

Comparative Analysis of Urban Core: Buffalo and Pittsburgh, the Relationship Between Urban Spatial Change and Economic Restructuring

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Abstract. Driven by China's "Dual Carbon" targets—peaking carbon emissions by 2030 and achieving carbon neutrality by 2060—Chinese firms are simultaneously confronting pressures from carbon compliance and digital investment. How to synergistically advance green and digital transformations, a challenge now widely termed the "Twin Transition," has become a frontier issue in management research. However, the interplay between these two types of pressure and the organizational capabilities required to navigate them remain insufficiently understood. Drawing on Institutional Theory and Dynamic Capabilities Theory, this paper proposes an integrative conceptual model. Its core propositions are that carbon governance pressure drives firms toward an integrated twin transition strategy; organizational resilience mediates the relationship between this strategy and performance outcomes; and entrepreneurial orientation moderates firms' ability to capitalize on opportunities arising from the transition. Unlike prior studies that treat sustainability and digitalization as parallel strategic tracks, this framework conceptualizes them as structurally coupled and co-evolutionary, rather than as a simple dual agenda. Finally, the paper discusses the implications of this framework for research design and management practice in emerging economy contexts.

Keywords: Economic restructuring, Urban spatial change, Topography, Deindustrialization, Service-based economy

1. Introduction

The aim of this study is to examine Buffalo's and Pittsburgh's economic development from 1990 to 2010 and its relationship to urban spatial change and economic restructuring. Through this analysis, This article analyzes the impact of economic restructuring on employment distribution and urban form in these two cities. Buffalo is in Erie County, New York State, Pittsburgh is in Allegheny County, Pennsylvania. Both cities are situated in the Rust Belt region of the northeastern and midwestern United States. Two cities share similar historical development patterns, Buffalo was founded in 1808, and Pittsburgh was founded in 1758. In terms of size, Buffalo covers 52.48 sq mi (135.92 km²), while Pittsburgh covers 58.35 sq mi (151.12 km²). The populations of the two cities are also similar, with Buffalo having a population of 278,349 and Pittsburgh having a population of

302,971. However, their GDPs differ significantly. Based on Federal Reserve Bank data, Buffalo's GDP was \$90.716 billion in 2023, while Pittsburgh's GDP was \$159.6 billion in 2023. Both cities experienced rapid industrial growth during the late nineteenth and early twentieth centuries, driven primarily by manufacturing industries. Due to their deindustrialization, however, both cities experienced significant economic decline. In response, both cities attempted to transition from manufacturing-based economies to service-based economies, particularly in sectors such as education and healthcare. Because the geographic characteristics of the two cities differ greatly, it is interesting to examine whether these geographic differences have affected their spatial development patterns over time. In this study, This article utilizes three primary datasets: NHGIS Census data (1990, 2000, and 2010–2014) for employment disaggregated by industry, NLCD land-cover data for urban expansion, and USGS DEM data for topographic analysis.

Buffalo is on the Erie/Ontario Lake Plain of the Eastern Great Lakes Lowlands, a narrow plain extending east to Utica, New York. (ACME) Pittsburgh downtown area sits where the Allegheny River flows from the northeast and the Monongahela River from the southeast to form the Ohio River. Many Pittsburgh neighborhoods are steeply sloped with two-lane roads. More than a quarter of neighborhood names make reference to "hills", "heights", or similar features. (Lowry) Their geographical differences provide a useful basis for our comparative analysis of their economic development patterns and the relationship to their urban form. Our analysis includes calculations of industry proportions in the manufacturing and education and medical sectors, employment density mapping, land cover change analysis, and slope analysis to evaluate terrain constraints on the development of both cities. This study addresses the following questions: How does industrial restructuring change employment patterns in Buffalo and Pittsburgh? How are these changes reflected in their urban spatial structure? And to what extent does topography influence their urban development patterns? The objective of this research is to link economic transformation with spatial outcomes and to explain the differences between the two cities [1].

2. Data and methods

This study utilized multiple datasets to explore the relationship between economic restructuring and urban spatial change. The employment data is sourced from the NHGIS population census datasets of 1990, 2000, and 2010-2014 and the data granularity is at the census area level. This article calculates the proportion of employment in manufacturing, education, and healthcare using these data.

The calculation method of employment ratio is to divide the number of employed people in each industry by the total employed population in each census area. This method standardizes comparisons between different time periods and between two cities.

To analyze the spatial pattern, An employment density map visually displays the distribution of employment positions across each research area.

The analysis of land cover change adopts the National Land Cover Database (NLCD) and focus on the expansion of development land between 1990 and 2010.

The terrain conditions were evaluated using the Digital Elevation Model (DEM) data from the United States Geological Survey (USGS). Through slope analysis, the terrain is divided into three categories based on development suitability: gentle slopes (0-5 degrees), moderate slopes (5-15 degrees), and steep slopes (greater than 15 degrees).

These methods provide a comprehensive framework for linking economic transformation with spatial and physical constraints on urban development.

3. Industry structure

3.1. Industry structure in 1990

Before 1990, Pittsburgh was known as the "Steel City," producing half of the nation's steel by 1911. However, the city faced economic collapse during the 1970s and 1980s. The decline of the steel manufacturing industry caused massive layoffs, with approximately 150,000 workers losing their jobs and the population declining from 675,000 in 1950 to 370,000 by 1990. Because of World War II, Pittsburgh dominated steel production in the United States. After the war, however, the city experienced the collapse of its manufacturing sector, with more than 75% of its steel-making capacity shutting down. This contributed to an unemployment rate of 18.3% during the 1980s. During the 1950s through the 1970s, Pittsburgh focused on developing major infrastructure projects, including Gateway Center, Civic Arena, and Three Rivers Stadium. In the late 1980s, the city-initiated redevelopment efforts by shifting its economy from steel manufacturing to healthcare and education. The healthcare workforce doubled between 1970 and 1990 [2].

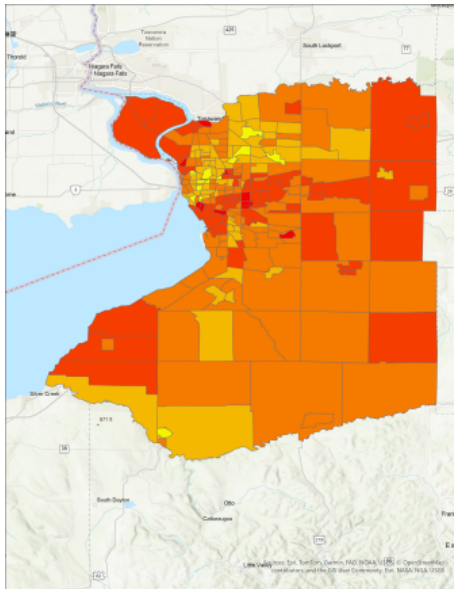


Figure 1. Industrial economic foundation dominated by Buffalo manufacturing (1990)

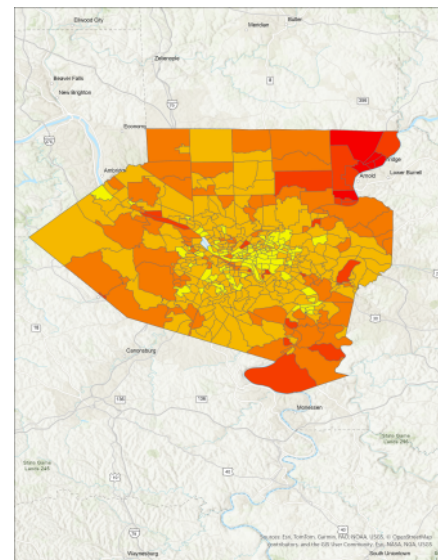


Figure 2. Pittsburgh's manufacturing-dominated industrial economy base (1990)

During the same period, Buffalo was shifting from a prolonged period of manufacturing industrial decline to a period of economic stabilization and diversification. Like Pittsburgh, Buffalo's economy was shifting from manufacturing industries to medical and service sectors. In 1999, the city began to develop its downtown and waterfront properties. Due to the decline of the manufacturing industry, Buffalo's population continued to decrease as part of a long-term trend of deindustrialization and suburbanization [3].

Both Buffalo and Pittsburgh demonstrated a strong dependence on manufacturing industries before 1990. Manufacturing employment was widely distributed across both cities, and its spatial distribution exhibited a dispersed pattern that reflected the nature of their industrial production. This study uses this period as the baseline for examining the major economic restructuring that occurred in both cities. One major difference between the two cities was their urban spatial growth patterns. Pittsburgh grew outward from the city center, while Buffalo experienced suburban growth.

Comparing the geographic characteristics of both cities, This topographic contrast—hills surrounding Pittsburgh versus flat terrain in Buffalo—has been a major factor shaping the urban spatial growth patterns of the two cities.

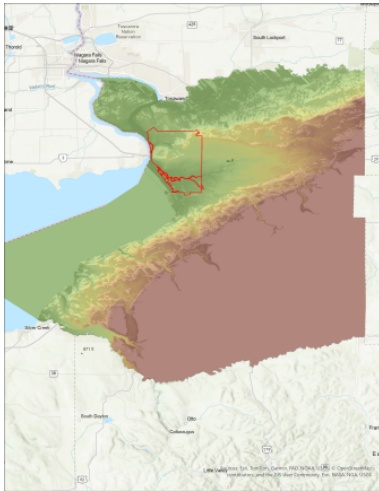


Figure 3. Geographic features of Buffalo

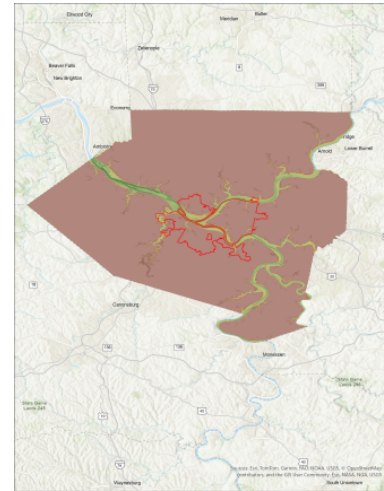


Figure 4. Geographic features of Pittsburgh

3.2. Industry structure in 2000

Starting in 2000, Buffalo and Pittsburgh began to show signs of economic transition. This was a critical period for Pittsburgh, as the city was transitioning away from the heavy steel manufacturing industry toward an economy driven by technology, healthcare, and education. Key developments included the continued transformation of brownfield sites into technology hubs, the revitalization of urban areas, and the initiation of major infrastructure projects such as the convention center. The Pittsburgh Technology Center served as a prime example of repurposing former J&L coke works into a high-tech hub, with 2000 Technology Drive being developed during the mid-to-late 1990s (Pittsburgh Technology Center Community and History). The city continued shifting its economy from steel manufacturing to the education, finance, and medical sectors. Pittsburgh also launched the "Pittsburgh Shines" tourism campaign to improve its image. Despite the development of new industries, however, the city's population continued to decline slowly, dropping to approximately 335,000 by 2000, representing a significant postwar population reduction.

In 2000, Buffalo was transitioning from a manufacturing-based economy (primarily steel and grain industries) into a post-industrial economy. The city began shifting toward education, healthcare, and service industries. Following the high unemployment of the 1990s, more than 17,000 jobs were lost between 2006 and 2010. At the same time, the city's focus on the education and medical sectors began to take shape through major developments such as the Buffalo Niagara Medical Campus. The city's waterfront redevelopment also continued. Previously dominated by manufacturing industries, the waterfront had become largely vacant due to industrial decline. During this period, it experienced its first major reinvestment initiatives, transitioning from industrial use to recreational, cultural, and commercial development. As the city underwent economic transition, it continued to experience the effects of the "Great Exodus," including population loss, the decline of its manufacturing base, and the dispersion of the urban population toward suburban areas. Both Pittsburgh and Buffalo experienced population loss in their city centers during the economic

redevelopment of the 2000s. However, due to their different geographic characteristics, suburban dispersion was easier in Buffalo than in Pittsburgh.

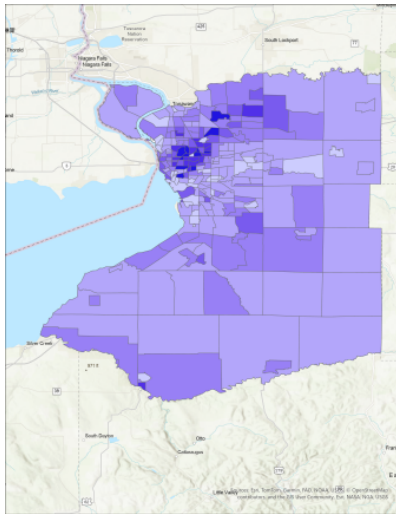


Figure 5. The rise of Buffalo's service economy and the growth of the education and healthcare sectors (2000)

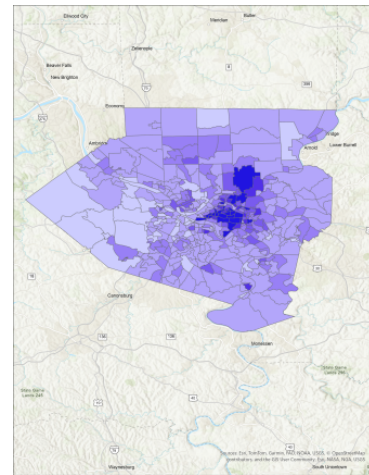


Figure 6. Pittsburgh's service economy rise and growth of education and healthcare sectors (2000)

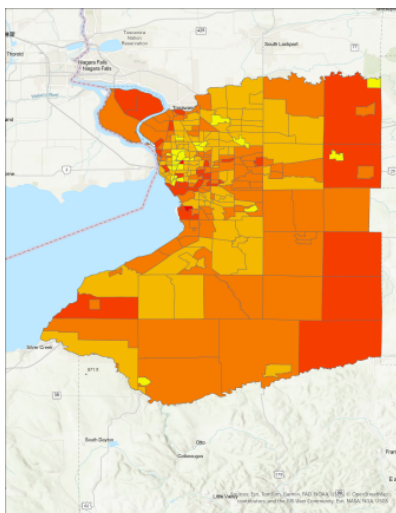


Figure 7. Industrial economic base dominated by Buffalo manufacturing (2000)

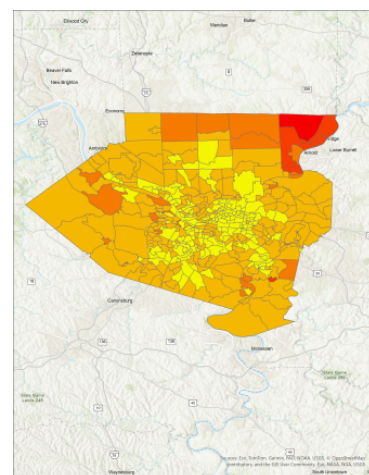


Figure 8. Pittsburgh's manufacturing-dominated industrial economy base (2000)

In the early 2000s, Buffalo and Pittsburgh faced an important and challenging period, as both cities began moving beyond their manufacturing era and planning for a more economically sustainable and diversified future. The 2009 G20 Summit was held in Pittsburgh, which helped set the tone for the city's emerging technology sector and strengthened its reputation as a technology-centered city. At this time, Pittsburgh showed a clearer shift toward new industries such as technology, while Buffalo's economic transition appeared slower and less concentrated than Pittsburgh's.

3.3. Industry structure in 2010–2014

By 2010–2014, Buffalo and Pittsburgh had largely transitioned toward service-based economies. The education and healthcare sectors became the primary sources of employment in both cities.

The main difference between Buffalo and Pittsburgh was the spatial concentration of employment. In Pittsburgh, employment was more concentrated in specific areas, which provided a foundation for stronger economic growth. In addition to medical and education sectors, technological and robotics research also expanded. Pittsburgh's robotics ecosystem grew significantly during this period, marked by the creation of Carnegie Robotics—a spin-off from the National Robotics Engineering Center designed to scale up the commercial production of robotics components [4]. The development of new projects in downtown areas, such as the Consol Energy Center (now PPG Paints Arena), and the continued transformation of former industrial sites into technology parks further supported this growths [5].

In 2014, Buffalo's industrial and economic development was defined by a major shift from a traditional Rust Belt manufacturing base to a high-tech, innovation-driven economy, heavily supported by the state-funded "Buffalo Billion" initiative [6]. Additional economic stimulus strategies were introduced to attract investment, such as the 43North Startup Competition, which was designed to attract early-stage companies to Western New York with \$5 million in annual cash prizes. Other technological developments, such as the SolarCity Gigafactory built by Tesla, signified a broader transition from a manufacturing-based economy toward green energy manufacturing.

However, in our study, Differences are evident in the pace and spatial organization of economic transition from the 1990s to the 2010s in Buffalo and Pittsburgh. Pittsburgh shows a more successful and concentrated transformation, while Buffalo shows a more gradual and dispersed shift. However, as the global economy continues to evolve, It is not possible to conclude which economic model is superior, as each city has developed its own unique economic path.

4. Urban expansion

Land cover analysis using NLCD data shows that Buffalo has experienced significant suburban expansion over the past 20 years. As shown in the graphs below, in 2014, Buffalo continued to experience the long-term effects of suburbanization. This pattern reflects a continued shift of population and development away from the downtown urban core toward adjacent suburban areas, such as Amherst. The outcome of this process has been the loss of city population and a weakened city tax base. At the same time, Buffalo has also begun a gradual process of re-urbanization in its core areas, supported by targeted redevelopment efforts such as the 43North Startup Competition, the growth of the Buffalo Niagara Medical Campus, and ongoing waterfront revitalization initiatives. These changes suggest a partial economic reversal of earlier decline, although the suburban structure remains dominant [7]. In contrast, Pittsburgh exhibits a different spatial development pattern. The graph indicates a more outward-growing and evenly distributed expansion. Rather than widespread dispersion away from the city center, as seen in Buffalo, Pittsburgh's growth appears more structured and concentrated around key urban centers. This suggests a more controlled form of urban expansion, where development is more closely tied to existing infrastructure and established economic hubs in surrounding areas.

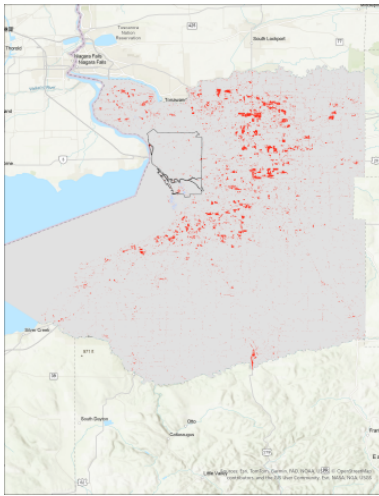


Figure 9. Urban form—before city expansion
(2014)

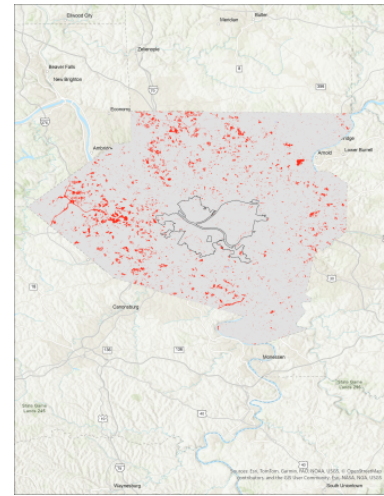


Figure 10. Urban form—after city expansion
(2014)

The comparison of the three periods shows that Pittsburgh's economic transformation was earlier and faster than that of Buffalo. Between 1990 and 2000, the number of manufacturing jobs in Pittsburgh had significantly decreased, while the service industry had shown significant growth.

In contrast, Buffalo's transformation was slower and only became more apparent after 2000. This difference indicates that local policy measures, economic diversification strategies, and institutional support have played a key role in shaping the process of industrial restructuring.

5. Observation

From the results of this study, A clear relationship exists between economic restructuring, the spatial distribution of employment, and urban form. Historically, both cities experienced similar trajectories, as they relied heavily on manufacturing sectors: Pittsburgh was dominated by the steel industry, while Buffalo depended on manufacturing and grain-related industries. The decline of these manufacturing sectors and the rise of service industries in both cities had a tremendous effect on their development. At the same time, employment patterns were reshaped due to population loss. These developments were not only the result of political and social changes but were also influenced by topography, which affected physical expansion patterns. Economic, social, and political factors help explain why the cities changed, while physical geography helps explain how they developed spatially. Studying Buffalo and Pittsburgh's economic development is particularly interesting because the two cities demonstrate very different urban development patterns. Buffalo has relatively flat terrain and shows dispersed employment patterns along with significant suburban expansion. Pittsburgh, with its hilly terrain, exhibits more concentrated employment and compact economic development. It can be concluded that these differences result from the combined effects of economic forces and physical geography in both cities.

6. Conclusion

This study has demonstrated that economic restructuring and topography jointly shape urban spatial patterns in Buffalo and Pittsburgh. Both cities experienced similar industrial decline; however, due

to different economic restructuring processes, their development outcomes diverged. Pittsburgh's more concentrated economic transition, combined with its terrain constraints, has led to a more compact urban form, while Buffalo's flat terrain and slower transition have contributed to urban sprawl. As both cities continue to grow, new industries such as education, healthcare, and technology are also expanding and evolving. These findings suggest that both economic strategies and physical geography should be considered in long-term urban planning and policymaking.

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