

From industrial specialization to diverging urban trajectories: Industrial legacies and population change in Czech large cities since the late 1980s

Josef Kunc¹✉ — Kateřina Důbravová¹ — Petr Tonev¹

¹Department of Regional Economics, Faculty of Economics and Administration, Masaryk University, Brno, Czech Republic

✉ kunc@econ.muni.cz

Abstract

This paper examines the relationship between industrial legacies and demographic trajectories in the large Czech cities after 1990. The analysis is based on a dataset of 26 cities with more than 45000 inhabitants, combining data on the development of industrial employment and population changes from the turn of the 1980s and 1990s to the present. Industrial structures were aggregated into five sectoral categories and compared with demographic development using statistical methods (Spearman's correlation, boxplots, Webb's diagram). The results show a significant association between long-term industrial trajectories and demographic outcomes. Cities historically dominated by machinery and electrical industries have experienced more stable or growing populations, while those dependent on heavy industries such as mining and metallurgy have undergone substantial decline. The findings demonstrate the persistence of path dependency in urban development, linking economic specialization before 1989 with post-socialist demographic shrinkage. The study highlights the importance of industrial legacy for understanding regional disparities in Central Europe and provides empirical evidence for debates on deindustrialization, shrinking cities, and post-socialist urban restructuring.

Keywords

Industrial legacies,
Deindustrialization,
Population change,
Shrinking cities,
Path dependency,
Czech Republic

Received:
21 October 2025

Received in revised form:
18 April 2026

Accepted:
25 April 2026

Highlights for public administration, management and planning:

- Industrial legacies continue to shape Czech urban development.
- Mining and metallurgy cities show the deepest population decline. Mechanical and electrical engineering-based cities maintain stable or growing populations.
- Less adaptable industrial structures are linked to long-term decline. Population loss concentrates in old industrial regions (e.g., North-West Bohemia, Ostrava region).

1 Introduction

After a long period of urbanization supported by industrial development and, in the case of cities in Central and Eastern Europe, also by specific socialist industrialization, many cities have been experiencing population decline in the last four decades. This is especially true for former industrial centers. Since the mid-1980s, Central Europe has experienced a gradual stagnation and decline in the importance of industrial production, which was reflected not only in a decrease in production volume but also

in a significant reduction in employment in this sector (Steinführer et al. 2010; Krzysztofik et al. 2016; Cudny & Kunc 2022). Industrial decline had a particularly strong impact on the development of cities and urban agglomerations, whose economies were historically closely linked to raw material extraction, metallurgy, the chemical industry, and heavy engineering. In many cases, this long-term trajectory illustrates the importance of path dependency - inherited specializations and industrial lock-ins limited the ability of cities to adapt when external shocks, such as the collapse of state socialism,

redefined market conditions (Židek 2017; Brezdeň & Szmytkie 2019; Blažek et al. 2020; Sikorski & Kryczka 2023). Another negative side effect was the demographic transformation of industrial cities, often associated with a long-term population decline, mainly due to job losses in industrial enterprises and subsequent emigration (Kovács 1999; Stanilov 2007; Cudny & Kunc 2022; Bleha & Buček 2024).

In the Czech Republic, industry accounted for about two-fifths of total employment in the late 1980s, but in the 1990s, there was a sharp decline in industrial production and the number of employees. The long-term process of deindustrialization, which intensified in Czech cities from the early 1990s, had a measurable impact on population development, especially in cities whose economies were historically based on heavy industry. The transition from a centrally planned economy to a market economy was a challenging task, especially when it was accompanied by population decline. This post-socialist restructuring represented a breaking juncture: in some cities it deepened decline, while in others it opened opportunities for renewal, depending on the alignment of inherited capacities with new global value chains. Some cities and regions have not been able to complete the deindustrialization process and move from traditional (and declining) industries to modern high-tech industries, higher services, research, or innovation (Haase et al. 2016; Kunc et al. 2023). Even after 35 years since the beginning of the economic transformation, some areas still struggle with an insufficient and undiversified sectoral structure and pay the price for the historically rooted importance of dominant industries. In such cities, transformational changes are accompanied by significant social, demographic, and environmental problems. These cumulative outcomes resonate with the shrinking-cities debate, which views population loss not as a temporary anomaly and isolated event but as a path-dependent process linking industrial outputs and employment decline with selective migration and ageing.

There is a wide range of analyses and studies dealing with population changes and urban shrinkage in Central and Eastern Europe (see below in part Shrinking Cities: Demographic Consequences of Economic (Industrial) Development Paths). However, analyses of population development provide only limited possibilities for a deeper look at one of the fundamental socioeconomic links that (post)socialist cities had. This is the relationship of industry, or rather industrial employment, and population size and changes in these two areas,

starting from the turn of the 1980s and 1990s, with a bridge to the present, which is the subject of our text. The original data content relies mainly on relevant data on industrial employment in enterprises and their possibility of aggregation into a sectoral and spatial (urban) structure, which is very difficult and unique.

The paper provides a threefold information base. First, we provide longitudinal evidence of the connection between industrial structure and changes in population size in large cities in the Czech Republic. Second, by consolidating heterogeneous industrial activities into a small set of analytically processable categories, we clarify which industrial legacy is most associated with decline versus resilience. Third, we highlight the emergence of divergent paths – the “transformation losers” concentrated in mining and metallurgical regions (especially in the Ostrava-Karviná region) versus the “transformation winners” such as Prague, Brno, Pilsen, Liberec or Jihlava – while also pointing to atypical cases (e.g., the industrial boom of Mladá Boleslav combined with demographic specificities). These findings are relevant to ongoing debates on post-industrial transformation, place-based policies, and prospects for renewal in structurally burdened regions.

The main objective of this study is to examine whether and to what extent the industrial specialization of Czech large cities at the end of the socialist period influenced their subsequent population trajectories between the turn of the 1980s and 1990s and the present (2024). Specifically, the article inquires whether cities with distinct dominant industrial profiles exhibited systematically different patterns of population growth, stagnation, or decline after 1990. By linking the longitudinal data on industrial employment structures with long-term population changes, the analysis aims to assess the strength and direction of the relationship between path-dependent industrial legacy and urban population development in the post-socialist context.

2 Theoretical background

2.1 Path dependency, industrial legacy, and urban trajectories

Path dependency offers a powerful conceptual perspective for understanding the divergent post-socialist trajectories of cities that otherwise shared a common national political environment. In the regional and urban literature, path dependency refers to the enduring imprint of past industrial structures,

locational choices, and institutional arrangements on contemporary opportunities, mediated by mechanisms of increasing returns, sunk costs, institutional routines, and network externalities (Arthur 1994; Martin & Sunley 2006). In industrial cities, lock-in occurs when skills, supply networks, infrastructure, and governance systems are tightly linked to a narrow set of activities (Grabher 1993; Hassink 2010). This lock-in effect, although capable of promoting stability and competitive advantage under favorable conditions, becomes a burden when activities are structurally disadvantaged (e.g., coal mining, metallurgy and metalworking, heavy chemical industries). The costs of necessary adjustments and new conditions increase, diversification slows down, and cities or regions become vulnerable to the cumulative decline of their economies (Sonn & Lee 2012; Ženka & Pavlínek 2013; Květoň & Blažek 2018). However, the related diversification and branching – upgrading from existing capacities towards technologically related fields – can alleviate lock-in and support renewal (Boschma & Frenken 2011; Isaksen 2014).

For the Czech urban system, this dynamic means that cities historically anchored in mining and metallurgy, or heavy engineering faced a higher risk of long-term decline. In contrast, cities with better capacities in engineering (including automotive and precision engineering) and electrical engineering, transport, and related links to research, development, creative industries, and innovation had a stronger adaptive base (Slach et al. 2013; Blažek et al. 2020; Kunc et al. 2023).

Recent research highlights that this industrial legacy is not static, but is constantly mediated by global production networks, innovation systems, and institutional changes, so that path dependence is both limiting and enabling (MacKinnon et al. 2019; Hassink et al. 2019; Grillitsch & Sotarauta 2019). Accordingly, the article operationalizes “initial conditions” through the industrial employment structure of the late 1980s and uses it as a starting point for assessing subsequent economic and demographic trajectories of cities.

2.2 Post-socialist restructuring as a breaking point

The collapse of state socialism represented a paradigmatic tipping point that reset market signals, ownership structures, and business geographies almost overnight (Stanilov 2007; Cudny & Kunc 2022). Such moments can reinforce existing pathways (through subsidies, institutional inertia, and resistance to change) or disrupt them

through privatization, foreign entry, and exposure to global value chains (Peng & Heath 1996; Uhlenbruck et al. 2003). Where the industrial legacy was not aligned with global demand and environmental standards, deindustrialization accelerated; where it overlapped with scalable, export-oriented niches (e.g., automotive, precision mechanics, electrical engineering), new investment tapped into pre-existing capacities. The concept of path dependence, originally formulated as an alternative to the neoclassical paradigm (Arthur 1989; Puffert 2002), thus sheds light on how socialist-era specialization and subsequent restructuring have created different trajectories for the future of cities. In both firms and regions, feedback effects reinforce trajectories: positive feedback increase competitiveness, while negative ones deepen decline (Martin & Sunley 2006; Isaksen et al. 2018). In Czechoslovakia before 1990, central planning incorporated enterprises into vertically and horizontally integrated structures, with production tied to CMEA (Council for Mutual Economic Assistance) demand and labor tightly regulated by the state (Židek 2017). While this system initially supported growth, by the 1980s it had led to technological obsolescence, material shortages, dependence on military exports, heavy industry, and the mining of both hard and brown coal (Ivánek 1994; Clark & Soulsby 1999; Blažek et al. 2020). The transition of the 1990s thus acted as a shock that exposed the vulnerability of lock-in strategies while opening up space for renewal and forging development paths.

Empirically, this article interprets the industrial profile of the late 1980s and early 1990s as the initial node of each city’s trajectory, with subsequent demographic outcomes (growth, stagnation, or decline) understood as secondary effects of whether inherited trajectories were reinforced, reoriented, disrupted.

2.3 Shrinking cities: demographic consequences of economic (industrial) development paths

Outcomes of expert studies on shrinking cities understand permanent population decline as a multi-causal, development-path dependent process that links employment erosion, selective population outflow, demographic aging, housing vacancy, and fiscal stress (Turok & Mykhnenko 2007; Rink et al. 2012, 2022; Buček & Bleha 2013; Haase et al. 2014, 2016; Khavarian-Garmsir 2023; Bleha & Buček 2024 and many others). In the context of Central and Eastern Europe (CEE), urban shrinkage is often industry-driven and spatially clustered, re-

flecting the weight of the industrial legacy of the socialist era and the uneven integration of cities into global production networks and value chains after 1990 (Kovács 1999; Sýkora & Bouzarovski 2012). This dynamic highlights the role of structural constraints, where inherited specializations shape demographic outcomes over several decades.

In the case of Czech cities, this framework suggests that places historically dominated by mining and metallurgical industry trajectories exhibit depopulation bottlenecks: an outflow of young and educated cohorts, compounded by reputational and environmental burdens that discourage new investment and limit diversification opportunities. In contrast, urban economies, more deeply rooted in mechanical and electrical engineering, transport, and precision manufacturing have shown greater resilience. These cities are better prepared to stabilize or even re-grow through processes of related diversification, shifting to higher value-added services, and leveraging institutional capacities and innovation linkages (Rumpel et al. 2013; Rumpel & Slach 2014; Šerý et al. 2018). In this sense, the sectoral taxonomy in the article also serves as a tool for mapping mechanisms: industrial categories serve not only as classification labels, but as proxies for distinct adjustment regimes with relatively predictable demographic characteristics. Another study further emphasizes that population decline trajectories are not only shaped by local industrial structures, but also by multiscalar governance, environmental transformations, sustainability, and policy responses (Mallach et al. 2017; Bontje 2024; Kraker et al. 2024). This highlights the importance of understanding urban shrinkage in Central and Eastern Europe as a process driven by both legacy and future, where dependencies on industrial practices interact with global restructuring pressures and local institutional activity.

While this study builds primarily on the relationship between industrial structure and urban population development, it does not assume a mono-causal interpretation of demographic change. Research on old industrial regions (cities) and shrinking cities consistently emphasizes the multifaceted nature of urban population trajectories, which are shaped by the interplay of industrial decline, suburbanization, migration preferences, agglomeration effects, governance conditions, and broader socio-spatial dynamics (Koutský 2011; Martinez-Fernandez et al. 2012; Hospers 2013). In this perspective, industrial structure is understood as a historically embedded structural condition that interacts with broader economic and behavioral processes, rather than operating as an isolated causal

factor. The present analysis, therefore, focuses analytically on industrial structure as a key explanatory dimension, while recognizing that urban population change reflects the combined influence of multiple structural and contextual forces.

3 Data, methods, and area of the study

The study is based primarily on data from the Czech Statistical Office (CZSO), especially statistics on employment in industry and population at the city level. Historical data on industrial enterprises and employment, calculated within the administrative boundaries of cities, were drawn from the publication *Industrial Establishments of Centrally Controlled Industry in 1987* (Czech Statistical Office 1988), which utilized the so-called workplace method, i.e., the actual location (address) where production took place. It was therefore possible to identify the real number of employees in industrial enterprises in administrative borders of given cities classified according to OKEČ (Industrial Classification of Economic Activities), or CZ-NACE codes, and subsequently aggregate these by sector and space. The end of the 1980s is a very suitable time milestone for a comparative basis of the industrial transformation of the last approximately 35 years.

Current data on employment in industry and sectoral structure were obtained via e-mail consultation with experts from the Czech Statistical Office (user support department) and were complemented by additional sources, including structural industrial statistics of the Czech Statistical Office (Czech Statistical Office 2025), the Czech Top 100 database (2025), and annual reports of the largest enterprises (2023). These sources were used primarily to identify the main industrial employers located within the administrative boundaries of the analysed cities and to approximate the current scale of industrial employment using the workplace principle. Again, the workplace method was used, which eliminated the discrepancy between people employed in industry with permanent/usual residence (census data) and those commuting to work at specific enterprises within the administrative boundaries of the city. Data on time horizons are largely original, and, in conjunction with data on population development in this form, the basic research approach is unique. Additional information on changes in individual sectors and employment at the enterprise level was collected from enterprise records, national statistics, and secondary academic sources (e.g., Toušek & Kunc 1999; Kunc et al. 2023; Důbravová et al. 2024).

Data on the number of inhabitants of selected cities were drawn from official demographic statistics of the Czech Statistical Office - historical lexicon of municipalities of the Czech Republic based on a long series of censuses and ongoing statistics (years 1991, 2024).

According to the predominant main industries identified in the 1987 database, industrial employment in each city was first calculated for individual industrial branches and subsequently aggregated to construct a five-fold typology of cities. Each type is defined by the combination of the two largest sectors in terms of absolute employment. Since the typology captures the dominant sectoral pair in a given city, the same industry - most notably mechanical industry — may appear in more than one type. The five types are as follows:

- mechanical and electrical engineering industry (including precision engineering and transport equipment),
- mining and metallurgy (including metalworking),
- mechanical engineering and light consumer goods industry (textiles, clothing, footwear, food processing, etc.),
- chemical and mechanical engineering industry,
- other industry (paper, wood, glass, ceramics, porcelain, etc.).

The first industry listed in each category represents the dominant sector in that category. The use of absolute employment levels allowed consistent classification across cities, while the identification of two leading sectors rather than only one reflects the structure of industrial statistics, where large enterprises were often classified across multiple related branches (e.g., mechanical and electrical engineering industry), and it was not always possible to assign workers precisely to a single sector. This approach, therefore, captures the prevailing industrial profile of each city without relying on arbitrary percentage thresholds. The two strongest sectors always accounted for more than 50% of the employed in the industry in the given city (except of Karlovy Vary). First mentioned type of industry in given categories was more robust as for number of employees.

The repeated presence of mechanical engineering in several categories reflects its historically dominant position within the industrial structure

of Czech cities. In many cases, mechanical engineering industries formed the core of local industrial systems and were closely linked with other sectors, such as electrical, chemical, or light consumer industries, resulting in combined industrial profiles rather than clearly separated sectoral specializations.

Methodologically, the analysis combines longitudinal comparisons (late 1980s vs. present) with sectoral aggregation. To visualize the trajectories of changes in industrial employment and population in selected cities, the Webb diagram was used, which classifies cities into four quadrants according to combinations of growth and decline. To further examine the relationship between industrial activity and demographic development, Spearman's rank correlation coefficient was calculated between the industrial category of each city (converted into an ordinal ranking reflecting the technological adaptability and restructuring potential of the dominant industries in the late 1980s) and the subsequent change in population size. For the purposes of the correlation analysis, the industrial categories were ordered on an ordinal scale according to their relative capacity to adapt to post-socialist economic restructuring, ranging from sectors historically associated with lower restructuring potential (mining and metallurgy) to technologically more advanced and diversified industrial structures (engineering and electrical industries).

The categories were ranked as follows:

1. mining and metallurgy (including metalworking),
2. mechanical engineering and light consumer goods industry (textiles, clothing, footwear, food processing, etc.),
3. chemical and mechanical engineering industry,
4. other industry (paper, wood, glass, ceramics, porcelain, etc.),
5. mechanical and electrical engineering industry (including precision engineering and transport equipment).

This ranking reflects the structural characteristics of the sectors rather than the observed demographic outcomes. This approach allows the relationship between industrial legacy and demographic trajectories to be tested without incorporating population change into the construction of the ranking itself. The study also uses descriptive statistics and historical comparative analysis



Fig. 1 The largest cities in the Czech Republic by population. Source: Authors processing. Note: List of cities, sorted by population (2024): Prague, Brno, Ostrava, Pilsen, Olomouc, Liberec, České Budějovice, Hradec Králové, Pardubice, Ústí nad Labem, Zlín, Havířov, Kladno, Most, Frýdek-Místek, Opava, Jihlava, Teplice, Karviná, Karlovy Vary, Chomutov, Mladá Boleslav, Jablonec nad Nisou, Prostějov, Přerov.

of cities according to their dominant type of industry, supported by boxplot visualizations, to highlight differences in demographic development across aggregated industries.

In addition to these quantitative techniques, the interpretation of results is informed by the conceptual frameworks outlined above. Specifically, the classification of cities by industrial legacy is not only a statistical exercise but also a means of operationalizing path dependency, highlighting how inherited structures may have reinforced or constrained later options. The temporal break around 1990 is treated as a breaking juncture, allowing us to examine whether trajectories were reinforced, reoriented, or disrupted in the post-socialist transition. Finally, observed population changes are read through the lens of shrinking-cities research, which conceptualizes decline as a multi-causal and path-dependent process rather than a temporary anomaly. This conceptual anchoring strengthens the explanatory value of the empirical analysis and connects the methodological design to broader theoretical debates.

The study area is all Czech cities with more than 45,000 inhabitants in 1991. This boundary was chosen (after deeper analysis and practical consider-

ation; with one exception – Mladá Boleslav, 44000 inhabitants) to include the largest urban centers of the late socialist era, which were most exposed to industrial restructuring and its demographic consequences. In total, 26 cities met this criterion (see Fig. 1). The number of people employed in industry in selected cities in 1987 was 650000, i.e. 37% of all those employed in centrally controlled industry enterprises and 31% of all those employed in industry (comprising centrally controlled industry, uranium industry, production co-operatives, etc.). These cities represent a diverse mix of industrial legacy, from the mining and metallurgical centers of the Ostrava-Karviná coalfield (Ostrava, Karviná, Havířov) to engineering centers such as Brno and Pilsen to metropolitan centers with more diversified economies such as Prague. The inclusion of all major cities allows for a comprehensive assessment of how different industrial structures shaped post-socialist population development trajectories.

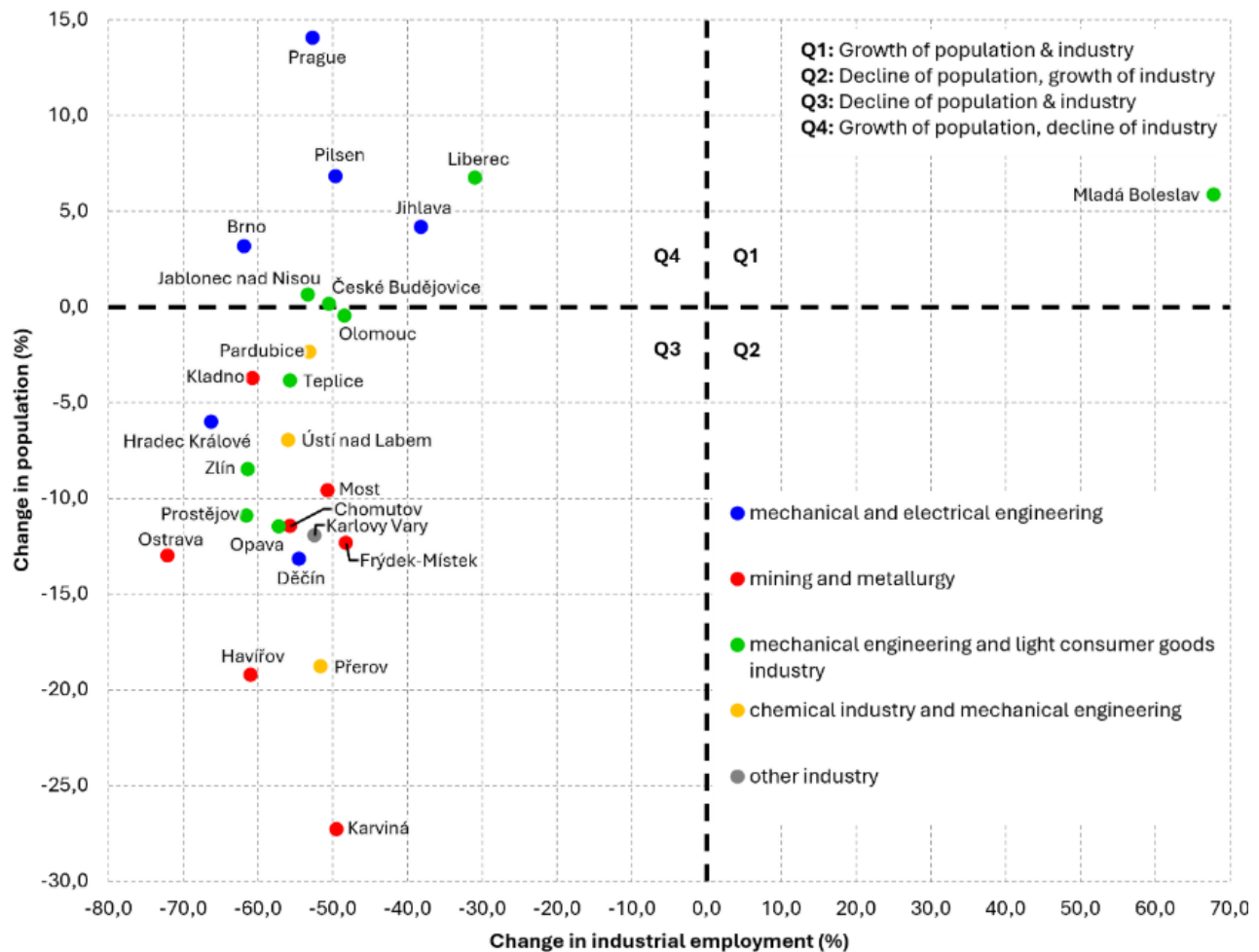


Fig. 2 The relationship between changes in population growth/decline and industrial employment in selected Czech cities in the Czech Republic (1987/1991–2024) Source: [Czech Statistical Office \(1988, 2004, 2024\)](#); Internal database of individual cities; [Czech Top 2025](#); Annual reports of companies for the year 2023; Author's editing.

4 Results

At the end of the 1980s, industry accounted for 40% of total employment in the Czech Republic, with almost 2.1 million workers (Toušek & Kunc 1999). By comparison, in 2023, there were 1.4 million people, which represented approximately 27% (almost 30% of GDP), which was still the highest figure among EU countries (Czech Statistical Office 2025). Since the 1920s, engineering has been the dominant sector (in terms of both the number of employees and production volume) of industrial production (overtaking traditional textile production), with large companies also established in black and brown coal mining, metallurgy, and the chemical industry. This sectoral structure has been completely fragmented over the past 35 years, with virtually all sectors in decline and the focus of industrial production shifting from the "centers" of large

cities to industrial zones and technology parks on the outskirts or beyond the city limits.

In the Czech Republic, industrial transformation and the associated depopulation affected most traditional industrial cities. However, some cities have been able to respond more adaptively to structural changes - they have diversified their economic base, attracted new investment, and focused on the service sector, administration, science, research, creative industries, or hi-tech manufacturing (Kunc et al. 2023; Důbravová et al. 2024). This not only stabilized their socioeconomic situation, but in many cases also led to renewed population growth, particularly in the largest Czech cities such as Prague, Brno, Pilsen or Liberec (except for the third largest city of Ostrava), which have gradually established themselves as regional or national centers of the knowledge economy, innovation and hi-tech industries. These adaptive re-

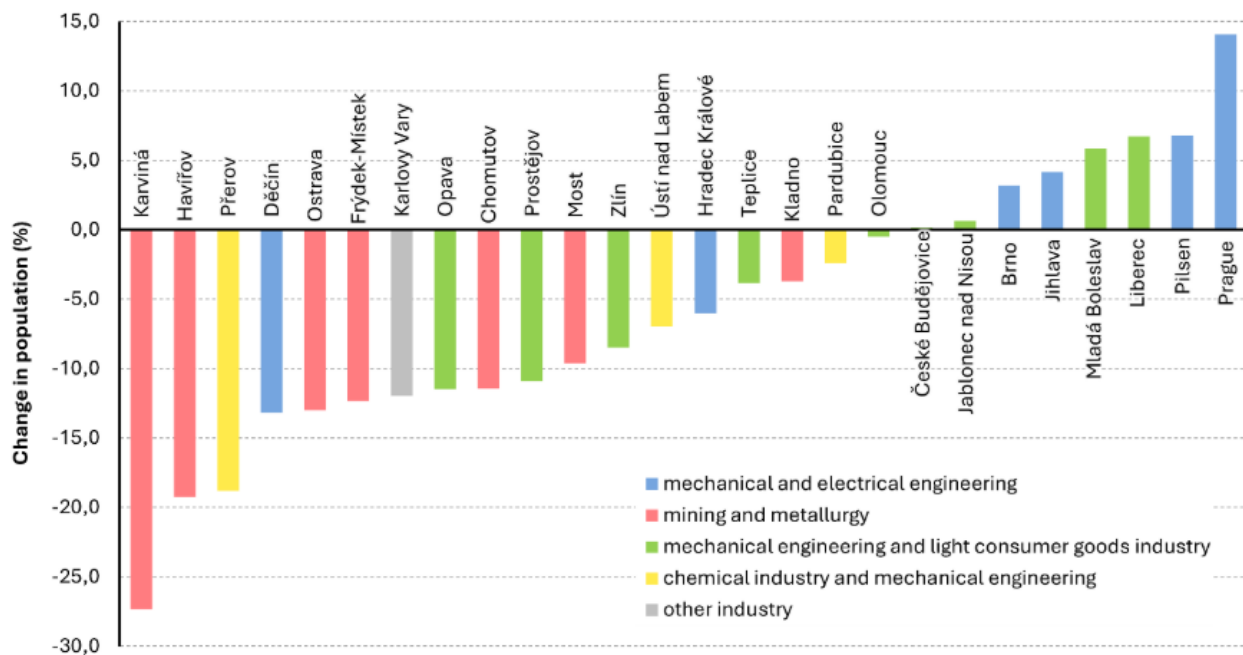


Fig. 3 Population change in selected Czech cities and their dominant category of industry (1987/1991–2024) Source: Czech Statistical Office (1988, 2004, 2024); Internal database of individual cities; Czech Top (2025); Výroční zprávy společností za rok 2023; Author's editing.

sponses illustrate the branching mechanisms highlighted in path dependency theory, where cities with a thicker base of related capabilities (e.g., precision engineering, R&D, higher education) were able to reorient their trajectories rather than remain trapped in decline.

Fig. 2 (Webb's diagram) divides 26 largest cities in the Czech Republic into four quadrants according to the kind of development they have experienced. In the case of the Czech Republic, the quadrant contains only one city, Mladá Boleslav. The city of Mladá Boleslav can be considered a unique case in the Czech Republic thanks to the automotive industry and its large employer, Škoda Auto. The city has a favorable geographical location near Prague and has also seen significant population growth in recent years. Škoda Auto is a strong attractor for domestic and foreign workers (typically from Slovakia, Ukraine, and Poland), among other things, due to above-standard earnings. Such trajectories are typically observed in globally competitive manufacturing centers integrated into international production networks.

Quadrant Q2 includes cities with industrial growth and population decline but remains empty in our analysis. Most cities are concentrated in quadrant Q3, with the worst parameters (a large decline in employment in industry and population decline) being shown by cities focused on coal min-

ing, metallurgy and metalworking, typically cities in the Ostrava agglomeration (Ostrava, Havířov, Karviná), in northwestern Bohemia Ústí nad Labem, Most and Chomutov or Kladno in Central Bohemia, as well as cities primarily focused on chemical production (Přerov, Ústí nad Labem, Pardubice). Quadrant Q4 represents cities where population growth occurred despite the decline in industry.

Quadrant Q4 represents cities where population growth has occurred despite a decline in industry. Successful deindustrialization and economic transformation concern primarily the two largest, most attractive cities in the Czech Republic in terms of investment and residence, Prague and Brno. Along with Pilsen and Jihlava, these cities were typical of strong mechanical and electrical engineering industry. Other successful cities include Liberec, Jablonec nad Nisou, České Budějovice, and, with the Q3 quadrant, the bordering Olomouc, which were profiled in mechanical engineering and light consumer goods industry. The reasons for the successful economic transformation, a balanced or growing population while maintaining a still relatively strong position of industry can be found in the advantageous geographical location near not only Prague (the economically strongest north-south axis in the Czech Republic - the agglomeration of Liberec and Jablonec nad Nisou - Mladá Boleslav - Prague - Tábor - České Budějovice)

with a turn to the west (Pilsen) and the location on the busiest D1 highway Prague – Brno (Jihlava), but also in the overall attractiveness of these cities for investors and residents.

This quadrant structure reflects both the reinforcing and disruptive aspects of post-socialist restructuring: in some cases, inherited lock-ins amplified demographic shrinkage (Q3), while in others, critical junctures created space for renewal despite industrial decline (Q4). In addition to the dominant industrial specialization, the broader diversity of local industrial structures may also have influenced the capacity of cities to adapt to post-socialist restructuring, as more diversified economic bases generally provide greater resilience to structural shocks.

To further specify the relationship between industry branches and urban population, industrial employment was aggregated into five categories, according to (i) the most frequent occurrence and (ii) the sectoral similarity of sub-sectors with the link between individual cities and aggregated industrial sectors. This analysis makes it easier to see which type of industry dominated the cities with the most shrinking population, and, on the contrary, which industrial branches stimulated population balance or even growth. As can be seen in Fig. 3, and as confirmed by Fig. 2, the largest decline in population occurred in cities where mining, metallurgy, and metalworking were concentrated. Out of the five most depopulating cities in this category of predominant industry, only one of the cities lies outside the Moravian-Silesian region (Chomutov – brown coal mining prevailing). The relationship between changes in population growth/decline and industrial employment in selected Czech cities in the Czech Republic (1987/1991–2024). The four remaining cities – Karviná, Havířov, Frýdek-Místek, and Ostrava – represent the Upper Silesian coal basin of the Ostrava-Karviná area in the northeastern part of the Czech Republic. The transformation of the economy in these “coal regions” led to massive layoffs, a decline in job opportunities, and a decline in the attractiveness of these locations, which led to an outflow of residents, especially younger and more educated ones. In addition, the urban and environmental burdens of the past have hampered a faster transition to a new economy and the overall revitalization of the region.

The population decline in other cities is linked to the crisis in traditional industries, such as light consumer goods (e.g. textiles, clothing, footwear, food processing), which lost their competitiveness after 1990 due to globalization, privatization, and the collapse of previously protected mar-

kets. Combined with the mechanical engineering sub-sectors that also faced declining demand and restructuring, this led to substantial job losses and a related outflow of population. A similar development affected cities with a predominant chemical and mechanical engineering industry, where environmental burdens, a weaker investment climate, and a less favorable image further reduced their attractiveness.

Unlike mining and metallurgical centers, however, other cities did not experience a collapse of the same magnitude; their trajectories were typically characterized by gradual erosion rather than sudden decline. In the case of Karlovy Vary, the only one designated as “other industry” (population decrease of approximately 12%), additional factors played a role: despite its both economic and industrial diversity and importance as the largest spa center in the Czech Republic, the city did not maintain a sufficient base of stable employment outside the tourism sector, contributing to a gradual but persistent population decline. Other industrial categories thus reveal more nuanced patterns of adjustment, moderate decline, or relative stagnation rather than a simple polarization between growth and shrinkage.

Cities with a positive population change balance are depicted on the right side of the graph, and all fall into the aggregate industrial category of mechanical and electrical engineering. It is important to mention that this category also includes employment in transportation and precision engineering, which was important for all cities in the “positive” part of the graph (Fig. 3).

Finally, Spearman’s correlation was performed between the ordinal ranking of industrial categories (reflecting the technological adaptability of dominant industries in the late 1980s) and the actual change in population, where ρ (rho) = 0.44 and p -value = 0.025. This result indicates a weak to moderately strong positive association between industrial structure and population development at the 0.05 significant level. In other words, cities whose dominant industrial sectors were historically more technologically advanced and adaptable tended to experience more favorable demographic trajectories. The population change in cities according to the individual industrial groups is depicted in Figure 4. A comparison of industrial categories in the box plot shows that cities focusing on mechanical and electrical engineering industry generally performed best in terms of population stability (median slightly above 0), although with considerable variation between individual cases. Cities with a dominant chemical industry and mechanical en-

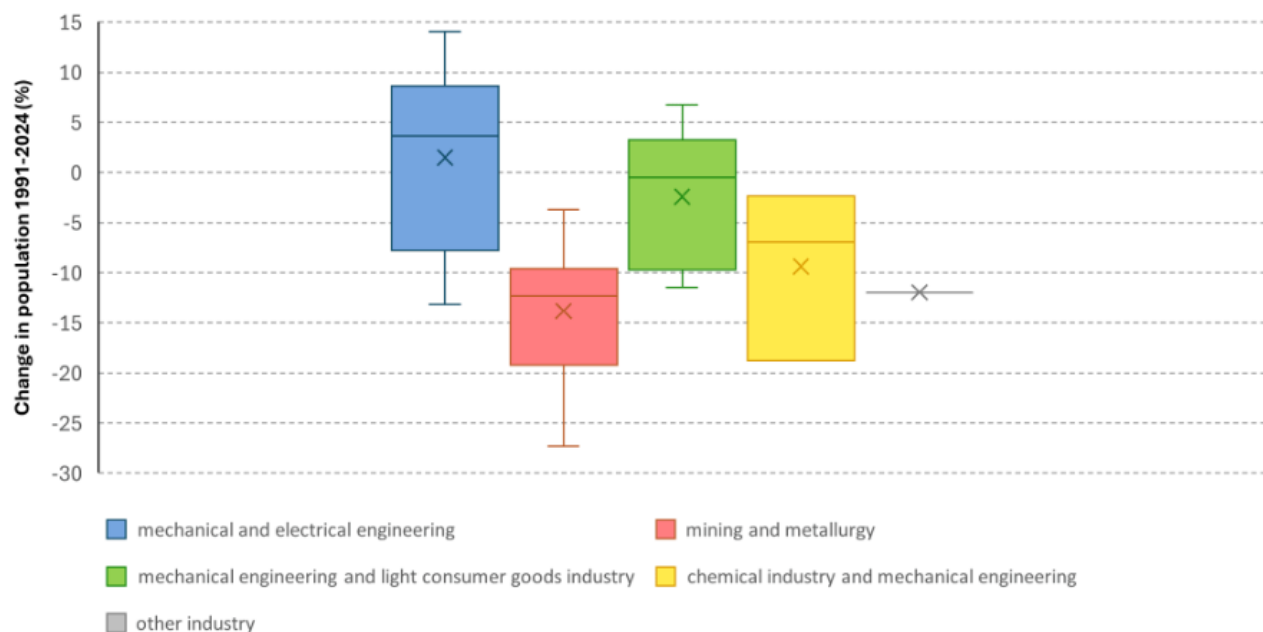


Fig. 4 Correlation between the predominant industry category and changes in population in selected Czech cities (1987/1991–2024) Source: [Czech Statistical Office \(1988, 2004, 2024\)](#); Internal database of individual cities; [Czech Top \(2025\)](#); Výroční zprávy společností za rok 2023; Author's editing.

gineering showed more moderate declines but still a negative trend, while cities classified in the “other industry” category (in the Czech Republic represented only by Karlovy Vary) displayed heterogeneous trajectories characterized by stagnation or only moderate decline. In several cases, the presence of technologically advanced segments mitigated demographic loss; however, the limited diversification of the overall urban economy prevented a shift towards sustained growth. A significant population decline affected cities focused on mechanical engineering and light consumer goods industry, while cities specializing in mining and metallurgy experienced the most pronounced population decline, with a median decline of almost 15%.

These results suggest that industrial legacies operate as a path-dependent mechanism: cities historically embedded in globally relevant and adaptable sectors demonstrated greater resilience, whereas those locked into declining heavy industries became archetypal shrinking cities. It should also be noted that the most recent population figures partly reflect the temporary demographic impact since 2022 inflow of Ukrainian refugees, which has increased the population of several major Czech cities, particularly Prague and Brno.

5 Discussion and conclusions

The findings suggest that long-term industrial specialization has played a significant role in shaping the demographic trajectories of Czech large cities after 1990. Urban centers historically tied to extractive and heavy industrial activities proved particularly vulnerable to post-socialist restructuring, as the transition to a market economy exposed structural rigidities and limited their capacity for rapid economic adaptation. These structural constraints were particularly evident in the traditional industrial belt of the Moravian-Silesian Region, where inherited production structures, environmental burdens, and weaker diversification potential combined to reinforce long-term demographic decline ([Koutský 2011](#); [Koutský et al. 2025](#)). The differentiated trajectories observed across industrial categories indicate that the depth of demographic loss was closely related to the adaptability of inherited economic structures. Cities associated with mining, metallurgy, and related heavy industries experienced the most pronounced population decline, reflecting cumulative processes of job contraction, selective out-migration, and declining locational attractiveness ([Bosák et al. 2018](#); [Rink et al. 2022](#)). Rather than representing short-term fluctuations, these developments illustrate how historically embedded industrial specialization can gener-

ate persistent demographic effects, reinforcing cycles of shrinkage where restructuring has remained incomplete or insufficiently diversified.

A contrasting trajectory can be observed in cities whose economic base was historically linked to more adaptable branches of mechanical and electrical engineering industries. In these cases, inherited industrial capabilities provided a foundation for diversification into higher value-added activities, advanced services, and innovation-oriented sectors. Metropolitan advantages, institutional capacity, and stronger integration into global production and knowledge networks enabled these cities to stabilize or even increase their populations. Such developments illustrate processes of industrial branching and adaptive restructuring, in which related capabilities supported a gradual reorientation of local economic structures rather than a prolonged phase of decline. In addition to dominant industrial specialization, the broader diversity of local economic activities may also influence the capacity of cities to adapt to structural change. Research on regional resilience suggests that diversified but technologically related industrial structures can facilitate processes of economic adjustment and industrial branching, as knowledge and capabilities can be recombined across sectors (Frenken et al. 2007; Boschma 2015). In this sense, cities whose industrial bases combined advanced engineering with related technological activities may have benefited from a wider portfolio of capabilities during the post-socialist transformation.

The statistical analysis confirms a significant relationship between industrial structure and demographic development: cities characterized by technologically more adaptable and globally embedded industrial profiles were more likely to maintain stable or growing populations. At the same time, the observed trajectories reflect the interaction of industrial restructuring with other demographic and spatial processes, including suburbanization dynamics, selective migration preferences, and the growing agglomeration advantages of the largest metropolitan centers. In several cases, population decline in core industrial cities has been accompanied by residential redistribution within metropolitan regions, while more diversified urban economies have benefited from their capacity to attract and retain skilled labor. Institutional readiness, geographical position, accessibility, and the capacity to attract investment and skilled labor have also played an important role in shaping the uneven outcomes of post-socialist urban transformation.

Looking ahead, the population and economic trajectories of Czech cities are likely to remain differentiated. Cities that have struggled to reorient their economic base continue to face risks of demographic decline, labor outflow, and socio-spatial marginalization. The findings suggest that strategies aimed at stabilizing these cities cannot rely solely on economic restructuring. In cities historically dependent on declining heavy industries, policy responses may need to focus on diversifying local economic structures, strengthening links to knowledge-intensive activities, and improving residential attractiveness in order to retain and attract population. At the same time, broader factors influencing mobility patterns and the retention of human capital remain crucial for shaping future demographic trajectories. Policy responses in these regions may therefore focus not only on economic regeneration but also on enhancing quality of life, improving educational opportunities, and fostering regional connectivity. Conversely, dynamically growing metropolitan areas will confront different challenges, including housing affordability, sustainable mobility, and increasing spatial inequalities, which require proactive and coordinated planning approaches.

More broadly, the Czech experience underscores the long-term impact of inherited industrial structures on shaping urban development paths. While structural legacies remain influential, their effects are mediated by institutional capacity, policy choices, and the ability of cities to adapt to changing economic conditions. The trajectories observed since 1990 thus reflect not only the weight of the industrial past but also the varying capacity of cities to respond to new economic and demographic realities.

In conclusion, the industrial past continues to shape the demographic and economic landscape of Czech cities in distinct and uneven ways. The analysis demonstrates that the capacity of cities to adapt to structural economic change has been closely linked to the adaptability of their inherited industrial base and to their ability to integrate into broader metropolitan and innovation systems. The success of future urban development will depend on the ability to combine structural economic change with well-targeted public policies reflecting both historical context and emerging challenges related to technological transformation, sustainability, and demographic change. The trajectories analyzed in this study therefore represent not only statistical patterns of growth and decline, but also long-term processes of urban adaptation whose relevance extends beyond the Czech case.

The analysis is conducted at the level of administrative city boundaries, which represent the smallest spatial units for which consistent historical and contemporary data on population and industrial employment were available. We are aware that this spatial definition has certain limitations. In some cases, important industrial employers associated with a given city may be located outside its administrative borders, particularly in suburban industrial zones that have more intensively developed since the end of the 1990s. Similarly, part of the recorded population decline in core cities may reflect suburbanization processes and residential redistribution within their surrounding hinterlands. Nevertheless, large cities historically represented the main centers of industrial employment and economic activity in the Czech urban system, and a substantial share of industrial jobs was concentrated within their administrative territories. The use of cities as analytical units, therefore, allows a consistent long-term comparison of industrial and demographic trajectories. Analyses based on broader functional urban regions (e.g., districts or administrative units such as SO ORPs) would represent a valuable extension of this research but would require a different methodological design and are beyond the scope of the present study.

Another limitation concerns the reconstruction of contemporary sectoral structures at the city level. Due to changes in statistical classifications, increasing sectoral fragmentation, and limited availability of workplace-based employment data, the study focuses primarily on the industrial structure of the late 1980s as the key reference point and uses current data mainly to illustrate the overall scale of industrial decline. Another potential factor influencing development of urban trajectories is the original diversity of industrial activities. While the present study focuses on dominant industrial sectors as indicators of industrial legacy, future research could explore more explicitly how sectoral diversity shaped the resilience of cities during the transformation period.

A specific external factor influencing the most recent population data is the inflow of refugees from Ukraine after 2022. According to official statistics, approximately 400,000 persons with temporary protection have been registered in the Czech Republic, with the largest concentrations in major urban centers such as Prague and Brno. This exceptional migration wave temporarily increased the number of residents in several cities and partly contributed to the short-term population growth observed in the most recent years of the analyzed period (2022–2024). However, this influx repre-

sents an external demographic shock rather than a structural process related to the long-term industrial transformation analyzed in this study.

Acknowledgement

This work was supported by Masaryk University in Brno under project No. MUNI/A/1458/2023 Former Industrial and Mining Cities: Urban Development Issues and Future Prospects.

References

- Arthur W, (1989), Competing technologies, increasing returns, and lock-in by historical events. *The Economic Journal*, 99, (394):116–131.
- Arthur W, (1994), *Increasing Returns and Path Dependence in the Economy*. The University of Michigan Press, Michigan.
- Blažek J, Květoň V, Baumgartinger-Seiringer S, Tripl M, (2020), The dark side of regional industrial path development: towards a typology of trajectories of decline. *European Planning Studies*, 28, (8):1455–1473.
- Bleha B, Buček J, (2024), Depopulation differences in Slovak former mining cities. The role of geographical conditions and local interventions. *Papers in Applied Geography*, 10, (1):34–52.
- Bontje M, (2024), Multiscalar governance of shrinkage in the Netherlands: Past, present... future? *Urban Planning*, 9:7972.
- Boschma R, (2015), Towards an Evolutionary Perspective on Regional Resilience. *Regional Studies*, 49, (5):733–751.
- Boschma R, Frenken K, (2011), Technological relatedness, related variety and economic geography. In: Cook P, (ed.) *Handbook of Regional Innovation and Growth*. Edward Elgar Publishing Cheltenham.
- Bosák V, Nováček A, Slach O, (2018), Industrial culture as an asset, barrier and creative challenge for restructuring of old industrial cities: case study of Ostrava (Czechia). *GeoScape*, 12, 1:52–64.
- Brezdeň P, Szmytkie R, (2019), Current changes in the location of industry in the suburban zone of a post-socialist city. Case study of Wrocław (Poland). *Tijdschrift voor Economische en Sociale Geografie*, 110, (2):102–122.
- Buček J, Bleha B, (2013), Urban Shrinkage as a Challenge to Local Development Planning in Slovakia. *Moravian Geographical Reports*, 21, (1):2–15.
- Clark E, Soulsby A, (1999), *Organizational Change in Post-Communist Europe: Management and Transformation in the Czech Republic*. Routledge. ISBN 0-415-20333-3.
- Cudny W, Kunc J, (2022), *Growth and Change in Post-socialist Cities of Central Europe*. Routledge, London.
- Czech Statistical Office, (1988), Průmyslové provozovny ústředně řízeného průmyslu v roce 1987.
- Czech Statistical Office, (2004), Historický lexikon obcí České republiky - 1869 - 2005. Available at: <https://csu.gov.cz/produkty/historicky-lexikon-obci-ceske-republiky-2001-877ljn6lu9>.
- Czech Statistical Office, (2024), Počet obyvatel v obcích - k 1. 1. 2024. Available at: <https://csu.gov.cz/produkty/pocet-obyvatel-v-obcich-9vln2prayv>.

- Czech Statistical Office, (2025), Roční (strukturální) statistiky průmyslu. Available at: <https://csu.gov.cz/prumysl>.
- Czech Top, (2025), Czech Top 100. Available at: <https://www.czechtop100.cz/>.
- Důbravová K, Kunc J, Neumannová M, (2024), Glory and Decline of Former European Textile Industry Leaders and Subsequent Changes Reflected in Population and Social Development: The Comparison of Manchester, Łódź and Brno. *Geografický Časopis*, 76, (4):377–398.
- Frenken K, Oort F, Verburg T, (2007), Related Variety, Unrelated Variety and Regional Economic Growth. *Regional Studies*, 41, (5):685–697.
- Grabher G, (1993), *Embedded Firm: On the Socio-economics of Industrial Networks*. Routledge, London.
- Grillitsch M, Sotarauta M, (2019), Trinity of change agency, regional development paths and opportunity spaces. *Progress in Human Geography*, 44, (4):704–723. ISSN 1477-0288. doi: 10.1177/0309132519853870.
- Haase A, Rink D, Grossmann K, Bernt M, Mykhnenko V, (2014), Conceptualizing urban shrinkage. *Environment and Planning A*, 46, (7):1519–1534.
- Haase A, Rink D, Großmann K, (2016), Shrinking Cities In Post-Socialist Europe: What Can We Learn From Their Analysis For Theory Building Today? *Geografiska Annaler. Series B, Human Geography*, 98, (4):305–319.
- Hassink R, (2010), Regional resilience: A promising concept? *Erdkunde*, 64, (1):5–13.
- Hassink R, Isaksen A, Trippel M, (2019), Towards a comprehensive understanding of new regional industrial path development. *Regional Studies*, 53, (11):1636–1645. ISSN 1360-0591. doi: 10.1080/00343404.2019.1566704.
- Hospers GJ, (2013), Coping with shrinkage in Europe's cities and towns. *Urban Design International*, 18:78–89.
- Isaksen A, (2014), Industrial development in thin regions: trapped in path extension? *Journal of Economic Geography*, 15, (3):585–600. ISSN 1468-2710. doi: 10.1093/jeg/lbu026.
- Isaksen A, Tödtling F, Trippel M, (2018). In: *Innovation Policies for Regional Structural Change: Combining Actor-Based and System-Based Strategies*. Springer International Publishing, pp. 221–238. ISBN 9783319716619. doi: 10.1007/978-3-319-71661-9_11.
- Ivánek L, (1994), Československý zbrojní průmysl v období socialismu. *Hospodářské dějiny*, 12, (2):45–68.
- Khavarian-Garmsir A, (2023), A systematic review of shrinking cities literature: lessons from the past and directions for the future. *International Planning Studies*, 28, (3-4):219–238.
- Koutský J, (2011), *Staré průmyslové regiony - vývojové tendence, možnosti rozvoje*. Univerzita J.E. Purkyně, Ústí nad Labem.
- Koutský J, Novák V, Holub J, (2025), The role of the automotive industry in the economic transformation and reindustrialisation of old industrial regions (a case study of Czechia. *Geoscape*, 19, (1):1–11.
- Kovács Z, (1999), Cities from state-socialism to global capitalism: an introduction. *GeoJournal*, 49, (1):1–6.
- Kraker J, Scholl C, Bontje M, (2024), Urban Shrinkage, Degrowth, and Sustainability: An Updated Research Agenda. *Urban Planning*, 9:8815.
- Krzysztofik R, Tkocz M, Spórna T, Kantor-Pietraga I, (2016), Some dilemmas of post-industrialism in a region of traditional industry: The case of the Katowice conurbation, Poland. *Moravian Geographical Reports*, 24, (1):42–54.
- Kunc J, Sikorski D, Novotná M, Brezdeň P, Ililnický D, Tonev P, Marek A, (2023), Industrial legacy towards modern urban environment: A comparative study of Wrocław and Brno. *Bulletin of Geography. Socio-economic Series*, 61:71–92.
- Květoň V, Blažek J, (2018), Path-development trajectories and barriers perceived by stakeholders in two Central European less developed regions: narrow or broad choice? *European Planning Studies*, 26, (10):2058–2077.
- MacKinnon D, Dawley S, Pike A, Cumbers A, (2019), Rethinking Path Creation: A Geographical Political Economy Approach. *Economic Geography*, 95, (2):113–135. ISSN 1944-8287. doi: 10.1080/00130095.2018.1498294.
- Mallach A, Haase A, Hattori K, (2017), The shrinking city in comparative perspective: Contrasting dynamics and responses to urban shrinkage. *Cities*, 69:102–118.
- Martin R, Sunley P, (2006), Path dependence and regional economic evolution. *Journal of Economic Geography*, 6, (4):395–437.
- Martinez-Fernandez C, Audirac I, Fol S, Cunningham-Sabot E, (2012), Shrinking Cities: Urban Challenges of Globalization. *International Journal of Urban and Regional Research*, 36:213–225.
- Peng MW, Heath PS, (1996), The Growth of the Firm in Planned Economies in Transition: Institutions, Organizations, and Strategic Choice. *The Academy of Management Review*, 21, (2):492. ISSN 0363-7425. doi: 10.2307/258670.
- Puffert DJ, (2002), Path Dependence in Spatial Networks: The Standardization of Railway Track Gauge. *Explorations in Economic History*, 39, (3):282–314. ISSN 0014-4983. doi: 10.1006/exeh.2002.0786.
- Rink D, Haase A, Bernt M, Großmann K, Couch C, (2012), From long-term shrinkage to re-growth? The urban development trajectories of Liverpool and Leipzig. *Built Environment*, 38, (2):162–178.
- Rink D, Bontje M, Haase A, Kabisch S, Wolff M, (2022), Challenges and problems of re-growth: the case of Leipzig (Eastern Germany). In: Cudny W, Kunc J, (eds.) *Growth and Change in Post-socialist Cities of Central Europe*. RoutledgeLondon,, pp. 158–177,.
- Rumpel P, Slach O, (2014), Shrinking cities in Central Europe. In: Koutský J, Raška J, Dostál P, Herrschel P, (eds.) *Transitions In Regional Science - Regions In Transitions: Regional Research In Central Europe*. Wolters KluwerPrague,, pp. 142–155.
- Rumpel P, Slach O, Koutský J, (2013), Shrinking Cities and Governance of Economic Regeneration: The Case of Ostrava. *E+M. Economics and Management*, 11, (2):113–127.
- Sikorski D, Kryczka P, (2023), Deconcentration of Industrial Activity as a Constituent of Sustainable Urban Development in a Post-Socialist City: A Case Study of Wrocław, Poland. *Sustainability*, 15, (20):14980.
- Slach O, Koutský J, Novotný J, Ženka J, (2013), Creative industries In the Czech republic: a spatial perspective. *E+M. Economics and Management*, 4:14–29.

- Sonn JW, Lee D, (2012), Revisiting the branch plant syndrome: Review of literature on foreign direct investment and regional development in Western advanced economies. *International Journal of Urban Sciences*, 16, (3):243–259. ISSN 2161-6779. doi: 10.1080/12265934.2012.733589.
- Stanilov K, (ed.), (2007), *The Post-Socialist City. Urban Form and Space Transformations in Central and Eastern Europe after Socialism*. Springer, Dordrecht.
- Steinführer A, Bierzynski A, Großmann K, Haase A, Kabisch S, Klusáček P, (2010), Population Decline in Polish and Czech Cities during Post-socialism? Looking Behind the Official Statistics. *Urban Studies*, 47, (11):2325–2346.
- Sýkora L, Bouzarovski S, (2012), Multiple transformations: Conceptualising the post-communist urban transition. *Urban Studies*, 49, (1):43–60.
- Toušek V, Kunc J, (1999), Průmyslová výroba a strategie rozvoje krajů v České republice. In: *Sborník referátů z II. mezinárodního kolokvia o regionálních vědách*. Masarykova Univerzita Brno, pp. 39–65.
- Turok I, Mykhnenko V, (2007), The trajectories of European cities, 1960–2005. *Cities*, 24, (3):165–182.
- Uhlenbruck K, Meyer KE, Hitt MA, (2003), Organizational Transformation in Transition Economies: Resource-based and Organizational Learning Perspectives. *Journal of Management Studies*, 40, (2):257–282. ISSN 1467-6486. doi: 10.1111/1467-6486.00340.
- Šerý O, Svobodová H, Šilhan Z, Szczyrba Z, (2018), Shrinking of Cities in the Czech Republic and its Reflection on Society: Case Study of Karvina City. *Geographica Pannonica*, 22, (1): 68–80.
- Ženka J, Pavlínek P, (2013), The Czech automotive industry in global production networks: regional dimensions of upgrading between 1998 and 2008. *Geografie*, 118, (2):116–137. ISSN 2571-421X. doi: 10.37040/geografie2013118020116.
- Židek L, (2017), *From Central Planning to the Market: Transformation of the Czech Economy 1989–2004*. Central European University Press, Budapest.