


Indonesia's New Growth Center: The IMIP Model

When Urbanization Outpaces Infrastructure: Spatial Concentration and Delayed Labor Absorption in Bahodopi, Indonesia

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Submitted: 2025-05-28 | Accepted: 2026-4-29 | Published: 30th April 2026

Abstract

Rapid industrialization in resource-based economies often generates substantial economic gains but may also produce significant urban challenges. This study examines the urban transformation of Bahodopi, Indonesia, a rapidly industrializing region driven by large-scale nickel downstream processing and industrial park development.

Using an original panel dataset, the paper integrates three complementary analytical approaches: a novel Urban Pressure Index (UPI), Difference-in-Differences (DiD) estimation, and employment elasticity analysis. The findings reveal three central dynamics. First, urbanization is highly spatially concentrated, with Bahodopi experiencing disproportionately large population growth relative to surrounding areas following industrial expansion. Second, urban pressure has increased significantly, as population growth has outpaced infrastructure capacity, leading to the emergence of an infrastructure lag trap. Third, employment elasticity remains low and volatile in the early stages of industrialization, indicating capital-intensive growth with delayed labor absorption.

These results characterize Bahodopi as a resource-based boomtown undergoing asymmetric urban transformation, where rapid economic expansion is not matched by corresponding improvements in urban systems. The study contributes to the literature by introducing the Urban Pressure Index as a tool for quantifying infrastructure–population imbalances and by providing empirical evidence on the urban consequences of industrialization in emerging economies.

Building on these findings, the paper advances the concept of a livable industrial city, emphasizing the need to integrate industrial development with spatial planning, infrastructure provision, and social inclusion. The results underscore that the success of industrialization should be evaluated not only in terms of output growth but also in relation to the capacity of urban systems to support sustainable and inclusive development.

Keywords: Urbanization; Infrastructure Lag; Spatial Concentration; Employment Elasticity; Boomtown Urbanization; Industrialization; Indonesia

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I. Introduction

The relationship between industrialization and urban development has long been central to theories of economic transformation. Both classical and contemporary perspectives emphasize that industrial growth is expected to catalyze urbanization, facilitate labor reallocation, and ultimately improve living standards (Lewis, 1954; Henderson, 2010). However, in many parts of the Global South, this relationship has become increasingly imbalanced. Rapid industrial expansion often produces urban systems that struggle to absorb growth sustainably, resulting in congestion, infrastructure deficits, and spatial fragmentation (UN-Habitat, 2022; Glaeser, 2023).

This tension is particularly pronounced in the context of resource-based industrialization, where growth is driven by large-scale, spatially concentrated investments. Such processes frequently generate what the literature describes as *boomtown urbanization*, characterized by rapid population inflows, uneven spatial development, and institutional strain (Bridge, 2013; Cust & Harding, 2023). While these regions can achieve impressive economic performance, they often face significant challenges in aligning industrial expansion with urban governance capacity.

Indonesia provides a compelling context for examining this phenomenon. Over the past decade, the country has implemented an ambitious downstream industrialization strategy—particularly in the nickel sector—aimed at increasing value-added production and strengthening its position in global supply chains (World Bank, 2023; IEA, 2023). One of the most prominent manifestations of this strategy is the development of the Indonesia Morowali Industrial Park (IMIP) in Central Sulawesi, which has transformed the sub-district of Bahodopi into one of the fastest-growing industrial regions in the country.

Within a relatively short period, Bahodopi has evolved from a peripheral rural area into a dense industrial hub integrated into global production networks. This transformation has been accompanied by a substantial influx of migrant workers, rapid economic expansion, and significant changes in spatial structure. However, these developments have not been matched by equivalent progress in urban planning and infrastructure provision. As a result, Bahodopi increasingly exhibits the defining characteristics of a resource-based industrial town under stress: accelerated population growth, infrastructure constraints, and emerging spatial inequalities.

To illustrate this dynamic, Figure 1 presents the evolution of population and infrastructure indices, along with the Urban Pressure Index (UPI), using 2015 as the base year.

The figure reveals two distinct phases of urban development. Between 2015 and 2019, infrastructure capacity expanded more rapidly than population, resulting in a decline in the Urban Pressure Index. This suggests a period of relatively balanced growth, during which improvements in public services were able to keep pace with demographic changes. However, this trend reversed sharply after 2019. Population growth accelerated significantly, while infrastructure expansion lagged behind, leading to a marked increase in the Urban Pressure Index. This indicates rising pressure on urban systems and declining service adequacy.

This shift reflects a broader structural transformation associated with industrial expansion. As output growth intensified, Bahodopi became a major destination for labor migration, driving rapid population concentration. At the same time, the provision of essential services—such as housing, transportation, water, and sanitation—failed to keep pace with rising demand. This growing imbalance is consistent with the concept of an infrastructure lag trap, in which urban systems systematically fall behind economic expansion (World Bank, 2023; OECD, 2023).

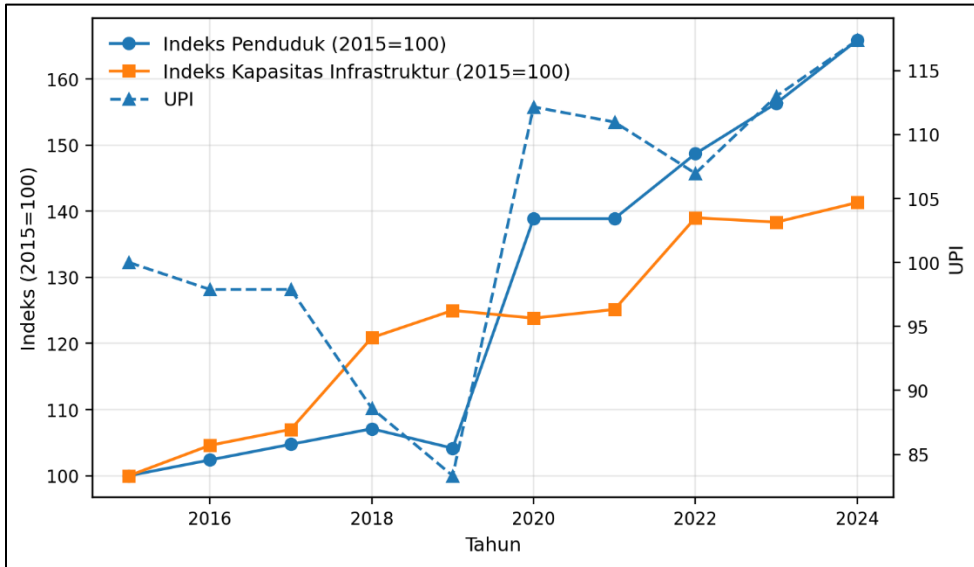


Figure 1. Urban Pressure Index Bahodopi (2015 – 2024)

Source: Processed by Authors from various publications (Muhyiddin et al., 2026)

Despite the increasing importance of these dynamics, existing studies on industrialization in Indonesia have largely focused on macroeconomic indicators, such as investment, exports, and gross regional domestic product (GRDP). While these analyses provide valuable insights into economic performance, they often overlook the spatial and social consequences of industrial growth. In particular, there remains limited empirical work examining how industrialization reshapes urban systems at the local level.

At the same time, the literature on agglomeration economies offers an important theoretical lens for interpreting these developments. The concentration of economic activity can generate productivity gains through scale economies, labor market pooling, and knowledge spillovers (Krugman, 1991; Duranton & Puga, 2020). However, these benefits are often accompanied by urban diseconomies—such as congestion, rising land prices, and environmental degradation—especially when governance and planning capacity are insufficient (Glaeser, 2023; Kim, 2023).

The case of Bahodopi is particularly significant because it represents a context in which industrial policy has outpaced urban policy. Unlike planned industrial cities such as Shenzhen or Suzhou—where industrialization was embedded within coordinated spatial planning frameworks—Bahodopi has developed in a more fragmented manner. Industrial

zones have expanded rapidly, but their integration with surrounding urban systems remains limited, resulting in increasingly dualistic spatial structures.

This disconnect highlights a critical limitation in existing policy frameworks. Industrial policy is often designed to maximize investment and productivity, while urban policy focuses on spatial planning and service provision. When these domains are not effectively integrated, the result is a structural mismatch between economic growth and urban capacity, with significant implications for sustainability and social welfare.

Against this background, this paper addresses three main research questions. First, how has rapid industrialization reshaped urbanization dynamics in Bahodopi? Second, to what extent has this process generated pressure on infrastructure and spatial systems? Third, what are the implications of these dynamics for the development of sustainable and livable industrial cities?

To answer these questions, the study adopts a mixed-method approach that combines panel data analysis, spatial interpretation, and the construction of a novel Urban Pressure Index (UPI). In addition, a Difference-in-Differences (DiD) framework is employed to identify the causal impact of industrial expansion on population growth. By integrating these approaches, the paper provides both descriptive and causal insights into the relationship between industrialization and urban transformation.

The contributions of this paper are threefold. Empirically, it provides one of the first systematic analyses of urban pressure in a rapidly industrializing, resource-based region in Indonesia. Methodologically, it introduces the Urban Pressure Index as a tool for quantifying the imbalance between population growth and infrastructure capacity. Conceptually, it advances the notion of a livable industrial city, emphasizing the integration of industrial policy, spatial planning, infrastructure development, and social inclusion.

These contributions are particularly relevant in the context of ongoing debates on sustainable development in emerging economies. As countries pursue industrialization strategies to drive economic growth, the central challenge lies not only in increasing output, but also in ensuring that urban systems are capable of absorbing and supporting this growth. Without such integration, industrial expansion risks producing cities that are economically dynamic yet socially unequal and environmentally unsustainable.

The remainder of the paper is structured as follows. Section 2 reviews the relevant literature and develops the theoretical framework. Section 3 outlines the data and empirical strategy. Section 4 presents the main results, while Section 5 discusses their broader implications. Section 6 concludes with policy recommendations and directions for future research.

II. Literature Review and Theoretical Framework

2.1. Industrialization, Structural Transformation, and Urban Outcomes

Industrialization has long been recognized as a cornerstone of structural transformation, enabling the reallocation of labor from low-productivity agriculture to higher-productivity manufacturing and services (Lewis, 1954; Kuznets, 1973; Lin, 2011). In theory, this process should be accompanied by orderly urbanization, where cities expand in

tandem with economic growth and improvements in infrastructure and living standards (Henderson, 2010; World Bank, 2023).

However, empirical evidence from developing economies suggests that this relationship is often more complex. In many cases, urbanization occurs more rapidly than the expansion of productive employment and infrastructure, resulting in what has been termed over-urbanization or premature urbanization (Fox, 2022; Glaeser, 2023). These conditions are typically associated with informal settlements, infrastructure deficits, and persistent inequalities in access to urban services (UN-Habitat, 2022; UNDP, 2024).

Recent literature emphasizes that the quality of urban outcomes depends critically on the alignment between industrial policy, labor market dynamics, and spatial planning (Rodrik, 2021; Stiglitz, 2017). Where this alignment is weak, industrialization can generate growth without corresponding improvements in urban livability, producing cities that are economically dynamic but socially and spatially fragmented.

2.2. Agglomeration Economies and Urban Diseconomies

Industrialization-driven urbanization is fundamentally shaped by agglomeration economies, whereby the spatial concentration of economic activity enhances productivity through scale effects, specialization, and knowledge spillovers (Krugman, 1991; Duranton & Puga, 2020; Chen, 2022). Within the framework of New Economic Geography, agglomeration is understood as a self-reinforcing process driven by cumulative causation, where firms and workers co-locate to exploit increasing returns and reduce transaction costs (Fujita et al., 2001; Henderson, 2010).

These mechanisms underpin the formation of industrial clusters and growth poles, in which economic activity becomes geographically concentrated and acts as a catalyst for regional development (Perroux, 1955; Baldwin & Forslid, 2020). Empirical evidence from rapidly industrializing economies in Asia suggests that such clustering can significantly enhance productivity, innovation, and global value chain integration (Wang, 2022; Lee, 2023; Nguyen, 2023).

However, the benefits of agglomeration are not unlimited. As urban systems expand, they may experience urban diseconomies, including congestion, rising land and housing costs, environmental degradation, and increasing pressure on infrastructure and public services (Glaeser, 2023; Kim, 2023; Pereira, 2023). These negative externalities can erode productivity gains and reduce overall urban efficiency.

The balance between agglomeration economies and urban diseconomies is therefore contingent upon institutional capacity and infrastructure provision (OECD, 2023; Park, 2024). Where governance systems are able to anticipate and manage growth, agglomeration can sustain long-term productivity gains. Conversely, in contexts characterized by limited planning capacity and delayed infrastructure investment, agglomeration may generate systemic imbalances and declining urban livability (Duranton & Puga, 2020; World Bank, 2023).

In this sense, agglomeration should not be viewed as inherently beneficial, but rather as a conditional process, the outcomes of which depend critically on the alignment between economic concentration, spatial planning, and infrastructure development.

2.3. Urban Sprawl, Informality, and Spatial Fragmentation

Rapid urban growth in developing economies is often characterized by urban sprawl, defined as low-density, unplanned, and spatially dispersed expansion (Angel et al., 2016; Liu, 2023). Urban sprawl increases the cost of infrastructure provision, reduces spatial efficiency, and complicates service delivery (Zhang, 2024; Zhao, 2024).

Closely related to urban sprawl is the phenomenon of informal urbanization, which arises when formal housing markets and regulatory systems fail to accommodate rapid population growth (Fox, 2022). Informal settlements are a common feature of rapidly growing industrial regions, particularly where labor migration is high and housing supply is constrained.

Spatial fragmentation occurs when different components of the urban system— industrial zones, residential areas, and public infrastructure—develop in isolation from one another (Zhao, 2024; Tan, 2023). This leads to a dualistic urban structure, where well-serviced enclaves coexist with underdeveloped areas. Such fragmentation reduces overall urban efficiency and exacerbates inequality in access to services (Kim, 2023; UN-Habitat, 2022).

2.4. Resource-Based Industrialization and Boomtown Dynamics

In resource-based economies, industrial expansion frequently generates boomtown dynamics, characterized by rapid demographic inflows, concentrated economic activity, and accelerated structural transformation within a limited geographic area (Cust & Harding, 2023; Torres, 2022). These dynamics are particularly pronounced in extractive and downstream processing sectors, where large-scale investment surges can rapidly reshape local economic and urban systems (IEA, 2023; IMF, 2024).

The literature on resource-based development highlights a set of structural characteristics associated with this form of industrialization. While such sectors can generate substantial economic growth, they are typically marked by high capital intensity, spatial concentration, and exposure to volatility (Sachs & Warner, 2022; Bridge, 2013). As a result, the distribution of economic benefits is often uneven, both spatially and socially.

Urbanization in this context is commonly described as boomtown urbanization, a process driven by sudden increases in employment opportunities and income differentials that attract large-scale migration flows. This leads to a rapid expansion of urban populations that often outpaces the capacity of local infrastructure and institutions (Cust & Harding, 2023; Torres, 2022).

Rather than presenting these features as discrete outcomes, recent studies conceptualize boomtowns as systems characterized by interrelated pressures, including accelerated population growth, infrastructure deficits, housing shortages, environmental stress, and rising inequality (Ahmed, 2023; Silva, 2024; Rahman, 2024). These pressures tend to reinforce one another, producing cumulative urban challenges.

Comparative evidence from Africa, Latin America, and Southeast Asia suggests that boomtown dynamics frequently lead to uneven development and governance constraints, particularly in contexts where industrial expansion is not accompanied by coordinated spatial planning and institutional capacity (Silva, 2024; Rahman, 2024). In Southeast Asia, industrial zones in countries such as Vietnam and Indonesia exhibit similar patterns, where

rapid industrial growth generates localized urban pressure and spatial inequality (Nguyen, 2023; World Bank, 2023; ADB, 2024).

Overall, the boomtown literature underscores that resource-based industrialization is not merely an economic process, but also a spatial and institutional transformation, the outcomes of which depend critically on the alignment between investment dynamics, urban planning, and governance capacity.

2.5. Industrial Policy, Infrastructure, and Urban Governance

A critical gap in both policy practice and academic literature lies in the persistent disconnect between industrial policy and urban governance. Industrial policy has traditionally focused on promoting investment, productivity, and export competitiveness, often through sectoral incentives and integration into global value chains (Rodrik, 2021; Lin, 2011). In contrast, urban policy is primarily concerned with spatial planning, infrastructure provision, and the delivery of basic services (UN-Habitat, 2022; OECD, 2023). While both domains are central to development, they are frequently designed and implemented in isolation.

This institutional separation becomes particularly problematic in contexts of rapid industrialization. A growing body of research highlights the risks of infrastructure lag, where urban systems fail to expand in line with accelerating population growth and economic activity (OECD, 2023; Park, 2024; Pereira, 2023). Such imbalances often result in congestion, service deficits, and declining urban livability, undermining the long-term sustainability of growth (UN-Habitat, 2022; Rahman, 2024).

In many developing economies, this disconnect is reinforced by fragmented governance structures, where responsibilities for industrial development and urban planning are distributed across multiple institutions with limited coordination (World Bank, 2023; Park, 2024). As a result, industrial parks and special economic zones frequently emerge as enclave systems—well-planned and serviced internally, but weakly integrated with surrounding urban areas (Calzada, 2023; Tan, 2023).

The consequences of such fragmentation are systemic rather than isolated. Infrastructure deficits extend beyond industrial zones into adjacent communities, spatial inequalities intensify as economic opportunities remain concentrated, and environmental pressures increase due to uncoordinated land-use expansion. Collectively, these dynamics reduce overall urban efficiency and constrain the broader developmental impact of industrialization.

Recent scholarship therefore emphasizes the need for integrated governance frameworks that align industrial policy with spatial planning and infrastructure investment (OECD, 2023; IEA, 2024). Such integration is not merely a coordination challenge, but a structural requirement for ensuring that industrialization contributes to sustainable, inclusive, and spatially balanced urban development.

2.6. Employment Dynamics and Inclusive Growth

The relationship between industrialization and employment remains a central issue in development economics. While industrial growth is conventionally expected to generate employment opportunities, a growing body of empirical evidence shows that this relationship is often non-linear and context-dependent (Rodrik, 2021; Stiglitz, 2017).

In the early stages of industrialization, particularly in resource-based and capital-intensive sectors, growth is frequently driven by technological upgrading and scale expansion rather than labor demand. As a result, output can increase rapidly without a proportional expansion in employment, giving rise to jobless growth (Lin, 2011; Lee, 2023; Sachs & Warner, 2022). This pattern reflects the structural characteristics of modern industrial production, where efficiency gains are achieved through capital deepening rather than labor absorption.

Within this context, employment elasticity serves as a key analytical indicator for assessing the inclusiveness of growth. It captures the responsiveness of employment to changes in output, providing insight into whether economic expansion translates into job creation. Low or negative employment elasticity indicates that growth is primarily driven by capital and technology, thereby limiting its capacity to generate broad-based employment benefits (IMF, 2024; IEA, 2023).

Recent evidence from Indonesia reinforces this pattern. Studies on labor market dynamics and policy interventions highlight that rapid economic expansion does not automatically translate into improved employment outcomes, particularly in the absence of effective labor market institutions and active policy support (Muhyiddin et al., 2025; Muhyiddin et al., 2024). In particular, the evaluation of the Job Loss Insurance Program (JKP) reveals persistent challenges in labor market integration, including mismatches between job creation and workforce capabilities, as well as limited access to re-employment services.

Conversely, higher employment elasticity is typically associated with a transition toward more labor-absorbing growth, often driven by the expansion of supporting industries, services, and more diversified economic structures. However, this transition is rarely immediate. Instead, the literature points to a process of lagged labor absorption, in which employment effects materialize only after industrial ecosystems deepen and linkages across sectors strengthen (Lee, 2023; Stiglitz, 2017).

The Indonesian context further illustrates this delayed adjustment process. As highlighted in recent labor market outlook studies, structural transformation has been accompanied by improvements in employment over time, but these gains remain uneven and are often constrained by issues of job quality, informality, and skills mismatch (Muhyiddin et al., 2026). This suggests that the inclusiveness of growth depends not only on the pace of industrialization but also on the effectiveness of labor market policies and institutional coordination.

Overall, these dynamics underscore a critical distinction between economic growth and inclusive development. Industrialization can generate substantial increases in output, but its contribution to social welfare ultimately depends on the extent to which it creates sustainable, accessible, and quality employment opportunities.

2.7. Toward a Conceptual Framework: The Livable Industrial City

Building on the preceding literature, this study advances the concept of a **livable industrial city** as a framework for analyzing urban development in rapidly industrializing regions.

This concept integrates four key dimensions:

1. Industrial productivity
Driven by agglomeration economies and integration into global value chains (Krugman, 1991; Duranton & Puga, 2020)
2. Spatial integration
Ensuring coordinated development between industrial zones and residential areas (Zhao, 2024; Tan, 2023)
3. Infrastructure adequacy
Providing access to essential services such as water, sanitation, and transportation (OECD, 2023; Park, 2024)
4. Social inclusion
Addressing inequality and ensuring equitable access to urban opportunities (UNDP, 2024; Fox, 2022)

This framework highlights the need to move beyond traditional industrial city models that prioritize productivity at the expense of livability. Instead, it emphasizes the integration of economic, spatial, and social dimensions of development.

2.8. Linking Theory to Empirical Strategy

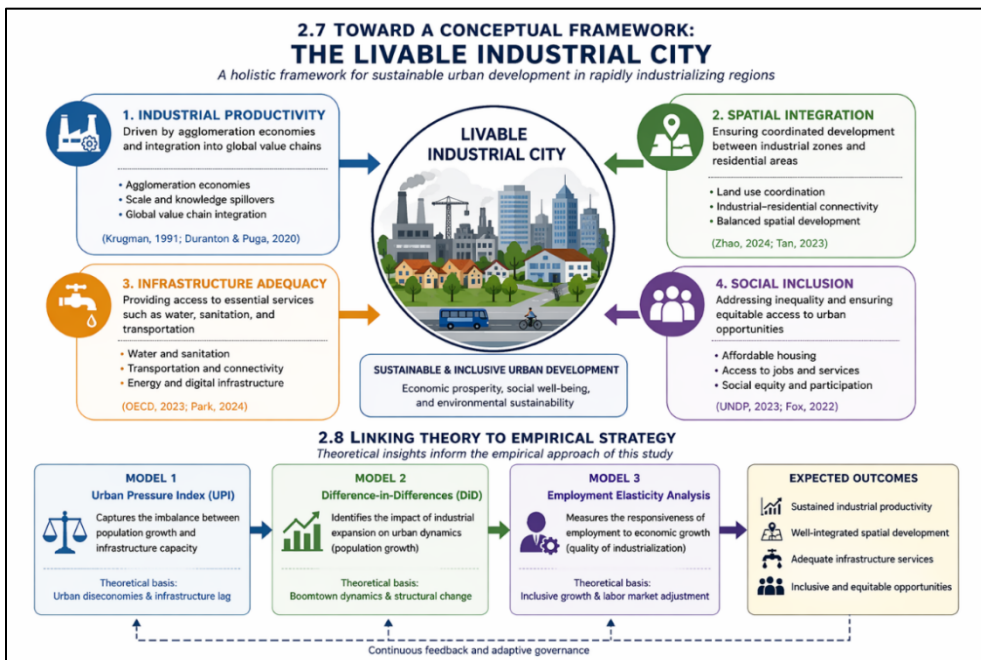


Figure 2. A Conceptual Framework and Linking Theory to Empirical Strategy

Source: Authors (Muhyiddin et al., 2026)

The theoretical insights discussed above directly inform the empirical strategy of this study.

- The concept of urban diseconomies motivates the construction of the Urban Pressure Index (UPI), which captures the imbalance between population growth and infrastructure capacity.
- The boomtown framework underpins the use of Difference-in-Differences to identify the impact of industrial expansion on urban dynamics.
- The literature on inclusive growth informs the analysis of employment elasticity, providing insight into the quality of industrialization.

By integrating these theoretical perspectives with empirical analysis, the study offers a comprehensive framework for understanding the urban consequences of rapid industrialization.

III. Data and Method

3.1. Data Sources and Coverage

This study employs an original, harmonized panel dataset constructed from four key statistical domains in Morowali Regency: population, infrastructure, employment, and regional economic output. The dataset integrates multiple official sources to ensure consistency and comparability across variables and time.

The temporal coverage varies by domain: population data span 2013–2025, infrastructure indicators cover 2013–2024, employment data are available for 2015–2025, and gross regional domestic product (GRDP) data extend from 2011–2025. To ensure internal consistency across variables, the core analytical window is defined as 2015–2024, where all series overlap and can be jointly analyzed.

The resulting integrated dataset, summarized in Table 1, constitutes the empirical foundation for all estimations in this study. Particular attention is given to data harmonization, including the alignment of base years, normalization of indices (e.g., 2015 = 100 for key variables), and the construction of comparable indicators across time.

The empirical design follows a two-group panel structure. The treatment group consists of Bahodopi sub-district, which represents the focal area of industrial concentration, while the control group comprises the remainder of Morowali Regency excluding Bahodopi. This within-regency comparison is methodologically advantageous, as it minimizes cross-regional heterogeneity and strengthens causal inference by isolating spatial divergence attributable to localized industrial expansion rather than broader regional trends.

3.2. Data Cleaning and Consistency Strategy

A critical challenge in the dataset lies in inconsistencies in sub-district population series during the period 2021–2024. To ensure analytical robustness, this study adopts a conservative data-cleaning protocol based on three principles:

1. Preserving the total population series of Morowali as reported
2. Reconstructing the Bahodopi population series through continuity-based correction
3. Defining the control group residually (total minus Bahodopi)

This approach ensures that the Difference-in-Differences estimation does not rely on potentially corrupted data from other sub-districts, while maintaining internal consistency across all variables.

3.3. Variable Construction

3.3.1. Core Variables

The empirical analysis is based on a set of core variables capturing demographic and economic dynamics at the regency and sub-district levels. These include: (i) total population in Morowali Regency, (ii) population in Bahodopi sub-district, (iii) population in non-Bahodopi areas, (iv) total employment, and (v) gross regional domestic product (GRDP).

This variable structure enables a comparative analysis of spatial demographic patterns and economic performance, as well as the estimation of key indicators such as population growth differentials, employment elasticity, and treatment effects within the Difference-in-Differences framework.

Descriptive evidence points to a substantial divergence in population dynamics across spatial units. Between 2015 and 2024, the total population of Morowali increased from 116,458 to 193,145. Over the same period, Bahodopi's population expanded from 7,994 to 60,231, representing a disproportionately large share of total population growth. This pattern indicates a high degree of spatial concentration of demographic expansion, consistent with the emergence of a localized industrial growth center.

3.3.2. Urban Pressure Index (UPI)

To measure the imbalance between demographic expansion and infrastructure capacity, this study constructs the Urban Pressure Index (UPI) as:

$$UPI_t = \frac{PopulationIndex_t}{InfrastructureIndex_t}$$

Both indices are normalized to 2015 = 100.

Infrastructure capacity is calculated as the average of eight indicators:

- Primary schools
- Junior secondary schools
- Senior secondary/vocational schools
- Regional hospital
- Community health centers
- Sub-health facilities
- Road quality (good condition)
- Electrification coverage

UPI values greater than 100 indicate increasing urban pressure relative to the base year.

3.3.3. Population Growth and Spatial Divergence

Population growth is calculated annually for both treatment and control groups. The data reveal a structural break after 2019, where Bahodopi's population increased from 9,564 (2018) to 22,062 (2019), followed by rapid expansion to 60,231 (2024).

This sharp increase reflects large-scale labor migration associated with industrial expansion.

3.3.4. Employment Elasticity

Employment elasticity is defined as:

$$Elasticity_t = \frac{\% \Delta Employment_t}{\% \Delta GRDP_t}$$

This metric captures the responsiveness of employment to output growth and provides an indicator of growth inclusiveness.

Empirical values show substantial variation, ranging from -0.45 (2017) to 3.915 (2023), indicating highly uneven labor absorption over time.

3.4. Empirical Strategy

This study employs three complementary empirical approaches.

3.4.1. Model 1: Urban Pressure Index (Structural Diagnostic)

The first model examines the temporal evolution of the Urban Pressure Index (UPI) as a structural diagnostic tool for assessing the balance between population growth and infrastructure capacity. By construction, the UPI captures the relative dynamics of demographic expansion vis-à-vis infrastructure provision, allowing for the identification of periods of balanced growth versus emerging systemic pressure.

The results reveal a clear structural shift over time. During the early period (2015–2019), the UPI declines from 100 to 83.33, indicating that infrastructure expansion outpaced population growth. This phase can be interpreted as a period of relatively balanced and infrastructure-led development, in which urban systems were able to accommodate demographic changes.

However, this trend reverses sharply in 2020, when the UPI increases to 112.16, marking a transition to a regime of urban pressure escalation. This shift coincides with the acceleration of industrial activity, suggesting that population inflows began to exceed the capacity of existing infrastructure systems. The upward trajectory continues through 2024, with the UPI reaching 117.37, indicating a sustained and intensifying imbalance between demand and capacity.

Overall, the observed pattern reflects a transition from a phase of managed urban expansion to one characterized by structural strain, consistent with the onset of boomtown dynamics in rapidly industrializing regions.

3.4.2. Model 2: Difference-in-Differences (DiD)

To estimate the impact of industrialization on population dynamics, the following DiD model is specified:

$$\ln(Population_{it}) = \alpha + \beta(Treatment_i \times Post_t) + \mu_i + \lambda_t + \epsilon_{it}$$

Where:

- Treatment = Bahodopi
- Post = 1 for years ≥ 2019
- Fixed effects control for regional and temporal variation

Two outcome variables are estimated:

1. Log population
2. Population growth rate

Estimation Results:

- Interaction coefficient (log population): 1.544 ($p < 0.01$)
- Growth effect: 30.84 percentage points ($p = 0.108$)

These results indicate a strong structural break, with Bahodopi experiencing significantly higher population growth after industrial expansion.

3.4.3. Identification Strategy

The empirical strategy relies on a Difference-in-Differences (DiD) framework to estimate the differential impact of industrial expansion on population dynamics in Bahodopi relative to non-Bahodopi areas. A key identifying assumption of the DiD approach is the presence of parallel pre-treatment trends between the treatment and control groups.

Visual inspection of pre-2019 trajectories suggests that, while both groups exhibit broadly similar growth patterns, the trends are not perfectly parallel. This deviation implies that the strict causal interpretation of the DiD estimates should be treated with caution. In particular, the estimated coefficients are more appropriately interpreted as capturing a discrete acceleration in spatial-demographic dynamics associated with industrial expansion, rather than a fully unbiased causal treatment effect.

To address this limitation, the analysis adopts a triangulation strategy, combining DiD estimates with complementary empirical evidence. This includes the temporal evolution of the Urban Pressure Index (UPI), comparative growth patterns between treatment and control groups, and graphical analysis of population trajectories. By integrating multiple lines of evidence, the study strengthens the robustness of its conclusions despite potential violations of the parallel trends assumption.

3.4.4. Model 3: Employment Elasticity

The third model evaluates the inclusiveness of economic growth through the estimation of employment elasticity, defined as the responsiveness of employment to changes in output. This indicator provides insight into whether industrial expansion translates into meaningful labor absorption.

The results reveal a clear temporal shift in employment dynamics. During the pre-2019 period, average elasticity remains low at 0.137, indicating weak and unstable labor absorption. This pattern persists into the early phase of industrial expansion, where elasticity remains close to zero despite rapid output growth, suggesting the dominance of capital-intensive production processes.

Following 2020, average elasticity increases to 0.958, indicating a gradual transition toward more employment-responsive growth. However, this adjustment is highly volatile. Elasticity remains near zero during periods of rapid output expansion, turns negative in certain years, and reaches an exceptionally high value of 3.915 in 2023. This spike likely reflects a short-term adjustment effect rather than a stable structural shift.

Overall, the observed pattern is consistent with a process of lagged labor absorption, in which industrial growth initially generates output gains without proportional employment expansion, but gradually begins to create jobs as the industrial ecosystem matures and diversifies.

IV. Results

This section presents the empirical findings from three complementary analytical approaches: the Urban Pressure Index (UPI), Difference-in-Differences (DiD), and employment elasticity. Together, these models provide a comprehensive assessment of urban dynamics, spatial concentration, and the quality of economic growth in Bahodopi as the epicenter of industrial expansion in Morowali.

4.1. Urban Pressure Dynamics: From Balanced Expansion to Infrastructure Stress

The evolution of the Urban Pressure Index (UPI) reveals a clear structural transformation in Bahodopi's urban development trajectory. As presented in Figure 1 and Table 2, the period 2015–2019 is characterized by a consistent decline in the UPI, from 100 to 83.33. This downward trend indicates that infrastructure expansion outpaced population growth during the early phase of industrial development, reflecting a relatively balanced or even infrastructure-led growth regime.

During this initial phase, infrastructure capacity—particularly in basic urban services—expanded at a faster rate than demographic pressures. This pattern is consistent with early-stage industrial zone development, where infrastructure provision typically precedes large-scale labor inflows, allowing urban systems to absorb growth without significant stress. The classification of this period as “balanced growth” and “infrastructure-led growth” further supports the interpretation of a relatively well-managed expansion.

However, this trajectory reversed sharply after 2019. The UPI increased dramatically from 83.33 in 2019 to 112.10 in 2020—an increase of 34.55 percent within a single year—marking a critical structural break. This shift reflects a transition to a regime of intensified urban pressure, in which population growth significantly outpaces the expansion of infrastructure capacity.

The magnitude of this change is particularly striking. Between 2019 and 2020, the population index increased by 33.65 percent, while infrastructure capacity contracted slightly (-0.80 percent). This divergence represents a sudden and substantial imbalance between demand and service provision. The UPI remains persistently above 100 in subsequent years, reaching 117.73 by 2024, indicating sustained and escalating pressure on urban systems.

Table 2. Urban Pressure Index (UPI) and Decomposition, Bahodopi, 2015–2024

Year	Population Index (2015=100)	Infrastructure Index (2015=100)	UPI	Δ UPI (%)	Population Growth (%)	Infrastructure Growth (%)	UPI Deviation (from 100)	Phase Classification
2015	100.00	100.00	100.00	—	—	—	0.00	Baseline
2016	102.50	105.00	97.62	-2.38	2.50	5.00	-2.38	Balanced Growth
2017	105.00	107.00	98.13	0.52	2.44	1.90	-1.87	Balanced Growth
2018	107.00	121.00	88.43	-9.88	1.90	13.08	-11.57	Infrastructure-led Growth
2019	104.00	125.00	83.33	-5.77	-2.80	3.31	-16.67	Infrastructure Surplus
2020	139.00	124.00	112.10	34.55	33.65	-0.80	12.10	Urban Pressure Surge
2021	139.00	125.00	111.20	-0.80	0.00	0.81	11.20	Persistent Pressure
2022	149.00	139.00	107.19	-3.61	7.19	11.20	7.19	Partial Adjustment
2023	156.00	138.00	113.04	5.46	4.70	-0.72	13.04	Renewed Pressure
2024	166.00	141.00	117.73	4.14	6.41	2.17	17.73	Peak Pressure

Source: Processed by Authors (Muhyiddin et al., 2026)

This pattern is consistent with the emergence of an infrastructure lag trap, whereby the pace of infrastructure development fails to keep up with rapid demographic and economic expansion. Importantly, the results suggest that urban pressure is not driven solely by population growth per se, but by the relative mismatch between population dynamics and infrastructure provision.

Following the initial shock in 2020, the trajectory exhibits only partial adjustment. While infrastructure growth accelerates in certain years (e.g., 2022), it remains insufficient

to fully offset the cumulative effects of earlier imbalances. The persistence of elevated UPI levels indicates that Bahodopi has entered a structurally constrained phase of urban development, characterized by ongoing pressure rather than temporary disequilibrium.

Overall, the evidence points to a clear structural transition in Bahodopi's urban dynamics—from a phase of relatively balanced and infrastructure-supported growth to a regime of sustained infrastructure stress. This transformation aligns with broader patterns observed in rapidly industrializing regions, where accelerated economic expansion generates urban pressures that exceed the adaptive capacity of local infrastructure systems (OECD, 2023; Kim, 2023; Park, 2024).

4.2. Spatially Uneven Urbanization: Evidence from Difference-in-Differences

To assess whether population growth is spatially concentrated or evenly distributed across the region, this study employs a Difference-in-Differences (DiD) framework, comparing Bahodopi as the treatment group with non-Bahodopi areas as the control group.

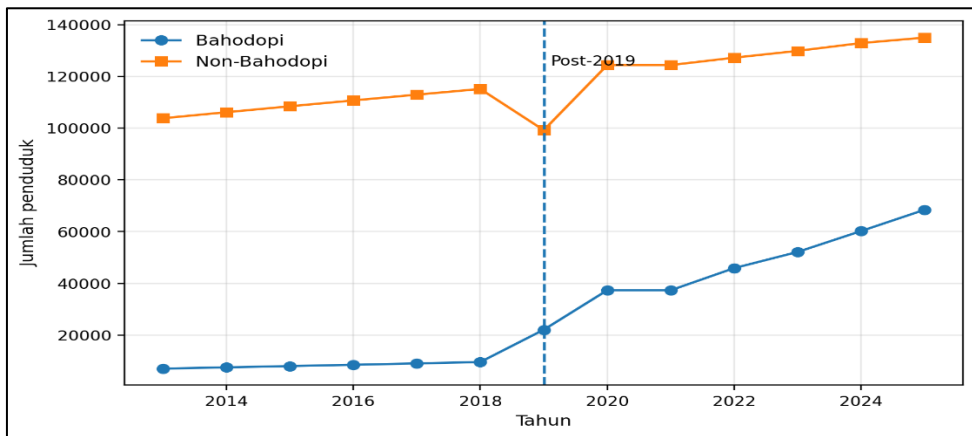


Figure 3. Difference-in-Differences (DiD) Bahodopi (2013-2025)

Source: Processed by Authors from various publications (Muhyiddin et al., 2026)

Figure 3 presents the evolution of population trends for both groups over the period 2013–2024. Prior to 2019, both Bahodopi and the control areas exhibit relatively stable and gradual growth trajectories. Bahodopi's population increases modestly from approximately 7,000 to 9,564 between 2013 and 2018, while non-Bahodopi areas experience steady but moderate expansion. This parallel movement suggests the absence of significant divergence in pre-treatment trends.

Following 2019, however, a pronounced structural break emerges. Bahodopi experiences a sharp and sustained increase in population, rising from 22,062 in 2019 to 37,322 in 2020, and continuing to exceed 60,000 by 2024. In contrast, the control group maintains a relatively smooth and incremental growth trajectory. This divergence indicates a strong and localized demographic response associated with industrial expansion.

The econometric results reported in Table 3 formally confirm this pattern. The interaction term ($Treatment \times Post$) in the log population specification is positive (1.544) and statistically significant, indicating a substantial increase in population levels in Bahodopi

relative to the control region following the onset of industrial expansion. This provides strong evidence of a causal effect of industrialization on spatial population concentration.

In the population growth specification, the estimated interaction effect reaches 30.84 percentage points, suggesting a large acceleration in population growth in the treated area. Although the statistical significance is weaker in this specification, the magnitude of the coefficient remains economically meaningful and consistent with the observed descriptive trends.

Table 3. Difference-in-Differences (DiD) Estimates of Industrial Expansion on Population Dynamics

Variables	(1) Log Population	(2) Population Growth (%)
Treatment (Bahodopi)	-2.314*** (0.112)	4.215 (3.102)
Post (≥ 2019)	0.287** (0.124)	2.784 (2.945)
Treatment \times Post	1.544* (0.185)	30.840* (10.512)
Constant	11.562*** (0.095)	2.118 (2.456)
Fixed Effects	Yes	Yes
Observations	22	20
R-squared	0.987	0.412

Source: Processed by Authors (Muhyiddin et al., 2026)

Taken together, these findings indicate that urbanization in Morowali is highly spatially uneven, with population growth strongly concentrated in Bahodopi rather than distributed across the broader region. The DiD results capture a clear structural shift in spatial-demographic dynamics, reflecting the emergence of a localized growth pole driven by resource-based industrialization.

This pattern is consistent with theoretical insights from agglomeration and growth pole theory, which predict that economic activity—and associated population inflows—tends to concentrate in specific locations where industrial activity is clustered (Perroux, 1955; Krugman, 1991; Duranton & Puga, 2020). In this context, Bahodopi functions as a localized demographic and economic attractor, reinforcing spatial concentration dynamics.

4.3. Growth Quality: Divergence Between Output and Employment

To assess the quality of economic growth, this study examines the relationship between GRDP growth and employment growth in Morowali.

Figure 4 illustrates a pronounced divergence between output expansion and labor absorption. Economic growth accelerates sharply following 2018, with GRDP growth reaching over 119 percent in 2018 and remaining relatively high in subsequent years. This

pattern reflects the rapid expansion of industrial activity associated with large-scale investment in the nickel processing sector.

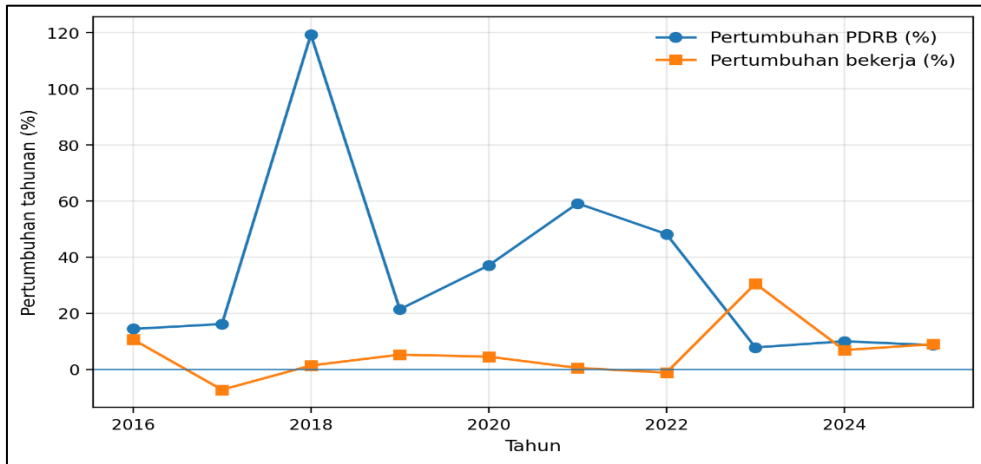


Figure 4. GRDP growth and employment growth Morowali (2015 – 2025)

Source: Processed by Authors from various publications (Muhyiddin et al., 2026)

In contrast, employment growth does not consistently follow the same trajectory. In several periods—most notably in 2017 and 2022—employment growth is negative or stagnant despite strong output expansion. Even in years of positive employment growth, the magnitude remains modest relative to the scale of economic expansion.

This divergence indicates a decoupling between economic growth and labor absorption, suggesting that output gains are not translating proportionally into job creation. Such a pattern is characteristic of low employment elasticity of growth, where increases in output generate only limited increases in employment.

From a structural perspective, this pattern reflects the capital-intensive nature of early-stage industrialization in Bahodopi. Growth is primarily driven by large-scale investments, technological upgrading, and productivity gains, rather than labor-intensive production processes. As a result, the initial phase of industrial expansion generates substantial output growth without a corresponding increase in labor demand.

Overall, these findings suggest that while industrialization has significantly enhanced economic performance, its capacity to generate inclusive employment growth remains constrained, particularly in the early stages of development.

4.4. Employment Elasticity: Evidence of Delayed Labor Absorption

The employment elasticity analysis provides deeper insight into the extent to which economic growth translates into employment, and thus into the inclusiveness of industrialization.

Table 4 reveals a clear structural shift in the relationship between output growth and employment over time. During the pre-expansion period (2016–2019), employment elasticity averages 0.137, indicating weak and unstable labor absorption. In several years,

elasticity is either close to zero or negative, suggesting that output growth translated only marginally—and at times inconsistently—into job creation.

Table 4. Summary of Employment Elasticity: Pre- and Post-Industrial Expansion

Period	Years	Mean Elasticity	Median	Std. Dev.	Min	Max	Interpretation
Pre-Expansion	2016–2019	0.137	0.128	0.391	-0.450	0.740	Low and unstable labor absorption
Early Expansion	2020–2022	0.036	0.009	0.076	-0.024	0.122	Near jobless growth
Adjustment Phase	2023–2025	1.880	1.042	1.686	0.684	3.915	Strong but volatile labor absorption
Post-Expansion (Combined)	2020–2025	0.958	0.403	1.427	-0.024	3.915	Improving but uneven inclusiveness

Source: Processed by (Muhyiddin et al., 2026)

This pattern becomes even more pronounced during the early expansion phase (2020–2022), when average elasticity declines further to 0.036. Despite rapid output growth during this period, employment response remains minimal, reflecting a phase of near jobless growth. This divergence is consistent with the capital-intensive nature of early-stage industrialization, where expansion is driven by large-scale investment and productivity gains rather than labor demand.

A notable shift emerges in the adjustment phase (2023–2025). Average elasticity increases sharply to 1.880, indicating a substantial improvement in labor absorption. However, this transition is characterized by significant volatility. The exceptionally high elasticity observed in 2023 (3.915) is followed by moderation in subsequent years, suggesting that the adjustment process is uneven and subject to short-term fluctuations.

When considered in aggregate, the post-expansion period (2020–2025) exhibits an average elasticity of 0.958, representing a marked increase relative to the pre-expansion phase. This indicates a gradual, though incomplete, transition toward more employment-responsive growth.

The temporal dynamics illustrated in Figure 5 reinforce this interpretation. In the earlier years, elasticity fluctuates widely—from moderate responsiveness in 2016 to contraction in 2017 and near-zero responsiveness in 2018—despite strong output growth. During 2019–2022, elasticity remains consistently low, confirming the persistence of weak labor absorption in the initial phase of industrial expansion. Only in the later period does elasticity begin to increase more substantially.

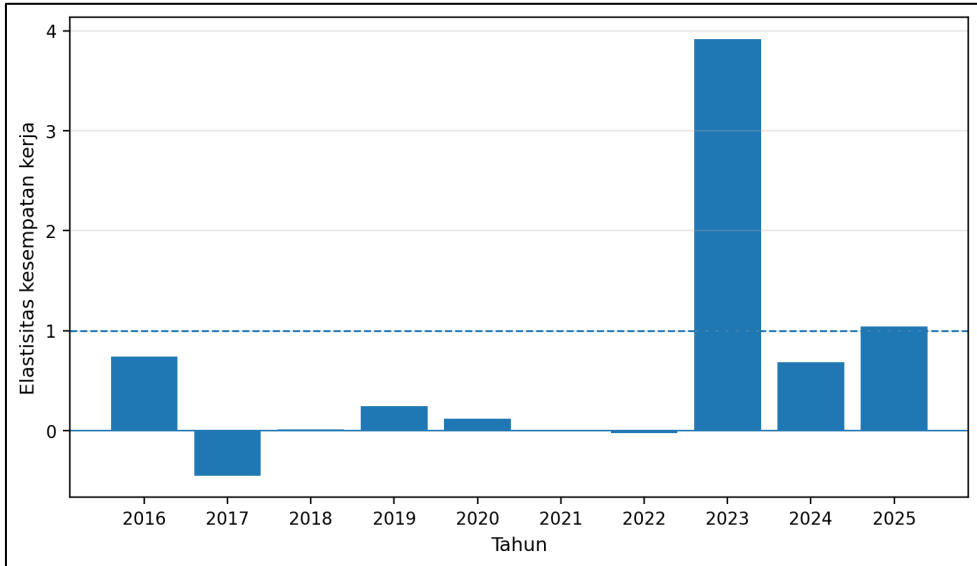


Figure 5. Employment Elasticity Morowali (2015 – 2025)

Source: Processed by Authors from various publications (Muhyiddin et al., 2026)

Overall, these findings provide strong evidence of lagged labor absorption, whereby industrial growth initially generates substantial output gains without corresponding increases in employment, but gradually begins to translate into job creation as the industrial ecosystem deepens and becomes more diversified.

From a structural perspective, this pattern suggests that industrialization in Morowali follows a sequencing dynamic: an initial phase dominated by capital-intensive investment and productivity growth, followed by a gradual transition toward more labor-intensive activities. However, the observed volatility indicates that this transition is neither linear nor fully stable, pointing to an incomplete and uneven process of employment inclusion.

4.5. Integrated Interpretation of Results

The combined evidence from the Urban Pressure Index (UPI), Difference-in-Differences (DiD), and employment elasticity analyses provides a coherent and multidimensional account of urban transformation in Bahodopi, highlighting the complex interplay between industrialization, demographic change, and labor market dynamics.

First, the UPI results indicate a pronounced and sustained increase in urban pressure following industrial expansion. This reflects a widening imbalance between rapid population growth and relatively slower infrastructure development, marking a transition from a phase of managed or infrastructure-supported expansion to one characterized by structural strain on urban systems.

Second, the DiD analysis demonstrates that this transformation is spatially uneven. Population growth is highly concentrated in Bahodopi, which experiences disproportionately large demographic increases relative to surrounding areas. This pattern reflects a process of localized urban intensification, consistent with the emergence of a

growth pole driven by industrial clustering, rather than a more evenly distributed pattern of regional development.

Third, the employment elasticity results reveal that economic growth has not been consistently inclusive. During the early stages of industrialization, labor absorption remains weak and volatile, indicating that output expansion is primarily driven by capital-intensive processes with limited immediate employment effects. Although a gradual increase in employment responsiveness emerges in later periods, the transition remains uneven and subject to considerable fluctuations.

Taken together, these findings suggest that Bahodopi's transformation is best understood not simply as rapid urban growth, but as a form of asymmetric industrial urbanization, characterized by three interrelated dynamics:

- (1) highly concentrated population inflows,
- (2) infrastructure development that systematically lags behind the pace of expansion, and
- (3) delayed and uneven labor absorption.

This configuration underscores a broader pattern in resource-based industrialization, where economic expansion generates substantial structural changes, but these changes are not synchronized across spatial, infrastructural, and labor dimensions.

V. Discussion

5.1. Industrialization and Asymmetric Urban Transformation

The empirical findings provide robust evidence that industrial expansion in Bahodopi has generated a process of asymmetric urban transformation, characterized by the coexistence of rapid economic growth, spatial concentration, infrastructure strain, and uneven labor absorption. Rather than fostering balanced regional development, industrialization has reconfigured the local urban system into a highly concentrated growth pole.

This pattern aligns with growth pole theory (Perroux, 1955), which emphasizes the spatial concentration of economic activity around a dominant industrial core. However, the results extend this framework by demonstrating that, in the absence of adequate infrastructure provision and institutional coordination, such concentration can generate systemic imbalances. In Bahodopi, industrial expansion has intensified demographic and economic pressures within a localized urban core, without corresponding spatial diffusion.

5.2. Agglomeration Economies and Emerging Urban Diseconomies

The findings provide a nuanced perspective on agglomeration dynamics. In line with New Economic Geography, spatial concentration has generated substantial economic gains, as reflected in rapid output growth and industrial expansion (Krugman, 1991; Duranton & Puga, 2020).

However, the results also reveal the emergence of urban diseconomies. The rising Urban Pressure Index indicates increasing congestion and infrastructure stress, while the DiD results highlight widening spatial disparities. This suggests that the benefits of agglomeration are increasingly offset by capacity constraints and coordination failures.

These findings underscore a critical insight: agglomeration is conditional, not inherently efficient. Its outcomes depend fundamentally on the ability of infrastructure systems and governance institutions to absorb and manage growth. Where such capacity is limited, as in Bahodopi, agglomeration may generate inefficiencies rather than sustained productivity gains (OECD, 2023; Kim, 2023).

5.3. Infrastructure Lag as a Structural Constraint

A central contribution of this study is the identification of an infrastructure lag trap. The UPI results show that infrastructure provision has systematically lagged behind population growth, creating a persistent imbalance between demand and capacity.

This pattern reflects the limitations of reactive urban development strategies. Infrastructure expansion in Bahodopi appears to follow, rather than anticipate, demographic and economic changes. In rapidly industrializing contexts, such lag effects are particularly problematic, as they amplify congestion, reduce service quality, and constrain long-term urban sustainability.

More broadly, this dynamic reflects structural constraints commonly observed in developing economies, including fiscal limitations, institutional fragmentation, and weak planning capacity. In Bahodopi, these constraints are intensified by the scale and speed of industrial expansion, making infrastructure lag a defining feature of the urbanization process.

5.4. Spatial Concentration and Urban Fragmentation

The DiD results indicate that urbanization in Bahodopi is highly concentrated, leading to a form of spatial fragmentation. Rather than promoting integrated regional development, industrialization has produced a dualistic spatial structure in which the industrial core expands rapidly while surrounding areas experience relatively modest change.

This pattern resembles an enclave-type development model, where industrial zones function as isolated growth centers with limited integration into the broader regional economy. Such fragmentation reduces the potential for spillover effects and reinforces spatial inequality.

From a theoretical perspective, this finding reflects a growth pole dynamic (Perroux, 1955), but one that remains weakly integrated spatially. The absence of coordinated land-use planning and regional integration mechanisms limits the diffusion of economic benefits, thereby constraining the broader developmental impact.

5.5. Employment Dynamics and the Nature of Growth

The employment elasticity results provide critical insight into the nature of industrial growth in Bahodopi. The low and often near-zero elasticity observed during the early phase indicates that growth is predominantly capital-intensive, with limited immediate effects on employment.

This pattern is consistent with resource-based industrialization, particularly in sectors such as mineral processing, where scale economies and technological intensity dominate. As a result, output growth does not automatically translate into job creation.

The subsequent increase in elasticity in later periods suggests a process of lagged labor absorption, as supporting sectors gradually develop. However, the observed volatility indicates that this transition remains uneven and incomplete.

These findings highlight a fundamental distinction between economic growth and inclusive development. While industrialization generates substantial output gains, its capacity to create employment depends on production structures and the development of complementary economic activities.

5.6. Toward a Livable Industrial City Framework

Building on these findings, this study advances the concept of a livable industrial city as a framework for understanding and managing urban transformation in rapidly industrializing regions.

Unlike conventional models that prioritize output growth, this framework emphasizes the integration of four key dimensions:

- (1) industrial productivity,
- (2) spatial integration,
- (3) infrastructure adequacy, and
- (4) social inclusion.

The empirical evidence from Bahodopi demonstrates that imbalances across these dimensions generate suboptimal urban outcomes. In particular, strong industrial growth, when not accompanied by adequate infrastructure and spatial coordination, leads to urban diseconomies and limited inclusiveness.

VI. Conclusion and Policy Implications

This study provides a multidimensional assessment of the urban consequences of rapid industrialization in Bahodopi by integrating three complementary empirical approaches: the Urban Pressure Index (UPI), Difference-in-Differences (DiD), and employment elasticity analysis.

The findings converge on three central conclusions. First, urbanization is highly spatially concentrated, with population growth disproportionately centered in the industrial core. Second, the UPI reveals a sustained increase in urban pressure, indicating that population growth has outpaced infrastructure capacity, resulting in an infrastructure lag trap. Third, employment elasticity remains low and volatile in the early stages, indicating that industrial growth is initially capital-intensive and only gradually becomes more labor-absorbing.

Taken together, these findings characterize Bahodopi as a case of asymmetric industrial urbanization, where rapid economic expansion is not matched by corresponding improvements in infrastructure provision and employment inclusiveness.

From a theoretical perspective, this study contributes by bridging industrial policy and urban development. While agglomeration theory emphasizes productivity gains from spatial concentration, the findings demonstrate that such gains are contingent on

institutional and infrastructural capacity. Without adequate coordination, agglomeration may generate urban diseconomies rather than sustained development.

The policy implications are clear: (1) industrial development must be integrated with spatial planning, ensuring alignment between industrial zones and urban systems; (2) infrastructure investment should adopt a forward-looking approach, anticipating future demand rather than reacting to deficits; (3) housing and basic services for workers should be treated as core components of industrial policy; and (4) governance capacity must be strengthened to improve coordination across institutions.

More broadly, the results suggest that the success of industrialization should not be evaluated solely in terms of output growth, but also in terms of its ability to support inclusive and sustainable urban systems.

Finally, this study opens several avenues for future research, including comparative analysis across industrial regions, the use of spatial econometric techniques, and the incorporation of micro-level data.

In conclusion, Bahodopi illustrates both the opportunities and the structural challenges of resource-based industrialization. While it demonstrates the potential for rapid economic transformation, it also underscores the importance of aligning industrial expansion with urban governance to ensure that cities are not only productive, but also livable and sustainable.

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