as a whole. The city has become a major research and development centre specialising in IT, engineering, chemistry and pharmaceuticals, and bio- and nanotechnology. It is also the country's leading R&D centre in the gaming sector and has an attractive startup ecosystem supporting successful innovators in international markets (Dolny Śląsk ..., 2000). In contrast, Brno is also the main exhibition centre of the Czech Republic and one of the top trade fairs and exhibition centres in CE. The tourist potential built on historical monuments, modern functionalist and industrial architecture, as well as the long tradition and underbelly of cafés, pubs, bars and national gastronomy, cannot be overlooked. Both cities also benefit from a very good geographic location close to several major cities and capitals, developed (Brno) or growing (Wrocław) transport

infrastructure and a good public transport system in a particular city and the entire metropolitan area.

A certain difficulty in the conducted research was the question of availability and comparison of collected statistical data for the examined cities. Although the cities studied are relatively close to each other in Central Europe, being part of two different countries meant that the availability, reliability and quality of data differed. This made it necessary, to some extent, to limit the analyses to overlapping sets of data.

The contribution of the study is an in-depth comparative analysis of the transformation of the model Central European cities of Wrocław and Brno from industrial centres to post-industrial environments, which enabled an understanding of the main factors and mechanisms that influenced the economic transformation and the new spatial arrangement of the cities. The comparison identified variously successful strategies used by the cities to adapt to new and dynamic forms of economic and social activities, such as creative and innovative activities, hi-tech industries, higher forms of services, modern transport infrastructure, shopping centres. The study therefore attempts to contribute to a better understanding of the process of transformation of industrial cities in Central Europe and to provide valuable information for planning the future development of these (and other) cities in the new economic and socio-cultural context.

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